



## The Herbaria of the State of São Paulo

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MAMEDE, M.C.H., SIMÃO-BIANCHINI, R. **The Herbaria of the State of São Paulo**. *Biota Neotropica* 22(spe): e20221408. <https://doi.org/10.1590/1676-0611-BN-2022-1408>

**Abstract:** This article compiles information on FAPESP's support for improving environmental conditions (temperature and relative humidity), expansion (acquisition of conventional and compacted cabinets) and conservation of botanical collections deposited in São Paulo's herbaria. Aspects related to the qualification of these collections and repatriation of data on Flora Paulista are also highlighted.

**Keywords:** *scientific collections; maintenance; preservation; conservation; data repatriation.*

## Os Herbários do Estado de São Paulo

**Resumo:** Neste trabalho são compiladas informações sobre o apoio da FAPESP à melhoria das condições ambientais (temperatura e umidade relativa), ampliação (aquisição de armários convencionais e compactados) e conservação das coleções botânicas depositadas nos herbários paulistas. Também são destacados, aspectos relacionados à qualificação dessas coleções e repatriação de dados sobre a Flora Paulista.

**Palavras-chave:** *coleções científicas; manutenção; preservação; conservação; repatriação de dados.*

### Introduction

An herbarium is a collection of dried plants and fungi (exsiccates) mounted on cardboard containing data on the location and date of collection, names of collectors and taxonomic information (family, genus and/or species). The procedures used in the preparation of the samples allow these collections to be perpetuated over the years. This includes proper temperature and relative humidity conditions, pest control and proper preservation in steel cabinets. Buildings must be suitable for storing collections with periodic maintenance of electrical installations, firefighting, and protection against excessive light.

There are 29 herbaria in the State of São Paulo (RBH 2022), most of them installed in Universities or Research Institutions, four of them in governmental institutions (Secretaria de Infraestrutura e Meio Ambiente, Secretaria de Agricultura e Abastecimento and Prefeitura do Município de São Paulo) [RBH, 2022]. They total 1,550,250 scientific collections, from algae to phanerogams and fungi, including wood collections, of which 1,073,707 are available on the web [speciesLink 2022; Reflora 2022, Canhos et al. 2022] with 383,159 images of exsiccates and live plants. The five largest herbaria in São Paulo are Herbarium SP (Instituto de Pesquisas Ambientais, SIMA), SPF and ESA (Instituto de Biociências and Escola Superior de Agricultura, USP), UEC (Instituto de Biologia, Unicamp) and HRCB (Instituto de Biociências, Unesp – Rio Claro) (Table 1).

#### 1. Importance, scope, and relevance of collections

All Botany research projects rely on herbaria for depositing vouchers to certify their results through the identity of the materials used in

their studies. Floristic inventory and taxonomy projects (including phylogenies and phylogenomics) are the ones that most contribute to the increase in herbarium collections.

Most of the herbarium collections reflect the distribution of species in the territory of São Paulo, especially because the collections of botanical material reflect institutional research lines, with the exception of the SPF and UEC herbaria that develop studies in rock outcrops in the States of Minas Gerais, Bahia and Goiás, and the SP Herbarium which houses collections from Europe, North and Central Americas, Africa, Asia and Oceania, acquired through exchanges (Figures 1, 2 and 3).

Collections of type material are important because they represent the specimens used in the description of new taxa. So far, 8,724 type materials (holotypes, isotypes, lectotypes, paratypes and syntypes) deposited in herbaria in the State of São Paulo have been recorded. The collections have, for the most part, data and images available on virtual repositories. Historical collections, such as those of the Geological and Geographical Commission of the Province of São Paulo (CGG), are also important as they portray the floristic diversity of the State of São Paulo in the late 19th and early 20th centuries. The SP Herbarium houses 4,470 specimens collected along the rivers in the State of São Paulo (the main access route used by naturalists Alberto Loefgren and Gustav Edwall).

### Material and Methods

Data on São Paulo Herbaria were obtained from the websites of the Brazilian Herbarium Network (RBH, 2022) and from speciesLink. The

**Table 1.** Herbaria of the State of São Paulo.

Acronym/Initials	County	Collection total	Types	On line records	On line images
SP	São Paulo	525.000	5.317	277.437	64.805
SPF	São Paulo	250.000	1.792	190.513	34.600
UEC	Campinas	205.000	1.022	198.139	161.038
ESA	Piracicaba	145.000	57	133.204	88.578
HRCB	Rio Claro	77.723	161	34.121	0
IAC	Campinas	65.918	103	57.595	0
SPSF	São Paulo	54.000	115	53.256	1.132
BOTU	Botucatu	38.000	3	32.894	6.023
SJRP	São José do Rio Preto	38.000	18	32.353	5.468
PMSP	São Paulo	20.886	25	18.555	20.286
SPFR	Ribeirão Preto	17.000	13	2.305	0
UNIP	São Paulo	14.200	4	0	0
HPL	Nova Odessa	13.661	74	0	0
HUSC	Santos	13.595	3	9.016	32
HISA	Ilha Solteira	11.503	0	10.517	0
SPSC	São Carlos	8.853	0	5.445	0
BAUR	Bauru	7.484	0	0	0
HUMC	Mogi das Cruzes	7.000	0	5.217	0
SORO	Sorocaba	7.000	17	7.524	0
UNBA	Bauru	6.200	0	0	0
CASA	Piracicaba	6.100	0	0	0
MACK	São Paulo	3.312	0	3.312	0
HASSI	Assis	3.250	0	0	0
HUFABC	São Bernardo do Campo	2.500	0	2.304	1.197
JABU	Jaboticabal	2.500	0	0	0
SPVR	Registro	2.000	0	0	0
JBMB	Bauru	1.953	0	0	0
LBMBP	Ribeirão Preto	1.900	0	0	0
IFSR	São Roque	712	0	0	0
Total		1.550.250	8.724	1.073.707	383.159

Data obtained from RBH and speciesLink, with the exception of the PMSP Herbarium whose data are available in Reflora.

survey of scientific articles published from the analysis of the collections of K and P was carried out by consulting the Lattes Platform from CNPq (2022) and Google Scholar (2022).

## Results

### 1. Support for improving infrastructure

The research projects and infrastructure support financed by Fapesp have provided conditions for many herbaria to improve their facilities and storage conditions for collections. The exchange of conventional cabinets for sliding files promoted the improvement of the storage of exsiccates in addition to allowing the growth of the collections, without necessarily expanding the space or the construction of new buildings. The acquisition of air conditioning units or temperature and humidity control systems improved the storage and conservation conditions of their collections.

The various research projects and postgraduate scholarships supported by Fapesp allowed for the increase and study of botanical collections, thus improving the quality of its collection and a significant increase in consultations and exchanges between São Paulo herbaria and other national and international herbaria. During the development of the “Phanerogamic Flora of the State of São Paulo” project, started in 1993, the SP Herbarium incorporated more than 29,000 specimens, and distributed the duplicates to the main São Paulo herbaria (especially SPF, UEC, ESA) in addition to sending material to study by Brazilian and foreign experts. This project also contributed to the better storage of the collections, providing conventional cabinets for several herbaria and resources for carrying out collection expeditions throughout the territory of the State. Financial resources for carrying out purges and sending materials by mail to the various herbariums participating in the project were fundamental for the preservation and qualification of the collections.

### Herbaria of São Paulo

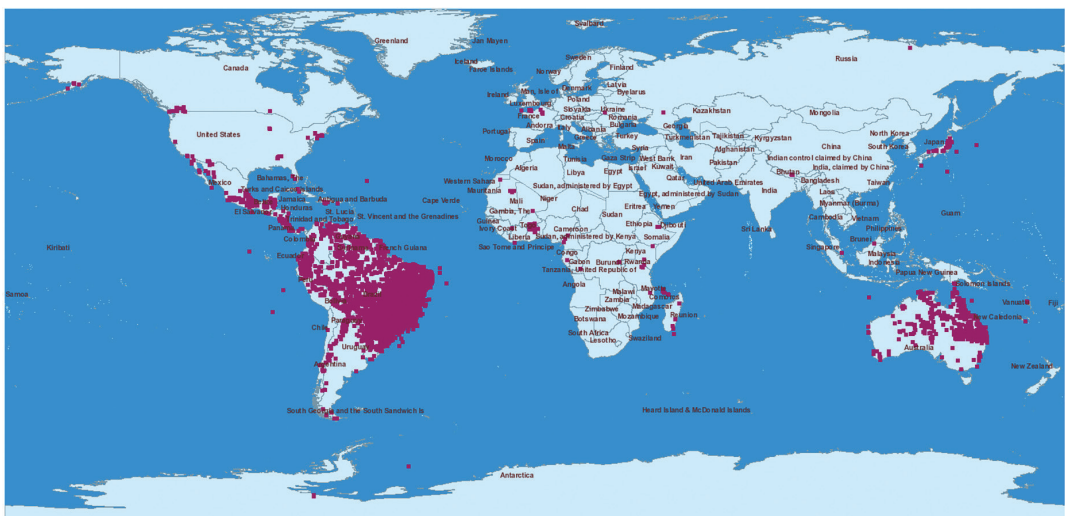


Figure 1. Geographical distribution of the scientific collections of the SP Herbarium.

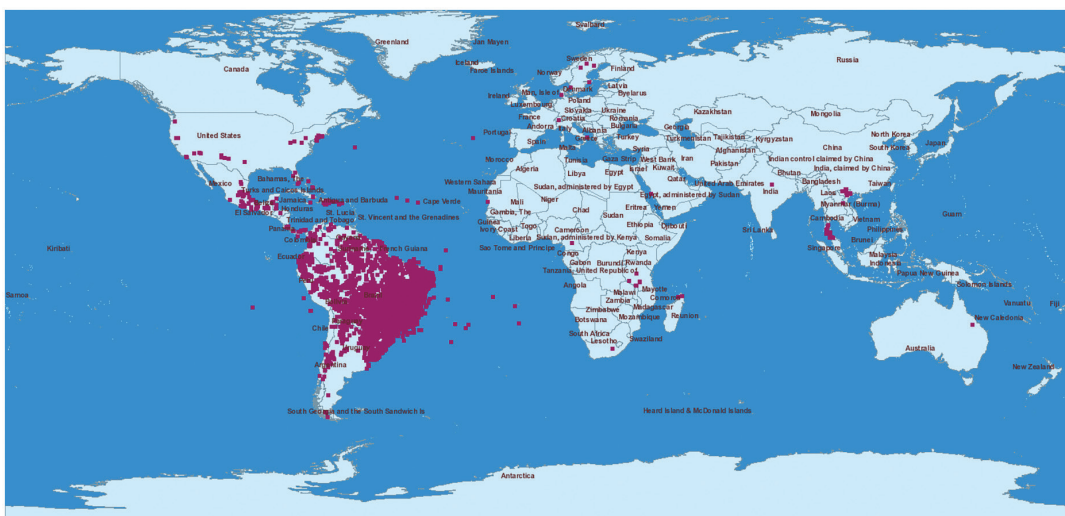


Figure 2. Geographical distribution of the scientific collections of the SPF Herbarium.



Figure 3. Geographical distribution of the scientific collections of the UEC Herbarium.



The exchange of conventional herbarium cabinets for sliding compressed files favored a better storage of the collections in addition to expanding the storage capacity, without the need to build new facilities.

## 2. Reflora Project – Data Repatriation

The REFLORA Program was proposed in 2010 with the aim of rescuing, qualifying, and making available to the public information on samples of Brazilian flora that were collected in the early 20th century and before that, and which are deposited in the herbaria of the Royal Botanic Gardens in Kew (K) and Muséum National d'Histoire Naturelle de Paris (P). The proposal was for specialists to confirm or identify exsiccates collected in Brazil and deposited in these herbaria, and later, high-resolution images and label information would be made available on the internet, both on the websites of these herbaria and on Brazilian platforms such as speciesLink (<https://specieslink.net/search>), Flora and Funga do Brasil ([reflora.jbrj.gov.br](http://reflora.jbrj.gov.br)), the Brazilian Biodiversity Information System (SiBBR) and the National Forest Inventory (IFN). A collaboration program was then created between the National Council for Scientific and Technological Research (CNPq), the Coordination for the Improvement of Higher Education Personnel (CAPES) and the various Research Support Foundations of Brazilian States. The Fundação de Amparo à Pesquisa do Estado de São Paulo supported four of the submitted projects.

There were several foreign botanical collectors who traveled through the native vegetation of the State of São Paulo and took samples of the flora to other countries during the 18th, 19th and early 20th centuries. Before national laws regulated the release of these samples and required that a portion remain in national herbaria, countries such as Germany, Belgium, England and France received materials from important botanical collectors, some who came to visit for a short period and exclusively for field trips, and others who already lived and worked in Brazil. Although there are some duplicates in Brazilian herbaria, especially in Rio de Janeiro (Museu Nacional – Herbarium R and Jardim Botânico do Rio de Janeiro – Herbarium RB) and São Paulo (Herbarium SP), new taxa were described based on materials from European herbaria and that have become nomenclatural types (Forzza et al. 2012), which are the essential for a taxonomist to study and understand species delimitation. Among the most important plant collectors who passed through the state of São Paulo during the XIX century, the following stand out: Alfred Usteri, Anders Fredrik Regnell, Auguste François César Prouvençal de Saint-Hilaire; Auguste François Marie Glaziou; Carl August Wilhelm Schwacke; Carl Wilhelm Hjalmar Mosen; Charles Gaudichaud-Beaupré (C. Gaudichaud); James Robert Weir, Johannes Eugenius Bülow Warming, Ludwig Riedel and William John Burchell.

The appropriate taxonomic study, carried out by a specialist, includes updating identifications and recognizing whether it is a type material and which category of this type (holotype, isotype, syntype, etc.). The subsequent availability of this information, including images, contributes to numerous studies. It is an effective way of knowing the Brazilian floristic composition before deforestation, being able to use native species for plant recomposition. It is also a great tool to know the current conservation status of the species.

Specialists and post-graduate students from Herbaria SP and UEC who went to the European herbaria (K and P) corrected and updated identifications and looked for type materials comparing with the protologs of the species that occur in Brazil. While handling the exsiccates, they



**Figure 4.** *Ipomoea langsdorffii* Choisy holotype, which until then had not been located (<http://mediaphoto.mnhn.fr/media/144588215421888394TdeB3KZxNFf>).

already performed the typing, of the information contained in the labels and which were later associated with the images. Only a few teams obtained the images, but the vast majority were prepared later by personnel hired by the project for this purpose or were already available and were only updated after certification by the experts.

The Reflora Program was important for Brazil to meet the goals established by the Global Strategy for Plant Conservation (Convention on Biological Diversity) for the years 2010 and 2020 ([reflora.jbrj.gov.br](http://reflora.jbrj.gov.br)).

FAPESP participated by supporting the repatriation of data on exsiccates from the Apocynaceae families (*Couma* Aubl., *Hancornia* Gomes, *Pacouria* Aubl. and *Parahancornia* Ducke), Convolvulaceae, Fabaceae, Moraceae and Rubiaceae (*Manettia* Mutis ex L.) (Figure 4). Undoubtedly the main results were the availability of information for the scientific community and the general public, enabling numerous scientific studies based on this and also the Flora e Funga do Brasil website would not have the quality and reliability without the results obtained with Reflora.

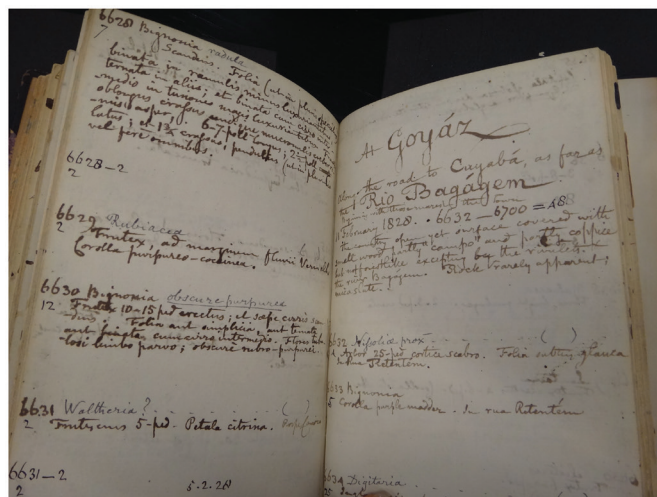
For many collections, it was possible to complement data on the place and date of collection by consulting the collection notebooks of botanists who visited Brazil. This is the case, for example, of Burchell's collections, where it was possible to accurately identify the data and place where the collection 6692 was made by Burchell in 1828 (Figures 5 and 6).



**Figure 5.** W.J. Burchell 6692, deposited in Herbarium K, note that there is no locality information on the exsiccata. (<http://specimens.kew.org/herbarium/K000612861>).

Also, this project resulted in many other publications (and there are still several in the pipeline), many of which were the result of the current availability of information on the internet, allowing many studies to benefit from such results even in the future. However, the results disclosed with explicit credits to Fapesp/Refloa were: Moura et al. (2012, 2013a,b, 2014, 2016), Cheek & Simão-Bianchini (2013), Fortuna Perez et al. (2013), Silva & Simão-Bianchini (2014), Corrado et al. (2015), Martins & Tozzi (2015), Pastore & Simão-Bianchini (2015, 2016, 2017), Pinto et al. (2015, 2017, 2018), São José & Romaniuc Neto (2016), Simão-Bianchini et al. (2016), Vasconcelos et al. (2016), Moreira et al. (2017, 2018), Pastore et al. (2017), Queiroz et al. (2019), Serbin et al. (2019).

It is also relevant as a result of these projects, the training of biologists at the postgraduate level in taxonomy of species of Brazilian flora. Six master's students, nine doctoral students, one post-doctoral student, in addition to scientific initiation students not listed here, were directly contemplated with some kind of help: Alessandra dos Santos, André Luiz Gaglioti, Fernanda Satori Petrongari, Gisela Pelissari, Marcela Firens da Silveira, Mayara Pastore, Patrícia A. São José, Rosemeri Morokawa, Adenilsa Aparecida Rodrigues Lima, Cíntia Vieira da Silva, Simone Soares da Silva, Ana Paula Fortuna-Perez, Tamires Carregosa da Silva, Tânia Maria de Moura and Rafael Barbosa Pinto.



**Figure 6.** Field notebook by W.J. Burchell, whose information was not attached to the herbarium material.

## Acknowledgments

We are grateful to the curators and technicians responsible for the maintenance and organization of the collections of the Herbaria of the State of São Paulo. We also thank to the various funding agencies through doctorate and master's scholarships, in addition to grants for research projects, such as Fapesp, CNPq and CAPES.

## Associate Editor

Carlos Joly

## Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

## Ethics

This study did not involve human beings and/or clinical trials that should be approved by one Institutional Committee.

## References

- CANHOS, D.A.L., ALMEIDA, E., ASSAD, A.L., BUSTAMANTE, M., CANHOS, V.P.C., CHAPMAN, A.D., GIOVANNI, R., IMPERATRIZ-FONSECA, V.L., LOHMANN, L.G., MAIA, L.C., MILLER, J., NELSON, G., PETERSON, A.T., PIRANI, J.R., SOUZA, S., STEHMANN, J.R. & THIERS, B. 2022. speciesLink: rich data and novel tools for digital assessments of biodiversity. *Biota Neotrop.* 22(Suppl. 1).
- CHEEK, M. & SIMÃO-BIANCHINI, R. 2013. *Keraunea* gen. nov. (Convolvulaceae) from Brazil. *Nordic Journal of Botany* 31 (4): 453-457
- CORRADO, A.R., GAGLIOTI, A.L., ROMANIUC-NETO, S. & LIN, C.M. 2015 Reports of the use of Urticaceae collected in Brazil and deposited in the herbaria of Kew (K), New York (NY) and Paris (P). *Ethnobiology and Conservation* 4: 1-12.
- FORTUNA-PEREZ, A.P., LEWIS, G.P., CÂNDIDO, E.S., ALVES, P., BEZERRA, L.M. & TOZZI, A.M.G.A. 2013. *Eriosema hatschbachii* (Leguminosae, Papilionoideae), a new species from Minas Gerais, Brazil. *Kew Bulletin* 68(4): 641-645.



- FORZZA, R.C., BAUMGRATZ, J.F.A., BICUDO, C.E.M., CANHOS, D.A., CARVALHO Jr, A.A., COELHO, M.A.N., COSTA, A.F., COSTA, D.P., HOPKINS, M.G., LEITMAN, M.P., LOHMANN, L.G., LUGHADHA, E.N., MAIA, L.C., MARTINELLI, G., MENEZES, M., MORIM, M.P., PEIXOTO, A.L., PIRANI, J.R., PRADO, P., QUEIROZ, L.P., SOUZA, S., SOUZA, V.C., STEHMANN, J.R., SYLVESTRE, L.S., WALTER, B.M.T. & ZAPPI, D.C. 2012. New Brazilian floristic list highlights conservation challenges. *BioScience* 62(1): 39-45.
- GOOGLE SCHOLAR. <https://scholar.google.com.mx/schhp?hl=pt-BR> (last access in 01/06/2022).
- MARTINS, M.V. & TOZZI, A.M.G.A. 2015. (2356) Proposal to conserve the name *Erythrina falcata* against *E. martii* (Leguminosae: Papilionoideae). *Taxon*, 64(2): 390-390.
- MOREIRA, A.L.C., ANTAR, G.M., SIMÃO-BIANCHINI, R. & CAVALCANTI, T.B. 2017. Contribution to the knowledge of *Bonamia* (Convolvulaceae) in Brazil: a new species and a new occurrence. *Phytotaxa* 306(2): 146-152.
- MOREIRA, A.L.C., SIMÃO-BIANCHINI, R. & CAVALCANTI, T.B. 2018. Sinopse do gênero *Jacquemontia* Choisy (Convolvulaceae) nos Estados de Goiás e Tocantins, Brasil. *Hoehnea* 45 (2): 191-200.
- MOURA, T.M., TORKE, B.M., MANSANO, V.F. & TOZZI, A.M.G.A. 2012. A new combination for an endemic Hawaiian species of *Mucuna* (Leguminosae: Papilionoideae), with a key to the Hawaiian taxa of the genus. *Kew Bulletin*, 67(4): 837-841.
- MOURA, T.M., MANSANO, V.F., TORKE, B.M., LEWIS, G.P. & TOZZI, A.M.G.A. 2013a. A Taxonomic Revision of *Mucuna* (Fabaceae: Papilionoideae: Phaseoleae) in Brazil. *Systematic Botany*, 38(3): 631-637.
- MOURA, T.M., LEWIS, G.P., MANSANO, V.F. & TOZZI, A.M.G.A. 2013b. Three new species of *Mucuna* (Leguminosae: Papilionoideae: Phaseoleae) from South America. *Kew Bulletin* 68(1): 143-150.
- MOURA, T.M., LEWIS, G.P., MANSANO, V.F. & TOZZI, A.M.G.A. 2014. Taxonomic Studies in *Mucuna* Adans. (Leguminosae-Papilionoideae) from Peru. *Systematic Botany* 39(3): 884-896.
- MOURA, T.M., LEWIA, G.P. & TOZZI, A.M.G.A. 2016. A revision of the South American genus *Platycyamus* Benth. (Leguminosae). *Kew bulletin* 71(1): 1-7.
- PASTORE, M. & SIMÃO-BIANCHINI, R. 2015. Taxonomic novelties in *Jacquemontia* Choisy (Convolvulaceae) from Southeastern Brazil. *Phytotaxa* 221(2): 193-197.
- PASTORE, M. & SIMÃO-BIANCHINI, R. 2016. *Jacquemontia aequisejala* (Convolvulaceae), a new species from Brazil. *Kew Bulletin* 71: 20-26.
- PASTORE, M. & SIMÃO-BIANCHINI, R. 2017 Sinopse do gênero *Jacquemontia* Choisy (Convolvulaceae) no Estado de São Paulo, Brasil: notas nomenclaturais, taxonômicas e geográficas. *Hoehnea* 44 (4): 611-634.
- PASTORE, M., MOREIRA, A.L.C., CAVALCANTI, T.B. & SIMÃO-BIANCHINI, R. 2017. A taxonomic study of *Jacquemontia evoluloides* (Moric.) Meisn. and related species (Convolvulaceae). *Adansonia* 39(2): 149-166.
- PINTO, R. B., MANSANO, V.F., TORKE, B. M. & TOZZI, A.M.G.A. 2017. On the “Cangaço” route: a new species of *Hymenaea* (Leguminosae) from the Brazilian Caatinga. *Kew Bulletin* 72(3): 1-7.
- PINTO, R.B., LUSA, M.G., MANSANO, V.F., TOZZI, A.M.G.A. & MAYER, J.L.S. 2018. Morphoanatomy of the leaflets of the *Hymenaea* clade (Fabaceae: Detarioideae) reveals their potential for taxonomic and phylogenetic studies. *Botanical Journal of the Linnean Society* 187(1): 87-98.
- PINTO, R.B., MANSANO, V.F. & TOZZI, A.M.G.A. 2015. Reestablishment of *Hymenaea travassii* (Leguminosae, Caesalpinoideae), a species endemic to the Bolivian Chaco. *Phytotaxa*, 219(1): 96-100.
- PLATAFORMA LATTES. <https://lattes.cnpq.br/> (last access in 01/06/2022).
- QUEIROZ, R.T., MOURA, T.M., GEREAU, R.E., LEWIS, G.P. & TOZZI, A.M.G.A. 2019. Resolving nomenclatural ambiguity in South American *Tephrosia* (Leguminosae, Papilionoideae, Millettieae), including the description of a new species. *Australian Systematic Botany* 32(6): 555-563.
- RBH – Rede Brasileira de Herbários. <https://www.botanica.org.br/a-rede-brasileira-de-herbarios/> (last access in 4/6/2022).
- REFLORA – Herbário Virtual. <http://reflora.jbrj.gov.br/reflora/herbarioVirtual/> (last access in 4/6/2022).
- SÃO-JOSÉ, P.A. & ROMANIUC NETO, S. 2016. Diversidade de *Dorstenia* L. (Moraceae) do Estado de São Paulo, Brasil. *Hoehnea* 43(2): 247-264
- SERBIN, G.M., MACHADO, R.M., PINTO, R.B., DINIZ FILHO, J.A.F., TOZZI, A. M.G.A., FORNI-MARTINS, E.R. & MANSANO, V.F. 2019. Karyological traits related to phylogenetic signal and environmental conditions within the *Hymenaea* clade (Leguminosae, Detarioideae). *Perspectives in Plant Ecology, Evolution and Systematics*, 39, 125462.
- SILVA, C.V. & SIMÃO-BIANCHINI, R. 2014. Three new species of *Evolvulus* (Convolvulaceae) from Bahia, Brazil. *Phytotaxa* 166 (2): 132-138 - ISSN 1179-3155 (print); ISSN 1179-3163.
- SIMÃO-BIANCHINI, R., VASCONCELOS, L.V. & PASTORE, M. 2016. Flora das cangas da Serra dos Carajás, Pará, Brasil: Convolvulaceae. *Rodriguésia* 67: 1301-1318
- VASCONCELOS, L.V., SIMÃO-BIANCHINI, R. & FRANÇA, F. 2016. Two new species of *Ipomoea* (Convolvulaceae) from the Chapada Diamantina of Bahia, Brazil. *Brittonia* 68(2), 142-147.

Received: 23/08/2022

Accepted: 20/10/2022

Published online: 05/12/2022