





Expanding the distribution of *Tapanhuacanga campinorum* (K.Krause) P.L.R.Moraes (Rubiaceae, Rubioideae) to central-western Brazil: the first record for the State of Mato Grosso, in the Parque Estadual do Cristalino

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How to cite: Carmo, J. A. M., Sobrado, S. V., Florentín, J.E. & Salas, R.M. 2024. Expanding the distribution of *Tapanhuacanga campinorum* (K.Krause) P.L.R.Moraes (Rubiaceae, Rubioideae) to central-western Brazil: the first record for the State of Mato Grosso, in the Parque Estadual do Cristalino. Hoehnea 51: e118223. <http://dx.doi.org/10.1590/2236-8906e118223>

ABSTRACT – (Expanding the distribution of *Tapanhuacanga campinorum* (K.Krause) P.L.R.Moraes (Rubiaceae, Rubioideae) to central-western Brazil: the first record for the State of Mato Grosso, in the Parque Estadual do Cristalino). We report the occurrence of *Tapanhuacanga campinorum* in the Parque Estadual do Cristalino, in the State of Mato Grosso, Central-West Brazil. This represents the first record of the genus in this State and the species in this region of the country, since *T. campinorum* was known only from the Amazonian campinas vegetation in the States of Amazonas and Pará, in the northern region of Brazil. We further comment on the distribution, conservation, and taxonomic aspects of this species.

Keywords: Amazon forest, Amazonian campinas, Brazilian flora, Cerrado, Spermaceae

RESUMO – (Expandindo a distribuição de *Tapanhuacanga campinorum* (K.Krause) P.L.R.Moraes (Rubiaceae, Rubioideae) para o Centro-Oeste do Brasil: o primeiro registro para o Estado de Mato Grosso, no Parque Estadual do Cristalino). Relatamos a ocorrência de *Tapanhuacanga campinorum* no Parque Estadual do Cristalino, no Estado do Mato Grosso, Centro-Oeste do Brasil. Este representa o primeiro registro do gênero neste estado e da espécie nesta região do país, já que *T. campinorum* era conhecida apenas das vegetações de campinas amazônicas dos Estados do Amazonas e Pará, na região Norte do Brasil. Comentamos ainda sobre a distribuição, conservação e aspectos taxonômicos desta espécie.

Palavras-chave: Amazônia, campina amazônica, Cerrado, flora brasileira, Spermaceae

Introduction

Psyllocarpus Mart. & Zucc. is an endemic genus from Brazil. As currently circumscribed, the genus is distributed in the Amazonia, Caatinga, and Cerrado phytogeographic domains and comprises 13 species (Kirkbride 1979, Carmo *et al.* 2018a, Sobrado *et al.* 2022). It is nested in the *Spermaceae* clade in the mostly herbaceous *Spermaceae*, a tribe characterized by, but not always, the fimbriate stipules and tetramerous flowers (Kårehed *et al.* 2008, Salas *et al.* 2015, Carmo *et al.* 2022, Nuñez Florentín *et al.* 2022). Among its relatives, *Psyllocarpus* is distinct mainly by the septifragal capsules compressed

parallel to a persistent septum (von Martius 1824, Kirkbride 1979).

Moraes (2019) has proposed new combinations of *Psyllocarpus* under the obscure *Tapanhuacanga*, its priority name. Such a proposal was based solely on nomenclatural reasons and did not involve a detailed and critical examination of herbaria material. Thus, to promote stability and the use of a long-established name, consistently used ever since its publication (von Martius & Zuccarini 1824), Carmo *et al.* (2019) proposed to conserve the name *Psyllocarpus*. Also, the monophyly of *Tapanhuacanga* remains to be tested, as well as how it relates to the other genera in the *Spermaceae* clade, hence some of the combinations by Moraes (2019) might

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be relegated to synonymy. Nevertheless, the proposal by Carmo *et al.* (2019) was not recommended (Applequist 2023, Wilson 2023), therefore the name *Tapanhuacanga* should be used from now on (Turland *et al.* 2018).

In the latest classification of the genus, when it was still called *Psyllocarpus*, Kirkbride (1979) divided it into two sections, namely *Psyllocarpus* sect. *Psyllocarpus* and *P.* sect. *Amazonica* J.H.Kirkbr., based on geographical distribution and morphology. *Psyllocarpus* sect. *Psyllocarpus*, which follows the concept of von Martius (1824), is characterized by the terete leaves, homostylous flowers, prolate-spheroidal pollen grains, psilate tectum with spinules generally distributed along each side of the colpi exine, and a weakly bilobate to rarely capitate stigma. This section is found in the Cerrado and campo rupestre of the Espinhaço range and the Planalto Central of eastern and central Brazil, in the States of Bahia, Goiás, Minas Gerais, and the Distrito Federal. Currently, this section comprises nine species (Kirkbride 1979, Carmo *et al.* 2018a, Sobrado *et al.* 2022).

On the other hand, the species included in the genus as *Psyllocarpus* sect. *Amazonica* present planar leaves, heterostylous flowers, oblate-spheroidal pollen grains, perforated tectum, finely and evenly spinulose exine, and deeply bifid stigma. The three species in this section are restricted to white-sand Amazonian campinas from the northern region of Brazil, occurring in the States of Amazonas, Pará, and Rondônia (Kirkbride 1979).

Two species have been described but not classified in any section. *Tapanhuacanga intermedia* (E.L.Cabral & Bacigalupo) P.L.R.Moraes (Cabral & Bacigalupo 1997), an endemic species from Bahia, northeastern Brazil, was not assigned to any section because of divergent characteristics that do not fully correspond to either *P.* sect. *Psyllocarpus* or *P.* sect. *Amazonica* (Cabral & Bacigalupo 1997, Carmo *et al.* 2023), while *T. densifolia* (Zappi & Calió) P.L.R.Moraes (Zappi *et al.* 2014), which also corresponds to the first synonym created by Moraes (2019), was transferred to a monotypic genus of its own, namely *Diadorimia* J.A.M.Carmo, Florentín & R.M.Salas (Carmo *et al.* 2022).

As our ongoing revision of *Tapanhuacanga* progresses, our field expeditions and examination of herbaria material have led to several taxonomic novelties (Carmo *et al.* 2017, 2018a, 2018b, 2022, 2023, Sobrado *et al.* 2022). During a visit to the SPF herbarium, we came across a duplicate collection of *Sasaki 2126*, which belongs to *Tapanhuacanga campinorum* (K.Krause) P.L.R.Moraes. This species was then included in *Psyllocarpus* sect. *Amazonica* and is known to occur in the States of Amazonas and Pará, northern Brazil (Kirkbride 1979). However, this particular collection was made in the Parque Estadual

do Cristalino, in the State of Mato Grosso, in the central-western region of the country. Thus, this represents the first record of the genus in this State and the species in this region. Therefore, we here report this new record of *T. campinorum*, and further comment on its distribution, conservation, and taxonomy.

Material and methods

We analyzed the protologue of the basionym *Borreria campinorum* K.Krause and specimens from the CTES, F, IAN, MG, MO, NY, RB, SPF, and US herbaria in person, and HGB and K online (acronyms according to Thiers continuously updated). The distribution map was elaborated using the QGIS® software (QGIS Development Teams 2018). An informal assessment of conservation status was carried out by range size (B criterion), following the IUCN Standards and Petitions Committee (2022) recommendations. Extent of occurrence (EOO) and area of occupancy (AOO) were estimated using GeoCAT (Bachman *et al.* 2011).

Results and Discussion

Tapanhuacanga campinorum (K.Krause) P.L.R.Moraes in Feddes Repert. 130: 51. 2019 \equiv *Psyllocarpus campinorum* (K.Krause) J.H.Kirkbr. Smithsonian Contr. Bot. 41: 13. 1979 \equiv *Borreria campinorum* K.Krause in Verh. Bot. Vereins Prov. Brandenburg 50: 118. 1908 (publ. 1909). Description in Kirkbride (1979). Type: BRAZIL - Amazonas, “Campina an den Cachoeiras des Marmelos”, III-1902, *Ule 6102* (lectotype [designated by Kirkbride (1979)] HBG 521835 [digital image]!; isotypes F!, K [digital image]!).

Material examined: BRAZIL. AMAZONAS: Estrada Transamazônica, 1-VI-1979, *T.R.Bahia 25* (IAN); Manicoré, BR 230, Rodovia Transamazônica, a 243 km de Humaitá, 7°40'S, 61°10'W, 24-IV-1985, *C.A.C.Ferreira 5815* (INPA, MG, MO, RB); Transamazon Highway, 53 km W of the Aripuanã river, 27-VI-1979, *C.E.Calderón 2695* (MO, NY, US); 9 km W of Rio dos Pombos, ca. 1.5 km E of Igarapé dos Pombos, and ca. 64 km E of the Aripuanã, 18-VI-1979, *C.E.Calderón 2560* (F, NY). MATO GROSSO: Novo Mundo, Parque Estadual do Cristalino, Serra do Rochedo, limite sul do Parque, acesso pela Fazenda AJJ, alt. 459 m, 9°41'16”S, 55°26'30”W, 02-II-2008, *D.Sasaki 2126* (K, SPF). PARÁ: Region of Missão Velha, a Mundukurú village ca. 2 km N of the Rio Cururú, alt. ca. 200 m, 7°45'S, 57°20'W, 13-II-1974, *W.R.Anderson 10918* (IAN, MO, NY, US).

Geographical distribution: *Tapanhuacanga campinorum* is found in the northern region of Brazil, specifically in the campinas, which is a form of low, woody vegetation found on podzolized white-sand soils. Campinas usually

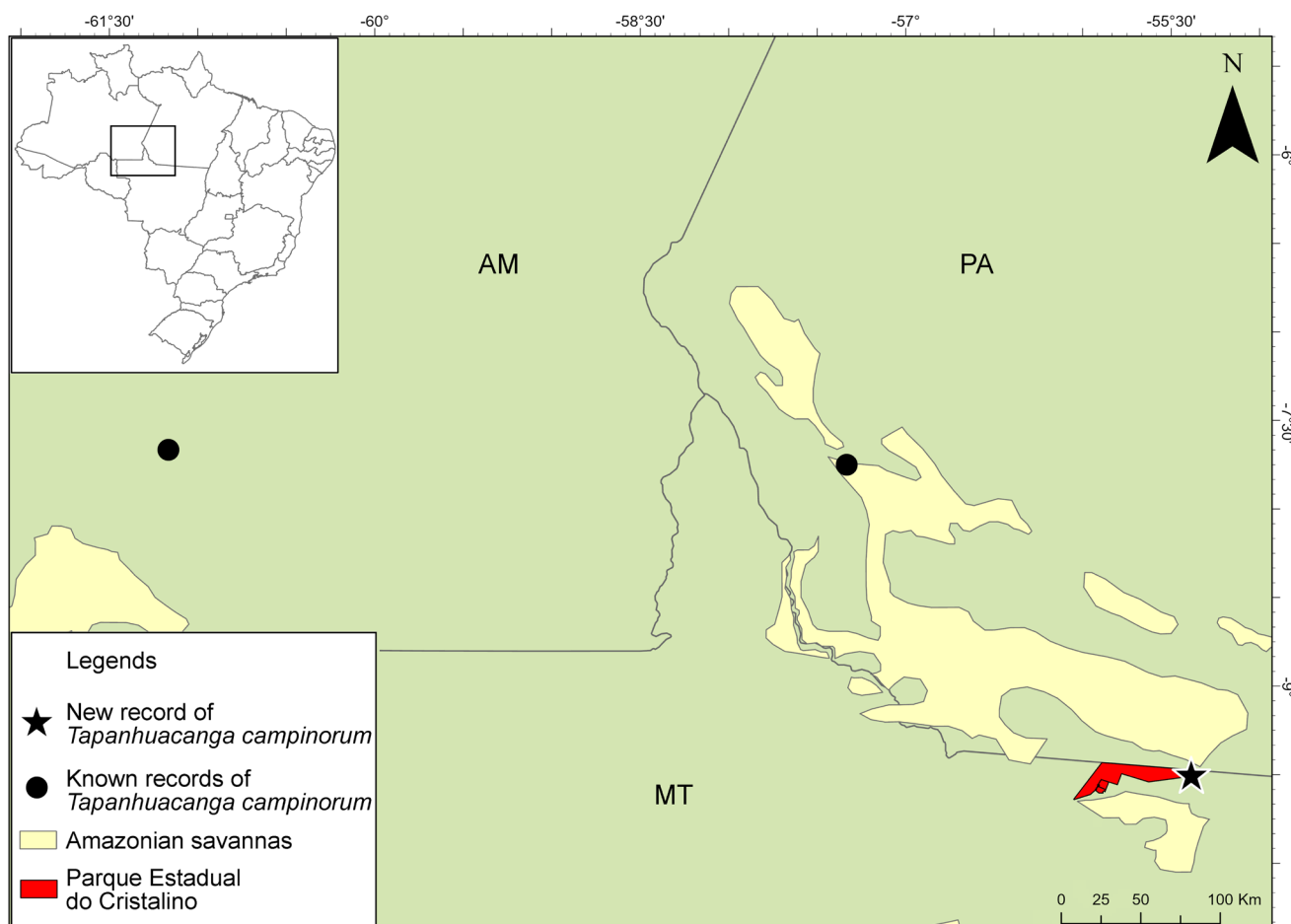


Figure 1. Distribution map in Brazil of *Tapanhuacanga campinorum* (K.Krause) P.L.R.Moraes (Rubiaceae, Rubioideae). AM: State of Amazonas. MT: State of Mato Grosso. PA: State of Pará.

present low species diversity, and their flora contains a number of endemics (Lisbôa 1975). *Tapanhuacanga campinorum* is found along the Rio Marmelos and Rio Aripuanã near the Transamazonian Highway, in the State of Amazonas, as well as in sandy areas along the Rio Cururú, in Pará (Kirkbride 1979). This species also thrives in the central-western region of the country, specifically in Parque Estadual do Cristalino, in the municipality of Novo Mundo, Mato Grosso, where it can be found in areas with opened vegetation associated with rocky outcrops (figure 1).

Preliminary conservation status: *Tapanhuacanga campinorum* presents EOO and AOO equal to 45002 km² and 12 km², respectively (kml file available as supplementary file <https://figshare.com/s/1d6de4a30eda8ddb48fd>). Until this point, this species was known to occur in the northern region of Brazil. We therefore expand its distribution by recording its occurrence in the central-western region of the country, in the Parque Estadual do Cristalino, a conservation unit of integral protection, in the municipality of Novo Mundo, Mato Grosso. Nevertheless, the criteria for the threatened categories are to be applied to a taxon whatever the level of conservation action affecting it (IUCN Standards and Petitions Committee 2022).

The EOO of *T. campinorum* would qualify the species as Least Concern (LC). However, due to the very nature of the campinas, which is a patchy type of vegetation where this species grows, we believe the AOO would be a more accurate estimate of this species distribution. Therefore, *T. campinorum* is preliminarily assessed as Endangered EN B2ab(iii), based on the AOO (less than 500 km²), occurrence in three locations, and an inferred continuing decline of the quality of the habitat, due to the advance of extensive cattle ranching and soybean plantations, among others, in the region (Fearnside 2005).

The rate of native vegetation loss along the southern and eastern edges of the Amazon domain in this region, which is called the “arc of deforestation”, is dramatic. Although Amazonian forest is cut for various reasons, cattle ranching predominates (Fearnside 2005). In fact, in an analysis of the spatial variability of the reasons for the deforestation in the Amazon in Brazil from 2010 to 2019, it was observed that the average variable of number of oxen was the one that showed the highest correlation with deforestation. Thus it was found that the livestock sector in southern Amazonia is the main economic agent that pressures large areas of deforestation, since stockfarming is practiced extensively (Santos *et al.* 2021).

Comments: In the last taxonomic revision of the genus, when it was still called *Psyllocarpus*, Kirkbride (1979) classified it into two sections based on morphology and geographic distribution, expanding the circumscription of the genus (von Martius & Zuccarini 1824, von Martius 1824). Such a circumscription was mainly due to the weight that was given to a single character, the capsules compressed parallel to the septum. The new classification resulted in a rather heterogeneous genus, with *Psyllocarpus* sect. *Amazonica* sharing the compressed capsules with *P.* sect. *Psyllocarpus* but distinctively differing in other features, such as planar leaves (as opposed to terete in *P.* sect. *Psyllocarpus*), heterostylous flowers (instead of homostylous with included stamens and style), and perforate tectum (rather than psilate).

In addition to the morphological and geographic differences, the species included in *Tapanhuacanga* (Moraes 2019) as the so called *Psyllocarpus* sect. *Amazonica* were either transferred from other genera or newly described. *Tapanhuacanga campinorum* was transferred from *Borreria* G.Mey. and *T. psyllocarpoides* (Sucre) P.L.R.Moraes from *Staelia* Cham., while *T. cururuensis* (J.H.Kirkbr.) P.L.R.Moraes was described by Kirkbride (1979). Therefore, the monophyly of *Tapanhuacanga* remains to be tested, as well as how it relates to the other genera in the *Spermacoce* clade.

Regardless of the identity of *T. campinorum*, which is being investigated by our group, it is its first record in the central-western region of Brazil and in the State of Mato Grosso, in the Parque Estadual do Cristalino (image of a duplicate of *Sasaki 2126* deposited at K available at <https://specieslink.net/rec/745/K000652747>, incorrectly identified as *Borreria spicata* (Miq.) Bacigalupo & E.L.Cabral). This is the largest conservation unit located in the “Cristalino region”, a term usually used to refer to the Mato Grosso portion of the Cristalino River basin, a tributary of the Teles Pires River, which rises in Serra do Cachimbo, in southern Pará (Zappi *et al.* 2011).

Since its establishment, the Parque Estadual do Cristalino has been embroiled in a series of disputes about its boundaries, with tensions escalating after 2006. The most significant of these disputes involved opposing factions of social actors. On one hand were those who advocated for preserving the park’s existing boundaries, including organized civil society groups and researchers. On the other hand, there were those who advocated for a reduction in the park’s size, such as farmers and large landowners (Pereira & Nascimento 2010). As of today the Parque Estadual do Cristalino, despite its relatively small size in Amazonian terms (184,900 ha), is considered one of the most relevant conservation units, as it is located on an edge of the Brazilian Amazon, in a transition zone with the Cerrado, and harbours exceptional biodiversity (Pereira & Nascimento 2010).

Zappi *et al.* (2011) conducted a floristic survey of vascular plants in the Parque Estadual do Cristalino, which identified 1,366 species belonging to 626 genera and 151 families. The survey documented at least seven previously unknown species and several endemics from the Serra do Cachimbo, along with new records for Mato Grosso and Brazil. The authors anticipated that future investigations would increase the number of species even further, as is the case of our study. Given its exceptional biological diversity, particularly in an ecotone region of the Amazonian periphery that is relatively understudied, and the ongoing threat of deforestation pushing northwards into the basin, conservation efforts in the Cristalino should be a top priority (Zappi *et al.* 2011).

Acknowledgments

João Afonso Martins do Carmo acknowledges Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), for the doctoral fellowship; CAPES for the PDSE scholarship (Process 88881.135488/2016-01); the Missouri Botanical Garden, for the Shirley A. Graham Fellowship in Systematic Botany and Biogeography; the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET - Argentina) for the postdoctoral fellowship; the staffs of the CTES, F, IAN, MG, MO, NY, RB, SPF, and US herbaria; Luisa de Pontes Ribeiro, for elaborating the distribution map of *Tapanhuacanga campinorum*; and Andreza Stephanie de Souza Pereira, for the photographs of *Psyllocarpus* collections deposited at the MG herbarium.

Conflict of interests

There is no conflict of interest.

Authors’ contributions

João Afonso Martins do Carmo: Conceived this work, analysed collections deposited in herbaria, and was the primary author of the manuscript, to which all authors have contributed to the final version.

Sandra Virginia Sobrado: analysed collections deposited in herbaria.

Roberto Manuel Salas: analysed collections deposited in herbaria.

Javier Elias Florentín: estimated the EOO and AOO of *Tapanhuacanga campinorum*.

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Associate Editor: Alain Chautems

Received: 11/12/2023

Accepted: 04/04/2024

