



A new saxicolous species of *Acisanthera* (Melastomataceae: Marcetieae) from Chapada dos Guimarães National Park, Mato Grosso, Brazil

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ABSTRACT

Acisanthera saxatilis is described, illustrated, and compared with putative relatives. The first specimen of this new species was collected 119 years ago by Oskar Andersson Gustaf Malme during his “second expedition Regnelliana”. *Acisanthera saxatilis* is a little collected species apparently endemic to rocky sandstone formations in Chapada dos Guimarães, Mato Grosso state, Brazil. It differs from similar species by its perennial habit, lignotubers, isomorphic to slightly subisomorphic androecium, stamens positioned in a circle around the style during anthesis, antesepalous stamens with short connectives, small inconspicuous staminal appendages, and purple anthers. Photos of living specimens, a distribution map, scanning electron photographs of seeds and leaves, a preliminary conservation status assessment, as well as comments on vascular plant endemism at the Chapada dos Guimarães are provided.

Keywords: *Acisanthera*, Brazil, Cerrado, Chapada dos Guimarães, Mato Grosso, neotropical region, endemism, endangered species.

Introduction

Acisanthera (Melastomataceae) is a neotropical genus comprising seven species of annual or perennial herbs to subshrubs (Kriebel 2008; Rocha *et al.* 2018). This genus has a complex taxonomic history and remarkable morphological variation (Kriebel 2008; Guimarães *et al.* 2017). About 18 species were traditionally recognized in a broadly circumscribed *Acisanthera*. Recent analyses based on both morphological and molecular data sets support the re-circumscription of *Acisanthera s.l.* into four genera, *i.e.* *Rostranthera*, *Dicrananthera*, *Noterophila*, and *Acisanthera s.s.* (Rocha *et al.* 2016, 2018). In this context, *Acisanthera*

s.s. was re-defined to include only species with 5-merous flowers and 3-locular ovaries (Rocha *et al.* 2018), matching *Acisanthera* sect. *Acisanthera* as previously delimited by Cogniaux (1885). Species of *Acisanthera s.s.* occur from Cuba south to Argentina. In the southern portion of their distributional ranges they are best represented in the mountainous regions of southern Brazil, where *A. variabilis*, *A. alsinaefolia* and *A. uniflora* are found (Kriebel 2008; Flora do Brasil 2020).

The Chapada dos Guimarães is a region of flat-topped mountains located in the State of Mato Grosso, Midwestern Brazil (Ross 2014). The summits of these flattened formations reach elevations between 600-800 m, consisting predominantly of Devonian and Cretaceous sandstones

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(Ross 2014). These mountains, which are located in the Cerrado Domain, are home to a wide variety of habitats, such as savannas, gallery forests, grasslands and palm swamps (IBAMA 2009). Remarkable plant communities grow directly on the rocky sandstone outcrops, with a predominance of *Vellozia*, lichens and bromeliads (IBAMA 2009).

The Chapada dos Guimarães National Park was established in 1989. It comprises 32,630.70 ha and protects a significant part of the local biota (IBAMA 2009). The region currently delimited as the National Park was initially visited by several naturalists in the 19th century who gathered relevant ethnological and scientific information about the people, fauna, flora and famous landscapes (Barman 1971; Santos 2016). Initial botanical explorations were undertaken by Georg Heinrich Langsdorff (1774-1852) and Ludwig Riedel (1790-1861) in 1827, during the Russian Imperial Scientific Expedition to Brazil (Barman 1971), and by Oskar Andersson Gustaf Malme (1864-1937) during his expeditions to Mato Grosso in 1892-1894 and 1901-1904 (Santos 2016). Despite these early efforts, biological studies in the Chapada dos Guimarães are still scarce. Several endemic taxa have been described from the Chapada in recent years; these include invertebrates (Vilela *et al.* 2018; Garcia & Urso-Guimarães 2018), fish (Tagliacollo *et al.* 2011), a burrowing snake (Santos *et al.* 2018), lichens (Ferraro & Lücking 2003), lycophytes (Valdespino *et al.* 2015) and flowering plants (Rapini *et al.* 2010; Leme *et al.* 2019). Here, we describe a new species of *Acisanthera* that is apparently endemic to rocky sandstone walls of the Chapada dos Guimarães. The first specimen of this new species was collected 119 years ago by Oskar Andersson Gustaf Malme during his “second expedition Regnelliana” (*Plantæ Itineris Regnelliani II.di*), a productive exploration to the interior of Brazil, Argentina and Paraguay, which resulted in about 2,600 botanical collections (Santos 2016).

Materials and methods

This study was mostly based on collections from BHCB, CAS, CEPEC, HUEM, MBM, NY and US (acronyms follow Thiers 2021 (continuously updated)). Specimens of all species mentioned in this study were examined, along with their protologues and online type images, available at the JSTOR Global Plants website (<http://plants.jstor.org/>). Comparative morphological characters of *Acisanthera alsinaefolia* (Mart. & Schrank ex DC.) Triana, *A. erecta* J. St.-Hil. and *A. uniflora* (Vahl) Gleason were obtained from treatments of Melastomataceae for the *Floras* of British Guiana (Gleason 1932), Peru (Macbride 1941), Panama (Gleason 1958), Venezuela (Wurdack 1973), Venezuelan Guayana (Berry *et al.* 2001), Mesoamerica Region (Almada 2009), Brazil (Cogniaux 1885), and from the recent treatment of *Acisanthera* in *Flora do Brasil 2020* (Rocha *et al.* 2020).

Scanning Electron Microscopy (SEM) studies used dried herbarium material. Leaf fragments and seeds were placed on aluminum stubs with carbon tape and covered with a 30 to 40 nm layer of gold; SEM photos were taken using a FEI Quanta 200 scanning electron microscope at the Universidade Estadual de Maringá, Brazil (COMCAP/UEM).

We used the GeoCAT online tool (Bachman *et al.* 2011) to estimate the Extent of Occurrence (EOO) and Area of Occupancy (AOO), based on coordinates obtained directly at the type locality and from specimen labels; these estimations and the recommendation for the conservation status follow IUCN guidelines and criteria (IUCN 2012; IUCN Standards and Petitions Committee 2019). The distribution map was prepared using QGIS 3.10 (QGIS Development Team 2021).

Results

Acisanthera saxatilis Almada & R. Pacifico **sp. nov.**

Type: BRAZIL. Mato Grosso, Chapada dos Guimarães, Parque Nacional da Chapada dos Guimarães, Trilha para o Morro São Jerônimo, (-15.4405, -55.83825), elev. 704 m, 5 July 2018, fl., fr, R. Pacifico 416 (holotype: HUEM!; isotypes: CAS!, CEPEC!, K!, RB!). (Figs. 1-2, 3C and 4-5).

Acisanthera saxatilis may be recognized by its perennial habit, lignotubers (xylopodia) membranaceous leaves with sparse glandular trichomes on the adaxial surface, isomorphic to slightly subisomorphic androecium, stamens erect and positioned in a circle around the style (during anthesis), connectives of both antesealous and antepetalous stamens measuring 0.2-0.3 mm long, inconspicuous ventral appendages divided in two lobes *ca.* 0.1 mm long, and purple anthers.

Well-branched perennial **shrub** with trailing or pendulous stems *ca.* 5-20 cm long perennating from a woody lignotuber with many old defoliated wiry branches persisting from previous years. **Roots** brownish *ca.* 10 mm long. Upper cauline **internodes** 4-15 mm long, quadrangular, with tenuous wings up to 0.1 mm wide, light green at the apex and becoming brown flushed with red towards the base (when fresh), glutinous, moderately beset with white glandular trichomes 0.2-0.4 mm long, the heads of the trichomes white when fresh, turning pale brown when dry. Older **branches** brown (when dry), subquadrangular, the bark peeling away with age. **Leaves** opposite, isomorphic in size and shape in each pair, membranaceous, light green (when fresh) turning pale green and brittle when dry; petioles 1.7-6 mm long, somewhat compressed to quadrangular, covered with glandular trichomes 0.2-0.4 mm long, blades 6-22 × 3-10 mm, ovate to elliptic, 3-nerved (tertiaries not evident), concolored, light green (when fresh) or pale green (when dry), apex acute, base attenuate, foveolate and glabrous to glabrescent with sparse glandular trichomes 0.2-0.4 mm long adaxially, smooth and sparsely covered with glandular trichomes 0.2-0.4 mm long and a



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few spherical glands abaxially, hypostomatic, the margin entire and ciliate with glandular trichomes 0.2-0.4 mm long. **Inflorescences** reduced to solitary ebracteolate flowers born on pedicels 3-3.8 mm long in terminal and axillary positions on uppermost branchlets. **Flowers** 5-merous

and diplostemonous. **Hypanthium** (at anthesis) 3.0-3.2 × 2.2-2.9 mm, cupuliform to campanulate, 10-ridged, smooth, light green when fresh turning pale green or flushed with purple when dry, covered with glandular trichomes 0.2-0.4 mm long. **Calyx tube** inconspicuous, ca. 0.1 mm long.

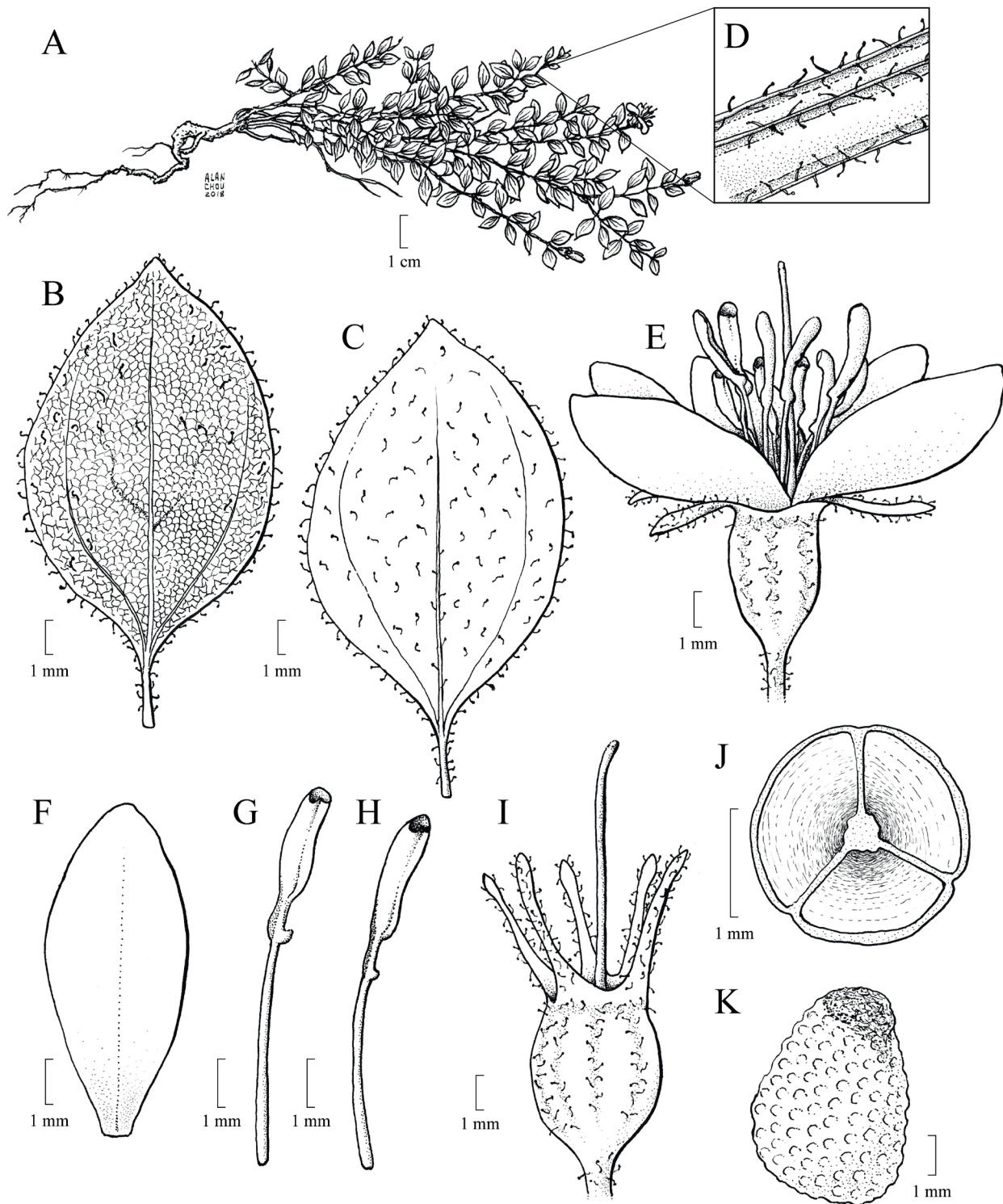


Figure 1. *Acisanthera saxatilis*. **A.** Habit. **B.** Leaf adaxial surface. **C.** Leaf abaxial surface. **D.** Detail of the internode. **E.** Flower in lateral view. **F.** Petal adaxial surface. **G.** Antesepalous stamen. **H.** Antepetalous stamen. **I.** Flowering hypanthium (petals and stamens removed). **J.** Capsule in cross section. **K.** Seed in lateral view. Drawn from Hatschbach et al. 36107 (US).

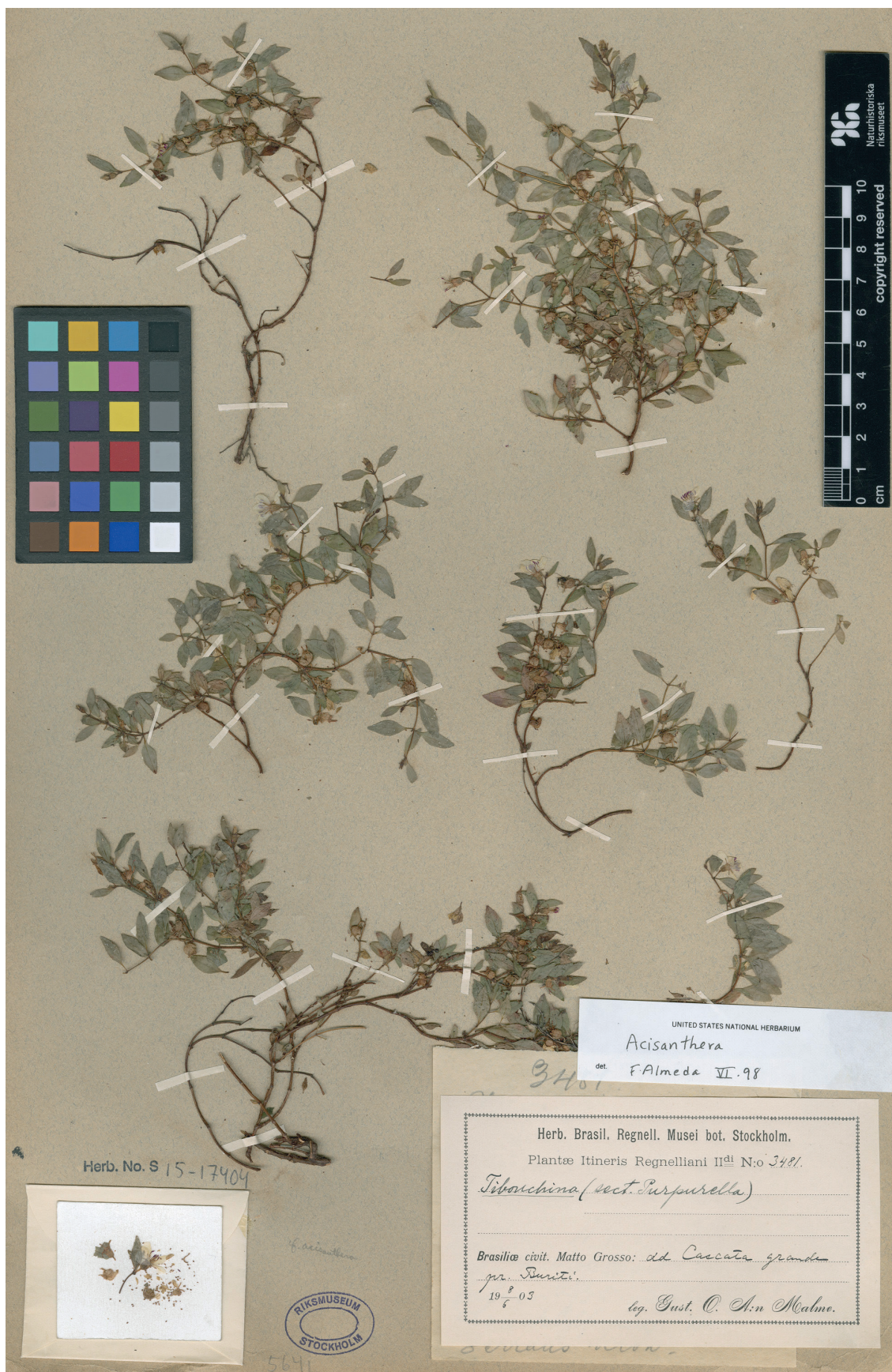


Figure 2. *Acisanthera saxatilis*. Photograph of paratype, O.A.G. Malme 3481 (S).

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Calyx lobes 3-3.4 × 0.7-0.9 mm, reflexed at anthesis, narrowly oblong with an obtuse apex, terminating in an apical glandular trichome *ca.* 0.4 mm long, the indumentum like that of the hypanthium, the margin entire and ciliate with glandular trichomes 0.2-0.4 mm long, light green when fresh, pale green when dry. **Petals** 6.2-6.6 × 2.9-3.1 mm, elliptic, light purple with an intense flush of purple at the base, glabrous throughout, the margin entire with a few minute glandular trichomes 0.1 mm long at the apex, the apex obtuse. **Stamens** 10, isomorphic to slightly subisomorphic, erect and positioned in a circle around the style (during anthesis): filaments 2.7-3.3 mm long, glabrous, white, anthers 1.6-2.5 mm long, purple, oblong and incurved, erostrate, with a ventrally inclined apical pore, connective prolonged 0.2-0.3 mm, ventral appendages inconspicuous and divided into two short thickenings *ca.* 0.1 mm long. **Ovary** (at anthesis) *ca.* 2.5 × 2 mm, superior, subglobose, glabrous; style 6.3-7 mm long, terete, slightly incurved, white. **Fruit** a globose loculicidal capsule 3-3.7 × 3-3.5 mm (when mature), 3-locular, glabrous, on pedicels

2.5-3.5 mm long, enveloped by the thin-walled hypanthium and persistent calyx lobes, then tardily rupturing and flaking away with age. **Seeds** subcochleate, beige to rusty brown, 0.5-0.6 × *ca.* 0.2 mm; the testa foveolate, raphal zone nearly circular, *ca.* 40% the length of the seed.

Recognition—*Acisanthera saxatilis* is somewhat similar to *A. erecta* and *A. uniflora* in leaf shape, indumentum, and in having solitary flowers. *Acisanthera saxatilis* consistently differs from both species by its perennial habit, production of lignotubers, isomorphic to slightly subisomorphic androecium (vs. conspicuously dimorphic in the compared species), stamens positioned in a circle around the style during anthesis (vs. forming a cluster at one side of the flower), antesepalous stamens with shorter connectives 0.2-0.3 mm long. (vs. 1-2.5 mm long in the compared species), inconspicuous appendages *ca.* 0.1 mm long. (vs. conspicuous, usually 0.5-1 mm long) and all anthers purple (vs. usually bicolored, purple and cream). Comparative morphological characters among the species of *Acisanthera* reported for Brazil are provided in Tab. 1.

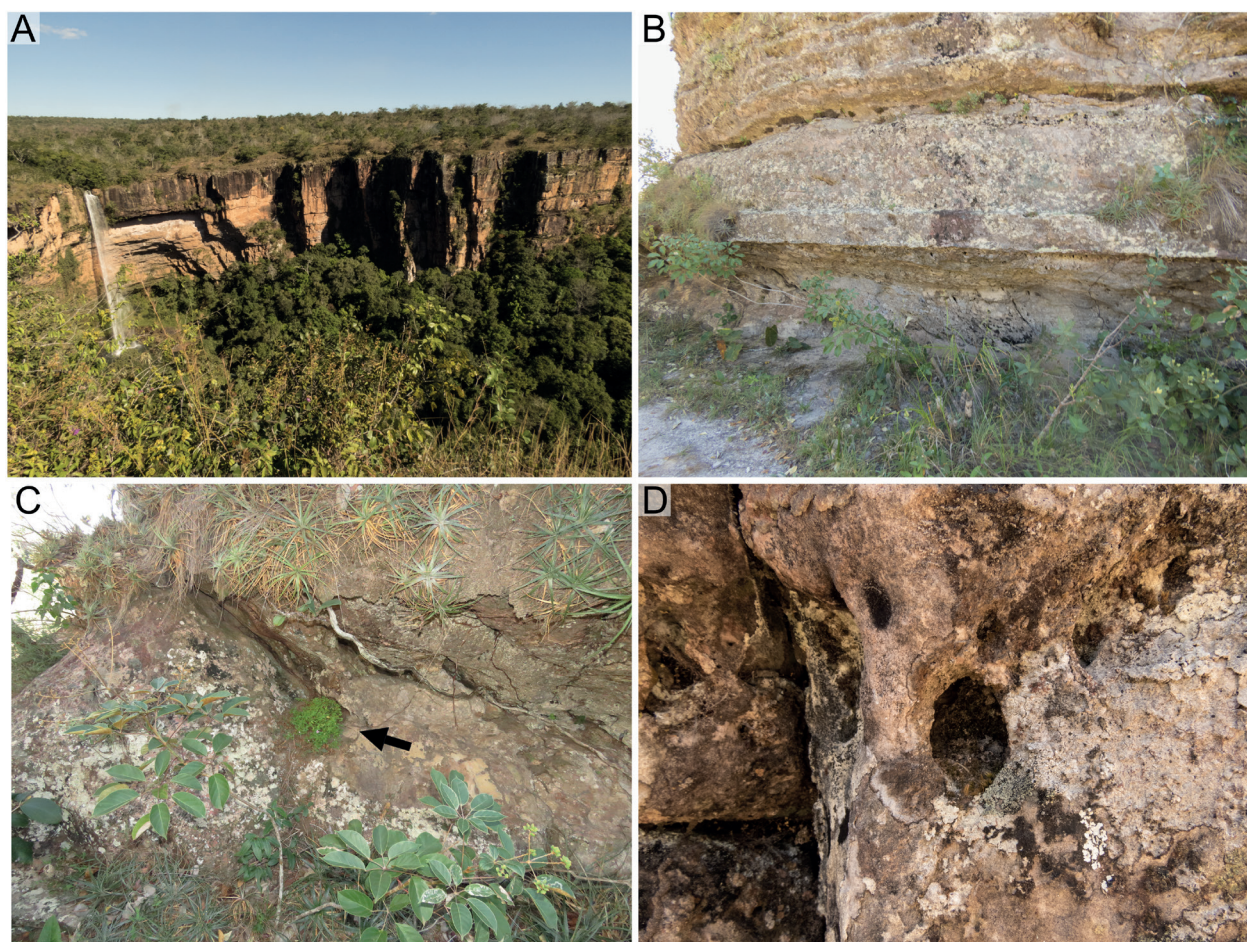


Figure 3. Habitat of *Acisanthera saxatilis*. **A.** Landscape at the Chapada dos Guimarães, Mato Grosso, Brazil, showing the Veu da Noiva Waterfall and a large sandstone rocky outcrop. **B-C.** Sandstone rocky outcrops on the trail to the Morro São Jerônimo, the type locality of *A. saxatilis*. The black arrow indicates one individual of *A. saxatilis*. **D.** Detail of a hole in a rocky sandstone outcrop on the trail to the Morro São Jerônimo, covered by lichens and accumulating organic matter, where individuals of *A. saxatilis* grow.

Etymology—The specific epithet, *saxatilis*, which means living among rocks, highlights the habitat preference of this species on exposed rocky outcrops of the Chapada dos Guimarães.

Distribution, habitat and phenology—*Acisanthera saxatilis* is probably endemic to the Chapada dos Guimarães,

Mato Grosso, Brazil (Fig. 6). It grows on shaded rocky sandstone outcrops, crevices and in round holes in these rocks, which accumulate organic material and may be externally covered with lichens and bryophytes (Fig. 3B-D), at elevations of about 676-704 m. It was collected flowering in February, March, June and July, and fruiting in February,



Figure 4. Photos of living individuals of *Acisanthera saxatilis*. **A-B.** Habit. **C.** Leaf. **D.** Floral bud with reflexed calyx lobes. **E.** Capsule enveloped by hypanthium and attached calyx lobes. **F.** Flower. **G.** Close-up photo of a flower. All photos taken from the type series, R. Pacifico 416 (CAS, CEPEC, HUEM, K, RB).

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June and July. According to specimen labels, its habitat is shared with the endemic bromeliad *Fosterella lilliputiana*, two rupicolous Gesneriaceae, *i.e.* *Mandirola* sp. and *Goyazea petraea*, and at least two species of ferns, *i.e.* *Cheilanthes pohliana*, *Anemia* sp., and one Lycophyte, *Selaginella* sp.; all of these taxa were collected on 13 February 1975 at the same sandstone rocky outcrops, during an expedition led by Gerdt Guenter Hatschbach (*G. Hatschbach et al.* 36107, 36109, 36110, 36111, 36112, 36113, 36114).

Conservation—All collections of *A. saxatilis* with geographic coordinates came from the same locality (Fig. 6D). The type series (*R. Pacifico* 416), was obtained from a population of about 15 individuals. Using GeoCAT we estimated the EOO and AOO of *A. saxatilis* to be 0.001 km² and 4 km², respectively. If criterion B of IUCN (2012) and IUCN Standards and petitions subcommittee (2019) is applied, we suspect that a conservation status of Critically Endangered (CR) would be assigned to *A. saxatilis*: B2ab(iii).

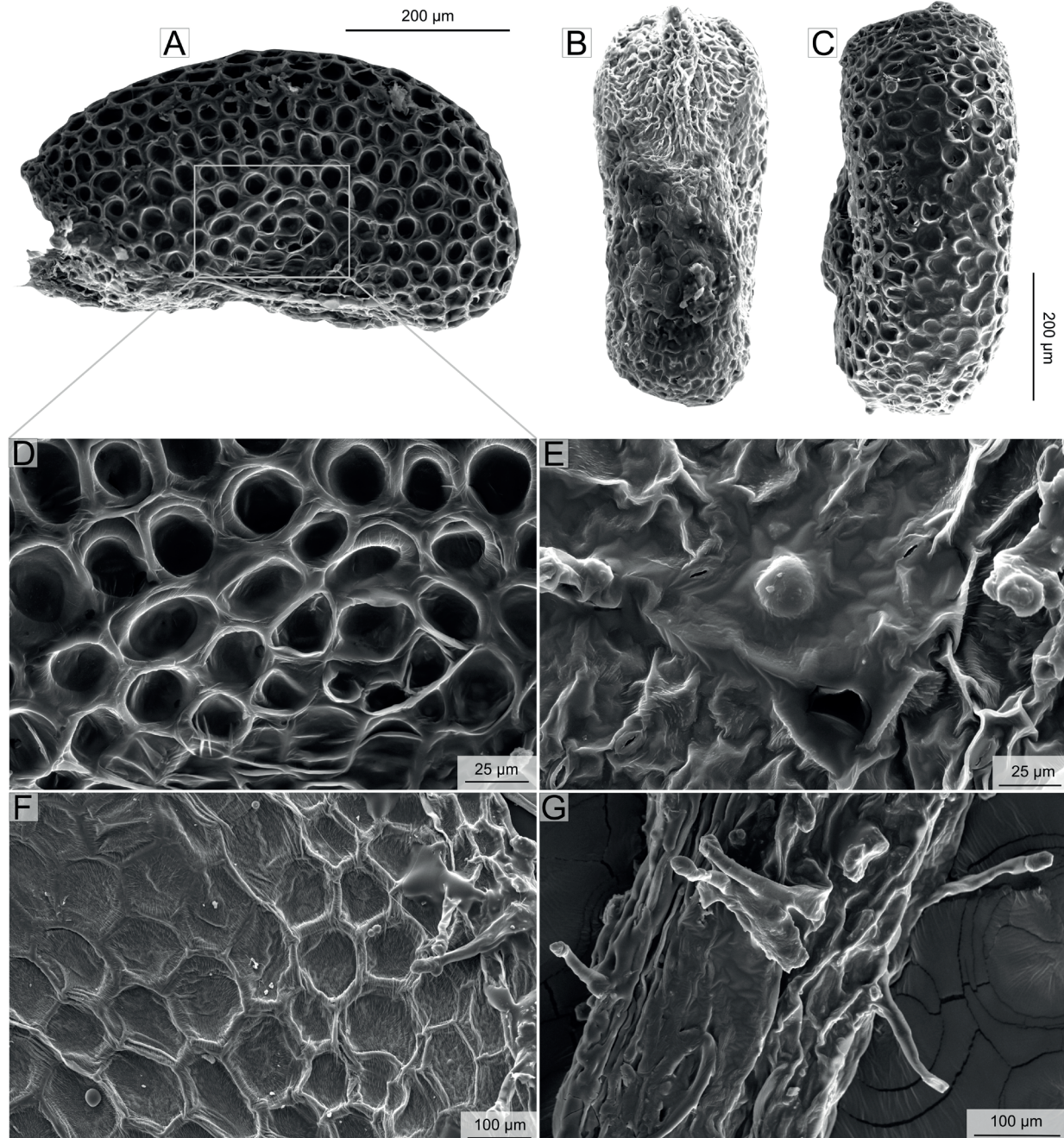


Figure 5. Scanning Electron Microscopy photos of *Acisanthera saxatilis*. **A.** Seed in lateral symmetrical plane view. **B.** Seed in raphal view showing raphal zone and hilum. **C.** Seed in anti-raphal view. **D.** Detail of the seed testa cells showing anticlinal boundaries and periclinal walls. **E.** A spherical gland on the leaf abaxial surface. **F.** Foveolate appearance of the leaf adaxial surface. **G.** Petiole with glandular trichomes. All photos taken from the holotype, *R. Pacifico* 416 (HUEM).

According to IBAMA (2009), the main threats to the vegetation of the Chapada dos Guimarães are: human-caused fires, human occupation, illegal logging, extraction of plants by locals, habitat degradation by cattle, unregulated tourism, and invasive alien species.

Additional specimens examined—Brazil. Mato Grosso: Chapada dos Guimarães, 13 February 1975, fl., fr., *G. Hatschbach 36107 et al.* (MBM, NY!, US!); ad Cascata grande, pr. Buriti (Chapada dos Guimarães), 8 June 1903, fl., fr., *O.A.G. Malme 3481* (S!); Chapada dos

Table 1. Comparative morphological features among the four species of *Acisanthera* reported for Brazil.

Character	<i>A. alsinaefolia</i>	<i>A. saxatilis</i>	<i>A. uniflora</i>	<i>A. variabilis</i>
Habit	Annual	Perennial	Annual	Annual
Lignotubers	Absent	Present	Absent	Absent
Plant height (cm)	30-60	5-20	20-60	30-80
Indumentum on leaf adaxial surface	Usually glabrous	Glandular trichomes	Glandular trichomes	Glabrous
Flowers	Arranged in inflorescences	Solitary, axillary	Solitary, axillary	Arranged in inflorescences or solitary, axillary
Stamen shape	Dimorphic	Isomorphic to subsisomorphic	Dimorphic	Dimorphic
Position of stamens during anthesis	Forming a cluster at one side of the flower	Positioned in a circle around the style	Forming a cluster at one side of the flower	Forming a cluster at one side of the flower
Anther color	Purple and cream to purple	Purple	Purple and cream to purple	Purple and cream
Length of connective on antepetalous stamens (mm)	ca. 2	0.2-0.3	1-2	1-2.5
Length of connective appendage on antepetalous stamens (mm)	ca. 0.5	ca. 0.1	0.5-1	0.5-1

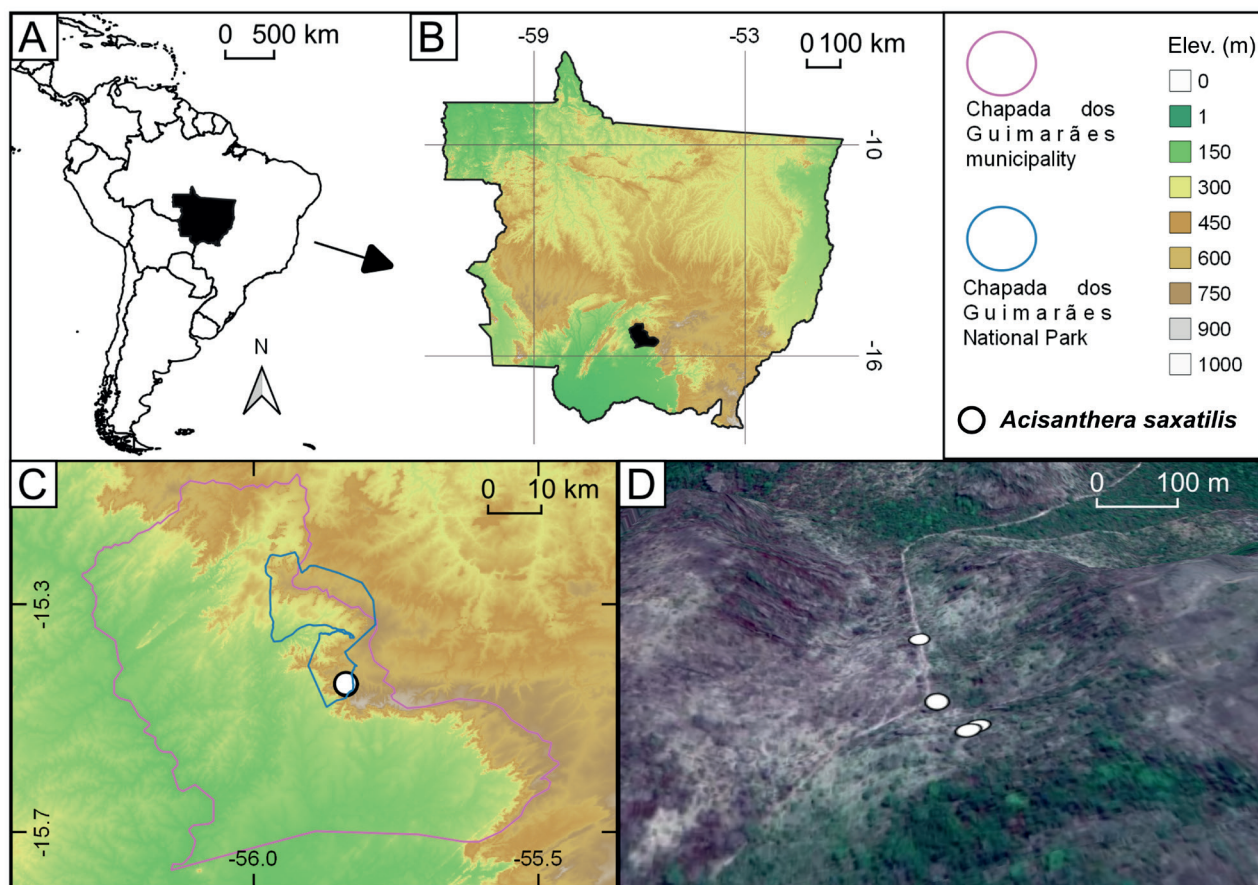


Figure 6. Distribution of *Acisanthera saxatilis*. **A.** South America with Mato Grosso State highlighted in black. **B.** Mato Grosso state with Chapada dos Guimarães municipality highlighted in black. **C.** Chapada dos Guimarães region showing the boundaries of the municipality (outlined in pink) and the National Park (outlined in blue), and the distribution of *A. saxatilis*. **D.** Trail to the Morro São Jerônimo in 3D view with the collection localities (white circles) of *A. saxatilis*.

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Guimarães, Parque Nacional da Chapada dos Guimarães, trilha para o Morro São Gerônimo, (-15.439722, -55.83833); 676 m; 3 March 2011, fl., N. F. O. Mota 2121 *et al.* (BHCB!, MBM!).

Discussion

Morphological variation is complex in *Acisanthera s.s.* and presents challenges for species delimitations (Kriebel 2008). Here, we treat *A. saxatilis* as a distinct species largely based on stamen shape and size, together with its perennial habit, production of lignotubers, peculiar habitat on rocky sandstone outcrops, and limited distribution on the Chapada dos Guimarães, Brazil. We know of no other species of *Acisanthera* with developed lignotubers but they are known in species of *Microlicia* (Microlicieae), especially those in the *Lavoisiera* clade (Martins & Almeda 2017), and in *Chaetogastra* (Melastomataceae) (Meyer *et al.* 2021). These woody subterranean structures are common in species of the Cerrado and other neotropical savannas (Sarmiento 1985). They serve as an organ that buffers plants against extremes of water loss, temporal mineral deficiency, and also provide protection against fires (Gottsberger & Silberbauer-Gottsberger 2006). The positioning of the stamens in a circle around the style (during anthesis), the reduced ventral connectives and staminal appendages, and the anthers of both cycles of stamens similar in color are other apparent synapomorphies of *A. saxatilis*.

Acisanthera saxatilis seems to occur only on the Chapada dos Guimarães. Currently, it is the only species of the genus endemic to Brazil. The compared species of *Acisanthera* have never been collected at the Chapada dos Guimarães, making sympatric occurrence improbable. *Acisanthera uniflora* is widely distributed in South and Central America (Kriebel 2008) and was cited in relevant treatments of Neotropical Melastomataceae such as the floras of Mesoamerica (Almeda 2009), Panama (Gleason 1958), Venezuela (Wurdack 1973), Venezuelan Guayana (Berry *et al.* 2001), and Brazil (Cogniaux 1885; Rocha *et al.* 2020). *Acisanthera erecta* is largely restricted to northern South America and Central America (Kriebel 2008), and was cited as *A. quadrata* in the floras for Peru (Macbride 1941), Mesoamerica (Almeda 2009), Panama (Gleason 1958), Venezuelan Guayana (Berry *et al.* 2001) and British Guiana (Gleason 1932); its occurrence in Brazil was not confirmed in a recent treatment of *Acisanthera* for this country (Rocha *et al.* 2020). A recent report of *A. erecta* (as *A. quadrata*) from Mato Grosso do Sul state by Romero *et al.* (2018) needs confirmation.

The narrow endemism of *A. saxatilis* is unusual in a genus with predominantly widespread taxa. Its apparent restriction to sandstone substrates suggests that it may be an edaphic endemic. To our knowledge, there is no catalogue of edaphic endemics for Brazil's vascular flora. Among Melastomataceae, many species of *Microlicia*

have narrow distributions and are endemic to quartzitic soils on Cadeia do Espinhaço (Pacífico *et al.* 2020); both *Microlicia macedoi* and *Pterolepis haplostemona* are endemic to serpentine in Goiás state (Reeves *et al.* 2007; Almeda & Martins 2015), whereas *Brasilianthus carajensis* and *Pleroma carajasense* are endemic to ironstone outcrops (canga) in Pará state (Almeda *et al.* 2016; Rocha *et al.* 2017). Further investigations using molecular data and chromosome number determinations may provide useful insights into the origin and interspecific relationships of *A. saxatilis*.

At least 16 species of vascular plants are apparently endemic to the Chapada dos Guimarães, Mato Grosso: *Alstroemeria chapadensis* (Alstroemeriaceae), *Nephradenia filipes* (Apocynaceae), *Hyppenia micrantha* (Lamiaceae), *Didymopanax cephalanthus* (Araliaceae), *Cuphea cuiabensis* (Lythraceae), *Mascagnia aptera* (Malpighiaceae), *Piriqueta lourteigiae* (Turneraceae), *Vochysia petraea* (Vochysiaceae), *Mimosa bipennatula* (Fabaceae) (CNCFlora 2012; Flora do Brasil 2020 2021), *Borreria guimaraesensis* (Rubiaceae) (Cabral & Bacigalupo 2004), *Fleischmannia matogrossensis* (Asteraceae) (Robinson 2015), *Fosterella lilliputiana* (Bromeliaceae) (Leme *et al.* 2019), *Rauvolfia anomala* (Apocynaceae) (Rapini *et al.* 2010), *Selaginella saltuicola* (Selaginellaceae) (Valdespino *et al.* 2015), *Syagrus guimaraesensis* (Arecaceae) (Noblick *et al.* 2014), and *Acisanthera saxatilis*. Several of these narrowly endemic species are considered threatened (CNCFlora 2012). In this context, the discovery of *A. saxatilis* emphasizes the importance of the Chapada dos Guimarães National Park as a critical area for the conservation of several Cerrado endemic lineages in Mato Grosso state, Brazil.

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