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Bibliometric analysis of ethnobotanical research in Brazil (1988–2013)

Mara Rejane Ritter[1, 3], Taline Cristina da Silva[2], Elcida de Lima Araújo[2] and Ulysses Paulino Albuquerque[2]

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ABSTRACT

This study aimed to define the current status of ethnobotanical research in Brazil based on published scientific articles and to detect current knowledge gaps in Brazil's ethnobotany. A database, including articles published in national and international scientific journals from 1988 to 2013, was gathered for this purpose. This report discusses the growing number of publications in ethnobotanical research and the main techniques used in the discipline. To identify current knowledge gaps, his report emphasizes the main focus of the different studies, target regions, and communities targeted or involved in the original study. Most publications focused on the northeast and southeast Brazil, and the most frequently studied biomes were the *Caatinga* and Atlantic forest. Further, the most frequently studied communities were located in rural areas, although the number of studies focused in urban areas has been steadily increasing. A lack of human resources in ethnobotanical research and a lack of current studies in the Amazon, *Cerrado*, *Pampa,* and *Pantanal* regions were the main identified gaps. These data provide a basis for future studies and investments aimed at strengthening ethnobotanical research in Brazil.

Keywords: economic botany, ethnobiology, ethnoecology, scientometrics, traditional knowledge

Introduction

Ethnobiology investigates the inter-relationships between human groups and nature (Clement 1998). This is a very broad discipline involving different areas of research, emphasizing on ethnobotany, one of the oldest fields within ethnobiology. The first definition of ethnobotany was provided by Harshberger in 1895 (defined as the study of plants used by primitive aboriginal people) (Albuquerque 2005). However, over the years, several other concepts have emerged, such as the definition of ethnobotany as the study of the direct interrelationship between people of extant cultures and the plants in their environment (Albuquerque 2005).

Over time, ethnobotany has been developed a theoretical and methodological perspective (Albuquerque & Hanazaki 2009). The theoretical aspects of the discipline are new, but it is an old discipline in practice, with a relevant role in the development of society and biological and cultural conservation (Hamilton *et al.* 2003).

The number of ethnobotanical studies has markedly grown in different parts of the world, particularly in Latin America (Fonseca-Kruel *et al.* 2005). In Brazil, the number of studies in this area has also increased, particularly since the 1990s (Oliveira *et al.* 2009). According to Fonseca-Kruel *et al.* (2005), the number of institutions and researchers involved in ethnobotanical studies has exponentially grown in Brazil. Several initiatives developed by the Ethnobotanical Committee of the Brazilian Society of Botany (EBC/BSB) and by the Brazilian Society of Ethnobiology and Ethnoecology (BSEE) have been fundamental in organizing and stimulating the development of different forums for discussion during their meetings (see Oliveira *et al.* 2009). Since then, ethnobotany has grown in terms of visibility and incentives in Brazil, which can be seen particularly seen in the different editions of the National Congress of Botany, where studies in this area are increasing (hosted in 2012 in Joinville city and in 2013 in Belo Horizonte city).

Due to this increase, several studies have sought to define a profile of the advances in this field in Brazil (Fonseca-Kruel *et al.* 2005; Oliveira *et al.* 2009; Albuquerque *et al.* 2013) as a tool for identifying information gaps and highlighting the need for future studies to consolidate this area of science.

Therefore, the present study aimed to define the current status of ethnobotanical research in Brazil based on published scientific articles and to identify knowledge gaps in Brazil's ethnobotany and therefore, sought answer the fol-

[1] Universidade Federal do Rio Grande do Sul, Instituto de Biociências, Departamento de Botânica, Av. Bento Gonçalves, 9500, Bairro Agronomia, 91501-970. Porto Alegre, RS, Brazil.
[2] Universidade Federal Rural de Pernambuco, Departamento de Biologia, Área de Botânica, Laboratório de Etnobotânica Aplicada, Rua Dom Manoel de Medeiros s.n., Dois Irmãos, 52171-900 Recife, PE, Brazil.
[3] Corresponding author: mara.ritter@ufrgs.br

lowing questions: Has the number of ethnobotanical studies in Brazil increased over recent years? Which regions have been highlighted, as shown by the number of publications covering those regions? What are the principal approaches used in these studies? In which biomes have these studies been performed? What are the principal social groups that have been studied? It is believed that it is important to answer these questions to draw conclusions about the development of this discipline. Considering these factors and perspectives, ethnobotany should be incorporated into the curriculum matrix of courses related to biodiversity and nature conservation as it aims to comprehend how the local population interacts with natural resources as background data to develop conservation strategies for the most explored species. In addition, these data would be useful in defining plans for future investigations. Moreover, this study differs from previous ones as it is not focus on the evolution of scientific articles published in Brazil but centers its analysis on theoretical gaps in Brazil ethnobotanical knowledge.

Materials and methods

To search for articles, a preliminary survey was conducted to cover the journals that publish articles on ethnobotany in Brazil (*Acta Botanica Brasilica*, *Brazilian Journal of Medicinal Plants*, *Brazilian Journal of Pharmacognosy*, *Rodriguesia* and *Brazilian Journal of Biosciences*). From this search, we selected articles based on Brazil that contained the word ethnobotany on the title, abstract, or keywords. To strengthen the survey, we used the databases Scopus (http://www.scopus.com) and ISI Web of Science (http//www.isiknowledge.com), using the keywords Ethnobotany + Brazil in the search fields "title," "abstract," and "keywords." All articles found on databases from 1988 to 2013 were analyzed and later selected. In these two searches, only the articles that investigated the relationships of human groups to plants were selected. We found publications starting from 1988; however, we only used those articles including primary data and excluded all literature reviews. Several classic and older ethnobotanical studies may not have been included in this study because of being unavailable in the mined databases.

After the selection of studies pertinent to the proposed survey, we extracted the following information: (1) year of publication of the article, (2) region/state in which the study was performed, (3) type of approach, (4) biome in which the study was performed, (5) locale of the communities (classified as urban, rural, or included within conservation units), and (6) studied social group.

To analyze the approach used in each study, the articles were classified into five categories: General ethnobotany, including studies addressing knowledge, use, and management of plant resources in general; specialized in ethnobotany, including those addressing knowledge, use, and management of plant resources for a particular purpose (e.g., food, ritual, wood, etc. except for medicinal purposes) of a species or a group of species; general medicinal use, including studies regarding knowledge and use of medicinal plants in general (with lists of plants and their uses), including medicinal plants sold on markets and fairs; specific medicinal use, including studies regarding knowledge and use of medicinal plants for a particular purpose, at the species, genus, or family level, and including the type of use (e.g., phytotherapeutic, commercial use) or therapeutic indication; and homegardens, including knowledge, use, and management of plant resources in rural or urban homegardens. All selected articles were ethnobotanical studies; however, it was considered the studies about medicinal plants a category apart because of the great number of articles found, in addition of the backyard theme, as it is a broadly studied theme on Brazil.

For this study, we considered the following Brazilian political regions (IBGE 2013): Midwest, North, Northeast, South, and Southeast. We considered six Brazilian biomes in this study as defined by Coutinho (2006): Amazon, *Caatinga*, *Cerrado*, Atlantic forest, *Pampa,* and *Pantanal*. The Amazon is located in the northern region and presents a mosaic of physiognomies, such as dryland, pluvial forest, and rupestrian fields. The *Caatinga* ecosystem, located in the northeastern region of Brazil, is a semi-arid savannah and includes different physiognomies (arboreal *caatinga*, shrubby *caatinga,* and shrubby–arboreal *caatinga*). The *Cerrado* has its largest portion located in the midwestern region of Brazil and includes three main phytophysiognomies: campestral, savannah, and forest. The Atlantic forest *sensu lato* is located in the coastal region of Brazil. Several studies performed in mangroves, salt flats shoals, and other types of areas in the region were also considered as part of the Atlantic forest ecoregion. The *Pantanal* ecosystem comprises a complex mosaic of different forest physiognomies, including hydrobiomes and helobiomes. Finally, the *Pampa* is located in the southern region of Brazil and its vegetation is predominantly campestral, mainly comprising herbaceous plants, shrubs, and subshrubs.

The social groups are cited by authors of the articles as Indigenous, African descendants, European descendants, Farmers, and in other categories as follows: 1. fishermen—with fishing as their main economic activity, 2. *caiçaras*—populations native of the southeastern coast of Brazil, originally descendants of indigenous people and Portuguese colonizers, 3. *ribeirinhos*–inhabitants of areas near rivers, 4. *sertanejos*—inhabitants of semi-arid regions of the Brazilian northeast region, 5. farmers—with subsistence farming as their main activity, 6. *pantaneiros*—residents of the *Pantanal*, 7. *marajoaras*—residents of Marajó Island, in Pará state in the northern region of Brazil (Adams 2000), 8. *caboclos*—people of mixed Caucasian and indigenous ancestry (Lima 1999), 9. *raizeiros*—people who sell and prepare medicines using plants, 10. extractivists—people who survive through the extraction of any forest product, 11. migrants—groups of people from one region who have

migrated to another region, 12. *seringueiros*—rubber extractors in the Brazilian Amazon region, 13. *benzedeiros/rezadeiros*—a person who follows rites and prayers for the treatment of diseases. It is noteworthy that in many articles, the authors did not specify the studied social group.

Results and discussion

According to the inclusion criteria defined for this study, 258 articles published from 1988 to 2013 involved ethnobotanical studies performed in Brazil. Of these articles, starting from 2006, there is a steep increase in the number of publications on ethnobotany (Fig. 1), data that reinforce those found by Oliveira *et al.* (2009) in their review article. Ethnobotany has only been recently developed as an academic discipline in Brazil, explaining the recent dates in most publications in the topic authored by Brazilian researchers (Oliveira *et al.* 2009). The greatest number of published articles (76) was found in 2012 and 2013.

The increase in the number of articles on this topic clearly reflects the increased investment on the topic in terms of human resources over the recent years. According to Fonseca-Kruel *et al.* (2005), the formal inclusion of ethnobotany in undergraduate and graduate courses in Brazil is essential for strengthening and disseminating studies in this field of knowledge. The year 2000 is a significant date in the history of this field because the advent of ethnobiology as a formal discipline occurred at approximately that time (Albuquerque *et al.* 2013). During this period, pioneering researchers from other areas emerged as the first ethnobiologists. Today, these researchers represent the main pool of human resources to train future researchers in this discipline. Furthermore, there was a huge increase in the number of research groups on this área. In a review evaluating the contribution of women on the studies of ethnobiology and ethnoecology in Brazil, Marques (2006) highlighted the importance of several researchers on the publication of the first works and in the development of human resources in these areas. These pioneering studies include several publications from the late 1960s. Several events have contributed to the increasing popularity of ethnobotany and the development of the discipline's human resources, including the publication of the first edition of *Suma Etnológica Brasileira* (updated edition of the Handbook of South American Indians) (Ribeiro 1987), scientific events in the area and the foundation of the Brazilian Society of Ethnobiology and Ethnoecology (Oliveira *et al.* 2009).

Number of articles by regions

The most ethnobotany articles cover the Northeast (101 articles, 39.1%) and Southeast regions (63 articles, 24.4%) (Fig. 2). This finding can be explained because these regions have the largest number of ethnobotanists and active research groups in the topic explaining this pattern. Fonseca-Kruel *et al.* (2005) found that the study of ethnobotany mainly occurs in higher education institutions in the Northeast and Southeast regions of Brazil, comprising 51% and 31% of the courses offered to undergraduate and graduate students, respectively, in these regions. Such a pattern most likely occurs as a consequence of the large concentration of universities and teachers and/or researchers in these regions.

The small number of articles from certain regions (or states) can be explained by the lack of human resources. Despite the existence of courses focusing on traditional populations in the Amazon, we only found few articles from the North (only 31 articles, 12.0%). Historically, early ethnobiological research in the Amazon was conducted by foreign investigators.

The Midwest region contributed 29 articles (11.2%). According to Fonseca-Kruel *et al.* (2005), the North and Midwest regions, with biomes considered to have high plant and cultural diversity, such as the Amazon and *Cer-*

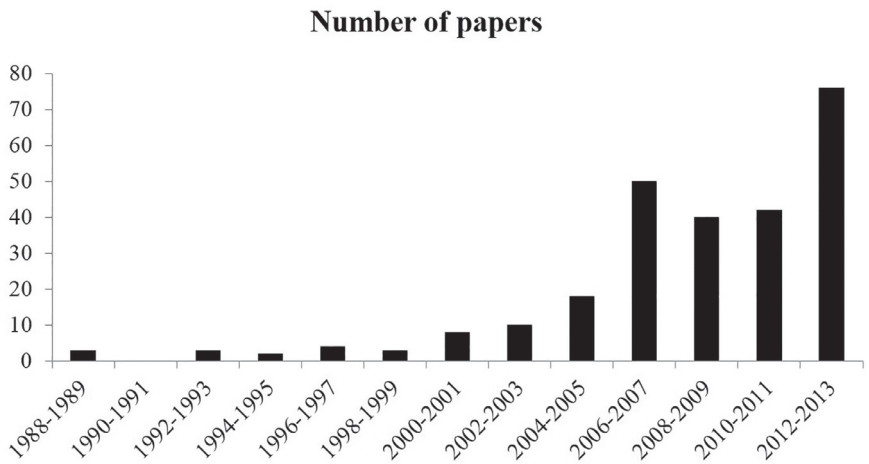

Figure 1. Number of ethnobotanical studies published and available in Scopus and ISI Web of Science databases, in a biannual basis, from 1988 to 2013.

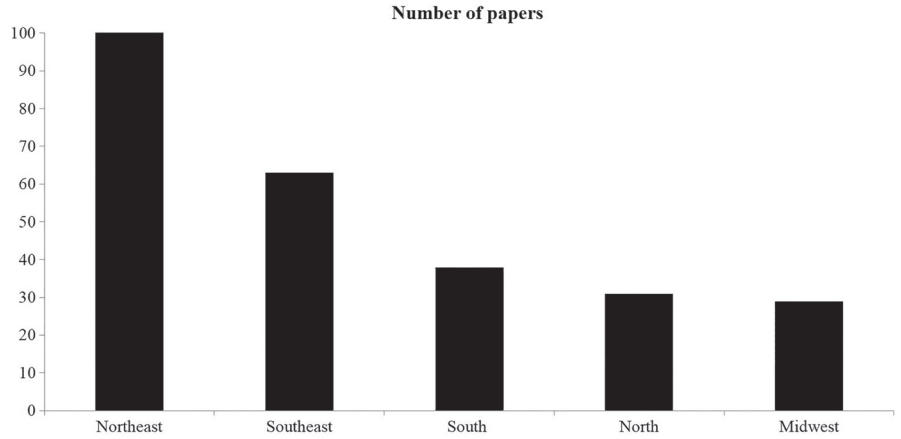

Figure 2. Number of ethnobotanical studies published and available in Scopus and ISI Web of Science databases per Brazilian region from 1988 to 2013.

rado, have fewer educational institutions that count with ethnobotany researchers. This finding reveals the need for the implementation of courses and programs for the development of this discipline or the need for implementation of the discipline in the curriculum matrix of courses related to biodiversity and conservation. Only 38 articles (14.7%) were found from the South, possibly because ethnobiology has been just recently introduced in the region as a formal discipline and it is still not fully implemented in many higher education and research institutions. This can be proved by the fact that the First Brazilian Symposium of Ethnobiology and Ethnoecology of the South Region occurred relatively recently, in 2003 (Baldauf 2006). This event attracted researchers working on this topic.

The states with the greatest number of articles are Pernambuco (48, 18.6%) and São Paulo (23, –8.9%). The level of activity of the research groups located in these states is also reflected by the number of studies conducted in neighboring states, thus increasing the ethnobotanical knowledge of these regions. Researchers from these states have produced a substantial number of articles on ethnobotany. In contrast, most articles on medicinal plants have been produced by researchers in other states in the country, such as Bahia, Minas Gerais, and Rio de Janeiro. In these states, studies that approach the knowledge and the use of plants through the applied ethnobotany of one or more species or genera were conducted. This pattern can be explained by the presence of existing research groups and the human resources associated with these groups.

Main approaches used in published articles

The types of approach represented by the articles on ethnobotany were classified into the abovementioned five categories, and the following results were obtained (Fig. 3): 1. General medicinal use, with 99 articles (38.3%), 2. Ethnobotany, particularly with 62 articles (24.0%), 3. Specific medicinal use, with 49 articles (19.0%), 4. General ethnobotany, with 39 articles (15.1%), and 5. Homegardens, with 11 articles (4.2%). The articles focused on general and specialized ethnobotany represented 36.6% of the total articles and those focused on medicinal purposes represented 59.8% of the total.

Most reports (57.3%; n = 148 articles) involved studies focused on medicinal purposes. The prevalence of this approach has already been noted by Oliveira *et al.* (2009) after analyzing several publications from 1990 to 2007, when they found that 64% of the articles were related to medicinal plants.

The relatively high number of articles involving this approach can be partly explained by the high demand for natural products by consumers and the resulting need for studies on these plants. In addition, we can highlight the increasing number of meetings and symposia that attract researchers specialized in this topic. For example, the Symposium on Medicinal Plants in Brazil held its 22nd meeting in 2012, with many studies presented at every session. According to Oliveira *et al.* (2009), large number of researchers working on medicinal plants can partially explain the current trend toward emphasizing on medicinal plants in ethnobotanical studies. Moreover, this result may be influenced by one of the early stages of ethnobotanical research (the pre-classical period) because studies that essentially focused on the survey of useful plants were predominant during this period (see Hunn 2007). Surveys of medicinal plants in a particular region may still be influenced by this stage of ethnobotany.

According to the classification of Clement (1998), many studies have a descriptive approach characteristic of the classical period; however, we can observe a trend illustrated by the increase in the number of articles using quantitative analysis. According to Oliveira *et al.* (2009), this trend is found primarily in more recent publications as a response to the appeal for more rigor and hypothesis-driven research in

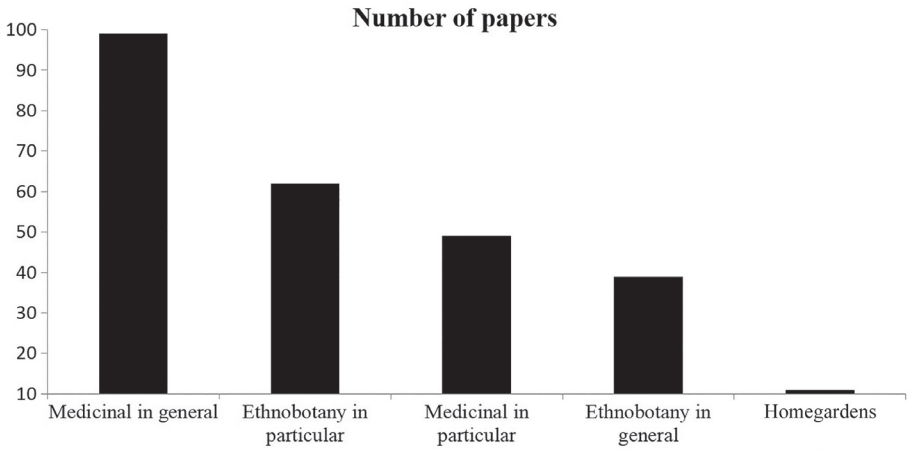

Figure 3. Number of ethnobotanical studies published and available in Scopus and ISI Web of Science databases per categories from 1988 to 2013.

ethnobotanical research. This priority has been maintained since the 1990s (see Albuquerque & Hanazaki 2009), and the trend to incorporate hypothesis-driven research, discussions, and critical reviews about methodology and a focus on solving practical problems has undoubtedly marked a new period for ethnobotanical studies worldwide.

A theme that has emerged in ethnobotanical reviews is the approach involving urban and rural homegardens. Although this theme was only found in seven articles, the study of these environments is important for the conservation of local diversity. The cultural, economic, and biological importance of these environments is mainly associated with their function as alternative food supply systems, complementing conventional agricultural production (Florentino *et al.* 2007).

Main environments and social groups studied

Ethnobotanical studies of rural communities represent the majority of the works surveyed (173 articles, 67%), also reflecting the large number of articles contributed by the research groups in the Northeast (75 articles), which work primarily in rural areas. The other regions contributed with 38 articles (Southeast), 22 (North), 21 (South), and 17 (Midwest).

Nevertheless, an increase in the number of studies in urban areas, including plant species sold in markets and fairs (106 articles, 41.1%). Almada (2011) reflects on this new scenario for ethnoecology in cities. These studies, conducted in Brazil since the 1980s, attempt to analyze and understand the ecological knowledge associated with urban centers. According to the author, this knowledge contributes to the conservation of social diversity in both rural and urban areas. The ease of access and funding in urban areas is currently encouraging the development of ethnobotanical studies in these areas. Furthermore, studies with traditional groups involve intellectual property issues, require benefit sharing (according with the products of these works and in accordance with Brazilian law), and require a higher level of adaptation to current laws, discouraging researchers from conducting research based on traditional populations.

Another important characteristic that attracts researchers is the cultural diversity of urban areas. The source of this diversity is that many of these areas comprise migrants (see Medeiros *et al.* 2012). Through immigration, cities have been transformed into multiethnic spaces where different traditions regarding the use of animals and plants are brought together (Ladio & Molares 2010). According to Medeiros *et al.* (2012), an improved understanding of the use of plant resources and exploitation dynamics in culturally diverse urban areas can be obtained from studying the knowledge, beliefs, and practices of different migrant communities, particularly in the case of medicinal plants. The knowledge of medicinal plants is influenced by the process by which the participation of the migrants affects the flora through the replacement and incorporation of plants from new regions, maintaining or replacing the knowledge of the plants previously used in their original communities.

Another interesting aspect of the studies analyzed is the ethnobotanical study of conservation units and/or their surroundings (14 articles, 5.4%), often emphasizing social and environmental conflicts and examining the issue of sustainable development. Oliveira *et al.* (2009) verified the increase in studies of nature conservation and the use of resources and ecosystems, and a trend to include local communities as partners. Within this context, studies of the environmental perception that local or neighboring communities in conservation units are important for verifying the possible social and environmental conflicts associated with these units and processes that created the units. According to Ferreira (2004), the idea that the success of conservation parks would depend on the creation of economic alternatives for people inside and around these areas has become influential since the 1980s.

Regarding ecosystem coverage, most ethnobotanical studies were primarily performed in the Atlantic forest *sensu lato* (125 articles, 48.4%) followed by the *Caatinga* (69 articles, 26.7%) (Fig. 4). These findings can be explained primarily by the tendency for the largest research groups to be concentrated in these regions. The remaining ecosystems have received less attention from an ethnobotanical point of view. The studies in the remaining regions covered the *Cerrado* (48 articles, 18.6%), Amazon (30 articles, 11.6%), *Pantanal* (7 articles, 2.7%), and only 2 in *Pampa* (2 articles, 0.7%), highlighting the need for further studies in these regions. The small number of studies on the *Pampa*, recently recognized as a biome, can be partly explained by the greater distance of this region from the large population centers that harbor concentrations of universities and research institutes. Furthermore, the *Pampa* region comprises extensive rural properties that are particularly dedicated to large-scale cattle breeding, making it difficult to conduct ethnobotanical studies. It is also stated that the concern with the conservation of this biome is a relatively recent phenomenon, contributing to the existence of few conservation studies.

The findings of this study regarding social groups show that the classic studies on indigenous people date from the late 1960s and were pursued with increasing intensity in the 1980s (Marques 2006). Several studies were conducted by foreign researchers, a situation that has changed over the years. However, few studies with indigenous people are currently found in the examined databases (14 articles collected in this review), possibly due to a lack of ethnobotany researchers specialized in indigenous communities, particularly in the Amazon (Haverroth 2010). Another problem identified by the same author is the difficulty of defining legal access to genetic resources and the associated traditional knowledge. The current law imposes greater restrictions on studies of traditional communities than previous ones.

Most articles did not involve a particular social group (143 articles, 55.4%), particularly because no predominant group could be identified in the studied population. This is often caused by difficulties in defining specific ethnic groups, as Brazil's population includes a large proportion of individuals of mixed descent and offers a very interesting pattern of cultural and biological diversity. However, the standardization of methodologies for comparative purposes would be worthwhile and important for the identification of social groups.

In other articles (44.6%), the dominant social group was reported. In such cases, the most studied groups were farmers (25 articles), indigenous groups (14), *caiçaras* (11), African descendants (10), traditional fishermen and European descendants (8), and extractivists and *caboclos* (7). Two groups (*caiçaras* and traditional fishermen) were particularly located in the Atlantic forest and have been the target of recent studies. Fewer studies have been conducted on *ribeirinhos*, *raizeiros*, *pantaneiros,* and *marajoaras*; however, the total number of studies on these groups is still reasonable and highlights the great cultural diversity of Brazil.

Final considerations

This review examines different aspects of the publication of articles on ethnobotany in Brazil during the period of 1988–2013. The evident increase in the number of these articles shown here reflects the increase in the development of human resources, particularly in the Northeast and Southeast regions. However, knowledge gaps in the available information still influence the definition of public policies for conservation and the planning of research schedules.

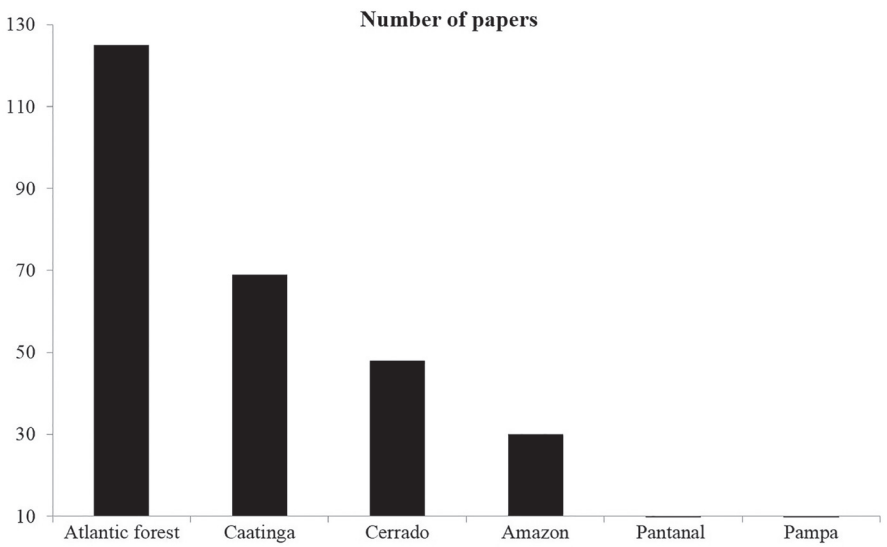

Figure 4. Number of ethnobotanical studies published and available in Scopus and ISI Web of Science databases per Brazilian biome from 1988 to 2013.

Because of the small number of articles detected, this study highlights the need for more research in the North, Midwest and South, including the Amazon, *Cerrado*, *Pantanal,* and *Pampa*. The study also reveals that these regions require substantial human resource support to form qualified individuals to study different aspects of ethnobotany. It is interesting to mention that this discipline was first developed in the Amazon region of Brazil with strong participation of foreign researchers. This situation has been changing over the years, and the contribution of Brazilian researchers has grown considerably since the 1990s. However, despite being the "birthplace" of the field in Brazil and containing a significant biological and cultural diversity, the Amazon region has fewer professionals with a background in ethnobiology than other regions of Brazil. This history of ethnobotany supports Brazil as the main producer of scientific articles in this topic in Latin America.

The inclusion of ethnobotany in the curriculum of higher education courses related to biodiversity and nature conservation needs to be considered within the National Policy on Education. This initiative will foster the development of human resources and encourage the interest of young scientists in this area of study at an early stage of their education.

Based on the study's findings on the topics investigated by ethnobotanical research, it is recommended that a stronger emphasis be given to ethnobotanical studies in conservation units and their surroundings. This shift in emphasis could contribute to the conservation of biodiversity and to the resolution of social and environmental conflicts. Moreover, it will facilitate the elaboration of targeted management plans for these conservation units. Future research of additional topics, such as homegardens, should be encouraged because the number of articles recorded to date is low. This lack of studies hampers further discussion of the role of these areas in biodiversity conservation.

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