

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

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Abstract *Begonia jocolinoi* 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. jocolinoi*, 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. jocolinoi* 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 jocolinoi*, Brazil, ecotourism impact, micro endemism, plant conservation, rare species, small population

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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 jocolinoi* (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. jocolinoi* 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. jocolinoi* 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. jocolinoi*. Previous records of *B. jocolinoi* 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. jocolinoi* 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. jocolinoi* 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. jocolinoi* on Specieslink are in fact *Begonia convolvulacea*

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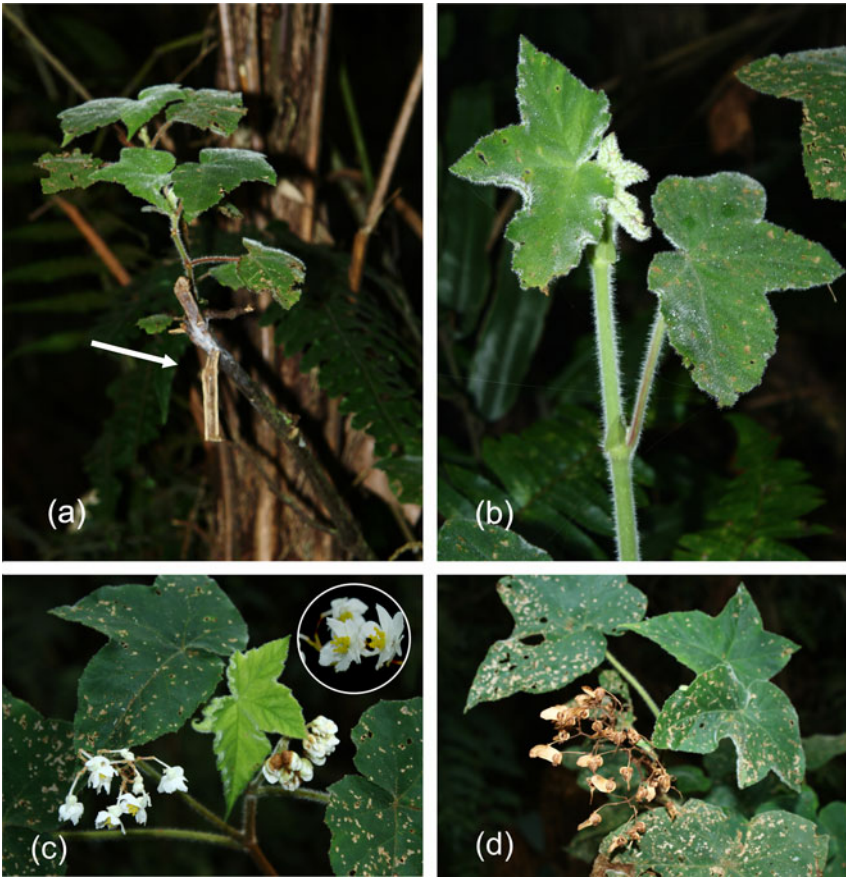


PLATE 1 (a) An adult *Begonia jodelinoi* that has been pruned (arrow) and that is sprouting, (b) a young plant, (c) adult plants at the reproductive stage, with female flowers, and (d) adult fruiting.

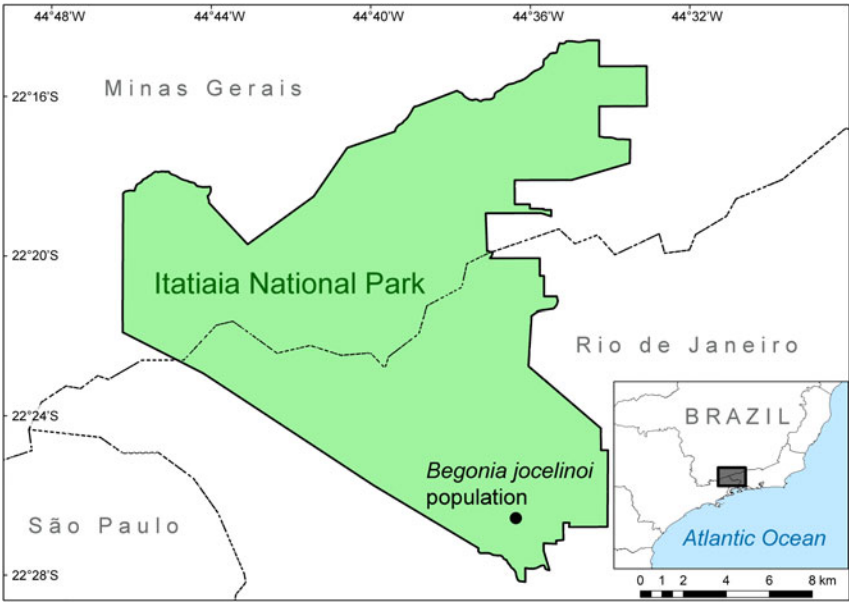


FIG. 1 The location of the single known population of *Begonia jodelinoi* in Itatiaia National Park, Rio de Janeiro, Brazil.

(Klotzsch) A.DC. *Begonia jodelinoi* 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).

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Conflicts of interest None.

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

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