



## ***Bradea borrierioides* (Rubiaceae), a new species from Brazilian inselbergs**

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### **Abstract**

*Bradea borrierioides* is here newly described as a species endemic to the inselbergs of Espírito Santo and Minas Gerais states, Brazil. It differs from all other *Bradea* species by its frondose-bracteate synflorescence with paraclades disposed in a monocal branch-pattern. Affinities, diagnostic characters, distribution and conservation status are discussed.

**Key words:** Atlantic Rainforest, *Borreria*, Coussareeae, granitic outcrop

### **Introduction**

*Bradea* Standley (1932: 122) is a small genus of the Neotropical tribe Coussareeae (Rubiaceae) (Delprete & Jardim 2012). This genus was monotypic when Standley (1932) described it, and four additional species were described later on by Brade (1950). *Bradea* can be recognized by its linear stipules, calyx with two sepals, corolla 4-merous, compressed septicial capsule and winged seeds (Standley 1932). This genus comprises herbs, sub-shrubs and shrubs endemics to the Atlantic Rainforest of southeastern Brazil, where they occur as small populations on rocky outcrops (Oliveira 2014).

While conducting a taxonomic revision of *Bradea*, a new species was discovered in Espírito Santo state, southeastern Brazil. At the same time, another collection from Teófilo Otoni (Minas Gerais) was sent to the CTES herbarium for identification, where it was also concluded it represented an undescribed species of *Bradea*. It soon became apparent that both collections represented the same undescribed species. Considering this coincidence, we joined efforts, and this new species is described and illustrated below.

### **Material and Methods**

**External Morphology:**—This study is based on recent collections and herbarium material from BHCB, CTES, K, MBML and RB (Thiers 2015). We used conventional taxonomic methods. Distribution is based on herbaria materials and field work data. The terminology follows Radford *et al.* (1974) for vegetative and floral structures, Harris & Harris (2003) for indumenta and Weberling (1989) for inflorescences. The official species conservation status was assessed by the Centro Nacional de Conservação da Flora (CNCFlora) committee following the recommendations of *IUCN Red List Categories and Criteria, Version 3.1* (IUCN 2001).

**Microscopy:**—The pollen grain and seed morphology were described based on the following samples taken from herbarium material: *L. F. M. De Paula & M. D. F. Augsten 303* (CTES). Pollen grains were acetolyzed according to Erdtman (1966) and mounted in glycerine jelly for analyses with light microscopy (LM). We measured the equatorial diameter (E) and the polar axis (P) in at least 20 grains under LM. To express the relative length of colpi we used the length colpi/polar axis rate multiplied by 100 (LC/P) (Dessein *et al.* 2002). All other measurements were made using scanning electron microscope (SEM) graphs. For SEM analyses, seeds and acetolyzed pollen grains were sputter-coated with gold, and then photomicrographed with a Jeol 5800 LV SEM. Pollen terminology follows Punt *et al.* (2007) and seed terminology follows Stearn (1986).

## Taxonomy

*Bradea borrierioides* J.A.Oliveira & Sobrado, *sp. nov.* (Figs. 1, 2)

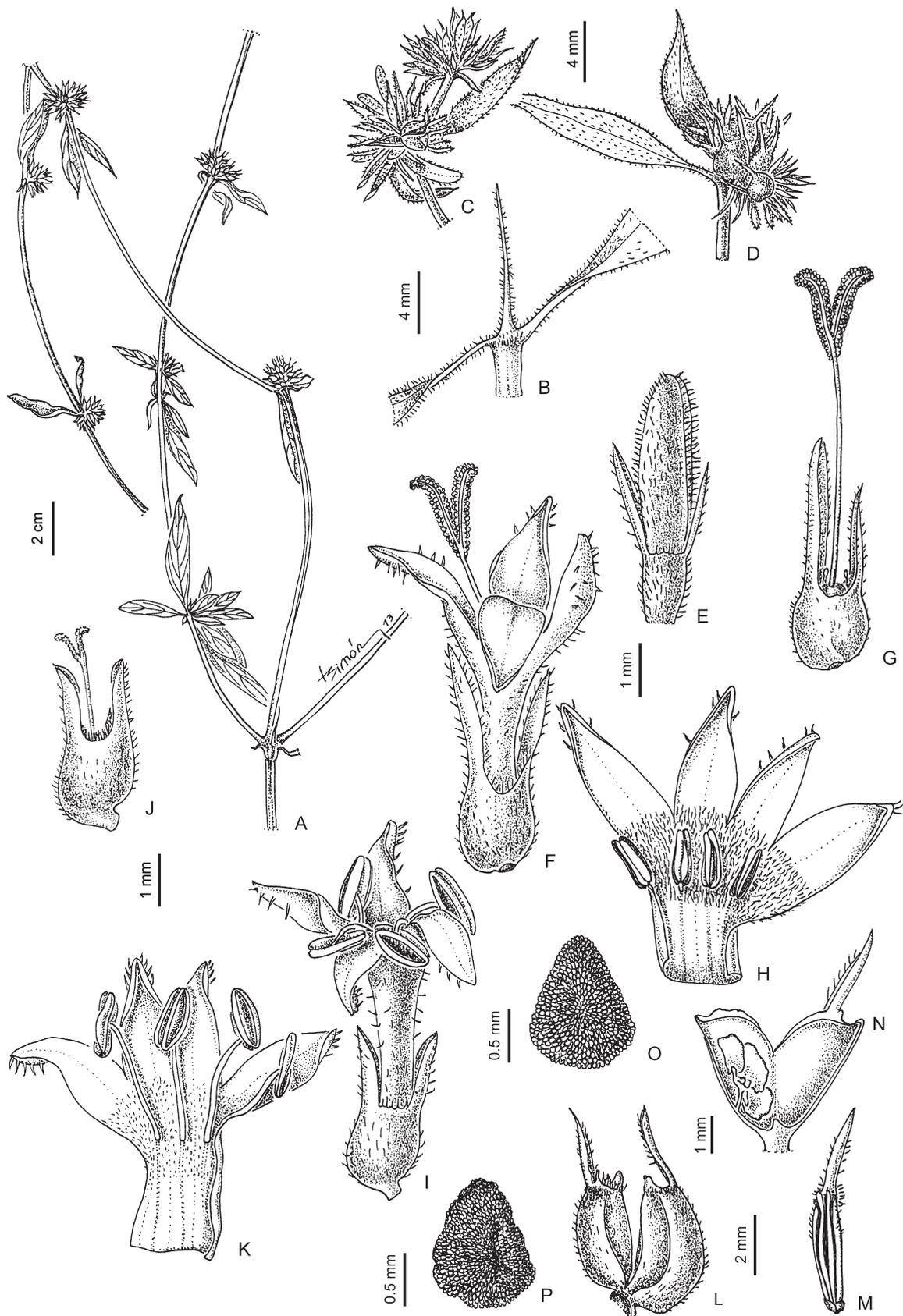
**Type:**—BRAZIL. Espírito Santo. Água Doce do Norte, morro da torre de celular, 22 April 2013, *J. A. Oliveira, M. O. O. Pellegrini & R. C. Forzza 354* [holotype: RB! (three sheets labelled 1 of 3, 2 of 3, and 3 of 3); isotypes: K!, MBML!, CTES!].

*This species is distinguished from all other species of the genus by the frondose-bracteate synflorescence with paraclades disposed in a monocasial branch-pattern, its diminute flowers with white to pale-lilac corolla and obcordate capsules.*

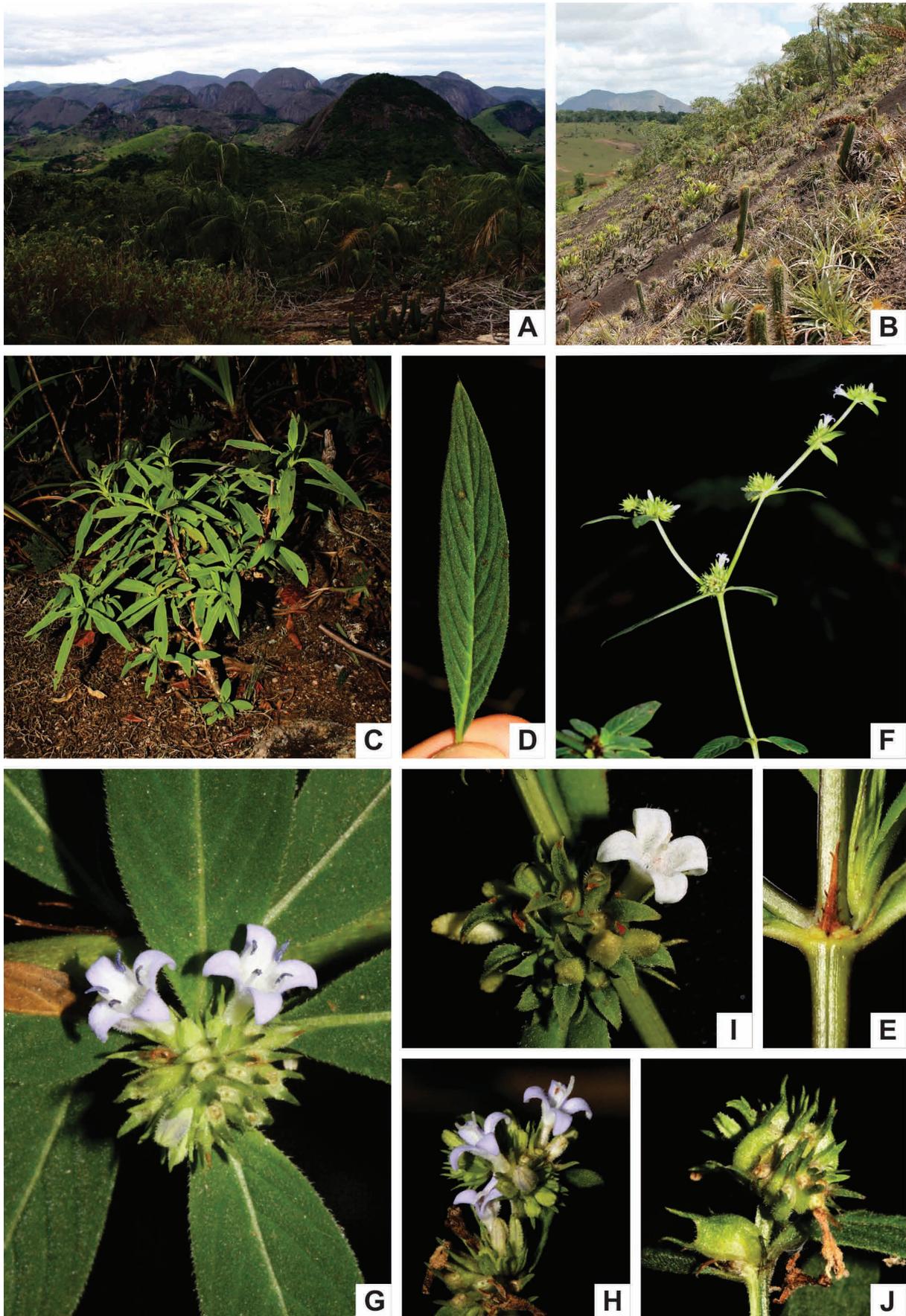
**Herbs** to sub-shrubs or shrubs, up to ca. 1.8 m tall; branches decumbent or erect, cylindrical to sub-tetragonal when young, dark greenish to brownish in older stages, glabrous to hispid or villosulous on young branches. **Stipular sheath** sub-triangular, 0.5–2 mm long, puberulous to villosulous externally, glabrous internally, bristle 1, 8–18 mm long, puberulous to pubescent, frequently with 1–3 pairs of lateral colleters, brownish. **Leaves** opposite; petioles 2–8 mm long, villosulous; blades lanceolate, narrowly elliptic to oblanceolate, (1.5–)3.1–6.3 × 0.4–0.9 cm, base narrowly cuneate and attenuate down the petiole, apex acuminate, papyraceous to chartaceous, slightly discolor, pubescent to villosulous, with hairs densely concentrated on the upper surface and on the veins underneath; midrib conspicuous on both surfaces, (3–)5–8 secondary veins on each side of the midrib, apparent only on lower surface; leaf margins scabrid to pubescent. **Synflorescences** terminal, 17.6–31.7(–47.8) cm long, frondose-bracteate, glabrescent to villosulous, paraclades disposed in a monocasial branch-pattern; cymules glomeruliform, many-flowered, decreasing in size towards the apex, 0.9–1.4 cm wide; bracts 1–2, leaf-like, two times longer than the glomerules, 20–50 × 6 mm at the axillary inflorescences and 8–15 × 5 at the terminal glomerule; bracteoles linear, 1.5–3.2 × 0.1–0.2 mm, villosulous, apex acuminate, colleters absent or one pair present. **Flowers** heterostylous, sessile; hypanthium obovoid to slightly reniform, 1.4–1.7 × 1.2–1.5 mm, laterally compressed, 0.46–0.5 mm thick, asymmetric, with one locule more developed than the other, pubescent to villosulous; point of insertion of the hypanthium displayed to the right side. Calyx 2-lobed, lobes slightly unequal, the larger one 1.4–3 × 0.4–0.6 mm, correlated with the more developed locule, the shorter one 1–2.3 × 0.2–0.6 mm, correlated with the locule less developed, lanceolate to narrowly triangular, pubescent, margins scabrid to pubescent; interlobular colleter dactyliform. Corolla 4-merous, white or pale-lilac, hypocrateriform, externally puberulous to villosulous; tube 2.7–3 mm long, 1.8–2 mm wide at base, 2–4 mm wide at mouth, lobes narrowly triangular to triangular, (1.6–)2–3.3 × 0.6–1.3 mm, internally glabrous or with sparse trichomes. Ovary bilocular, with 4–5(–6)–ovules per locule, locules unequal; style bifid, style branches papillate; nectariferous disc entire. **Longistylous flowers:** internally with moniliform hairs from the middle of the tube to the base of the lobes; style 5–6.4 mm long, exserted; stamens 4, included; filaments 0.2–0.3 mm long; anthers oblong, 1–1.4 × 0.2–0.5 mm. **Brevistylous flowers:** internally with moniliform hairs from the upper 2/3 of the tube to the base of the lobes; style 1.5–2.6 mm long, included; stamens 4, exserted; filaments 1.5–2.4 mm long; anthers oblong, 1.2–1.7 × 0.2–0.5 mm. **Capsules** obcordate, asymmetric, (2–)3.3–4(–5.4) × (2–)3.1–3.7 mm, 0.5–0.8 mm thick, lignified, pubescent, dehiscent with septicial and longitudinal dehiscence, calyx lobes persistent; one mericarp more developed than the other, larger mericarp 2–3.8 × 1–2 mm, smaller mericarp 1.6–2.8 × 0.9–1.7 mm. **Seeds** 3–4 per mericarp, sub-triangular to sub-obovoid, 1–2.6 × 1–1.8 mm, lightly lenticular, winged, peltate, dorsiventrally compressed, dorsal surface marginally convex, ventral surface flat, testa papillate (Fig. 3 E–G).

**Pollen grain morphology:**—*Bradea borrierioides* pollen grains are 3-colporate, medium (P= 44.97 (49.69) 54.48 μm; E= 43.7 (48.37) 51.67 μm), and prolate-spheroidal (P/E= 0.92 (1.03) 1.11). The outline is slightly triangular in polar view with apertures situated at the angles. The ectoaperture is a long colpus (37.67 (39.86) 42 μm long; LC/P= 87.3), slit-like, with sharp ends and margins with tufts of nanospines. The colpi have an apertural membrane, 6–14 μm long, with granulate surface. The endoaperture is a pore alongate, which width is ca. 1/4 the length of the ectoaperture. The pori are 10.51 (15.17) 17.63 μm in diameter at the ectocolpus area and 4.86 (6.37) 9 μm at the mesocolpium area. The exine is 2.89 (3.57) 4.35 μm thick, the nexine 1.37 (1.96) 2.49 μm thick, and the sexine 1.29 (1.96) 2.49 μm thick. Both are separated in a vestibule (3.84 (5.09) 6.35 μm) at the aperture area. The exine is semitectate with inconspicuous nanospines, and the tectum is microreticulate. The lumina are 1.07 (1.35) 1.8 μm in diameter and have nanospines arranged in groups at the center. There is no difference between the mesocolpium and apocolpium exine pattern ornamentation. (Fig. 3 A–D).

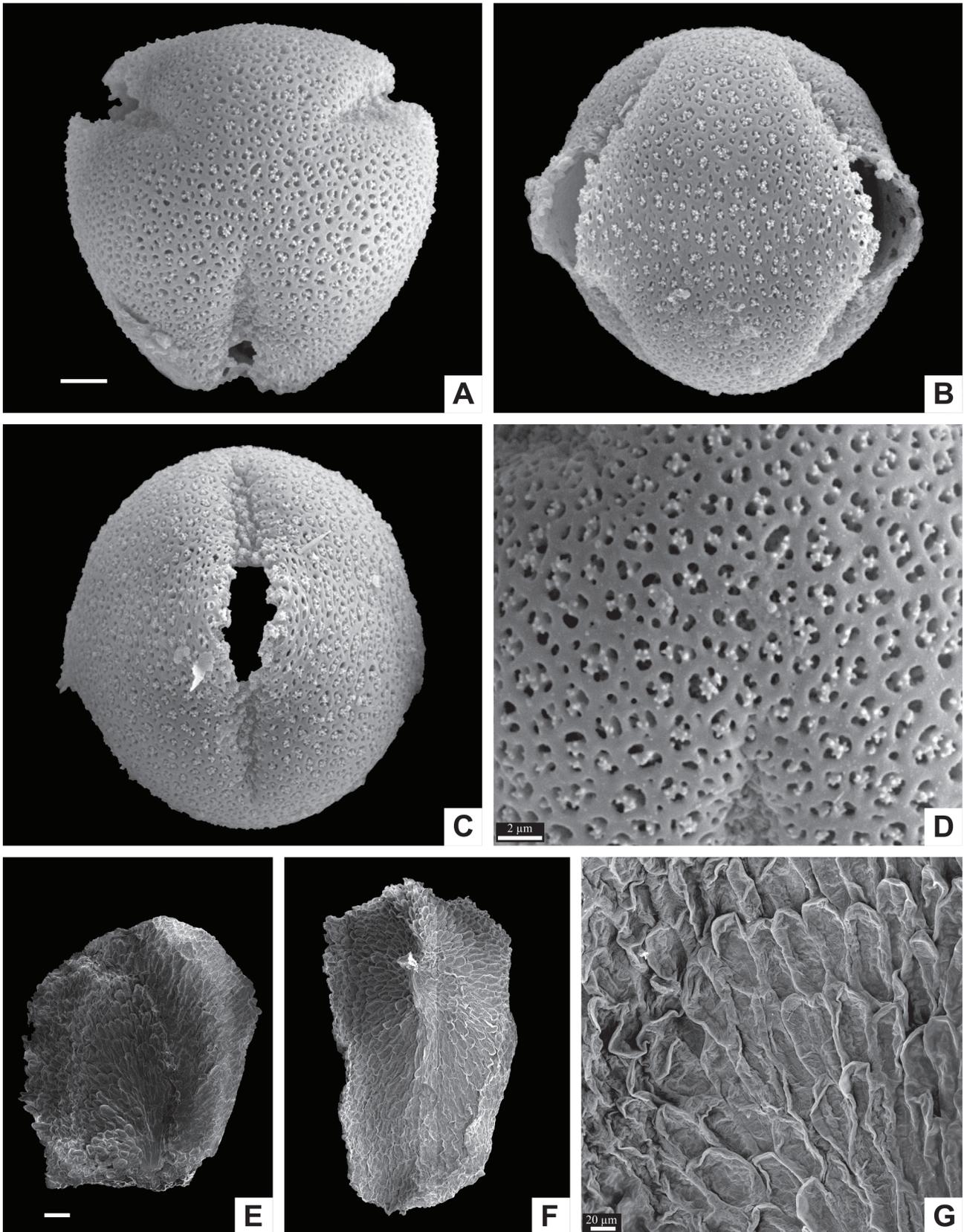
**Morphological observations:**—The capsules in *Bradea borrierioides* are obcordate as in *B. brasiliensis* Standley (1932: 123) and *B. kuhlmannii* Brade (1950: 14), and its flowers are small like the ones of *B. bicornuta* Brade (1950:



**FIGURE 1.** *Bradea borrerioides*. **A.** Habit. **B.** Stipular sheath. **C.** Glomeruliform cymule. **D.** Detail of the cymule with foliate bracts. **E.** Flower bud. **F.** Longistylous flower (=LF). **G.** Hypanthium, style and stigma of LF. **H.** Open corolla of LF. **I.** Brevistylous flower (=BF). **J.** Hypanthium, style and stigma of BF. **K.** Open corolla of BF. **L.** Capsule. **M.** Internal view of a mericarp to display septicial dehiscence. **N.** Open mericarp showing the placenta and seeds. **O.** Dorsal view of seed. **P.** Ventral view of seed. (A–H, L–P from *L. F. M. De Paula & M. D. F. Augsten 303*; I–K from *L. F. A. De Paula & M. D. F. Augsten 355*). Illustration by L. Simón.



**FIGURE 2.** *Bradea borrierioides*. **A.** Type locality. **B.** Inselberg in Nova Venécia. **C.** Habit. **D.** Leaf. **E.** Stipular sheath. **F.** Synflorescence. **G.** Detail of a lilac brevistylous flowers. **H.** Detail of lilac longistylous flowers. **I.** Detail of white longistylous flowers. **J.** Capsules. (Photos B–C, E, I by *H. Medeiros*; A, D, F–H, J by *M. O. O. Pellegrini*).



**FIGURE 3.** Scanning electron microscopy (SEM) micrographs of pollen grains and seeds of *Bradea borrierioides*. Pollen: **A.** Polar view. **B.** Equatorial view. **C.** Detail of the compound aperture. **D.** Detail of exine ornamentation at the apocolpium. Seed: **E.** Dorsal view. **F.** Ventral view. **G.** Detail of the papillate testa and digitate cells. (A–G from *L. F. M. De Paula & M. D. F. Augsten 303*). Pollen scale bar 5  $\mu\text{m}$ ; seed scale bar 100  $\mu\text{m}$ .

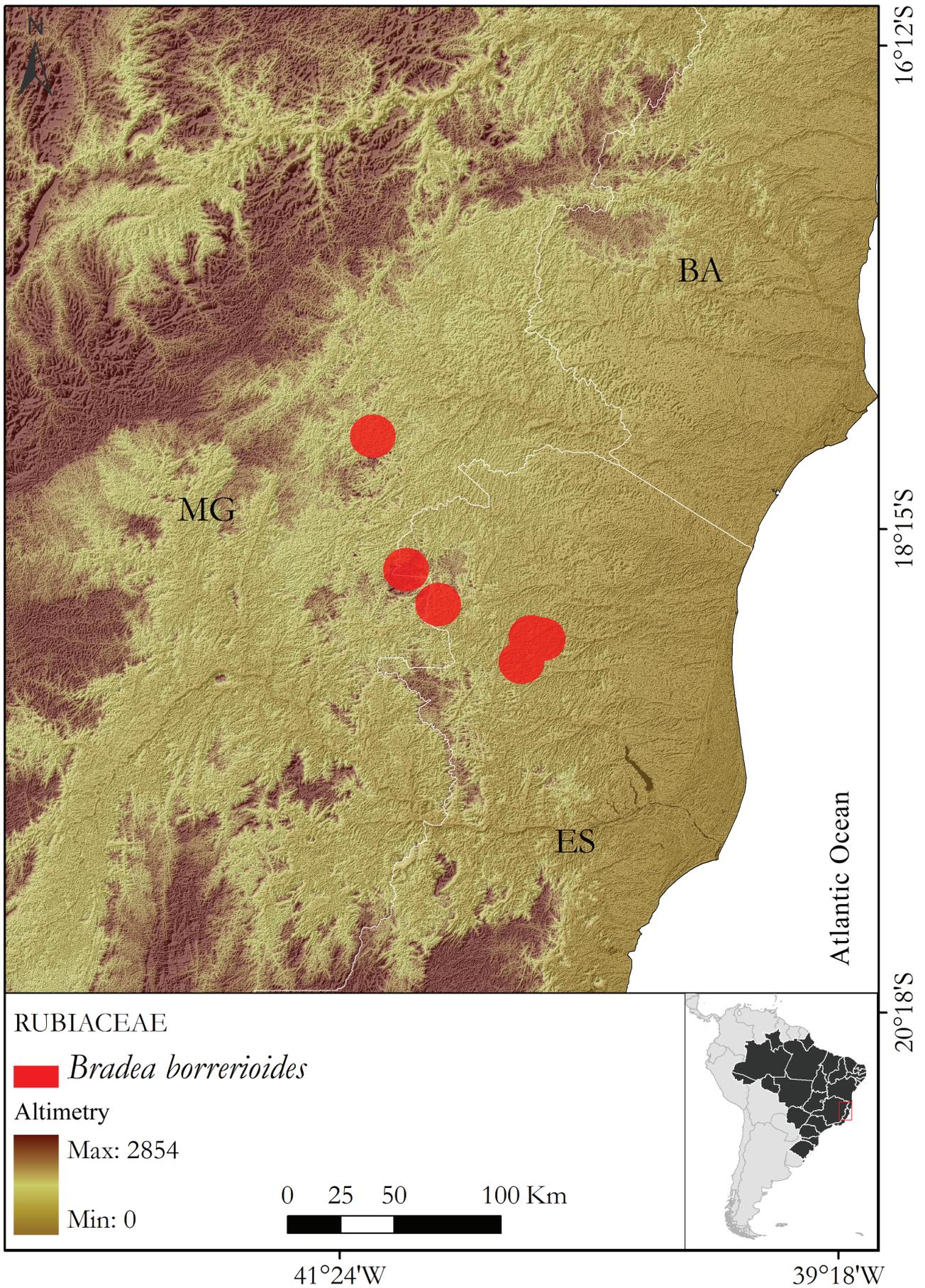


FIGURE 4. Distribution of *Bradea borrierioides* in Brazil. Produced by Centro Nacional de Conservação da Flora (CNCFlora). 2014.

15). However, *B. borrierioides* can be recognized by possessing the longest synflorescences in the genus (commonly 17.6–31.7 cm long, rarely up to 47.8 cm long), which are frondose-bracteose, with its paraclades disposed in a monocasial branch-pattern, a feature exclusive to the species. In addition, it can be distinguished by its herbaceous to sub-shrub growth-form, with decumbent branches and flowers with white to pale-lilac corollas.

**Etymology:**—The epithet “*borrierioides*” makes reference to the similarity in habit, inflorescence form and the diminutive white to pale-lilac corollas as in some species of the genus *Borreria* Meyer (1818: 79) (Spermacoceae).

**Distribution and Habitat:**—The species is known from northeastern Minas Gerais and northern Espírito Santo state, Brazil (Fig. 4). Unlike other species of the genus, *Bradea borrierioides* is not heliophylous. It occurs in semi-shaded understory in open forests on granitic outcrops or on the margins, at elevations between 144 and 620 m.

**Phenology:**—Collected with flowers and fruits from February through April.

**Conservation status:**—*Bradea borrierioides* is classified as Endangered, EN B1ab(i,ii,iii,iv,v)+2ab (i,ii,iii,iv,v); C2ai; D1 (Negrão 2014), according to IUCN Standards (IUCN 2001). The species presents EOO of 1.925 km<sup>2</sup> and AOO of 24 km<sup>2</sup>, and since it only occurs on rocky outcrops, its habitat is naturally and severely fragmented leading to isolation of the subpopulations. Six subpopulations of this species are known, the largest one is composed of approximately 50 mature individuals, and none of them are protected by Conservation Units. The global population suffers impact from several human activities that imply continuous decline of EOO, AOO, habitat quality, and number of subpopulations. The threats are: granite mining based in implosion of inselbergs; vegetation suppression for installation of mobile phone towers, TV antennas and other technologies; and the current use of the outcrops for cultivation of coffee and *Eucalyptus*. In addition, the invasion of exotic grasses, tourism and recreational activities on inselbergs involving the installation of paragliding ramps or opening of trails and trampling of vegetation imply declining habitat quality and the number of mature individuals. Whereas the endemic plants of inselbergs rarely survive in *ex situ* collections due to the climatic and ecological conditions of these environments, investment is required in the creation and expansion of protected areas that include the species’ habitats (Negrão 2014).

**Additional specimens examined (paratypes):**—BRAZIL. **Espírito Santo:** Água Doce do Norte, Córrego Havaí, torre de celular/rampa de vô livre, topo, afloramento rochoso, 27 April 2008, *A. P. Fontana, L. Kollmann, E. Leme, M. Zanoni, O. Ribeiro & N.F.B. Botelho* 5077 (K, MBML!); idem, Santa Luzia do Córrego Azul, 28 April 2008, *L. Kollmann, A. P. Fontana, E. Leme & M. Zanoni* 10975 (MBML!); Nova Venécia, Distrito de Cristalina, 15 February 2014, *R. C. Forzza, K. Hmeljevski & H. Medeiros* 7807 (RB!); idem, inselbergue, 14 February 2014, *R. C. Forzza, K. Hmeljevski & H. Medeiros* 7790 (RB!); Vila Pavão, Barra da Rapadura, Fazenda do Sr. Wagner Scardini, 16 February 2014, *R. C. Forzza, K. Hmeljevski & H. Medeiros* 7874 (RB!). **Minas Gerais:** Teófilo Otoni, afloramento rochoso ao lado esquerdo da MG-418, cerca de 30 km ao N de Teófilo Otoni, 16 April 2011, *L. F. A. De Paula & M. D. F. Augsten* 303 (BHCb, CTES!); idem, *L. F. A. De Paula & M. D. F. Augsten* 355 (BHCb, CTES!).

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