

A narrowly endemic species of Begoniaceae: rediscovery, distribution and conservation of *Begonia jocelinoi*

ISIS PAGLIA, JAQUELINI LUBER

VIDAL DE FREITAS MANSANO and LEANDRO FREITAS

Abstract *Begonia jocelinoi* Brade (Begoniaceae) is a threatened species, endemic to a small locality in the Brazilian Atlantic Forest. The species was formerly listed as Wanted in the Red List of Endemic Flora of the state of Rio de Janeiro because it had not been recorded since 1953. After evaluating herbarium collections and conducting fieldwork during May 2019–February 2020, we report the rediscovery of a single population of 65 reproductive individuals of *B. jocelinoi*, along with numerous seedlings, besides a trail in Itatiaia National Park. This Park is an IUCN category II protected area that permits some tourism activities. Some individuals of *B. jocelinoi* showed signs of pruning following the maintenance of the trail. We recommend strategies for in situ and ex situ conservation of this narrowly endemic species, including provision of advice to tourists regarding the occurrence of threatened species, and diversion of the trail where the species occurs.

Keywords Atlantic Forest, *Begonia jocelinoi*, Brazil, ecotourism impact, micro endemism, plant conservation, rare species, small population

Supplementary material for this article is available at doi.org/10.1017/S0030605321000740

In response to increased biodiversity loss (Ceballos et al., 2015), international conventions and plans, such as the Global Strategy for Plant Conservation (GSPC, 2008), have been established. One of the main goals of conservation is the maintenance of ecosystems, communities, habitats and the species within them (Soulé, 1987). Habitat loss, however, is a significant threat to biodiversity, especially for species with restricted geographical distributions such as narrowly endemic species, which usually have specific habitat requirements (Essl et al., 2009).

Most Brazilian species of *Begonia* are endemic to the country, mainly to the highly diverse and threatened Atlantic Forest (Jacques & Gregório, 2020). As a result of

historical loss and fragmentation of natural habitats, the Atlantic Forest is one of the so-called hottest global hotspots (Laurance, 2009; Rezende et al., 2018), and protected areas are critical for the conservation of the remaining fragments of this forest. The first protected area in Brazil, Itatiaia National Park, was founded in 1937 in an important centre of endemism in the Atlantic Forest, the Mantiqueira Mountain Range (Fiaschi & Pirani, 2009). The Park is an IUCN (1994) category II protected area, which allows public visitation.

Itatiaia National Park contains 13.5% (25) of the *Begonia* species known from the Atlantic Forest and 29% of the *Begonia* species known from Rio de Janeiro state (Jacques & Gregório, 2020). *Begonia jocelinoi* (Plate 1) is endemic to the Park and was formerly categorized as Wanted in the Red List of the Endemic Flora of Rio de Janeiro state as the species had not been recorded since 1953 (Rosa et al., 2018). Until now, *B. jocelinoi* was only known from herbarium specimens: the first collection was in the Park in 1943 (J.J. Sampaio 09, holotype RB, isotypes CEPEC, NY, SP; E. Pereira 324, paratypes RB), which appear in the protologue of specimen A.C. Brade 21228, paratype MBML, RB, in 1953.

To obtain information on *B. jocelinoi* we consulted JABOT (2019), Specieslink (2020), and herbarium collections at RB and SPF. We visited Itatiaia National Park four times during May 2019–February 2020 to search for *B. jocelinoi*. Previous records of *B. jocelinoi* were at 1,000–1,500 m altitude and therefore we explored trails close to the type collection site and other similar trails up to c. 2,000 m altitude (Fig. 1).

We located a single population of *B. jocelinoi* with 65 individuals at the reproductive stage and several hundred seedlings in five localities over 1,123–1,532 m on the Três Picos trail. The individuals at the reproductive stage had flower buds, flowers and/or fruits. Fruits had well-formed seeds, but we did not test viability. The location is shaded, with high humidity and diffuse sunlight. Some individuals were in a clearing resulting from the death of the native bamboo *Guadua tagoara* (Nees) Kunth following synchronous flowering.

We also located additional collections of *B. jocelinoi* in herbaria, all of them from the Três Picos trail: M.L.O. Trovó 510 (RB) collected in 2012, J. Lubert 421 (RB), I. Páglia 31 and 72 (RB) and C. Baez 1876 (RB) collected in 2019. Other specimens that we found identified as *B. jocelinoi* on Specieslink are in fact *Begonia convolvulacea*

ISIS PAGLIA (Corresponding author, orcid.org/0000-0002-5570-8079, isispaglia@jbrj.org.br), JAQUELINI LUBER, VIDAL DE FREITAS MANSANO and LEANDRO FREITAS Instituto de Pesquisa Jardim Botânico do Rio de Janeiro, Rua Pacheco Leão, 915, Jardim Botânico, Rio de Janeiro, CEP 22460-030, Brazil

Received 31 July 2020. Revision requested 25 September 2020.

Accepted 20 May 2021. First published online 18 March 2022.

This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted re-use, distribution, and reproduction in any medium, provided the original work is properly cited.

Oryx, 2022, 56(6), 935–938 © The Author(s), 2022. Published by Cambridge University Press on behalf of Fauna & Flora International doi:10.1017/S0030605321000740

<https://doi.org/10.1017/S0030605321000740> Published online by Cambridge University Press

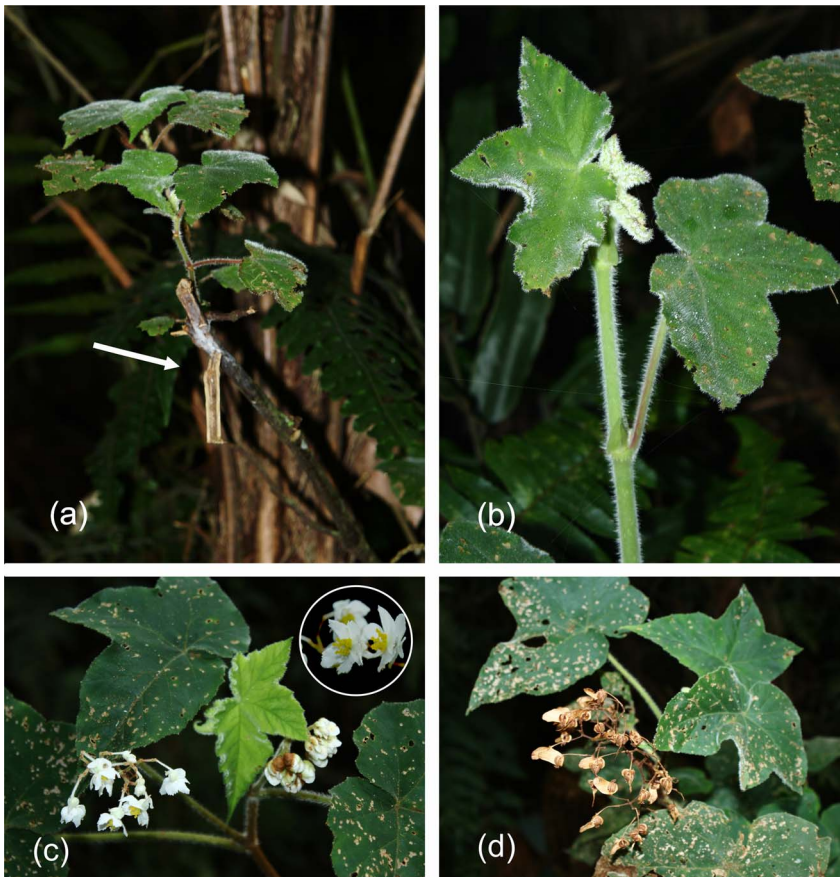


PLATE 1 (a) An adult *Begonia jocolinoi* that has been pruned (arrow) and that is sprouting, (b) a young plant, (c) adult plants at the reproductive stage, with female flowers, and (d) adult fruiting.



FIG. 1 The location of the single known population of *Begonia jocolinoi* in Itatiaia National Park, Rio de Janeiro, Brazil.

(Klotzsch) A.D.C. *Begonia jocolinoi* was previously categorized as Critically Endangered based on criteria B2ab-i, ii, iii (Jacques et al., 2018). Our findings support this categorization, but based on criteria B1a + C2aii (IUCN 2012), because of its restricted geographical range (extent of occurrence

1.5 km², area of occurrence 16.0 km²), and small population size with few mature individuals.

Few studies have directly examined the impacts of tourism on rare and threatened plants and how this may affect the risk of extinction in protected areas. Direct threats of

tourism include collection of plants by tourists, maintenance of trails and damage from activities such as walking, biking and vehicles (Kelly et al., 2003). A typical maintenance activity in Brazilian protected areas is clearing trails to keep them open for walkers. This maintenance occurs recurrently on the Três Picos trail, and led on at least one occasion to the inadvertent pruning of *B. jocelinoi* (Plate 1a), including of flowering individuals. A reduced number of reproductive individuals in an isolated population can decrease genetic diversity via inbreeding and genetic drift caused by low gene flow and a small effective size (Barrett & Kohn, 1991).

Our research in Itatiaia National Park indicates the vulnerability of *B. jocelinoi* as its single known population lies on a trail in a severely fragmented biome. The Atlantic Forest has the largest number of Alliance for Zero Extinction sites among Brazilian biomes (Diniz et al., 2017). Based on the concepts of irreplaceability and vulnerability (Margules & Pressey, 2000), the rediscovery of a population of *B. jocelinoi* indicates the need to prioritize this area for local conservation. Of 16 additional threatened species in the Park that were recorded only once prior to 1969, six were recorded during 2019–2020 (Moreira et al., 2020) but 10 have yet to be relocated.

Narrowly endemic species may be best conserved by local conservation efforts (Crain et al., 2015). For this reason, we recommend the following actions for *B. jocelinoi*: (1) an in situ conservation plan, including studies on phenology, pollination, seed dispersal and population dynamics; (2) an ex situ conservation plan for greenhouse cultivation and to foster ornamental use; (3) advice for tourists about threatened plant species on trails and awareness of the improper collection of plants; (4) diversion of the part of the Três Picos trail where the population is located, to minimize the effects of tourism and pruning; (5) mapping other potential areas of occurrence of this species; (6) fieldwork to search for other populations in any potential areas identified. These strategies have already been proposed or are in use for the conservation of other species with a highly restricted distribution (e.g. Martinelli et al., 2011; De Lirio et al., 2018; Zhang et al., 2020).

Acknowledgements We thank Coordenação de Aperfeiçoamento de Pessoal de Nível Superior for graduate scholarships to IP (88887.335096/2019-00) and JL (88882.447055/2019-01), Conselho Nacional de Desenvolvimento Científico e Tecnológico–Bolsa de Produtividade em Pesquisa and Fundação de Amparo a Pesquisa do Estado do Rio de Janeiro–Cientista do Nosso Estado for research grants to LF and VFM, the curators of herbaria RB and SPF for access to collections, Rafael da Silva Ribeiro for the help with the map, and Itatiaia National Park staff for logistical support and encouragement.

Author contributions Data collection, species identification, figure preparation: IP, JL; writing: all authors.

Conflicts of interest None.

Ethical standards This research abided by the Oryx guidelines on ethical standards.

References

- BARRETT, S.C.H. & KOHN, J.R. (1991) Genetic and evolutionary consequences of small population size in plants: implications for conservation. In *Genetics and conservation of rare plants* (eds D.A. Falk & K.E. Holsinger), pp. 3–30. Oxford University Press, Oxford, UK.
- CEBALLOS, G., EHRLICH, P.R., BARNOSKY, A.D., GARCIA, A., PRINGLE, R.M. & PALMER, T. (2015) Accelerated modern human-induced species losses: entering the sixth mass extinction. *Science Advances*, 1, e1400253.
- CRAIN, B.J., SÁNCHEZ-CUERVO, A.M., WHITE, J.W. & STEINBERG, S.J. (2015) Conservation ecology of rare plants within complex local habitat networks. *Oryx*, 4, 696–703.
- DE LÍRIO, E., FREITAS, J., NEGRÃO, R., MARTINELLI, G. & PEIXOTO, A. (2018) A hundred years' tale: rediscovery of *Mollinedia stenophylla* (Monimiaceae) in the Atlantic rainforest, Brazil. *Oryx*, 52, 437–441.
- DINIZ, M.F., GONÇALVES, T.V. & BRITO, D. (2017) Last of the green: identifying priority sites to prevent plant extinctions in Brazil. *Oryx*, 51, 131–136.
- ESSL, F., STAUDINGER, M., STÖHR, O., SCHRATT-EHRENDORFER, L., RABITSCH, W. & NIKLFELD, H. (2009) Distribution patterns, range size and niche breadth of Austrian endemic plants. *Biological Conservation*, 142, 2547–2558.
- FIASCHI, P. & PIRANI, J.R. (2009) Review of plant biogeographic studies in Brazil. *Journal of Systematics and Evolution*, 47, 477–496.
- GSPC (2008) *Global Strategy for Plant Conservation*. cbd.int/gspc [accessed 2 April 2020].
- IUCN (1994) *Guidelines for Protected Area Management Categories*. IUCN, Gland, Switzerland, and Cambridge, UK.
- IUCN (2012) *Red List Categories and Criteria*. Version 3.1, 2nd edition. iucnredlist.org/technical-documents/categories-and-criteriam [accessed 20 January 2020].
- JABOT (2019) *JABOT–Banco de Dados da Flora Brasileira*. Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, Rio de Janeiro, Brazil. jabot.jbrj.gov.br [accessed 19 October 2019].
- JACQUES, E.L. & GREGÓRIO, B.S. (2020) *Begoniaceae in Flora do Brasil 2020 em Construção*. Jardim Botânico do Rio de Janeiro, Rio de Janeiro, Brazil. reflora.jbrj.gov.br/reflora/floradobrasil/FB59 [accessed 12 January 2021].
- JACQUES, E.L., MORAES, L., AMARO, R., MORAES, M., AMORIM, T., WIMMER, F. et al. (2018) Begoniaceae. In *Livro Vermelho da Flora Endêmica do Estado do Rio de Janeiro* (eds G. Martinelli, E. Martins, M. Moraes, R. Loyola & R. Amaro), pp. 165–172. Jardim Botânico do Rio de Janeiro, Rio de Janeiro, Brazil.
- KELLY, C., PICKERING, C.M. & BUCKLEY, R.C. (2003) Impacts of tourism on threatened plant taxa and communities in Australia. *Ecological Restoration and Management*, 4, 37–44.
- LAURANCE, W.F. (2009) Conserving the hottest of the hotspots. *Biological Conservation*, 142, 1137.
- MARGULES, C.R. & PRESSEY, R.L. (2000) Systematic conservation planning. *Nature*, 405, 243–253.
- MARTINELLI, M.C., LÓPEZ-PUJOL, J., BLANCHÉ, C., MOLERO, J. & SÁEZ, L. (2011) Conservation assessment of *Aquilegia pavi* (Ranunculaceae): a case study of an extremely narrow endemic. *Oryx*, 2, 187–190.
- MOREIRA, M.M., CARRIJO, T.T., ALVES-ARAÚJO, A., AMORIM, A.M.A., RAPINI, A., SILVA, A.V.S. et al. (2020) Using online databases to produce comprehensive accounts of the vascular plants

- from the Brazilian protected areas: the Parque Nacional do Itatiaia as a case study. *Biodiversity Data Journal*, 8, e50837.
- REZENDE, C.L., SCARANO, F.R., ASSAD, E.D., JOLY, C.A., METZGER, J.P., STRASSBURG, B.B.N., TABARELLI, M. et al. (2018) From hotspot to hopespot: an opportunity for the Brazilian Atlantic Forest. *Perspectives in Ecology and Conservation*, 16, 208–214.
- ROSA, P., BAEZ, C., MORAES, L., MARTINS, E., MORAES, M., MAURENZA, D., NEGRÃO, R. et al. (2018) ‘Procura-se’: entre a falta de informação e a redescoberta de plantas endêmicas do Rio de Janeiro. In *Livro Vermelho da Flora Endêmica do Estado do Rio de Janeiro* (eds G. Martinelli, E. Martins, M. Moraes, R. Loyola & R. Amaro), pp. 42–96. Jardim Botânico do Rio de Janeiro, Rio de Janeiro, Brazil.
- SOULÉ, M.E. (ed.) (1987) *Viable Populations for Conservation*. Cambridge University Press, Cambridge, UK.
- SPECIES LINK (2020) sblink.cria.org.br [accessed 18 October 2019].
- ZHANG, X., ZHOU, X.-L., LIU, Y.-H., MO, J.-Q., ZHANG, L.-Q., WANG, Y.-H. & SHEN, S.-K. (2020) Investigating the status of *Cinnamomum chago* (Lauraceae), a plant species with an extremely small population endemic to Yuannan, China. *Oryx*, 54, 470–473.