

## Confirmation of *Aloysia dusenii* Moldenke (Verbenaceae) for South Brazil: implications for conservation

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### Resumo

**Confirmação de *Aloysia dusenii* Moldenke (Verbenaceae) para o sul do Brasil: implicações para a conservação.** *Aloysia dusenii* Moldenke (Verbenaceae) é uma espécie reófito endêmica da região Sul do Brasil. Habita beira de rios, sobre afloramentos rochosos com cursos d'água rápidos. Recentes revisões, tratamentos taxonômicos e coletas em campo confirmaram a ocorrência desta espécie para a região sul do Brasil. Com os dados atuais de distribuição, é apresentado o status de conservação desta espécie, de acordo com os critérios da IUCN. As primeiras fotos de *A. dusenii* em campo são fornecidas para a literatura. É destacada a importância da inclusão desta espécie nas listas regionais de flora ameaçada de extinção, tendo em vista sua restrita área de ocupação e o alto grau de ameaça que seu ambiente tem sofrido por barragens e empreendimentos hidrelétricos.

**Palavras-chave:** Espécies ameaçadas; GeoCat; Hidrelétricas; Reófitas

### Abstract

*Aloysia dusenii* Moldenke (Verbenaceae) is a rheophyte species endemic to South Brazil. The species inhabits riverbanks on rocky outcrops along rivers with swift-running streams. Recent revisions, taxonomic treatments and field work have confirmed the species for South Brazil. In this note, the distribution records of *A. dusenii* were compiled and a proposal was made to classify the conservation status of this species according to IUCN guidelines. The first photographs of *A. dusenii* in field were provide for the literature. The importance of including this taxon in the regional lists of endangered flora is emphasized in view of the great threat to their environment coming from dams to hydroelectric projects.

**Key words:** Endangered species; GeoCat; Hydroelectric dams; Rheophytes

## Introduction

*Aloysia* Paláu is an endemic genus of the New World, mainly found in subtropical regions and in the Andes (O'LEARY et al., 2016). The genus has a blurred taxonomic history with different circumscriptions according to authors and analyzed characters (BENTHAM; HOOKER, 1876; MOLDENKE, 1959; MARX et al., 2010; LU-IRVING; OLMSTEAD, 2013; LU-IRVING et al., 2014).

Recent molecular phylogenetic studies have made new combinations and arrangements to be able to establish a well-supported monophyletic *Aloysia* (LU-IRVING et al., 2014). Therefore, this new circumscription comprises 31 species, whose members are shrubs and small trees with dry fruits and long racemose florescences with the rachis longer than the peduncle, and alternate or opposite flowers (O'LEARY et al., 2016). The genus, as newly circumscribed, is almost exclusively found in South America, with only three species restricted to North America.

*Aloysia dusenii* Moldenke was described in 1940 based on material collected from Per Karl Dusén at Paraná State (Brazil) in 1914 (MOLDENKE, 1940; Type: *P.Dusén 1050a* at NY, S), and so far, few records have been checked for the region. The collections of Gerdt Hatschbach made in the 20<sup>th</sup> century in Southern Brazil deserve attention. Hatschbach was one of the largest plant collectors in the last century with more than 80,000 specimens, especially in Paraná State, and all *Aloysia* materials from Hatschbach were studied by Moldenke. However, the formal inclusion of *A. dusenii* in the Brazilian flora was done only recently (BFG, 2015; O'LEARY et al., 2016).

Siedo (2006), in his dissertation regarding the systematics of *Aloysia*, cited the species for the states of Paraná, Santa Catarina and Rio Grande do Sul. Despite that, Múlgura et al. (2008) mentioned *A. dusenii* only for Paraná, and Crespam (2010) did not confirm the species for Rio Grande do Sul. Moreover, Salimena et al. (2010) mentioned the species as belonging to thefor Brazilian flora of Rio Grande do Sul, Paraná and Santa Catarina, but citing material only for Paraná.

A recent taxonomic revision of *Aloysia* provided comprehensive and reliable information about the identity and circumscription of the species of the genus (O'LEARY et al., 2016). However, the authors did not seem to know about populations of *A. dusenii* in the field, where they did not mention any data regarding the conservation status of the species. Based on field work and revision of regional herbarium collections, we determined the distribution of the species and provide a proposal to classify the conservation status of this species according to IUCN guidelines.

## Materials and Methods

The distribution records of *Aloysia dusenii* were compiled using online database of collections available on SpeciesLink (<http://www.splink.org.br>) and Refflora – Virtual Herbarium (<http://refflora.jbrj.gov.br/refflora/herbarioVirtual/>), considering the synonyms according to O'Leary et al. (2016). We also compiled data contained in the taxonomic literature and biodiversity inventories. All data were checked for accuracy and validity of the geographic coordinates through data cross-checking with databases of political units of Brazil in GIS (Google Earth®) and label data. Additionally, we confirmed the identity of the species deposited in the ICN and MBM herbarium (acronym according to Thiers, 2017), the collections with most representative materials, and all the images online available from others herbaria.

The IUCN conservation status of *A. dusenii* was assessed using the criteria of the IUCN Red List (IUCN, 2012). The extent of occurrence (EOO) and the area of occupancy (AOO) were calculated with GeoCAT (BACHMAN et al., 2011; BACHMAN; MOAT, 2012), using cell width of 4 km based on our observations. Field and label data were also used to enhance the categorization.

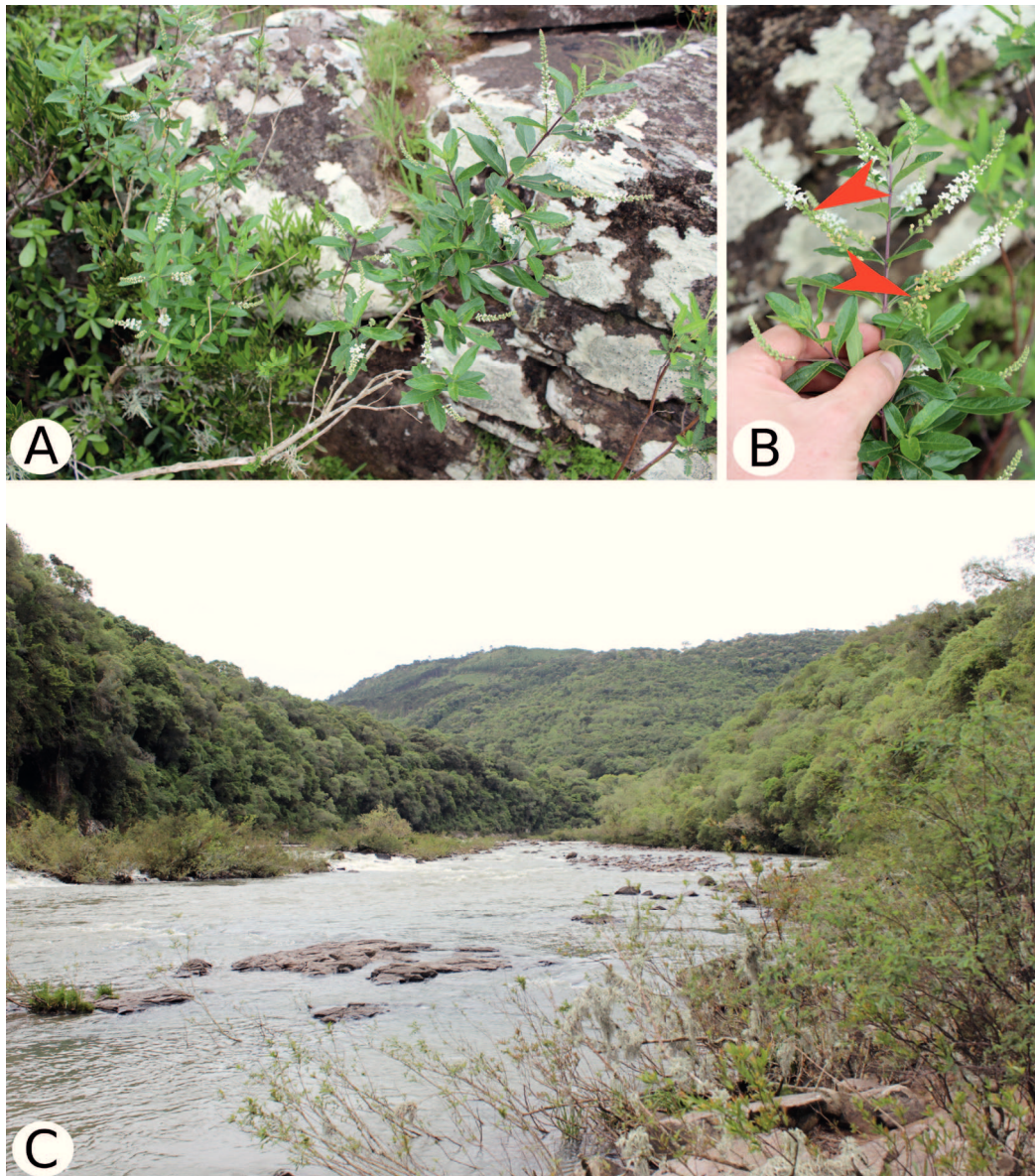
## Results and Discussion

*Aloysia dusenii* Moldenke is an endemic species of South Brazil and has been observed to grow strictly on riverbanks and rocky outcrops along rivers (Figure 1A-C). This characteristic was corroborated by all

the label data that we analyzed, which reported plants growing on riverbanks or in marginal riparian forests. Rheophyte is a term coined by Van Steenis (1981; 1987) to refer to plants that grow along the margins of swift water currents or on the streambed and its rocks, adapted to withstand the force of water with particular traits in their architecture, roots, leaves, flowers and fruits, which facilitate their resistance to the strong currents. A species may be exclusively, preferably or occasionally rheophyte, and *A. dusenii* seems to be exclusive to this environment.

*Aloysia dusenii* is notable in relation to its bilobulated calyx (Figure 1B), which is 4-toothed in the rest of the South American *Aloysia* taxa. Two records found at ICN were mistakenly identified as *A. dusenii*, and we proved that the correct identification was *A. gratissima* (Gillies & Hook. ex Hook.) by its 4-toothed calyx and additional leaf characters. Additionally, these two records were from habitats very distinct from those where *A. dusenii* occurs, being an additional characteristic of the species.

FIGURE 1: A. *Aloysia dusenii*, as sub-shrub, in its natural habitat. B. Detail of a floriferous branch of *A. dusenii* with bilobulated calyx (see zoom in red arrow). C. General aspects of rheophytic habitat with rocky outcrops and swift-running streams.



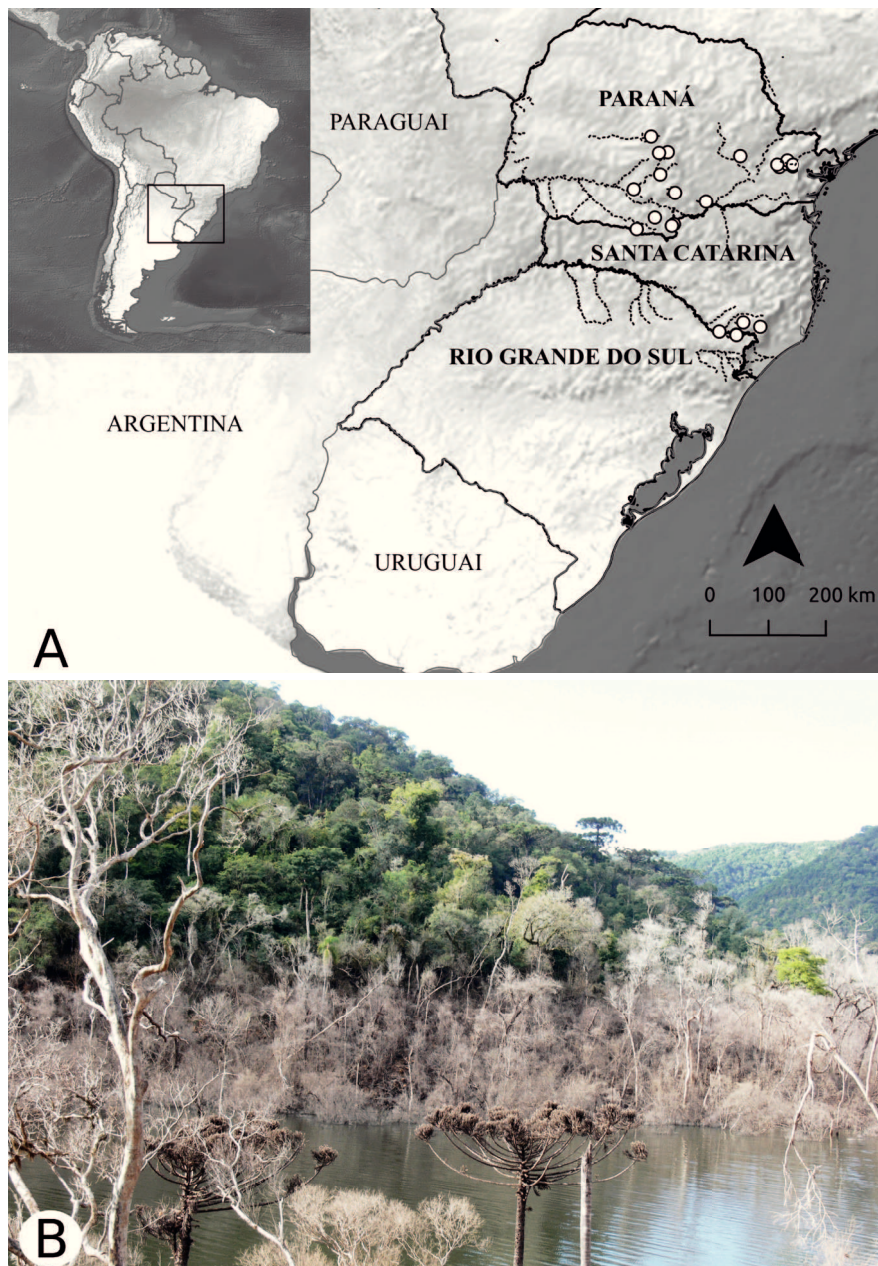


We confirmed 25 records of *A. dusenii* in South Brazil: 17 (68 %) in Paraná, 5 (20 %) in Santa Catarina and 3 (12 %) in Rio Grande do Sul (Figure 2A, see in Supplementary Materials the Specimens Examined). No material was found for the State of Pará, Brazil, although the species is currently cited for this region (MORRONI; O'LEARY, 2017). This is probably related to some orthographic or phonetic error, given the similarity

between “Paraná” and “Pará” spellings, because *Aloysia* is reported only as being cultivated in Pará State.

The predominance of collections for Paraná may be related to the sample effort expended by Hatschbach in that region. However, we know that Santa Catarina was also relatively well studied by the “Flora Ilustrada Catarinense”, planned by Raulino Reitz, but there is no material of *A. dusenii* coming from these efforts. Thus,

FIGURE 2: A. Distribution records of *Aloysia dusenii* in South Brazil (dashed lines are rivers associated with occurrences; white circles represent areas of occurrence). B. Impacts of a river dam: transformation of lotic environment into lentic habitat, and death of many species.



we still do not know if the largest number of records in Paraná is due to the species being more frequent in that region than in the others or if there are gaps to be filled.

### Proposed IUCN Conservation Assessment

This species is given an IUCN Red List Category of Endangered: EN B2b(ii,iii)c(ii,iii). The extent of occurrence (EOO) of the species is estimated to be 84,972.978 km<sup>2</sup>, whereas its area of occupancy (AOO) is estimated to be 352 km<sup>2</sup>, which falls within the limits for EN status under the subcriterion B2. Also considering factors such as continued decline projected for the area of occupancy (b[ii]), decrease in habitat quality (b[iii]); extreme fluctuations in the area of occupancy (c[ii]) and in the number of locations or subpopulations (c[iii]), the species qualifies under conditions “b” and “c” of Endangered (IUCN, 2012).

Rheophytes are usually poorly studied, probably due to the difficulties in accessing their habitat. Few studies are reported for South America with a community or floristic approach (KLEIN, 1979; FONTANA, 2001; BERNARDES, 2012; KÖHLER et al., 2016; HOYOS-GÓMEZ; BERNAL, 2018). Most records of rheophytic species are from individual plants, sometimes new to scientific community (GALEANO-GARCÉS; SKOV, 1989; BERRY; OLSON, 1998; GONÇALVES; ARRUDA, 2013; BERNAL et al., 2017). Additionally, many rheophytic plants are endemic to small areas, even to a single river, and are useful indicators of river health (VAN STEENIS, 1981; 1987). Thus, they are the first species to become locally extinct when a river is dammed (LEES et al., 2016).

*Aloysia dusenii* is so far recorded only along rivers of South Brazil, which are highly threatened by hydroelectric projects (BRACK et al., 2015). River dams for hydroelectric power transform the lotic environment of the rivers into lentic habitats compromising the conditions for rheophytic species (Fig. 2B). Thus, we emphasize the importance of including this species in the regional lists of threatened flora. Currently, the species is only included in the list of the Santa Catarina threatened flora as Vulnerable (CONSEMA, 2014), where it is disregarded in the Paraná and Rio Grande do Sul lists.

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