

Typification, geographical expansion and conservation of *Catasetum rooseveltianum* (Orchidaceae, subtribe Catasetinae), a species revealed by the Rondon Commission in the Early 20th century

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Abstract

Based on literature survey, protologue analysis, field collections, and examination of herbarium specimens, we propose a lectotype for *Catasetum rooseveltianum*. The study also extends the geographical distribution of this species into the northern part of Brazil. An emended description of the taxon is provided together with taxonomic and ecological notes, a distribution map, and a preliminary conservation assessment.

Keywords Brazilian amazon · Cerrado · Lectotype · Orchid · Taxonomy

Introduction

Catasetum Rich. ex Kunth (1822:330) (Orchidaceae) has the largest number of species of any Neotropical genus within subtribe Catasetinae, with 192 accepted species and 46 natural hybrids (Krah1 et al. 2023a; 2025a; 2025b; 2025c; POWO, 2024). Its members are characterized by fusiform pseudobulbs, plicate leaves that are usually oblanceolate, and by a lateral racemose inflorescence bearing unisexual (staminate or pistillate) or rarely bisexual flowers (Holst, 1999). The vegetative morphology as well as the characters of the pistillate and hermaphrodite flowers can rarely be used to separate the species because of their weak variation. Thus, we can rely only on the staminate flowers for classification and identification (Walker-Larsen & Harder, 2000).

The genus is widely distributed from southern Florida, USA, to northern Argentina and southern Brazil (Romero & Carnevali, 2009), but the Amazonian forest is regarded as its center of diversity center. This area has the most species of *Catasetum* (104 spp.), with high a proportion of endemics (73 spp.) (Krah1 et al., 2023b; 2023c; 2024a; 2024b; 2025a; Petini-Benelli, 2025), some of which are regarded as rare (Valsko et al., 2019; Krah1 et al., 2023d).

In Brazil, the state of Mato Grosso stands out in having 33 species of *Catasetum*, as well as nine natural hybrids and one form (Petini-Benelli, 2025). Some of these taxa were described in the early twentieth century by Frederico Carlos Hoehne, based on material collected during the expeditions

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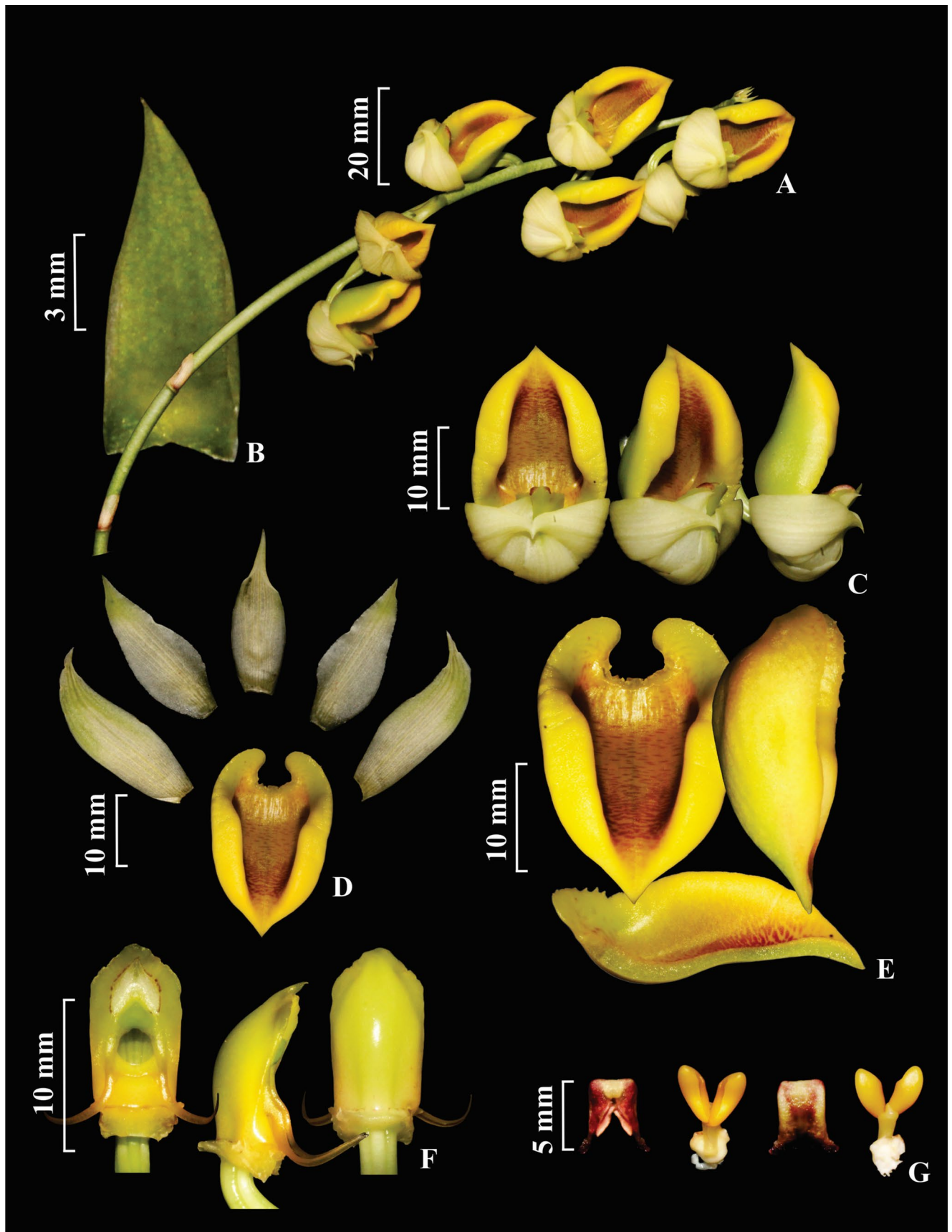
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◀**Fig. 1.** Composite color plate of *Catasetum rooseveltianum* Hoehne. **A.** Inflorescence. **B.** Floral bract. **C.** Flower. **D.** Dissected perianth. **E.** Lip. **F.** Column. **G.** Anther cap and pollinarium. Photographs and plate by A.H. Krahll (from A.H. Krahll 1724).

of the “Comissão de Linhas Telegráficas Estratégicas do Mato Grosso ao Estado do Amazonas”, also known as “Comissão Rondon” (Hoehne, 1910; 1916a). Among members of subtribe Catasetinae that he described there is *Catasetum rooseveltianum* Hoehne (in Hoehne 1916b: 35, t. 172 and 173). In the protologue, the author presents only the collection number and illustrations of the species. A few years later, he indicated that the holotype had been deposited at the herbarium of the Institute of São Paulo (Hoehne & Kuhlmann, 1951), but this material has never been located (Romero & Jenny, 1993).

Therefore, this study provides a lectotype for *Catasetum rooseveltianum*. It also report the first record of this taxon from the Brazilian state of Amazonas, based on new collections made in the northern part of Brazil. We also provide an expanded description, taxonomic and ecological notes, a photographic plate, a distribution map, and a preliminary evaluation of the conservation status.

Materials & Methods

The study is based on the analysis of the protologue of *Catasetum rooseveltianum*, along with a study of specimens collected in the wild and on materials deposited in the herbaria BOLV, LPB (including the Vasquezianum Herbarium), CNMT, R, RB, SP, UFMT, USZ, and UPCB (acronyms according to Thiers, 2025). The material collected in the South of Amazonas state has been prepared according to Mori et al. (1989) and Peixoto & Maia (2013), before being incorporated into the collections of the INPA herbarium. Data relating to habitat, ecology, and phenology are based on in situ observations and on data taken from labels on the material consulted in herbaria. The morphological terminology follows Dressler (1993) and Gonçalves & Lorenzi (2007).

The characterization of the geographical distribution of *C. rooseveltianum* is based on occurrences recorded in the herbaria consulted and on the following databases: SpeciesLink (Canhos et al., 2022), JABOT (Silva et al., 2017), POWO, (2024), and GBIF (Robertson et al., 2019; Barve, 2023). The map has been produced with the software QGIS 3.28.0-Firenze (QGIS, 2021), using SIRGAS 2000. Typification is made in accordance with the International Code of Nomenclature for algae, fungi and plants (Turland et al., 2018).

The extent of occurrence (EOO) and area of occupancy (AOO) have been evaluated using the online tool GeoCAT (Bachman et al., 2011; <http://geocat.kew.org/>). For AOO

we used $2 \times 2 \text{ km}^2$ cells. To place the species within one of the nine categories of threat according to IUCN (2022), we applied criterion B (size of the geographical distribution, fragmentation, number of locations, decline and/or fluctuation of population size). We considered a location as a geographically/ecologically defined area where at least one confirmed occurrence has been recorded.

Three specimens deposited in EAC (barcode EAC0018627!), SP (barcode SP0174980!), and TANG (barcode TANG000001630!) were excluded from the calculations of EOO and AOO because they were either cultivated material or represented specimens of dubious origin.

Taxonomic Treatment

Catasetum rooseveltianum Hoehne, Comm. Lin. Telegr., Bot. 47(9): 35, t. 172 and 173 (1916b). TYPE: Brazil: Mato Grosso, Serra dos Parecis, Salto da Felicidade, alto rio Sepotuba, Jan, bloomed in cultivation in March (fl. ♂) and March 1916 (fl. ♀), F.C. Hoehne 6848 (holotype: SP9109 [not found]). Fig. 1. Lectotype (**here designated**): original illustration published in the protologue by Hoehne (1916b): t. 173 [!].

Description. Plant epiphytic, caespitose, semi-pendent. Rhizome inconspicuous. Pseudobulb $9.9\text{--}16.1 \times 1.7\text{--}3.6$ cm, fusiform, erect to arched, 5–6-leaved, covered by leaf sheaths. Leaves $11.5\text{--}28.1 \times 2.5\text{--}3.1$ cm, linear-lanceolate to oblong-lanceolate, lamina pendent, apex acute. Inflorescence $19.8\text{--}26.7$ cm long, lateral, racemose, erect to hanging with the flower weight, 5–7-flowered; flower bract $0.9\text{--}1.1 \times 0.5\text{--}0.6$ cm, lanceolate, apex acute. Staminate flowers greenish yellow with irregular brownish spots inside the lip, not resupinate, pedicelled; pedicel long $1.2\text{--}2.4$ cm, cylindrical, winding; dorsal sepal $2\text{--}2.5 \times 0.9\text{--}1.2$ cm, elliptical, symmetrical, apex acute; lateral sepals $2.4\text{--}2.8 \times 0.9\text{--}1.1$ cm, elliptical, asymmetrical, curved, apex acute; petals $2.1\text{--}2.5 \times 0.9\text{--}1.4$ cm, ovate to elliptical, symmetrical, apex acute; lip $2.5\text{--}3 \times 1.5\text{--}2$ cm, entire, cymbiform, concave, outline ovate, $0.6\text{--}0.9$ cm deep with a patent bottom, glabrous inside, margin entire and thickened, apex acute; antennae $1\text{--}1.3$ cm long, diverging, thread-like, curved; column $1.4\text{--}1.6 \times 1.4\text{--}1.5$ cm, without beak, apex rounded; pollinia 2, serous, obovate, laterally compressed and grooved in the middle, yellow. Pistillate flower and fruit not seen.

Additional Specimens Examined. **BOLIVIA. Unknown department:** Sítio do Sr. Andrade, 16 Jun 2013, R.P. Andrade ADA165 (UFMT40859!); *idem*, 19 Jun 2013, R.P. Andrade ADA166 (UFMT40860!), *idem*, 03 May 2014, R.P. Andrade ADA167 (UFMT41394!); **Santa Cruz:** Guarayos, no date, R. Vasquez 666 (LPB, ex Herbarium Vasquezianum – Photography!).

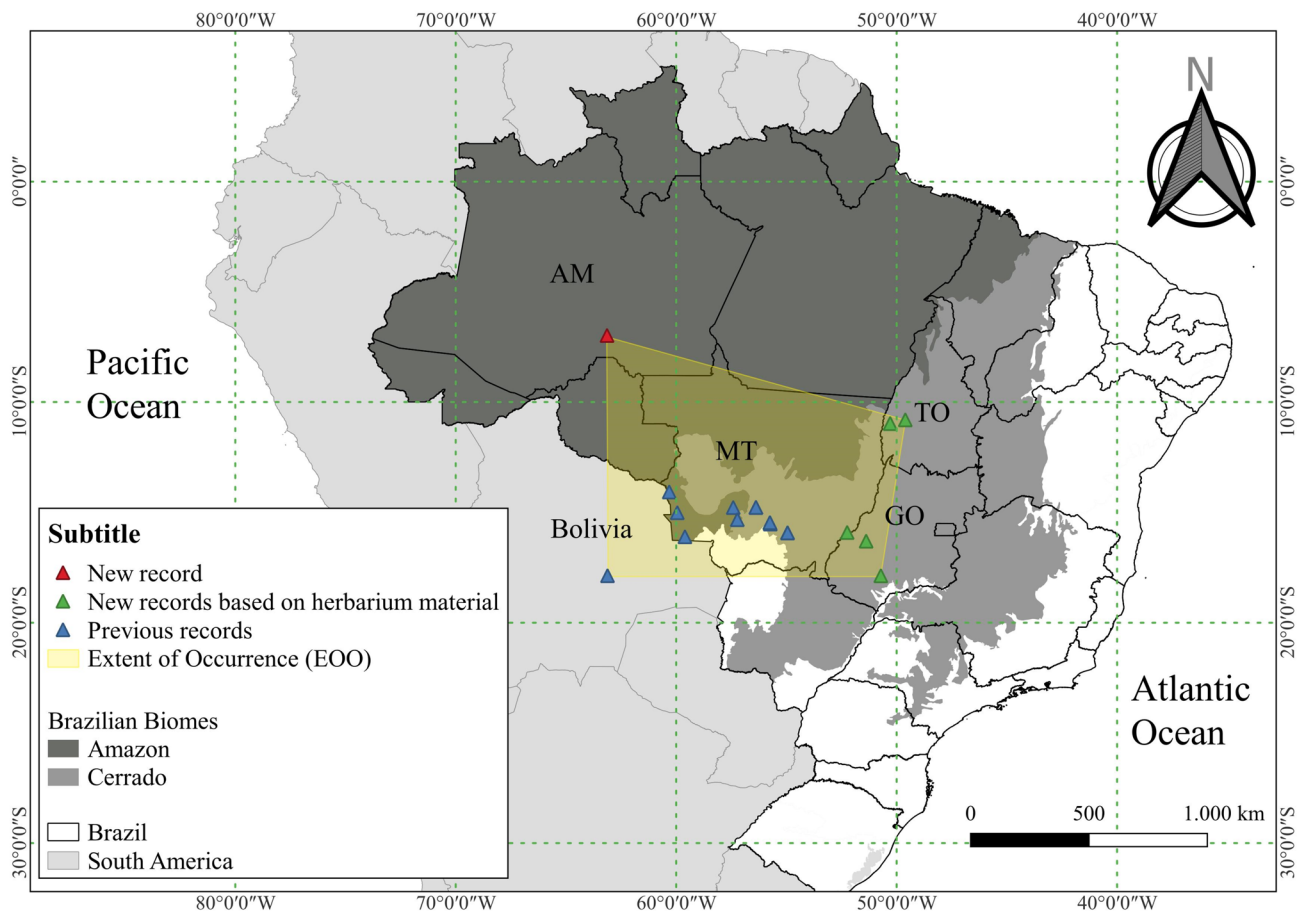


Fig. 2. Geographical distribution of *Catasetum rooseveltianum* Hoehne. AM=Amazonas; GO=Goiás; MT=Mato Grosso; and TO=Tocantins. Map by A.H. Krahll.

BRAZIL. Amazonas: Humaitá, Distrito de Realidade, próximo ao Rio Ipixuna, 10 Feb 2024, *R.R.P. do Nascimento ex A.H. Krahll* 1724 (INPA [!]). **Goiás:** Aragarças, Mar 1947, *H.B. Sick* 60 (RB61996!); *idem*, *H.B. Sick* 147 (RB61997!); Iporá, Povoado Coca, próximo à BR-060, 06 Jun 2014, *M. Novais APB962* (UFMT41426!); Santa Helena de Goiás, próximo à cachoeira de São Tomas, 06 Jun 2014, *R. F. Nunes APB961* (UFMT41423!). **Mato Grosso:** Rio Guaporé, próximo à Bolívia, 1965, *A. Bleher s.n.* (SP175159!); Arenápolis, encontrada em área urbana do município, 23 May 2017, *A. Fumero 001* (TANG6988!); Chapada dos Guimarães, APM-Manso, 19 Apr 2001, *M. Macedo et al.* 7693 (UFMT25230!); *idem*, 04 Apr 2006, *A. Petini-Benelli* 23 (UFMT36447!); Chapada dos Guimarães, próximo ao mirante, 19 Apr 2014, *A. Petini-Benelli APB933* (UFMT41434!); *idem*, 28 Mar 2016, *A. Petini-Benelli CTESE1614* (UFMT43317!); *idem*, 01 Apr 2016, *A. Petini-Benelli CTESE1616* (UPCB90092!); Jaciara, Rio Cuiabá-Mirim, antigo Garimpo do Jatobá, 19 Apr 2014, *A. Petini-Benelli ADA330* (UPCB77051!; CNMT987!; UFMT41435!); Porto Estrela, Serra das Araras, 08 Apr

2014, *A. Serra APB958* (UFMT41431!); Rosário Oeste, Serra da Caixa Furada, 03 Mar 2014, *A. Petini-Benelli ADA1163* (RB597051!; UFMT41240!); *idem*, 1 Apr 2014, *A. Petini-Benelli ADA1235* (RB597032!); Vila Bela da Santíssima Trindade, 15 Feb 2013, *A. Petini-Benelli* 270 (UFMT40857!); pastagem nas proximidades da Área 2 Alagada da Linha de Transmissão de Energia Elétrica Porto Velho-Araraquara, 29 Mar 2014, *A. Petini-Benelli et al.* ADA396 (UFMT41405!). **Tocantins:** Lagoa da Confusão, próximo à lagoa homônima, em área de campo inundável com palmeiras, epífita sobre *Atallea* sp., 15 Feb 2014, *N. Monteiro APB964* (UFMT41790!); Lagoa da Confusão, 06 May 2014, *R. F. Nunes APB959* (UFMT41425!); *idem*, 19 Jul 2014, *R. F. Nunes APB950* (UFMT41784!).

Geographic Distribution, Habitat & Ecology. *Catasetum rooseveltianum* is a species restricted to South America, where it is distributed only in Brazil and adjacent Bolivia (Fig. 2). In Brazil, it can be found as an epiphyte in the Purus-Madeira Moist Forests and Chiquitano Dry Forests of the Amazon and in the Cerrado, being typical of anthropic areas, floodplains,

gallery forests, and palm groves (Borsato et al. 2015; Petini-Benelli, 2025), and confirmed records are known only from the Center-West region in the states of Mato Grosso, Goiás, and Tocantins (Petini-Benelli, 2025). In the present study we add the first record of this taxon in the Brazilian North region, in the municipality of Humaitá, Amazonas.

For Bolivia, the distribution of *Catasetum rooseveltianum* is based on the observations by Vásquez et al. (2003a, 2014). Both studies mentioned vouchers collected by R. Vásquez (collection numbers 666 2505). In theory, both specimens had been deposited in the Herbarium Vasquezianum (VASQ) (Vásquez et al., 2003a,b), but Vásquez 666 was transferred to LPB, the National Herbarium of Bolivia (see Vásquez et al., 2014) after the death of Roberto Vásquez Chávez. The curator of the LPB collection informed us that material relating to the collection of R. Vásquez 666 could be located there, the specimen of R. Vásquez 2505 could not be found. Therefore, we believe that R. Vásquez 2505 may have been lost during the transfer of the material from VASQ to LPB. We also emphasize that Vásquez et al. (2003a) reported that *C. rooseveltianum* is found in the Department of Santa Cruz (Guarayos province) on the basis of R. Vásquez 666, and it was reported to grow in low-elevation areas (0 to 500 m) in the Chiquitano semideciduous forest, in grassland areas, and Cerrado areas.

In Brazil, *C. rooseveltianum* has been observed from the Amazonian region and especially in Cerrado. The Cerrado is a vegetation similar to savannas, with low sparse gnarled-trunked trees, and has a well defined dry climate. Therefore for *C. rooseveltianum* to develop in this biome it must have certain adaptations that make it resistant to long dry periods, and such adaptations can be observed in its leaf anatomy (see Benevenuto et al., 2013).

According to the literature (e.g., Hoehne, 1942; Hoehne & Kuhlmann, 1951; Dubs, 1998; Holst, 1999; Petini-Benelli, 2012; Ostetto, 2015; Faria et al., 2016; Barros et al., 2010; 2018; Petini-Benelli, 2025), *C. rooseveltianum* is distributed in the states of Mato Grosso, Mato Grosso do Sul, and Rondônia. However, no herbarium material could be found from either Mato Grosso do Sul or Rondônia. In Amazonas state, it has been observed near the Rio Ipixuna, located in the Distrito de Realidade, municipality of Humaitá. From material examined in RB and UFMT, we concluded that the species also occurs in the states of Tocantins and Goiás, but only in the Cerrado biome. We emphasize that the records *H.B. Sick 60* (RB61996 [!]) and *H.B. Sick 147* (RB61997 [!]), already previously known, were considered to be collections from Mato Grosso, but here, we assert that they should be regarded as coming from the Goiás state because the reported gathering municipality (Aragarças) is located within the territorial limits of Goiás, albeit at the border with Mato Grosso.

Preliminary Conservation Assessment. *Catasetum rooseveltianum* is known from 27 records grouped into 15 subpopulations (as defined in article 4.2 of the Guidelines for Using the IUCN Red List Categories and Criteria). These subpopulations are distributed in four to six locations (as defined in article 4.11 of the above Guidelines, i.e., geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals) respectively located in Central Amazon, Southern Amazon, Bolivia and Western Cerrado (see Fig. 2), all falling outside of any protected area. Using *GeoCAT*, we estimated EOO to 1,419,990.458 km² (qualifying only as for LC, least concern, under criterion B1) and AOO to 76 km² (potentially qualifying for EN, endangered, under B2). The criterion B2a is met both through a severely fragmented population (15 specimens distributed in more than 1.5 million km²) and a small number of locations. Moreover, due to continuous deforestation for human uses in non-protected areas, we may infer a continuing decline in the area extent and quality of habitat. Therefore, this species should be assessed as EN under criterion B2b(ii,iii).

On the other hand, looking at the criterion C, we may note that the total number of mature individuals is well under 250 and that the number of mature individuals in each subpopulation is under 50, and we may infer a continuing decline of this number due to human activities. These conditions could lead an assessment of CR, critically endangered under criterion C2a(i), but we propose to recommend EN.

Phenology & Floral Visitors. The specimen collected in this study was observed blooming in February, not far from the time indicated by Hoehne (1916b) in his protologue (March), and flowering can continue until July.

In the revision published by Milet-Pinheiro & Gerlach (2017), the authors mention the visitors and pollinators of many *Catasetum* species, but *C. rooseveltianum* does not appear in their list. Nevertheless, males of *Euglossa* spp. (Apidae, Euglossini) have been observed visiting, in loco, the lip of *C. rooseveltianum*, attracted by the volatile compounds present in the flowers (Fig. 3).

Notes. *Catasetum rooseveltianum* belongs to the subgenus *Catasetum*, section *Isoceras*, subsection *Divaricatae*, since it presents diverging symmetrical antennae (Hoehne, 1916b; Bicalho & Barros, 1988; Mauad et al., 2022). Nevertheless, it differs from the other species of the group by having unique morphological traits that easily distinguish it from them, including pseudobulbs with partly leaning growth, narrow leaves with pendent lamina, cymbiform lips that are not resupinate and have lateral margins that are thickened (Hoehne, 1916b; Holst, 1999). As for the vegetative parts, *C. rooseveltianum* has a morphology partially distinct from most of the other species of the group, which are indistinguishable when not in flowers (Holst 1999). The particular pseudobulbs and leaves of *C. rooseveltianum*



Fig. 3. Color plate demonstrating the visit of *Euglossa* sp. to the staminate flowers of *Catasetum rooseveltianum* Hoehne. Photographs by A.H. Krahll (from A.H. Krahll 1724).

vaguely resemble those of *C. longifolium* and natural hybrids related to the latter (e.g. Pabst, 1975; Romero & Jenny, 1992; Bicalho, 1996). We note the existence of two natural hybrids in which *C. rooseveltianum* is one of the parents: *Catasetum* × *eliasii* U.L.C.Ferreira and *Catasetum* × *santoantoniense* U.L.C.Ferreira & R.M.C.Filho (Ferreira, 2019; Ferreira & Filho, 2019), which illustrates the high hybridization potential of the taxon in the wild.

Hoehne (1916b) described *Catasetum rooseveltianum* based on a specimen collected in Mato Grosso state during the expeditions of the Rondon Commission. The specific epithet honors Colonel Theodore Roosevelt Jr., naturalist, historian and 26nd President of the United States between the years 1901 and 1909. In the protologue, Hoehne does not cite the herbarium where the holotype was deposited, giving only a collection number, 6848^a (in liquid), and the drawings n°172 and n°173, which illustrate the pistillate (♀) and staminate (♂) flowers, respectively.

Some decades later Hoehne (1942), in *Flora Brasílica* (volume 10, chapter VI), indicates that the type material of *Catasetum rooseveltianum* had been deposited in the Departamento de Botânica do Estado, of the Instituto de Botânica do Estado de São Paulo (now herbarium SP), under the number 9.109 (Hoehne, 1942: 99) and proposed new illustrations of specimens with staminate flowers (Tab. 58) and with pistillate flowers (Tab. 59). The information relating to the registration of the holotype was confirmed by Hoehne & Kuhlmann (1951: 168) when they published the *Índice Bibliográfico e Numérico das Plantas Colhidas pela Comissão Rondon ou Comissão de Linhas Telegráficas, Estratégicas de Mato-Grosso ao Amazonas, de 1908 até 1923*.

Despite thorough searches together with the curator of SP, no material corresponding to the holotype could be found, as Romero & Jenny (1993) had already stressed it. Because some duplicates from the Rondon Commission were also deposited in the herbaria R and RB (Hoehne & Kuhlmann, 1951), searches were carried out in these collections as well, but no material corresponding to *C. rooseveltianum* could be found in either of these two herbaria. Therefore, since the holotype cannot be located, we here designated the original illustration (Hoehne, 1916b, t. 173), published by Hoehne in the protologue of *C. rooseveltianum*, as the lectotype, according to articles 9.3, 9.4 and 9.12 of the Shenzhen Code (Turland et al., 2018). Art. 9.3 indeed states that “A lectotype is one specimen or illustration designated from the original material as the nomenclatural type, [...] if the holotype is lost or destroyed [...]”. According to article 9.4, original material comprises any illustrations published as part of the protologue and article 9.12 states that the lectotype must be chosen from among the cited illustrations of the original material, when no isotype, syntype, isosyntype, paratype exists, which is the case here.

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Author contributions

DRPK contributed writing (original draft), methodology, and research; MSO writing (review and editing) and research; PS writing (review and editing) and research; GC writing (review and editing) and translation of the text; JBFS writing (review and editing) and research. AHK writing (original draft), research, and preparation of the images; PCC writing (review and editing) and research.

Declarations

Competing interests

No potential conflicts of interest are reported by the authors.

Literature Cited

- Bachman S., J. Moat, A.W. Hill, J. De La Torre & B. Scott. 2011. Supporting Red List threat assessments with GeoCAT: Geospatial conservation assessment tool. *ZooKeys* 150: 117–126.
- Barros, F., F. Vinhos, V.T. Rodrigues, F.F.V.A. Barbarena & C.N. Fraga. 2010. Orchidaceae. Pages 1344–1426 in: R.C. Forzza, P.M. Leitman, A. Costa, A.A. Carvalho Jr., A.L. Peixoto, B.M.T. Walter, C. Bicudo, D. Zappi, D.P. Costa, E. Lleras, G. Martinelli, H.C. Lima, J. Prado, J.R. Stehmann, J.F.A. Baumgratz, J.R. Pirani, L.S. Sylvestre, L.C. Maia, L.G. Lohmann, L. Paganucci, M. Silveira, M. Nadruz, M.C.H. Mamede, M.N.C. Bastos, M.P. Morim, M.R. Barbosa, M. Menezes, M. Hopkins, R. Secco, T. Cavalcanti & V.C. Souza (eds.), *Catálogo de Plantas e Fungos do Brasil*, vol. 2. Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, Rio de Janeiro.
- Barros, F., C.F. Hall, V.B. Paiva-Neto & J.A.N. Batista. 2018. Checklist das Orchidaceae do estado de Mato Grosso do Sul. *Iheringia, Série Botânica* 73: 287–296.
- Barve, V. 2023. Elevating the fitness of use of GBIF occurrence datasets: A proposal for peer review. *Biodiversity Information Science and Standards* 7: e112237.
- Benevenuto, S.A., D.G. Larocca, S.K. Alves, I.V. Silva & I.V. Karsburg. 2013. *Anatomia Foliar de Três Espécies do Gênero Catasetum*. I. Seminário de Biodiversidade e Agroecossistemas Amazônicos, Alta Floresta, Mato Grosso.
- Bicalho, H.D. 1996. *Catasetum* × *faustii* Bicalho – Orchidaceae, um novo híbrido natural. *Revista Brasileira de Horticultura Ornamental* 2: 64–65.
- Bicalho, H.D. & F. Barros. 1988. On the taxonomy of *Catasetum* subsection Isoceras. *Lindleyana* 3: 87–92.
- Borsato, R., R. Loyola, P. Lemes. 2015. *Ecorregiões do Brasil: Prioridades Terrestres e Marinhas*. Instituto LIFE, Curitiba.
- Canhos, D.A.L., E.A. Almeida, A.L. Assad, M.M.D. Cunha-Bustamante, V.P. Canhos, A.D. Chapman, R.D. Giovanni, V.L. Imperatriz-Fonseca, L.G. Lohmann, L.C. Maia & J. T. Miller, G. Nelson, A. Townsend Peterson, J.R. Pirani, S. de Souza, J. Renato Stehmann & B. Thiers. 2022. SpeciesLink: Rich data and novel tools for digital assessments of biodiversity. *Biota Neotropica* 22: 1–15.
- Dressler, R.L. 1993. *Phylogeny and Classification of the Orchid Family*. Dioscorides Press, Portland.
- Dubs, B. 1998. *Prodromus Florae Matogrossensis*, series B, no. 3. Betrona-Verlag, Künsnacht.
- Faria, R.T., R.C. Colombo, L.V.R. Oliveira & M.R. Camolesi. 2016. *Orquídeas do Gênero Catasetum no Brasil*. Editora Mecenasa, Londrina.
- Ferreira, U.L.C. 2019. Two new natural hybrids in *Catasetum* (Orchidaceae) from Centre-West Brazil. *Richardiana, nouvelle série* 3: 80–91.
- Ferreira, U.L.C. & R.M.C. Filho. 2019. Two new natural hybrids in *Catasetum* (Orchidaceae) from Brazil. *Richardiana, nouvelle série* 3: 39–49.
- Gonçalves, E.G. & H. Lorenzi. 2007. *Morfologia Vegetal: Organografia e Dicionário Ilustrado de Morfologia das Plantas Vasculares*. Instituto Plantarum de Estudo da Flora, São Paulo.
- Hoehne, F.C. 1910. *História Natural: Botânica. Parte I: Bromeliaceas, Pontederiaceas, Liliaceas, Amaryllidaceas, Iridaceas, Orchidaceas, Aristolochiaceas, Droseraceas e Passifloraceas*. Comissão de Linhas Telegraficas e Estratégicas de Matto Grosso ao Amazonas, Rio de Janeiro.
- Hoehne, F.C. 1916a. *História Natural: Botânica. Parte IX: Bromeliaceas e Orchidaceas*. Comissão de Linhas Telegraficas e Estratégicas de Matto Grosso ao Amazonas, Rio de Janeiro.
- Hoehne, F.C. 1916b. *Catasetum rooseveltianum*. *Comissão de Linhas Telegraficas, Botanica* 47(9): 35, t. 172–173.
- Hoehne, F.C. 1942. Orchidaceae. *Flora Brasílica*. Vol. XII (VI): 1–218. Secretaria de Agricultura Indústria e Comércio, São Paulo.
- Hoehne, F.C. & J. Kuhlmann. 1951. *Índice Bibliográfico e Numérico das Plantas Colhidas pela Comissão Rondon ou Comissão de Linhas Telegráficas, Estratégicas de Mato-Grosso ao Amazonas, de 1908 até 1923*. Instituto de Botânica de São Paulo, São Paulo.
- Holst, A.W. 1999. *The World of Catasetums*. Timber Press, Portland.
- IUCN. 2022. *Guidelines for Using the IUCN Red List Categories and Criteria*, version 15.1. IUCN Standards and Petitions Committee, Gland.
- Krahl, D.R.P., P. Schmal, G. Chiron, J.B.F. Silva, A.H. Krahl & P.C. Cantuária. 2023a. *Catasetum* × *grasineideae* (Orchidaceae: Catasetinae), a new nothospecies from Brazilian Amazon and taxonomic notes for the genus. *Phytotaxa* 594: 89–104.
- Krahl, D.R.P., M.S. Oliveira, J.B.F. Silva, G. Chiron & P.C. Cantuária. 2023b. *Catasetum krahlii* (Orchidaceae, Catasetinae): A new and threatened species from the Brazilian Amazon. *Acta Botanica Brasílica* 37: e20220258.
- Krahl, D.R.P., M.S. Oliveira, P. Schmal, G. Chiron, J.B.F. Silva, A.H. Krahl, A.A.M.S. Almeida & P.C. Cantuária. 2023c. *Catasetum tavaresii* (Catasetinae), a new species from the Central Brazilian Amazon. *Lankesteriana* 23: 485–493.
- Krahl, D.R.P., P. Schmal, G. Chiron, J.B.F. Silva, A.H. Krahl & P.C. Cantuária. 2023d. Taxonomic notes on *Catasetum meae* (Orchidaceae: Catasetinae). *Phytotaxa* 609: 240–246.
- Krahl, D.R.P., P. Schmal, G. Chiron, J.B.F. Silva, A.H. Krahl & P.C. Cantuária. 2024a. *Catasetum queirozii* (Orchidaceae: Catasetinae): a new species from the Brazilian Amazon. *Acta Amazônica* 54: e54bc23180.
- Krahl, D.R.P., P. Schmal, M.S. Oliveira, J.B.F. Silva, G. Chiron & A.H. Krahl. 2024b. *Catasetum cantuarii* (Orchidaceae, Catasetinae), a new species from the Brazilian Amazonian biome. *Kew Bulletin* 79: 583–595.
- Krahl, D.R.P., M.S. Oliveira, P. Schmal, J.B.F. Silva, G. Chiron, A.H. Krahl & P.C. Cantuária. 2025a. *Catasetum* × *angelae* (Orchidaceae: Catasetinae), a new nothospecies from the Brazilian Amazon in the subgenus *Pseudocatasetum*, and taxonomic notes for *C. pusillum*. *New Zealand Journal of Botany*, <https://doi.org/10.1080/0028825X.2025.2469623>.

- Krahl, D.R.P., P. Schmal, G. Chiron, J.B.F. Silva, M.S. Oliveira, A.H. Krahl & P.C. Cantuária. 2025b. *Catasetum* × *abreuanum* (Orchidaceae, Catasetinae), a new nothospecies from the Brazilian Amazon belonging to the *C. cristatum* complex. *Botany Letters*, <https://doi.org/10.1080/23818107.2025.2486760>.
- Krahl, D.R.P., M.S. Oliveira, P. Schmal, J.B.F. Silva, G. Chiron, A.H. Krahl & P.C. Cantuária. 2025c. *Catasetum* × *humaitaense* (Orchidaceae: Catasetinae), a new nothospecies from the Brazilian Amazon. *Biota Colombiana* 26: 1–14.
- Kunth, K.S. 1822. *Catasetum*. *Synopsis Plantarum* 1: 330–331.
- Mauad, A.V.S.R., A. Petini-Benelli, T.J. Izzo & E.C. Smidt. 2022. Phylogenetic and molecular dating analyses of *Catasetum* (Orchidaceae) indicate a recent origin and artificial subgeneric groups. *Brazilian Journal of Botany* 45: 1235–1247.
- Milet-Pinheiro, P. & G. Gerlach. 2017. Biology of the Neotropical orchid genus *Catasetum*: A historical review on floral scent chemistry and pollinators. *Perspectives in Plant Ecology, Evolution and Systematics* 27: 23–34.
- Mori, S.A., L.A. Silva, G. Lisboa & L. Coradin. 1989. *Manual de Manejo do Herbário Fanerogâmico*. Ceplac, Ilhéus.
- Ostetto, S. 2015. *Orquídeas de Mato Grosso do Sul*. Gráfica e Editora Alvorada, Campo Grande.
- Pabst, G.F.J. 1975. New or critical Orchids from Brazil—VII. *Orchid Review* 83: 405–406.
- Peixoto, A.L. & L.C. Maia. 2013. Manual de procedimentos para herbários. *INCT-Herbário virtual para a Flora e os Fungos*. UFPE, Recife.
- Petini-Benelli, A. 2012. *Orquídeas de Mato Grosso, Genus Catasetum L.C. Rich. ex Kunth*. PoD Editora, Rio de Janeiro.
- Petini-Benelli, A. 2025. *Catasetum*. Flora e Funga do Brasil 2020. Jardim Botânico do Rio de Janeiro, JBRJ. <http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB11312> (Accessed: 3 February 2025).
- POWO. 2024. *Plants of the World Online*. Royal Botanic Gardens, Kew. <http://www.plantsoftheworldonline.org/> (Accessed: 3 May 2025).
- QGIS Development Team. 2021. QGIS geographic information system. Open source geospatial foundation project. Downloadable from: <https://qgis.org/en/site/>.
- Robertson, T., S. Belongie, H. Adam, C. Kaeser-Chen, C. Zhang, K. Chuan-Tan, Y. Liu, D. Brulé, C. Deltheil, S. Loarie, G. Van Horn, O. Mac Aodha, S. Beery, P. Perona, K. Copas & J. Waller. 2019. Training Machines to Identify Species using GBIF-mediated Datasets. *Biodiversity Information Science and Standards* 3: e37230.
- Romero, G.A. & G. Carnevali. 2009. *Catasetum*. Pages 13–18 in: A.M. Pridgeon, P.J. Cribb, M.W. Chase & F.N. Rasmussen (eds.), *Genera Orchidearum, Epidendroidea*, Part II. Oxford University Press, New York.
- Romero, G.A. & R. Jenny. 1992. New natural hybrids and nomenclatural novelties in *Catasetum* (Orchidaceae) from the Guianas, Ecuador, and Peru. *Novon* 2: 241–248.
- Romero, G.A. & R. Jenny. 1993. Contributions toward a monograph of *Catasetum* (Catasetinae, Orchidaceae) I: A checklist of species, varieties, and natural hybrids. *Harvard Papers in Botany* 1: 59–84.
- Silva, L.A.E., C.N. Fraga, T.M.H. Almeida, M. Gonzalez, R.O. Lima, M.S. Rocha, E. Bellon, E.S. Ribeiro, F.A. Oliveira, L.S. Clemente, U.R. Magdalena, E.S.M. Medeiro & R.C. Forzza. 2017. Jabot—Sistema de Gerenciamento de Coleções Botânicas: a experiência de uma década de desenvolvimento a avanços. *Rodriguésia* 68: 391–410.
- Thiers, B. 2025 [continuously updated]. *Index Herbariorum: The Herbaria of the World*. <http://sweetgum.nybg.org/ih/> (Accessed: 3 May 2025).
- Turland, N.J., J.H. Wiersema, F.R. Barrie, W. Greuter, D.L. Hawksworth, P.S. Herendeen, S. Knapp, W. Kusber, D. Li, K. Marhold, T.W. May, J. McNeill, A.M. Monro, J. Prado, M.J. Price & G.F. Smith. 2018. *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code)*. Regnum Vegetabile 159. Koeltz Scientific Books, Königstein.
- Valsko, J., A.H. Krahl, A. Petini-Benelli & G. Chiron, G. 2019. *Catasetum sophiae*, a new species of Orchidaceae (Catasetinae) from northern Brazil. *Phytotaxa* 402: 104–120.
- Vásquez, R., P.L. Ibisch & B. Gerkmann. 2003a. Preliminary list of Bolivian Orchid Species. *Organisms Diversity & Evolution* 3, Electr. Suppl 4: 1–14.
- Vásquez, R., P.L. Ibisch & B. Gerkmann. 2003b. Diversity of Bolivian Orchidaceae – a challenge for taxonomic, floristic and conservation research. *Organisms Diversity & Evolution* 3: 93–102.
- Vásquez, R., P.L. Ibisch & I. Jiménez-Pérez. 2014. Orchidaceae. Pages 894–989 in: P.M. Jørgensen, N.H. N.
- Walker-Larsen, J. & L.D. Harder. 2000. The evolution of staminodes in Angiosperms: patterns of stamen reduction, loss, and functional re-invention. *American Journal of Botany* 87: 1367–1384.

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