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Schwenckia aurantiaca (Solanaceae), a new species from calcareous outcrops of northern Minas Gerais, Brazil

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Abstract

A new species of *Schwenckia* (Solanaceae) from calcareous outcrops of the Serra Azul Biological Reserve in northern Minas Gerais, Brazil, is described and illustrated. *Schwenckia aurantiaca* is an annual plant characterized by a cylindrical corolla tube with five orange, linear appendages, an androecium with two stamens and three, unequal pilose staminodes, and a calyx that tears to the base in fruit. We discuss the morphological characters, habitat, and conservation status of the species, which is assessed as Critically Endangered.

Resumo

Descrevemos e ilustramos uma nova espécie de *Schwenckia* (Solanaceae), que cresce associada a afloramentos de calcário na Reserva Biológica Serra Azul, no norte de Minas Gerais, Brasil. *Schwenckia aurantiaca* é uma espécie anual caracterizada pelo tubo da corola cilíndrico, com cinco apêndices lineares e alaranjados, presença de dois estames e três estaminódios desiguais com filetes pilosos, bem como pelo cálice frutífero rasgado na maturação. Discutimos neste trabalho os caracteres morfológicos, o hábitat, bem como o estado de conservação da espécie, considerada Criticamente em Perigo.

Keywords: Caatinga, corolla appendages, endemic species, Neotropical flora, Schwenckieae

Introduction

Schwenckia Linnaeus (1764: 567) (Solanaceae) is the largest genus of the Schwenckieae Hunziker (1977: 42) (Carvalho 1978a, Hunziker 2001). The tribe with approximately 25 species originally included four Neotropical genera, *Schwenckia, Melananthus* Walpers (Mohl & Schlechtendal 1850: 788, Solereder 1891), *Heteranthia* Nees & Martius (Neuwied 1823: 41) and *Protoschwenckia* Solereder (1898: 234) (Hunziker 2001), but phylogenetic analysis based on molecular data has shown that *Protoschenckia* is nested within the Cestroideae clade (Olmstead *et al.* 2008). As a consequence, *Schwenckieae* now contains three genera, with *Schwenckia* placed sister to a clade formed by *Heteranthia* and *Melananthus* (Särkinen *et al.* 2013).

Schwenckia comprises herbs and subshrubs, with erect or climbing stems, a very distinctive small corolla with five divided lobes (often trilobulate), and two to four stamens (Paucar *et al.* 2019). The two contiguous lateral divisions of each corolla lobe form a structure often called the intermediary lobule (Carvalho 1978a), here termed inter-appendicular lobe. In addition, the corolla lobes often have elongated appendages, uniquely shared within the tribe with *Melananthus.* Among the species of *Schwenckia*, the appendages vary in size, shape, and color and are an important diagnostic character (Carvalho 1966, Carvalho 1978a). Morphological and histochemical studies have revealed the presence of osmogenic tissues in the appendages, which release sweet fragrances during the night and probably are involved in pollinator attraction (Paucar *et al.* 2019).

In Brazil, *Schwenckia* has 16 species, with six of them endemic (Flora do Brasil 2020). *Schwenckia americana* Linnaeus (1764: 567) is the most widespread species in the Neotropical region (Carvalho 1978a, Benítez de Rojas

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1993); it is also invasive in Africa where it is considered medicinal (Magassouba *et al.* 2007, Noba *et al.* 2017). The other Brazilian species are generally associated with seasonally flooded areas, such as ponds or swamps, or rocky outcrops, such as granitic-gneissic inselbergs (Carvalho 1978a, Benítez de Rojas 1993, de Paula *et al.* 2017).

During the development of the taxonomic treatment for the Flora do Brasil 2020, which involved field collection and visits to several herbaria, collections were found that corresponded to an undescribed species of rocky outcrops in northern Minas Gerais, southeastern Brazil. In this work, we describe, illustrate, and compare it with morphologically similar species, and discuss its geographic distribution, habitat, phenology and conservation status.

Material and methods

The morphological description of the species is based on herbarium specimens, cultivated plants, and flowers and fruits fixed in 70% ethanol. Morphological characters were primarily measured from fresh and/or fixed material (in the case of a single set of measurements). We reviewed literature pertaining to the genus, including *Schwenckia* species' protologues, and collections in the following herbaria (Herbarium acronyms follow Thiers 2021): ALCB, BHCB, CEN, HUEFS, ICN, MG, R, RB, SP, SPF, and VIES. Virtual herbaria, such as the REFLORA digital collections (http://reflora.jbrj.gov.br/reflora/herbarioVirtual/) and INCT Virtual Herbarium (http://inct.splink.org.br/), were also consulted.

The terminology used to describe general morphological characters follows Radford *et al.* (1974) and Harris & Harris (2001). The description of trichomes was based on the nomenclature proposed by Mentz *et al.* (2000). We took photographs of the plants with a Nikon D90 camera (Nikon Corporation), using a 60 mm Macro lens. For detailed observations and flower measurements, we used a Binocular Stereo Microscope (Zeiss Stemi 508) and a Zeiss axio binocular Microscope (Lab A1), both with an attached camera, and Zen 2 Lite software.

The preliminary conservation status assessment was based on IUCN (2020) categories and criteria. To estimate the Area of Occupancy (AOO), we drew a polygon built on Google Earth Pro ver. 7.3.3.7786 (Google Inc. 2021) representing the suitable habitat occupied by the new species at the Serra Azul Biological Reserve.

Taxonomic treatment

Schwenckia aurantiaca Paucar & Stehmann, *spec. nov.*
Figures 1–4.

Type:—BRAZIL. Minas Gerais: Município de Jaíba, Reserva Biológica Serra Azul, Furados, 15°12'32"S, 43°51'16"W, 480 m, 15 April 2019, fl., fr., *J.O.A. Paucar & J.R. Stehmann 203* (holotype BHCB195125!, isotype RB!).

Diagnosis:—*Schwenckia aurantiaca* is characterized by the short cylindrical corolla with five linear orange appendages and triangular inter-appendicular lobes, and by the presence of two fertile stamens and three shorter staminodes. It is morphologically similar to *S. glabrata* Kunth in Humbold *et al.* (1817: 374), which differs in having a corolla with only two developed appendages, obcordate inter-appendicular lobes, and staminodes subequal to the fertile stamens.

Annual herb, erect or ascending, up to 55 cm tall. Stem hollow, initially single, later with secondary branches arising from the basal nodes, green to olive-green, striated, puberulent at the base, distally glabrescent, pubescent with both eglandular and glandular trichomes, the eglandular trichomes antrorse, with 1–4 cells, the capitate-glandular trichomes with 1–3 cells. Leaves simple, alternate, those of the lower stem with blades 8–19.9 × 4–12 mm, elliptic, membranaceous, glabrous to glabrescent on both sides, abaxially sparsely pubescent along the midrib with antrorse eglandular trichomes, the base rounded, the apex mucronate, the venation brochidodromous, with up to 3 pairs of primary veins, the petioles 3–8.8 mm long, glabrescent, with eglandular trichomes; leaves of upper stems usually longer and narrowed, with blades 14.6–34.8 × 2–10.5 mm, lanceolate to oblong-lanceolate, sparsely puberulent on both faces with 1–4 celled, eglandular trichomes and minute, two-celled, glandular trichomes, abaxially the midrib marked, the base attenuate, the apex acute, the margin entire or slightly wavy, sparsely ciliate with 4-celled, eglandular trichomes, the venation brochidodromous, with up to 6 pairs of lateral veins, petioles 1–5.6 mm long. Inflorescences paniculate, with at least 3 flowers simultaneously opened in anthesis, distributed evenly along the branches, axis glabrous, the bracts 0.9–1.3 mm long, lanceolate, ciliate-pubescent with 1–3 celled, eglandular trichomes, the pedicels

0.6–1.6 mm long, glabrous. Calyx in anthesis tubular, the tube 1.9–3.1 mm long, the lobes 0.5–1.5 mm long, unequal, the apex acute, papillose, the abaxial and adaxial surfaces glabrescent with sparse 1–3 celled glandular trichomes. Corolla cylindrical, glabrous, the tube straight, 7.5–10.3 mm long, greenish-yellow, purple on the upper third, the five corolla lobes each with one central appendage and two lateral lobes, the appendages linear, 1–2.2 mm long, unequal, one visibly smaller, green in pre-anthesis, changing to orange at anthesis, the inter-appendicular lobes unequal, 0.3–0.7 mm long, triangular, reflexed, papillose at the margin. Androecium with 2 fertile stamens, the anthers 0.7–1.1 mm long, connivent, the filaments free, 3.2–5.2 mm long, adnate in the lower third of the corolla tube, pilose at the base with mostly 4-celled (a few 5-celled), eglandular trichomes, the staminodes 3, 0.6–1.6 mm long, unequal, lanceolate to subulate, pilose with trichomes like those of the fertile stamens. Nectariferous disk present. Ovary 2-locular, 0.7–1.1 × 0.4–0.6 mm, subglobose, the style 5.9–7.5 mm long, the stigma capitate. Calyx persistent in fruit, tearing to the base. Fruiting pedicel up to 3 mm long. Capsule 2.6–3.8 × 2.1–3.6 mm, subglobose. Seeds 5–14, 0.7–1.4 × 0.6–0.8 mm, cuboidal to polyhedric, testa reticulate-foveolate. Chromosome number: unknown.

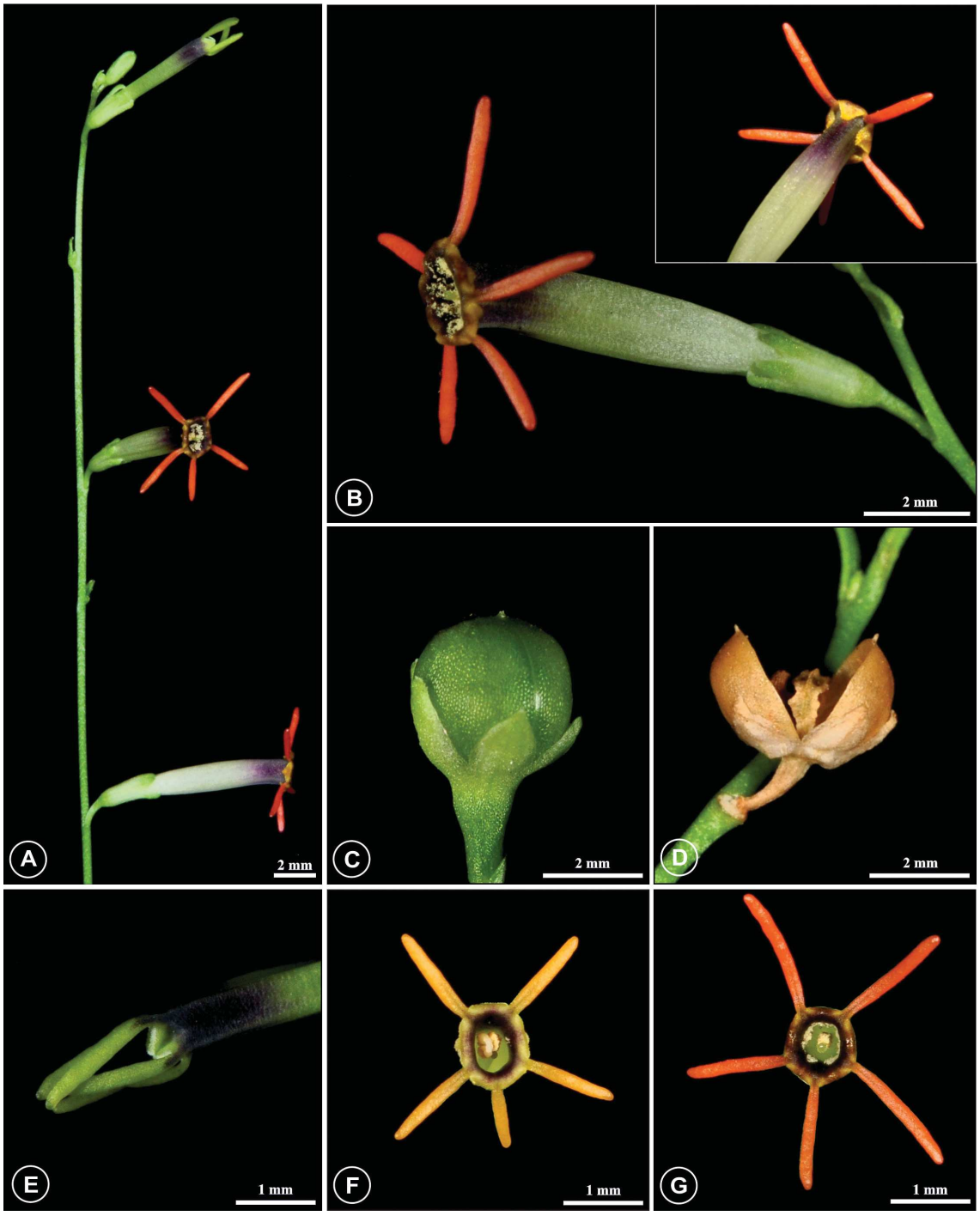

FIGURE 1. *Schwenckia aurantiaca* (A) habit, (B) flower with open corolla at night, (C–D) immature and mature capsule, (E–G) color change of the appendages, green in pre-anthesis (E), orange in anthesis (G).

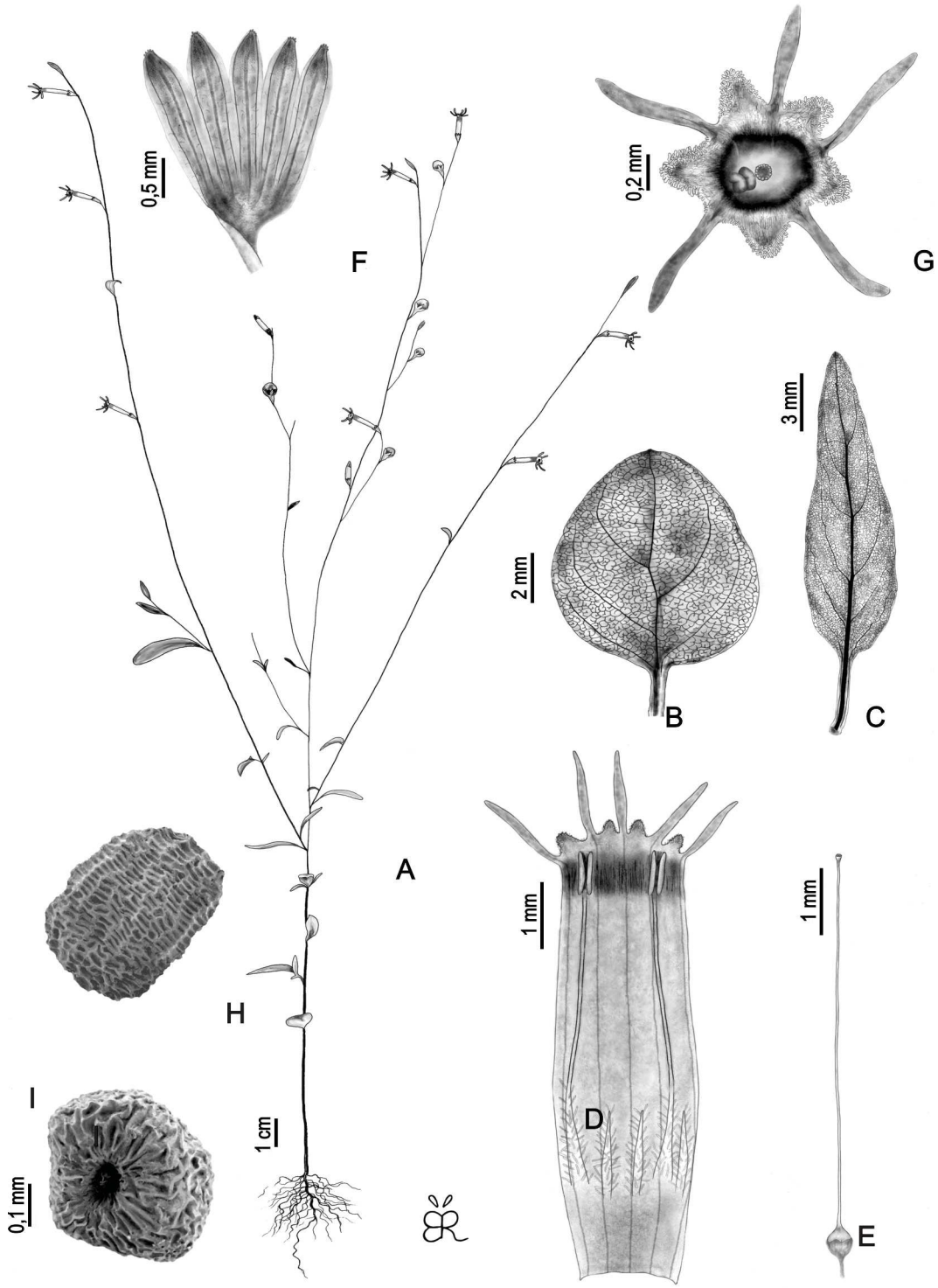

FIGURE 2. *Schwenckia aurantiaca* (A) habit, (B) basal leaf, (C) upper leaf, (D) opened corolla tube with two stamens and three staminodes, all filaments pilose, (E) gynoecium, (F) opened calyx, showing lobes unequal in size, (G) corolla (in frontal view during anthesis) with the patent linear appendages (a) and the triangular papillose inter-appendicular lobes (ial), (H–I) reticulate-foveolate seeds. (A–I based on *Paucar & Stehmann 203*)

FIGURE 3. Holotype of *Schwenckia aurantiaca* (*J.O.A. Paucar & J.R. Stehmann 203*, BHCB).

Distribution, habitat, and ecology:—*Schwenckia aurantiaca* has a restricted distribution, known only from an unusual ecosystem regionally called Furados, at Serra Azul Biological Reserve in the northern Minas Gerais (Fig. 4). The typical vegetation is the arboreal Caatinga where *Cavanillesia umbellata* Ruiz & Pavón (1798: 166) (Malvaceae) is commonly found, with islands of calcareous outcrops, open areas with exposed rocks, and depressions that are seasonally flooded during the rainy season (Fig. 4B–C). This seasonally dry vegetation is adapted to the semi-arid climate of the region, classified as Aw-tropical with dry winter (Reboita *et al.* 2015). The temporarily flooded, open areas are the habitat of the new species, which is an annual plant. The seeds germinate in the rainy season, which is when the plant grows, reproduces, and dies, leaving seeds in the soil to germinate in the next rainy season. Anthesis observed in cultivation, is nocturnal and has a cycle that begins with the opening of the corolla lobes in the late afternoon or early evening and closing at dawn the next day, a process repeated for three consecutive days. The tubular corolla, the nocturnal anthesis, and the sweet fragrance released at night suggest that moths may be the pollinators of *S. aurantiaca*.

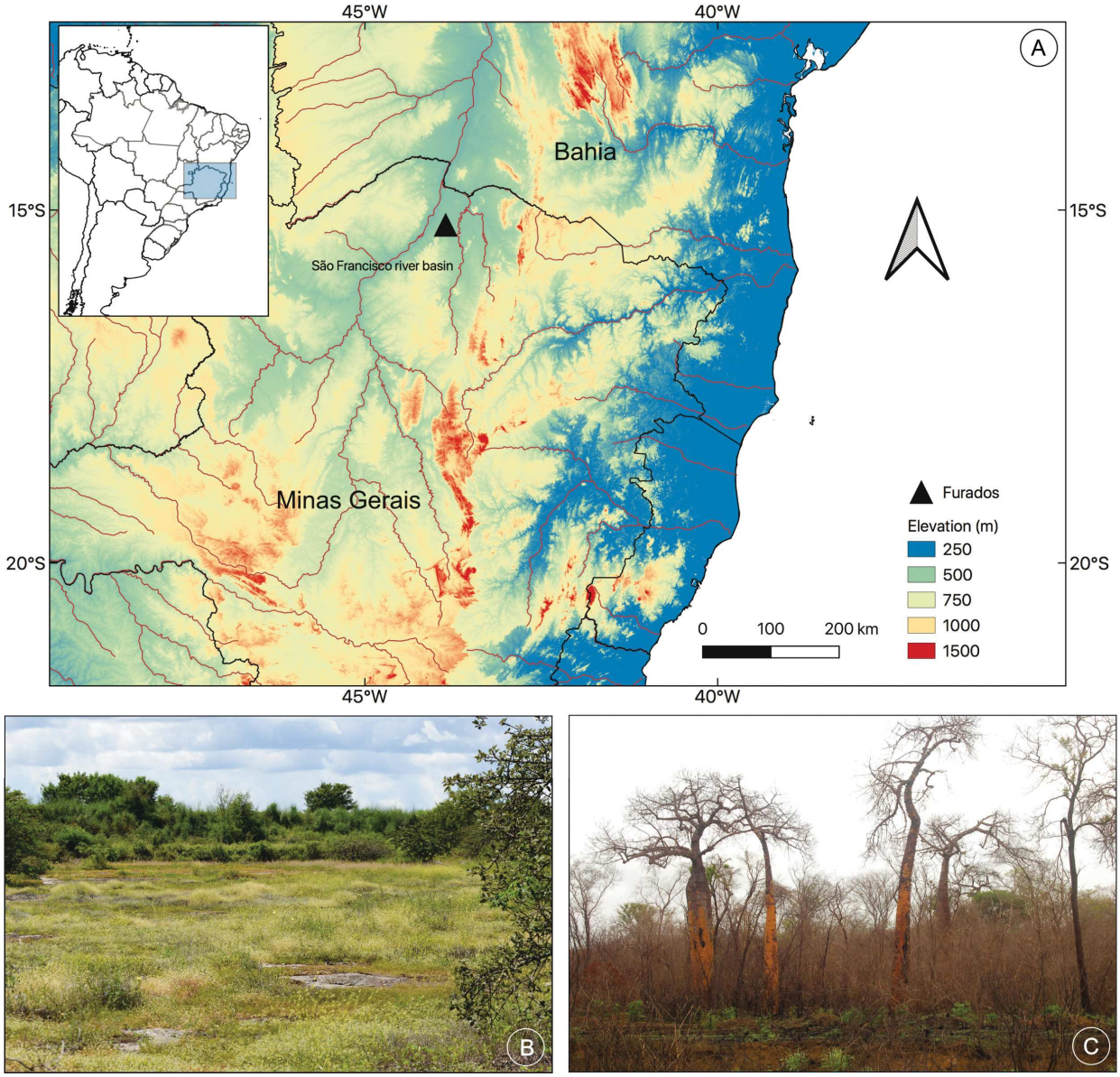

FIGURE 4. *Schwenckia aurantiaca* distribution and habitat. (A) Map showing Furados (triangle), the site of the species occurrence in northern Minas Gerais, (B) Caatinga seasonally flooded during the wet season, with a view of the calcareous outcrops, (C) Caatinga with *Cavanillesia umbellata* Ruiz & Pavón in the Serra Azul Biological Reserve, disturbed by fire during the dry season in 2007. Photographs by J.R Stehmann.

Etymology:—The specific epithet "*aurantiaca*" comes from Latin and means orange, an allusion to the color of the corolla appendages during anthesis.

Phenology:—Flowering and fruiting occur from February to April.

Conservation status:—Critically Endangered (CR) [B1, B2b(i,iii), D]. *Schwenckia aurantiaca* is known only from one area of Serra Azul Biological Reserve, with one or few populations (<5), which are usually formed by numerous individuals (<50). The Serra Azul Biological Reserve has about 38 km^2 and was created to protect the unique environment known as Furados, which is strongly threatened by the surrounding intensive agricultural use (irrigated fruit farming) (Barbosa & Santos 2008) and by fire, already documented for the area (Fig. 4C). In this environment, placed in the São Francisco river basin (Fig. 4A), the species is found only in open temporarily flooded places, which correspond to an area of less than 1 km^2 (AOO). Considering the specialized and restricted environment in which the species occurs, as well as the anthropic pressure on the Biological Reserve, our preliminary assessment for *S. aurantiaca* is Critically Endangered (IUCN 2020).

Paratypes:—BRAZIL. Minas Gerais: Municipality of Jaíba, Reserva Biológica Serra Azul, Furados, 15°12'26"S, 43°51'17"W, 480 m, 20 February 2017, fl., fr., *J. R. Stehmann et al. 6406* (BHCB186348); Reserva Biológica Serra Azul, Furados, 15°12'26"S, 43°51'17"W, 480 m, 20 February 2017, fl., fr., *J. R. Stehmann et al. 6444* (BHCB190182).

Discussion

Schwenckia aurantiaca has a unique set of traits compared to others species of the genus: the cylindrical and straight corolla tube with five linear appendages and triangular inter-appendicular lobes (Fig. 1B, 2G), two stamens and three unequal staminodes that are hairy throughout their entire length (Fig. 2D), and a calyx that tears unevenly in fruit leaving the capsule visible (Fig. 1C–D). Because of its annual habit, small flowers, and unusual (and rare) environment, it's not surprising that it was not collected until recently.

Five sections of *Schwenckia* were established by Bentham (1846: 192) based on morphological characters, such as the corolla shape, number of stamens and staminodes, and presence of developed or reduced corolla appendages (Carvalho 1978a; Benítez de Rojas 1993). According to this classification, *S. aurantiaca* should be placed in *S.* sect. *Schwenckia* Bentham (1846: 194), which includes about eight species, all with short corolla tubes (<15mm), developed corolla appendages and two fertile stamens (Carvalho 1978a; Benítez 2006). The linear appendages present in the described species, however, are not common in this section, usually characterized by claviform appendages. The appendages of *S. aurantiaca* are more similar to those of *S. glabrata* Kunth, but this species has two appendages developed and three reduced (Carvalho 1978a). *Schwenckia glabrata* can also be distinguished by its obcordate inter-appendicular corolla lobes (*vs.* triangular in *S. aurantiaca*) and staminodes subequal to the stamens (*vs.* shorter) (Benítez de Rojas 1993). Phylogenetic studies using molecular data have not yet been performed in the genus in order to test the monophyly of the sections and provide information on the relationships among the species.

The species described here inhabits rocky outcrops, an environment already recorded for some species of *Schwenckia* (Benítez de Rojas 1993), such as *S. americana* (Moraes *et al.* 2009, Lucena *et al.* 2015), *S. hyssopifolia* Bentham (1846: 195), and *S. novaveneciana* Carvalho (1978b: 146) (de Paula *et al.* 2017). In this environment, species of *Schwenckia* are classified as therophytes (Raunkiaer 1934), and are part of the ephemeral or perennial vegetation flush that emerges during the rainy season (de Paula *et al*. 2017). In inselbergs, especially in drier areas of northeastern Brazil, therophytes are commonly reported from this microhabitat (Gomes & Alves 2010, Gomes & Sobral-Leite 2013).

We highlight the need of protecting the Furados in the Jaíba region at the northern Minas Gerais, where the new species of *Schwenckia* was described. Unlike other areas of calcareous outcrops in the Caatinga, which are extremely dry and well drained, this site is seasonally flooded and contain a very peculiar flora, significatively different from that of its surroundings (Brandão *et al.*, 1998). It is an extremely rare and unreplaceable environment in the regional landscape, biologicaly few studied, that deserves prority in conservation efforts.

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