The scholarly literature affiliated to the National Institute of the Atlantic Forest (INMA) published in journals indexed at Scopus database (2009-2018)

A produção periódica científica afiliada ao Instituto Nacional da Mata Atlântica (INMA) na base Scopus (2009-2018)

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Abstract

Introduction: this study considers as object of analysis the scientific articles production affiliated to the National Institute of the Atlantic Forest (INMA). It aims to recognize visibility, impact, thematic and collaborative relationships established by researchers affiliated to the Institute over ten years (2009-2018). It starts from the scientific question: how is this scientific production configured regarding priority thematic areas, journals, authors, institutions and most productive countries, and what is its impact on the citations received? **Method:** it adopts the metric studies of information as methodology, identifying a corpus of 73 articles linked to INMA by the institutional affiliation of its researchers over a period of ten years. It uses the Scopus database to identify this production and also the Scival database as an instrument to generate indicators. **Results:** it points out that the production affiliated to INMA has high internationalization rates, as it is published in 72% of international journals. In addition, the corpus receives a high average of citations (4.22 citations per article). The articles with the highest number of citations have greater impact than the average citations of the journals in which they are published. Interinstitutional relations and between authors are built in line with the thematic and historical scope of the institute, consolidating areas and research trends on zoology and botany. **Conclusion:** the profile of the scientific production portrayed contributes as a strategic element for the consolidation of INMA's research memory.

Keywords: National Institute of the Atlantic Forest; Scientific production analysis; Metric Studies of information; Scientific Visibility; Scientific Impact; Scientific Collaboration.

Resumo

Introdução: apresenta-se, como objeto de análise, a produção de artigos científicos afiliados ao Instituto Nacional da Mata Atlântica (INMA), nova denominação do Museu de Biologia Professor Mello Leitão (MBML). Objetiva-se reconhecer a visibilidade, o impacto e as relações temáticas e colaborativas estabelecidas pela pesquisa do INMA ao longo de dez anos (2009-2018). Parte-se da seguinte questão: como se configura essa produção científica no que tange a áreas temáticas prioritárias, periódicos, autores, instituições e países mais produtivos e, ainda, qual seu impacto pelas citações recebidas? Metodologia: adotam-se os estudos métricos da informação como metodologia de coleta e análise, identificando-se um corpus de 73 artigos vinculados ao INMA pela afiliação institucional de seus pesquisadores no período de dez anos. Utiliza-se a base de dados Scopus para identificação dessa produção e, também, a base de dados Scival como instrumento para geração de indicadores. Resultados: destaca-se que a produção afiliada ao INMA apresenta índices de internacionalização expressivos, visto que está publicada em 72% de periódicos internacionais. Além disso, o corpus recebe uma média de citações elevada (4,22 citações por artigo). As pesquisas com maior número de citações apresentam impacto superior à média de citação dos periódicos em que estão veiculadas. As relações interinstitucionais e entre autores constroem-se alinhadas ao escopo temático e histórico do Instituto, consolidando áreas e tendências de pesquisa nos domínios da zoologia e da botânica Conclusão: o perfil da produção científica retratada contribui como elemento estratégico para a consolidação da memória de pesquisa do INMA.

Palavras-chave: Instituto Nacional da Mata Atlântica; Análise da produção científica; Estudos Métricos da Informação; Visibilidade científica; Impacto científico; Colaboração científica.

INTRODUCTION

The production of scientific articles affiliated with the National Institute of the Atlantic Forest (INMA), a new name for the Professor Mello Leitão Biology Museum (MBML), is presented as an analysis object. The Museum was founded in 1949 by Augusto Ruschi, in the city of Santa Teresa- ES, Brazil, moving from private tutelage to public administration in 1984 - a process that culminated in the incorporation of its heritage by INMA, created in 2014, and formally institutionalized in 2017, as a research unit linked to the Ministry of Science, Technology, and Innovations (MCTI) of Brazil.

Based on the need to recognize the visibility, impact, and thematic and collaborative relationships established by INMA's research, the aim is to analyze, over ten years (2009-2018), the periodic scientific production linked to it by researchers who, in the period, declared a link with the Institute. To achieve this objective, production and citation indicators are generated, allowing us to answer the research question of how this scientific production is configured in terms of areas, themes, authors, journals, institutions, most productive countries, and what impact of this production by the citations received.

Analyzing this activity makes it possible to infer the characteristics of the research that INMA has been promoting, to contribute to the historical reconstruction of its memory - from the researchers who passed through it, institutions and countries with which it was more intensely related and to recognize the global impact of these researches in the scientific scope, to contribute to the future design of the Institute's areas of competence in research related to the Atlantic Forest.

The relevance of this article is also associated with the need to organize and preserve the scientific knowledge produced and fostered by the Institute and to know its collaborative relationships as an institution administered by the public power, whose mission is to provide opportunities for the production, preservation, and socialization of the recorded knowledge about the Atlantic Forest. This mission must be evidenced, in the context of the scarcity of investments in scientific research, for the conservation of the biodiversity of the Brazilian Atlantic Forest.

THEORETICAL REFERENCE

The application of metric studies of information for mapping and analysis of the scientific production of a scientific and/or institutional domain is an essential task for the reconstruction of the history of institutions and research areas, as well as the recognition of their scientific identities.

Besides, metric studies of information, recognized in bibliometric and scientometric techniques, directly assist in the scientific evaluation and contribute to the analysis and elaboration of performance indicators. Regarding the role of indicators, they are statistical data used to analyze and evaluate the potential of the scientific and technological base of countries (Silva, Sobral, Santana, & Cruz, 2012).

The indicators generated through the application of information metrics help the evaluation process of any area of knowledge and can answer questions about the growth, decline, and dissemination of certain themes. They also contribute to the monitoring of opportunities and identification of more promising activities and projects for the future in different areas, assisting in the strategic decisions of managers of scientific and technological policies (Silva et al., 2012, p. 21).

Especially in recent decades, the field of metric studies has provided the generation of indicators in the planning, management, analysis, and evaluation of research policies in science and technology. It has also contributed with feedback on the impacts provided by innovation, supporting analyses of production in different scientific areas. The possibility of recognizing patterns of behavior of periodic scientific production at micro, meso, and macro levels has been crucial for the construction of information policies in diverse contexts. In this sense, the field of Information Science (IS), through metric studies of Information, has, as one of its roles, to contribute to the production, organization, and analysis of information in different fields of knowledge, living up to its metascientific nature.

It is up to Bates (1999) to conceptualize information science. For whom IS is a metascience that conducts research and develops theories related to the products of information records of other disciplines and activities. For the author, this metascience crosses different knowledge fields across the board, having the universe of recorded information as a domain.

Therefore, to promote the recognition of methodological perspectives and dimensions of analysis developed by the area, in addition to it, is also to exercise its scientific purpose. Studies that bring data and interpretations related to production, collaboration, impact, and scientific indicators, visibility have been the object of attention in different areas and the discussion in current science, especially in the scientific policies field.

In an attempt to organize the types of bibliometry — metric study modality — according to their purposes, Glänzel (2003) proposed three distinct perspectives: bibliometry for bibliometry practitioners (G1); bibliometry applied to scientific disciplines (G2), and bibliometry for the generation of indicators focused on scientific and management policies (G3). G2 metric studies also contribute to other areas of knowledge, besides IC, representing the most appropriate perspective in this article's context. For Glänzel (2003), this modality of applied metric studies is the most comprehensive and diversified group of bibliometry, where interests are related to the area of specialty analyzed.

The interaction between researchers of metric studies of information and other areas can provide interesting and innovative lines of research. According to Meneghini and Packer (2010), with almost no exception, the first articles on the subject were written by researchers from the natural sciences, who found a new opportunity to

employ quantitative tools to create stimuli for the insertion of Brazilian scientific production in the international scenario (Meneghini & Packer, 2010, p. 2).

Studies similar to this can be referenced within the IC, especially because they are applied to the Biological Sciences area. This is the Santin, Vanz, and Stumpf (2014) article case, which allows the visualization of collaboration networks related to the scientific production of evolutionary biology from the years 2000 to 2012. According to the authors, the interactions between the main actors of an area study allows revealing patterns and trends of national and international collaboration. Santin and Silva (2013) is another relevant study for this context, where they highlight the prominence of the evolutionary biology field in the national context and the high impact of international citation and international collaboration indexes by publications that analyze thus justifying the importance of metric studies applied to the understanding of other areas.

Lima, Maroldi, and Silva (2012) analyze the scientific behavior of the Master's Program in Biology of the Federal University of Rondônia from their dissertations. Similarly, the article entitled "Scientific production in Biological Sciences at UFRGS: thematic trends in the period 2000-2011" presents the growth of production and the themes evidenced in the Program (Santin, Vanz, & Stumpf, 2015). Also, Gheno et al. (2020) address the internationalization impact on the scientific production of the Graduate Program in Biological Sciences: BIO QUÍMICA/UFRGS (2007-2016) visibility.

Another similar study is by Silva and Brisola (2017), where the publications of professors from the Graduate Program in Molecular and Cellular Biology of the Federal University of the State of Rio de Janeiro, from 2011 to 2016, are mapped to provide greater knowledge about the profile of the research of this group and to outline actions that favor the improvement of the said Graduate Program score. The authors present, in this publication, the documentary types with the highest publication rate, the percentage of most productive researchers, and the profile of publishing journals, quantifying efforts to expand the international visibility of Brazilian production.

Silveira and Teixeira (2017), in "Shared Knowledge in the network: a study of the Biological Sciences and Environmental Sciences area of IFRS, Porto Alegre campus (RS)," reveals the research practices and academic production of effective professors and collaborators in the Biological Sciences and Environmental Sciences area of the institution, through scientometrics. According to the authors, acting in collaborative networks allows the expansion and application of its scientific production more substantially since the interaction of knowledge and competencies accelerates the generation of innovations.

The reference presented demonstrates that the metric studies of information applied to the Biology area have been widely used and turn to the management of scientific policies and the design of profiles of research activities.

METHOD

This article starts from the metric studies of the information to generate indicators of production and impact of the periodic scientific production of articles linked to INMA by the institutional affiliation of its authors in ten years (2009-2018).

The analysis corpus was consolidated based on the production of 41 researchers linked to INMA (mapped from analysis of administrative institutional documents), whose articles were published during the periods of their ties with the Institute, are indexed in the Scopus database. There was a total of 73 articles from 2009 to 2018. The corpus, obtained from Scopus, was exported to the Scival database (also from Elsevier), which contributed as a generator and analysis of indicators instrument.

The areas of concentration of the delimited production were identified, the themes of the articles through their keywords, the prominent publishing journals in the institutional domain, the years of greater productivity and the impact of production, and collaboration were recognized through authors, institutions, and collaborating countries that stood out for their productivity indicators.

The keyword cloud, built on the Scival database, considered the 50 most incident keywords in the corpus, presenting the growing words, those that remained stable, and those that decreased the incidence during the analyzed period.

It is important to note that the indicators used to measure the impact of the analyzed production were: a) the number of citations received by articles in Scopus; b) Field-Weighted Citation Impact (FWCI) indicator, shown in Figure 2, which is a weighted citation indicator in the areas of concentration of articles in the Scopus database, that is, it measures the proportion of the total citations that were received by the output of the denominator and the total expected citations, based on the average citation for that subject field. The value of this indicator, when it is equal to 1, indicates that the article obtained a performance within the expectation for the articles in that concentration area; when it is greater than 1, it indicates that the article is cited more than expected for the global average in the subject field, for example, an article with 1.60 FWCI, obtained 60% more citations than the global average; when the value is less than 1, it indicates that the article is less cited than the global average of citation in the subject field of that article. Finally, one last indicator used was: c) Citations per

document (2 years) to measure the impact and visibility of journals, which, to simplify their writing, was called the impact index. This indicator was collected in Scimago Journal & Country Rank (Scopus) and is equivalent to the Impact Factor (FI) of Clarivate Analytics' Web of Science database.

The focused production is limited to research with greater visibility and impact linked to INMA, thus excluding the diversity of publications tied to the Institute that do not correspond to the mainstream literature indexed in Scopus. On the other hand, the corpus allows obtaining a portrait of the studies that constitute an element of identity and international reference of the research consigned to INMA from its collaborators.

It is worth mentioning that INMA's collaborations that are not characterized as co-authorships, but that originate mentions to the Institute in the fields of thanks and funding, were mapped before this analysis, in an exploratory study at Scopus, but quantitatively meaningless for analysis purposes. For this reason, it was decided to map the research produced by the researchers in the period of connection with INMA. Also included in the analysis were volunteer employees who declared themselves as INMA researchers.

FINDINGS AND DISCUSSION

INMA was described as an institutional affiliation of authors who published 73 articles, from 2009 to 2018, in the Scival database. This corpus involved 385 authors and received 308 citations in these ten years, an average of 4.22 citations per article. Only 15.6% of the articles (11) in the corpus did not receive citations, which indicates that this production has a significant impact.

The production by areas of knowledge defined by Scopus, for the corpus in question, was distributed as follows: most of the articles in the corpus are concentrated in "Agricultural and Biological Sciences", making a total of 69 articles consigned to this domain, which represents 84.1% of the knowledge socialized in scientific articles and review articles.

The second-largest area of concentration is "Environmental Science" (8.5%), with a total of seven indexed articles. After that, in the third position, appears the domain of "Biochemistry, Genetics, and Molecular Biology", with three articles (3,7%). "Earth and Planetary Sciences" were represented by 2,4% of the production (two articles), and, finally, "Veterinary" had only one indexed article (1,2%).

Table 1 shows how the publications were sub-divided, taking into account the sub-areas of the large area "Agricultural and Biological Sciences." Considering that an article can be contemplated in more than one area and/or sub-area, the most contemplated sub-area was "Ecology, Evolution, Behavior and Systematics," with 39.1% of the production, totaling 43 articles published in the period. The sub-area "Plant Science" had the second-highest concentration, with 27.3% of the production, in a total of 30 articles. The third highest concentration of articles was in the sub-area "Animal Science and Zoology," with 22 articles (20%). The other sub-areas were: "Aquatic Science" with nine articles (8.2%), "Horticulture" with three publications (2.7%), and three other publications 2.7% without a classification specified by the Scival database. This configuration may show more active lines of research by INMA in the period portrayed.

Agricultural and Biological Sciences (84,1%)		
Subárea	(%)	nº artigos
Ecology, Evolution, Behavior and Systematics	39,1	43
Plant Science	27,3	30
Animal Science and Zoology	20,0	22
Aquatic Science	8,2	9
Horticulture	2,7	3
Other	2,7	3
Environmental Science (8,5%)		
Subárea	(%)	nº artigos
Ecology	55,6	5
Ecological Modeling	11,1	1
Environmental Chemistry	11,1	1
General Environmental Science	11,1	1
Nature and Landscape Conservation	11,1	1
Biochemistry, Genetics and Molecular Biology (3,7%)		
Subárea	(%)	nº artigos
Genetics	40	2
Molecular biology	40	2
General Biochemistry, Genetics and Molecular and Molecular Biology	20	1
Earth and Planetary Sciences (2,4%)		
Subárea	(%)	nº artigos
Atmospheric Science	50	1
Oceanography	50	1
Veterinary		
Subárea	(%)	nº artigos
General veterinary	100	1

Table 1. Distribution of scientific production analyzed in the knowledge categories of the Scival Database (2009-2018).
Fonte: Research data (2020).

Ecology, a specialty of biology that studies living beings, the environment, and the interaction between, encompasses a diversity of other areas of study, allowing an understanding of the global functioning of nature, its conservation, and biodiversity. The number of articles INMA affiliated in the sub-area "Ecology" can be explained by the thematic scope that this scientific domain brings together and, also, by the focus of INMA's research in the knowledge and conservation of the biodiversity of the Atlantic Forest.

Seeing that a single publication can adapt to more than one thematic area, studies related to fauna and flora can also be considered by the ecology field when they aim to study the interaction of these beings with the environment or between them. That explains the significant percentage of studies in the sub-area of Agricultural and Biological Sciences called "Ecology, Evolution, Behavior, and Systematics" and in the sub-area of "Environmental Science," called "Ecology."

One of the reasons considered for the highlight of "Plant Science" as a publication domain, in the ten years analyzed, stems from the presence of one of the most productive authors of the corpus at INMA in this period as a volunteer and scholarship holder, publishing about botanical families depicted in Figure 1.

We must consider the historical importance that the MBML Herbarium botanical collection has had since its foundation. According to Bates (1959), the Herbarium was founded in 1940 by Augusto Ruschi, with 3 thousand specimens. In the last 30 years, the Herbarium has shown an exponential increase in the number of samples due to the intense field activity and collections carried out in partnerships and projects, with researchers from different institutions, such as the CNPq project (400360/01-2) "Biodiversity of the Atlantic Forest of Espírito Santo" that served as support for the research carried out at INMA in the 2000s, in which Ludovic Kollman, who is the most productive author of the corpus, integrated. Other projects, such as Projeto Cores, linked to the Research Institute of the Botanical Garden of Rio de Janeiro, highlight the institutional partnerships of INMA, which generated research in co-authorship.

The recognition of the MBML Herbarium in number 11 of the Instituto Paranaense de Botânica Bulletin of 1959, by Bates (1959), contributed to its national research visibility. Furthermore, the addition to the New York Botanical Garden Herbariorum Index (New York Botanical Garden, 2018), by meeting the minimum volume criteria of the collection, allowed it to gain international notoriety. Added to this is the information that external visits to the botanical collection deposited there approached 957 consultations in the ten years analyzed. These

events may have contributed, even if indirectly, to the recognition of the Herbarium as a means of research by external researchers, generating partnerships in publications.

It is important to highlight that, although the concentration area "Plant Science" presents a substantial number of published articles corresponding to botany, it does not compare to the field with the most considerable impact of citations, which is "Animal Science and Zoology." It observed that three of the five articles with the broad influence of citing the corpus are related to the domain of herpetology, which studies amphibians and reptiles.

As for the sub-areas of the large "Environmental Science" area (Table 1), the highest concentration of articles was also in "Ecology," with 55.6% of the articles indexed in this sub-area, totaling five publications. The other sub-areas: "Ecological Modeling," "Environmental Chemistry," "General Environmental Science," and "Nature and Landscape Conservation," had a concentration of 11.1%, equivalent to one article each.

The "Biochemistry, Genetics and Molecular Biology" area, with 3.7% of the publications indexed, included three sub-areas: "Genetics" and "Molecular Biology," which concentrated 40% (two publications) each; and "General Biochemistry, Genetics and Molecular Biology" with 20% of the production (one publication). "Earth and Planetary Sciences," as shown in Table 1 covered two sub-areas, with 50% each (one article) of the total indexed articles, namely "Atmospheric Science" and "Oceanography." And finally, the "Veterinary" area had only one indexed article (1.2%) in the "General Veterinary" sub-area.

The themes studied are also identified through the articles' keywords. The word cloud (Figure 1[1]) was built based on the 50 most used keywords in the corpus. The green words are growing, the gray ones stabilized, and the blue ones have declined, falling into disuse over time.

Figure 1. Keyword cloud of scientific production affiliated to INMA researchers between 2009.

It is observed that studies on new species stand out significantly due to the growing use of the term in the analyzed period. Within the botany field, there is a growing use of various keywords, such as Aristolochia, Tibouchina, Vriesea, stamens, inflorescences, Aristolochiaceae, Myrtaceae, Cryptanthus, Orchidaceae, flowers, and epiphytes. Some botanical families, such as Melastomataceae and Bromeliaceae, are evident in the growing themes for the period. On the other hand, the keyword Begoniaceae, which represents a botanical family, has given rise to the use of the term Begonia, which identifies a genus of that family. In the zoology field, there is also an increase in the use of several keywords, with emphasis on the domain of ichthyology (the study of fish), denoted by terms such as Characiformes, Siluriformes, and catfish, as well as herpetology (the study of amphibians and reptiles), with emphasis on the terms Amphibia, tadpoles, amphibians, Ranidae, Pipidae, Boa, and Squamata. The keywords that refer to the environment, in general, are related to studies of ecology or conservation, such as forests, drainage, extinction, urban areas, rain forests, and ecoregions.

Considering that the collaborating researchers of the Institute are, in their majority, passers-by/temporary, and in small numbers, as will be evidenced in the text, it is observed that the thematic profile of the publications is strongly influenced by the period in which they remain at the Institute.

Impact and Visibility

Regarding the visibility and impact of corpus research, it can be said that between 2009 and 2018, INMA socialized its scientific production in 39 journals, of which 72% are international, which demonstrates a high internationalization of research affiliated to researchers of the Institute.

[1]Green words are growing, gray ones stabilized, and blue ones have declined.

The following shows the distribution of the articles in the corpus for ten years, as well as the impact of citing these articles and their prominence indexes related to the topics addressed. These elements are based on indicators from the Scopus base, viewed within the Scival base.

In the graph representing the distribution of publications, the years 2010 and 2016 were marked by the peak of productivity in the corpus research, and the years 2016 and 2017 have a high number of citations. It is worth mentioning that the impact of citing a publication can only be appropriately measurable after two years. There are an irregular distribution and growth of production in the analyzed period. This irregularity converges with the situation of INMA, which is atypical for a Brazilian public research unit, which has only 7% of researchers with effective ties to public servants, with the rest being scholars and volunteers who develop research temporarily.

The thematic prominence index of articles shows the most significant growth in 2016, with its peak in articles published in 2017, with a prominence of 0.77 for corpus studies (this indicator ranges from 0 to 1).

It is considered that the quantitative expressiveness of articles is not always proportional to their impact and prominence in the scientific community, as is the case of the distinction between areas of botany and zoology in the corpus, in which one presents a larger production and the other stands out for a higher impact. That may be related to the number of authors in the articles. In botany, there is a smaller number of authors in the corpus, and the researcher who stands out as the most productive author (Table 4) is from botany and presents 21.7% of his articles in individual authorship.
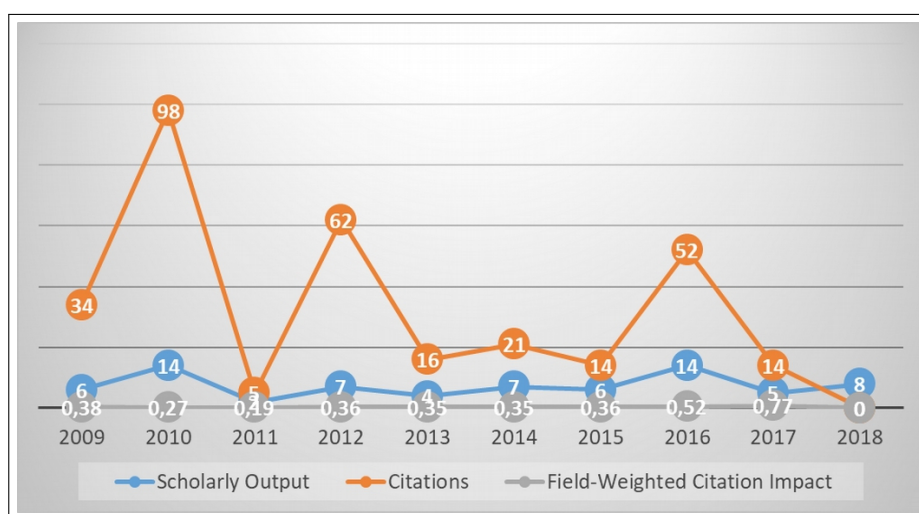

Figure 2. Distribution, impact, and thematic prominence of articles from the corpus in the period. *Scholarly Output*: Subtitle: Scholarly Output: number of articles indexed in Scopus; Citations: number of citations received at Scopus; Field Weighted Citation Impact: the global average of citation impact in the indexed area at Scopus.
Fonte: Scival (2020).

The analyzed production, although small by institutional standards, has a higher international citation and visibility impact than expected, as can be seen in the number of citations received by related articles in each journal, and also by the impact index of the publishing journals themselves (Table 2).

The five most used journals for publication by INMA were: Candollea (eight articles), Phytotaxa (seven articles), Herpetology Notes (six articles), Check List (four articles), and Pan-American Journal of Aquatic Sciences (four articles).

Table 2 shows the seven journals among the 39 with the highest visibility measured by the number of citations received (more than 20 citations each) in the analyzed period. The journal that brought significant visibility to the Institute in the period under analysis was New Zealand's Phytotaxa. In this, INMA published seven articles (second most used journal for the socialization of knowledge), which received 31 citations, making an average of 4.43 citations per article. This average is significantly higher than the expected impact of the journal measured by the indicator "Citations per document" from the Scimago Journal & Country Ranks Scimago Journal Country Ranks (2020), which here is called the impact index, which for this journal was 1,232. This indicator is equivalent to the Impact Factor of the Web of Science database.

Magazine	Country	Impact Index	Quotations received	Total articles
Phytotaxa	Nova Zelândia	1,232	31	7
Rodriguesia	Brasil	0,743	29	3
Journal of Herpetology	Estados Unidos	1,030	27	1
Candollea	Suíça	0,606	23	8
Pan-American Journal of Aquatic Sciences	Brasil	0,493	23	4
Herpetology Notes	Alemanha	0,975	22	6
Kew Bulletin	Reino Unido	0,731	21	3

Table 2. Impact and visibility of journals used by researchers affiliated to INMA between 2009 and 2018.

Another six journals, with more than 20 citations, provide visibility to the Institute, two of which are Brazilian, which may indicate expressive international visibility of the knowledge socialized in Brazilian journals. That is the case of Rodriguesia, from the Rio de Janeiro Botanical Garden, with an impact index of 0.743, which provided INMA with 29 citations in three articles published in the period, with an average of 9.67 citations per article. In the third position, regarding the visibility measured by the number of citations received, appears the USA Herpetology Journal (impact index 1.030), which obtained 27 citations in just one article. It should be noted that the article entitled "Diet, fecundity, and use of bromeliads by Phyllodytes luteolus (Anura: Hylidae) in southeastern Brazil" by the most productive authors highlighted in Table 4, was the one that received the most citations in the analyzed period, having as co-authors two of the researchers featured in the corpus, and also, as a partner institution, Utah State University.

Switzerland's Candollea journals (impact index 0.606) with eight articles (the journal that published the most INMA publications) and Pan-American Journal of Aquatic Sciences of Brazil (impact index 0.493), with four articles, received 23 citations each in the period analyzed, followed by the Herpetology Notes (impact index 0.975) from Germany (with six articles) and Kew Bulletin (impact index 0.975) from the United Kingdom (with three articles) that received 22 and 21 citations respectively.

The seven journals previously mentioned, which provided greater visibility to INMA, captured about 56.4% of the total citations received. It is also worth mentioning that these seven journals were responsible for socializing around 44% of the total produced by the Institute in the analyzed decade.

It is noted that their scopes are directly related to the specialty of the authors, who published the most and with the themes contained in the keywords. Rodriguesia, the Brazilian journal with the highest visibility in the corpus, has as its scope studies related to the several domains of plant biology, as well as the history of botany and the activities associated with botanical gardens (Rodriguesia, 2020).

Throughout the journals, it is clear that botany and zoology, specifically with herpetology, stand out in the analyzed time frame.

As for collaboration at the micro, meso, and macro-level (authorship, institutions, and countries)

Concerning institutional collaboration, measured by the co-authors' affiliations, Table 3 presents the five institutions that most collaborated with INMA from 2009 to 2018. The first three institutions collaborated with a large part of INMA's production, an expressive result that demonstrates close ties between them.

Collaborating Institution	Number of articles
Universidade Federal do Rio de Janeiro	19
Universidade Federal do Espírito Santo	13
Utah State University	11
Instituto de Pesquisas Jardim Botânico do Rio de Janeiro	8
Universidade Vila Velha	7

Table 3. TOP 5 of institutions that published the most articles co-authored with INMA between 2009 and 2018.

The major collaborating institution, with 19 articles, with more than 1/4 of all INMA production in the analyzed period (26% of the total) was the Federal University of Rio de Janeiro (UFRJ). According to Folha's University Ranking (RUF), 2019, UFRJ is considered the third-best higher education institution in the country, behind only the University of São Paulo (USP) and the State University of Campinas (Unicamp). At The world university rankings 2020 (2020), UFRJ is among the first 801–1,000.

The Federal University of Espírito Santo (UFES) appears as the second-largest collaborator of INMA, with 13 articles (18% of the total), and occupies the 27th position in the RUF and also, a position above 1,001 at THE

ranking. Among the five institutions that collaborated the most with INMA, Utah State University is the only foreign institution that occupies a place in the 201–250 group of the best universities in the world at THE, and with which INMA obtained a partnership in 15% of the articles (11 publications).

Rio de Janeiro's Botanical Garden Research Institute, which occupies the 839th position in the Web of Research Centers (2019) ranking, appears in the fourth position among the five institutions with the most prominent collaboration with INMA, with 8 articles (10.9%) published. This collaborative relationship does not necessarily explain the close and intense proximity between researchers from both institutions, who worked together with botanical collections on different projects, thus transcending the types of collaboration that not only through co-authorship.

Finally, in the fifth position of the most present institutions in the corpus is the Vila Velha University (UVV-ES), RUF's 112th position, with whom INMA published 9.5% of its production in partnership between 2009 and 2018. The strong presence of UFES and UVV-ES can be explained due to geographical proximity, which facilitates institutional collaborations between INMA and higher education institutions, that benefits from the Institute's research framework to conduct their collections, consultations, warehouses, and field classes.

As for the country of origin of the researchers who co-authored INMA's scientific production, among the five who collaborated the most, one is a North American country, two Latin American and two European.

The United States, representing North America, is the world's largest scientific producer, ranking first in the Scimago Journal & Country Rank (SJR) with an H Index = 2222. This country had its researchers as co-authors in 17.8% of all scientific production of INMA in the period analyzed. About the other countries, each one contributed in 3 articles (4.1%), namely: as representatives of Latin America - Colombia as the second country that most collaborated with INMA, currently occupying the 50th position in the SJR of Scopus, with Index H = 261 and Argentina, as the fifth country that most collaborated with INMA, occupying the 37th position in the SJR with Index H = 393. As representatives of Europe, Germany is the third-highest contributor to INMA and occupies the 4th position in the SJR with an H Index = 1203, and the United Kingdom is the fourth highest contributor to INMA and occupies the 3rd position in the SJR with an H Index = 1373.

The collaborations identified by the co-authorship with the United States, United Kingdom, and Germany are consolidated primarily in the zoology field. The collaborations with South American countries are mainly in the botany field.

The scientific collaboration that INMA provides goes beyond the co-authorships of its affiliated researchers since the Institute is a space, locus of scientific knowledge, with biological collections allocated there, a fact that makes it a valuable agent in the promotion of scientific research related to the Atlantic Forest.

There is a distinction between scientific collaboration and co-authorship practices according to the fields of knowledge. In INMA's case, the identification of co-authorships allows for a more precise assessment of institutional collaborators.

According to Hilário and Grácio (2017), the average collaboration by co-authorship in articles in the Biological Sciences major area is, in general, 5.3 authors. However, in this corpus, the average is 3.87 authors per article, and the average number of collaborators per article, referring to the most productive authors, is even lower, varying between 1.5 and 3 authors. This information indicates greater leadership in the development of research by the most productive authors who were linked to INMA between 2009 and 2018.

It is important to note that one of the articles in the corpus, a datapaper with 218 authors, was disregarded for this collaboration average to not bias the result. It is noteworthy that both the visibility and the probability of citing the research are increased when developed under multiple authorship, especially when different international research institutions are brought together.

Also, the order of authorship can denote the degrees of participation of authors. It can be observed that, in 34 articles in the corpus, there are authors affiliated to INMA first, which represents 47.22% of the total articles, and shows the Institute leadership in research. The INMA leads researches and congregates the collaboration of researchers from other institutions in the botany fields, especially in the study of bromeliads, begonias, and melastomaceae, and zoology with the study of herpetology (amphibians/reptiles), and with more discreet expressiveness for ichthyology (fish).

Author	Number of articles	Average of collaborators
Kollmann, Ludovic Jean Charles	23	1,96
Ferreira, Rodrigo Barbosa	14	2,86
Silva-Soares, Thiago	10	2,90
Sarmento-Soares, Luisa Maria	10	2,40
Martins-Pinheiro, Ronaldo Fernando	7	3,00
Teixeira, Rogério Luiz	7	2,43

Table 4. TOP 6 of INMA affiliated researchers that have published the most articles between 2009 and 2018.

Regarding the authors highlighted in the corpus as affiliated to INMA, Ludovic Jean Charles Kollman, from the field of botany, stood out in the first position due to the number of publications. The author did volunteer work at the MBML herbarium in the 1980s for the first time, especially with begonias, bromeliads, and orchids. Kollman also contributed to research as a scholarship holder in the 1st Institutional Training Program at INMA (PCI/INMA - 2014-2018), establishing different partnerships in his studies.

Luisa Maria Sarmento Soares, from zoology (ichthyology), as well as being a volunteer researcher, was a scholarship holder at the Espírito Santo's Research and Innovation Support Foundation. (FAPES) at INMA and was one of the fellows of the referred PCI-INMA. It also brought contributions to the process of organizing the Institute's zoology collections.

Another author highlighted in the corpus, Rodrigo Barbosa Ferreira, that works in zoology (herpetology) and was linked to the Department of Wildland Resources and Ecology Center at Utah University in 2014, an institution mentioned in the ranking of the five most productive institutions in the corpus, one of the reasons that explain its presence among the partner institutions.

Thiago Silva-Soares, also active in herpetology, stands out among the five most incident researchers in the corpus, integrating the National Museum of Rio de Janeiro's Herpetology Laboratory. Both Thiago Silva-Soares and Rodrigo Barbosa Ferreira were co-authors in a publication with a researcher at the Laboratory of Terrestrial and Aquatic Ecology at the University of Vila Velha. Both authors were scholarship recipients of the PCI Program.

The variables analyzed regarding productivity, impact, and visibility of INMA affiliated research, when contextualized historically, reveal elements of the Institute's identity and contribute to the preservation of its memory as an object of scientific research. Also, the results may be compared in the future to indicators of national scientific production on the Atlantic Forest, allowing us to infer whether the thematic domains are aligned and convergent.

This analysis, besides being part of INMA's scientific memory, contributes as an institutional management tool by pointing out the lines of greatest consolidation and showing that the visibility of INMA's research can be influenced by scholarship and volunteer studies, that is, employees with temporary ties.

CONCLUSIONS

The internationalization and the impact of research linked to INMA are significant, especially since the most cited articles in the corpus have a great impact above the general average of their publishing journals. In addition to this sign of internationalization, the high percentage of international magazines in which INMA publishes. Also, there is a high number of article citations, and some of these articles have significant international prominence when compared to articles in the same area produced worldwide.

Finally, the publications corpus, affiliated to INMA, may be larger than the one portrayed, since not all research conducted with the collaboration of INMA, as an affiliated institution, has been adequately credited to the Institute as a primary or secondary affiliation institution and/or with standardized nomenclatures that allow an exhaustive recovery.

This can serve as a warning, for authors' affiliations to be properly declared by researchers as collaborators of an institution, so that the periodic scientific production, resulting from the partnerships, can be exhaustively mapped, thus providing an accurate analysis of the collaborative nature of an institution's research and a more reliable portrait of its memory.

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