



Borreria apodiensis (Rubiaceae: Spermaceae), a new species from Ceará and Rio Grande do Norte, Brazil¹

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ABSTRACT

A new species of *Borreria* (Rubiaceae) from Chapada do Apodi in northeastern Brazil is described and illustrated. A distribution map, illustrations, a conservation assessment, a key to morphologically similar taxa and images of the seeds and pollen grains are provided.

Keywords: Caatinga, northeastern Brazil, pollen grains, Rubioideae, seeds, semiarid, taxonomy

Introduction

Borreria (Rubiaceae) is the largest genus in tribe Spermaceae *sensu stricto*, with about 100 species. It is distributed throughout the American continent from the southern United States to Uruguay and central Argentina. More than half of these species (69) occur in Brazil and 33 are endemic to it (Miguel & Cabral 2013; Miguel *et al.* 2015; Cabral & Salas 2015). For the Northeastern region, 27 species are recorded and 12 occur in Ceará state (Cabral & Salas 2015).

Bacigalupo & Cabral (1996), studying American species of *Borreria*, recognized two subgenera (*Borreria* and *Dasycephala*), two sections (*Borreria* and *Pseudodiodia*), two subsections (*Borreria* and *Latifoliae*) and three series (*Borreria*, *Brachystemonoides* and *Laeves*) based on morphological data. *Borreria* subsect. *Borreria* is defined by the septicial dehiscence of the fruit into two dehiscent mericarps, flowers with exserted stamens and style, the stigma mainly bilobed and zonocolporate and pantoporate pollen grains. Within *Borreria* subsect. *Borreria* the series

are defined only by seed morphology: *Borreria* ser. *Borreria* by reticulate seeds, *Borreria* ser. *Brachystemonoides* by seeds with an elaisome and *Borreria* ser. *Laeves* by ruminant seeds.

The delimitation of the genera *Borreria* and *Spermaceae* is confused and remains unclear. Some infrageneric groups of Bacigalupo & Cabral's classification (1996) seem not to be monophyletic. This has been made evident on phylogenetic studies for the tribe Spermaceae, however those include a small number of species of *Borreria* *sensu* Bacigalupo & Cabral (1996) representing the American flora (nine species in Dessein 2003; five in Kårehed *et al.* 2008; four in Groeninckx *et al.* 2009; eleven in Salas *et al.* 2015). Further molecular studies and a revision of the American species of *Borreria* are needed to assess whether these genera should be considered separate or merged into a wider, all-encompassing *Spermaceae*. But for the time being we follow the generic circumscription proposed by Bacigalupo & Cabral (1996).

The new species here described was found as result of the study of Rubiaceae for the regional flora of Ceará. It is only known in the Chapada do Apodi, on the border between

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the Brazilian states of Ceará and Rio Grande do Norte. We present a morphological description, a distribution map, illustrations, a conservation assessment, a key to morphologically similar taxa and images of the seeds and pollen grains.

Materials and methods

This study is based on field observation and the study of collections from the herbaria CTES, EAC, HUEFS and HUVA (Thiers 2015).

Flower and seed samples were fixed in 70% alcohol, dried at critical-point, and sputter-coated with gold-palladium for scanning electron microscope (SEM) studies.

Pollen grains were obtained from anthers of one collection (Souza 3511). Samples for light microscopy (LM) were acetolyzed according to Erdtman (1966) and mounted in glycerin jelly. Polar axis and equatorial diameter were measured on 25 pollen grains using a Leica DM LB2 microscope. The terminology used to describe the pollen grains follows Punt *et al.* (2007).

Scanning Electron Microscope (SEM) images were taken from flowers, petals epidermis, stigma and acetolyzed pollen grains using a Jeol 5800 LV SEM at the Universidad Nacional del Nordeste, Corrientes, Argentina.

Characterization of the Chapada do Apodi

The Chapada do Apodi is located in the Northeast region of the Brazil, between the lower courses of the Jaguaribe and Piranhas-Açu rivers, along the border of the states of Ceará and Rio Grande do Norte (Prates *et al.* 1981). It comprises a sedimentary relief formed by Cretaceous rocks of the Apodi Group, particularly calcareous from the Jandaíra Formation (Souza 1989) and partially covered by sandy and shallow soils (Fig. 1A). The altitude does not exceed 250 m and the predominant climate is semiarid with rainfall of 750-850 mm a year (Souza 1989). The vegetation in the Chapada do Apodi is Caatinga, composed of deciduous shrubs, subshrubs, small trees and annual herbs. The area was considered to be of "Extreme Importance" for the conservation of Caatinga flora by Tabarelli & Cardoso-Filho (2002). Typical Caatinga plants occur in the area, such as *Poincianella pyramidalis* (Tul.) L.P. Queiroz and *Pityrocarpa moniliformis* (Benth.) Luckow & R.W. Jobson (Leguminosae), *Cordia trichotoma* (Vell.) Arráb. ex Steud. (Boraginaceae), *Jatropha* spp. (Euphorbiaceae), *Bromelia laciniosa* Mart. ex Schult. & Schult.f. and *Encholirium spectabile* Martius ex Schult. f. (Bromeliaceae), *Pilosocereus gounellei* (A. Weber ex K. Schum.) Bly. ex Rowl. (Cactaceae) and *Combretum leprosum* Mart. (Combretaceae). Species endemic to the Caatinga are also a feature of the Chapada do Apodi landscape, such as *Cordia oncocalyx* Allemão and *C. glazioviana* (Taub.) Gottschling & J.S. Mill, as well as *Hydrothrix gardneri* Hook.f., a rare aquatic plant (Giulietti *et al.* 2004).

Results and discussion

Taxonomic treatment

Borreria apodiensis E.L. Cabral, L.M. Miguel & E.B. Souza, **sp. nov.** Type: BRAZIL. CEARÁ. Chapada do Apodi. Limoeiro do Norte, 05°11'34"S 37°59'20"W, 86 m, 28/V/2015, fl., fr., E.B. Souza 3555, R.A.S. Pontes, E.C. Thomaz & L.C. Silvestre (Holotype: EAC; Isotypes: CTES, HUEFS, HUVA).

Figs. 1-3

Borreria apodiensis is very close to *Borreria brownii* (Rusby) Standl., but differs in the inflorescence having terminal and with 2-5 axillary glomerules [vs. 1 terminal and 1 (rarely 2) subterminal glomerules], the calyx lobes narrowly triangular, 2-2.5 mm long with pilose margin (vs. calyx lobes ovate 0.8-1 mm long with ciliate margin) and non-ruminate seeds (vs. ruminant seeds).

Herb to subshrub, erect, (5-)20-50(-100) cm tall; stem simple or with 3-4 opposite lateral branches, quadrangular to subquadrangular, glabrous to glabrescent, green-yellowish when dry, internodes (0.9)-2-8.5(-12) cm long. Leaves opposite, rarely pseudovercillate, sessile, rarely pseudopetiolate, leaf blades (3.5-)5-7.5(-10) x 0.5-2 cm, narrowly elliptic to elliptic, apex acute and base attenuate, sometimes with a pseudopetiole of 5-7 mm long, membranaceous to chartaceous, glabrescent above, pilose on the nerves underneath, margins scabrous, 5-6 pairs of strongly marked secondary veins; stipular sheath 3-5 mm long, pubescent to puberulous, with (6-)8-10(-14) fimbriae; fimbriae 1-3(-5) mm long, glabrous or pubescent at the base and colleter-tipped. Inflorescence terminal and with 2-4(-5) axillary glomerules, (5-)10-20(-25) mm wide, hemispheric; involucre bracts 4-8(-12), unequal, (0.7)-2-6.7(-9.2) x (0.3)-1-2.7 cm, the external pair twice as long as glomerule diameter. Flower subsessile, pedicel 0.7-1 mm long, hypanthium 1.2-2 mm long, pilose on the third upper part; calyx 4-lobed, lobes 2-2.5 mm long, narrowly triangular, pilose at the margin; corolla 5-6.5 mm long, cyathiform, white, tube 4-5 mm long, lobes 1-1.5 mm long, triangular, externally glabrescent with long hairs on the apex of lobes, internally with short and sparse hairs on the lobes and a ring of hairs in the throat; stamens exerted, filaments 1-1.3 mm long, anthers 0.7-0.9 mm long; style 5.3-6.8 mm long, stigma bilobed, papillose; nectariferous disk bilobed. Capsule (3.5-) 4-5 x 1-1.5 mm, oblong ellipsoid, pilose in the upper part. Seeds 2-2.5 x 0.5-0.8 mm, ellipsoid, brown, ventral surface with a longitudinal groove covered by a strophiole with numerous raphides; testa reticulate-areolate.

Pollen morphology: Pollen grains 8-10 zonocolpate, small (P= 25.7-(30)-33.2 µm and E= 26.4-(31.5)-35.1 µm), oblate spheroidal (P/E= 0.91-0.98), outline circular in polar view. Ectocolpus 5.8-7.6 µm long, slit-like. Endoaperture an endocingulum 2.78-5.76 µm wide which in LM analyses is seen as a longitudinal pore. Exine 1.3-(1.7)-2.1 µm thick.



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Figure 1. A-C. Habitat and morphology of *Borreria apodiensis*. A. Calcareous rocks in Chapada do Apodi; B. Detail of a terminal glomerule and elliptic bracts; C. Detail of four cyathiform corollas. (A. by E.B. Souza; B-C. by E. Thomaz).

Tectum perforate, uniformly nanospinate, infractectum columellar. Perforations subcircular or irregular, small, 0.1-0.25 μm , nanospines 0.15-0.3 μm long (Fig. 3E-F).

Phenology: All the specimens were collected from May to July with flowers and fruits.

Distribution and habitat: This species is known only in the Chapada do Apodi in Ceará and Rio Grande do Norte states. Field observations indicate that it is restricted to the Chapada do Apodi. This suggests a probably edaphic preference for calcareous substrates (Fig. 4). In contrast



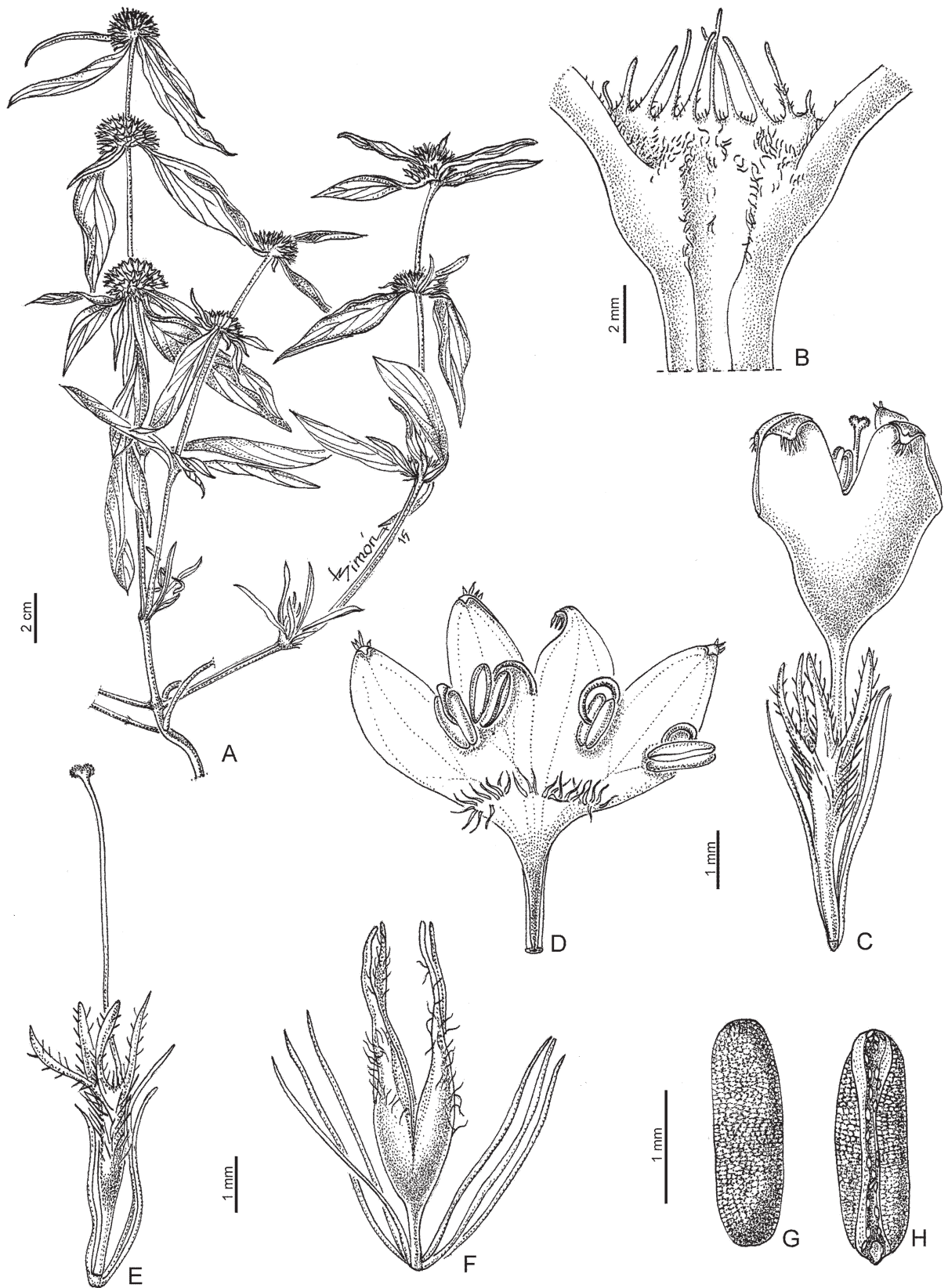


Figure 2. A-H. *Borreria apodiensis* (Souza 3555). A. Habit; B. Stipular sheath; C. Flower; D. Open corolla; E. Hypanthium, calyx, style and stigma; F. Fruit; G-H. Seeds; G. dorsal view; H. ventral view. (Drawn by Laura Simón)

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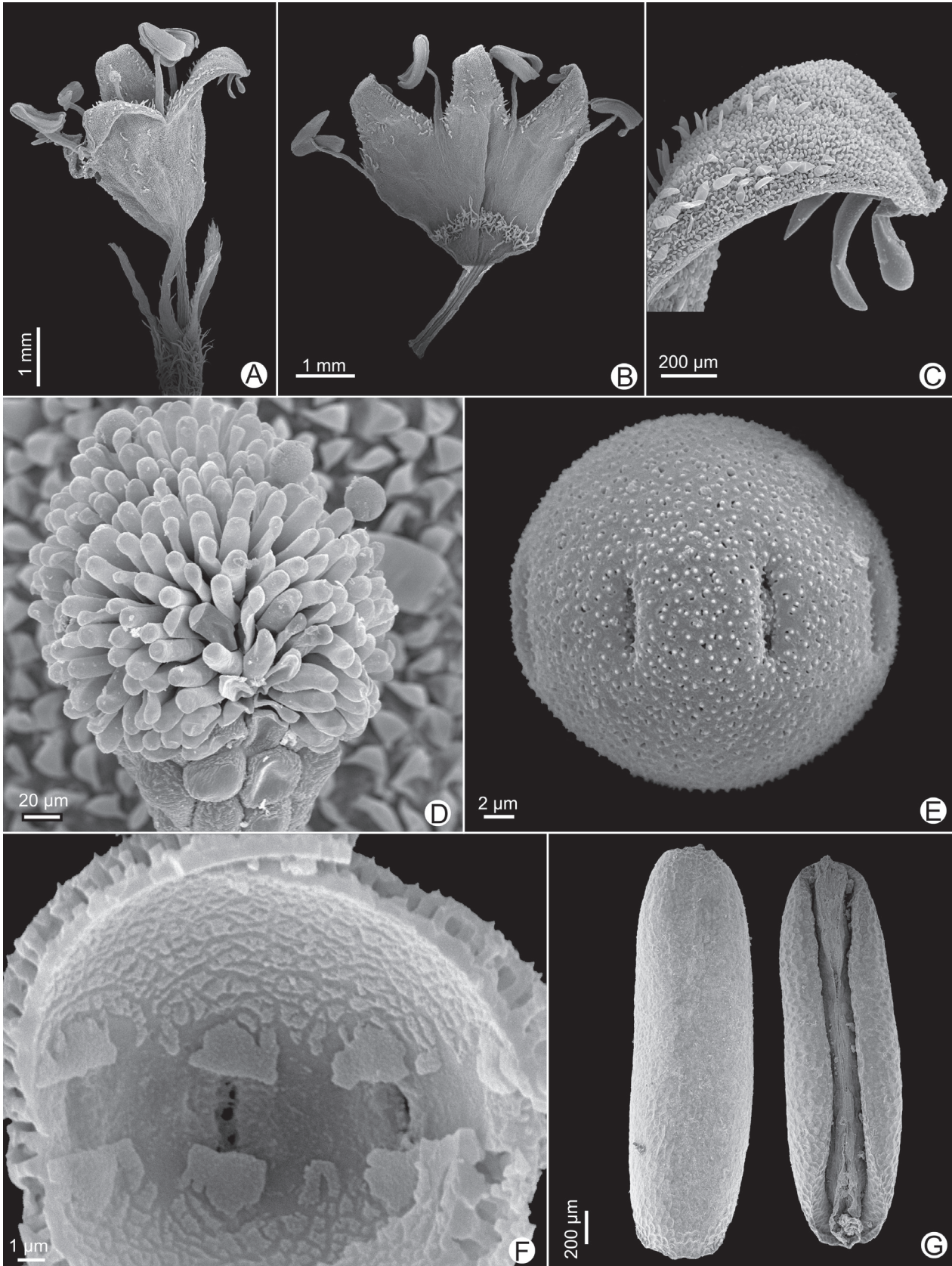


Figure 3. A-G. Micromorphological features of *Borreria apodiensis* (Souza 3555). A. Complete flower; B. Opened cyathiform corolla; C. Apex of the corolla lobes showing internal and external papillae; D. Bilobed papillose stigma; E-F. Pollen grains; E. Equatorial view; F. Broken grain showed endocingulum; G. Dorsal and ventral view of seeds.



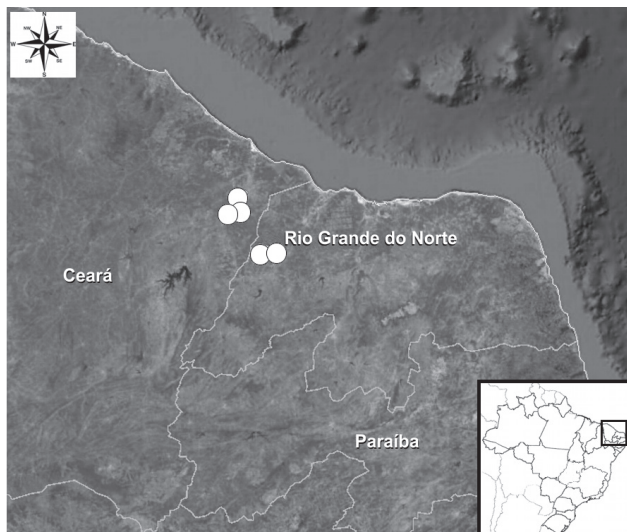


Figure 4. Distribution map of *Borreria apodiensis*.

the related species *Borreria brownii* and *B. remota* are widely distributed in the Americas and Brazil and grow on a wide range of soils (Cabral *et al.* 2011).

Remarks: *Borreria apodiensis* is similar to *B. brownii* (Rusby) Standl. and *B. remota* (Lam.) Bacigalupo & E.L. Cabral, because they share the annual herbaceous habit, elliptic leaves with strongly marked secondary veins and a cyathiform corolla. However, *B. apodiensis* has very narrowly triangular calyx lobes and seeds without transverse grooves,

Key for *Borreria* with cyathiform corolla

1. Leaves narrowly elliptic or elliptic, sessile, rarely pseudopetiolate; calyx lobes very narrowly triangular; corolla 5-6.5 mm long.; pollen grains with endocingulum; seeds without transverse grooves ***B. apodiensis***
- 1'. Leaves ovate or broadly elliptic, pseudopetiolate; calyx lobes broadly triangular or ovate; corolla 2-3.5 mm long; pollen grains without endocingulum; seeds with transverse grooves.
 2. Inflorescence glomerules 1 terminal and 1 (rarely 2) subterminal, around the nodes; calyx lobes ovate ciliate; pollen grains with colpi 12-13 µm long; seeds oblongoid ***B. brownii***
 - 2'. Inflorescence glomerules 1 terminal and 7-9 subterminal, unilateral; calyx lobes broadly triangular with hirtulous margins; pollen grains with colpi 4-5 µm long; seeds ovoid ***B. remota***

& L.C. Silvestre (CTES, HUEFS, HUVA).

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whereas *B. brownii* and *B. remota* have broadly triangular or ovate calyx lobes and seeds with 11-13 transverse grooves (ruminate seeds). Other features which distinguish *B. apodiensis* from the other two species with cyathiform corollas are presented in the key.

Etyymology: The epithet '*apodiensis*' refers to its distribution in Chapada do Apodi, where the species was collected.

Conservation status: The species is known from only five localities, within two adjacent Brazilian states. The extent of occurrence (EOO) was calculated to be 864.346 km². The area of occupancy (AOO) was estimated at 20 km² and is being progressively reduced the impact of farms, mechanized fruitculture, charcoal production, fires, and limestone quarrying. Following the IUCN criteria (IUCN 2001), this species should be considered as Endangered: EN B1 a,b (iii) + B2 a,b (ii).

Representative specimens examined (paratypes):
BRAZIL. Ceará: Limoeiro do Norte, 05°18'17"S 37°52'25"W, 144 m, 28/V/2015, fl., fr., E.B. Souza 3549, R.A.S. Pontes, E.C. Thomaz & L.C. Silvestre (CTES, EAC, HUEFS, HUVA); Quixeré, 3/VII/1996, fl., L.W. Lima-Verde *et al.* 269 (CTES, EAC). **Rio Grande do Norte:** Apodi, Lajedo da Soledade, 05°35'24"S 37°50'03"W, 110 m, 25/V/2015, fl., fr., E.B. Souza 3511, 3515, R.A.S. Pontes, E.C. Thomaz & L.C. Silvestre (CTES, HUEFS, HUVA); Felipe Guerra, Cachoeira do Roncador, 05°34'29"S 37°40'47"W, 58 m, 27/V/2015, fl., fr., E.B. Souza 3538, 3539, R.A.S. Pontes, E.C. Thomaz

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