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An updated description of *Galianthe vaginata* (Spermacoceae, Rubiaceae), a species endemic to the Serra da Mantiqueira and Serra do Mar, Southeast Brazil

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Abstract

An updated description of *Galianthe vaginata* is here presented. This species is endemic to the Serra da Mantiqueira and Serra do Mar, Southeast Brazil, and occurs in remnants of the Atlantic forest phytogeographic domain, in the *campos de altitude*, rocky outcrops, and along trails in montane rainforest. Its bracts, short-styled flowers, fruits and seeds are described and illustrated for the first time. The conspicuously winged stems and the pubescent stipules constitute a combination of diagnostic characters useful for distinguishing *G. vaginata* from *G. polygonoides*. Its conservation status is reassessed based on recent collections.

Key words: amendment, *Borreria*, heterostyly, *Spermacoce* clade

Introduction

Galianthe Grisebach (1879: 156) is a Neotropical genus of the tribe Spermacoceae (Rubiaceae) in the *Spermacoce* clade (Kårehed *et al.* 2008, Salas *et al.* 2015), distributed along tropical and subtropical regions and comprising 50 species (Borhidi 2004, Cabral 2009). Although it has been considered as a section of *Borreria* Meyer (1818: 79) by previous authors (e.g., Schumann 1888), Cabral (1991) reinstated the generic status of *Galianthe*, which can be distinguished from *Borreria* mainly by the presence of heterostylous flowers arranged in lax thyrsoid inflorescences (vs. homostylous flowers in glomerules in *Borreria*), and also by seed, palynological and cytological characters.

Cabral & Bacigalupo (1997) and Cabral (2009) taxonomically reviewed *Galianthe*. These authors expanded the circumscription of the genus by transferring to it species previously described in other genera of the *Spermacoce* clade, and proposed an infrageneric classification of *Galianthe* in two subgenera. Species of *Galianthe* subg. *Ebelia* Cabral & Bacigalupo (1997: 859) have fruits with indehiscent mericarps, seeds with unwinged margins, variable habit, stems usually winged, and chromosome number $x = 12, 14, 15$; on the other hand, species of *Galianthe* subg. *Galianthe*, have fruits with dehiscent mericarps, seeds with winged margins, erect habit, stems not winged, and chromosome number $x = 8$. Nevertheless, the relationships within the *Spermacoce* clade are complex and the monophyly of *Galianthe* and its subgenera has never been tested. Phylogenetic studies focused on this genus are needed to determine its circumscription, closest relatives, patterns of character evolution and the validity of an infrageneric classification.

Galianthe vaginata Cabral & Bacigalupo (1997: 875) is a species endemic to Southeast Brazil, positioned in *Galianthe* subg. *Ebelia* by Cabral & Bacigalupo (1997), although fruits, seeds, and short-styled flowers were not described. The species has tubular stipular sheaths covering part of the internode above the corresponding pair of leaves, in a similar way of that of *Galianthe polygonoides* Cabral & Bacigalupo (1997: 875), the only other species of the subgenus presenting this feature. These species can be distinguished from each other by the conspicuously winged stems and the pubescent stipules in *G. vaginata* (Cabral & Bacigalupo 1997).

Galianthe vaginata was described using the holotype *P. Dusén 109* (R), collected in the Serra do Itatiaia, Minas Gerais state (MG), and two paratypes, *A. Regnell 178* (BR) and *E. Friderich s.n.* (PACA 27764), from the states of Minas Gerais and São Paulo (SP), respectively. According to Cabral & Salas (2015), this species occurs in the Atlantic

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forest phytogeographic domain, in the *campos de altitude* and rainforest vegetation, and has been recorded in the state of Rio de Janeiro as well. Due to partial knowledge of the morphological features of *G. vaginata*, we present here an updated description of the species, along with illustrations and photographs. In addition, based on recent collections, the geographic range is expanded, and comments on ecological and morphological aspects are provided. Since new data regarding this species is available, a new evaluation of its conservation status is also provided.

Material & Methods

Collections deposited at the ESA, ESAL, ICN, PACA, R, RB, SP and UEC herbaria (acronyms according to Thiers (2015)) were analyzed, as well as natural populations in the district of Monte Verde, municipality of Camanducaia, and Serra do Lopo, municipality of Extrema, in the state of Minas Gerais, Brazil. The holotype (*P. Dusén 109* [R]), a paratype (*E. Friderich S. J. s.n.* [PACA 27764]) and two additional specimens determined by Elsa Cabral in 1996 (probably after the submission of the manuscript Cabral & Bacigalupo (1997)) as *G. vaginata, M. Kuhlmann 3378* (SP) and *H. Luederwaldt s.n.* (SP 11378), were also analyzed. General morphological terminology followed Simpson (2010). Since most of our study is based on herbarium material, conservation status assessment was based on range size (criterion B), following IUCN (2014) recommendations. Most of the specimens analyzed were not georeferenced, therefore the coordinates from the municipalities were used as proxies. EOO (Extent of Occurrence) and AOO (Area of Occupancy) were estimated utilizing GeoCAT (Bachman *et al.* 2011). For AOO, we utilized a grid size of 2 km (cell area of 4 km^2), as recommended by the IUCN (2014), since it relates to the thresholds of the B criterion.

Taxonomy

Galianthe vaginata E.L.Cabral & Bacigalupo

Type:—BRAZIL. Minas Gerais: Serra do Itatiaia, ad marginem viae, ca. 1800 m, 25 May 1902, *P. Dusén 109* (holotype R!). Figs. 1, 2.

Subshrubs or perennial herbs, up to 1 m tall. *Stems* simple or sparsely branched, rooting at basal nodes, decumbent, scandent or erect, tetragonal, glabrous, conspicuously winged at each angle, wings 0.3–2 mm wide, scabrous at margin. *Stipular sheaths* tubular, 3–12 mm long, covering part of the internode above the corresponding leaf pair, pubescent, deciduous at basal nodes, 7–12-fimbriate on each side of the stem, fimbriae 4–12 mm long, narrowly triangular to linear, glabrous to sparsely pubescent. *Leaves* sessile to petiolate; petioles (when present) up to 5 mm long, terete, glabrous; *blades* elliptic, ovate or lanceolate, 2.4–9 × 0.7–3.3 cm, discolorous, membranous to coriaceous, attenuate at the base, ciliolate at the margin, acuminate at the apex, adaxial surface glabrous, abaxial surface glabrous, strigulose on the veins; secondary veins 4–5 on each side of the midrib, occasionally impressed on the adaxial surface, conspicuous on the abaxial surface. *Inflorescences* terminal, rarely axillary, compound cymes, partial inflorescences dichasial or monochasial cymes, with flowers arranged in fascicles separated by 0.1–3 cm; *peduncles* 2–7 cm long, winged, glabrous; *bracts* narrowly elliptic to lanceolate, 2.5–5 × 0.8–1.5 mm, glabrous on both sides, margin strigulose. *Flowers* sessile to subsessile, distylous; *hypanthium* turbinate, 1.5–2 mm long, strigulose; *calyx* 4-lobate, with the lobes slightly unequal, in opposite pairs, the two larger ones ca. 1.7 mm long, the two shorter ones ca. 1.2 mm long, triangular, glabrous on both sides, margin strigulose. *Corolla* infundibuliform, 3–4 mm long, white, papillose outside, pubescent at the throat and lobe bases inside; lobes (3–)4, triangular, 2–3 mm long. *Long-styled flowers*: *stamens* included, filaments ca. 0.5 mm long, anthers ca. 1 mm long, *style* exserted, ca. 6 mm long, stigma 2-lobate, stigmatic lobes ca. 1 mm long. *Short-styled flowers*: *stamens* exserted, filaments ca. 1.5 mm long, anthers ca. 1.5 mm long, *style* included, ca. 3.2 mm long, stigma 2-lobate, stigmatic lobes ca. 1.5 mm long; *nectariferous disk* bipartite. *Capsules* septicidal, with indehiscent mericarps, 1.5–2 mm long, subturbinate, slightly compressed laterally, strigulose, calyx lobes persistent. *Seeds* 2, ellipsoid, 1.5–2 mm long, ventral surface with a longitudinal groove partially covered by strophiole, dorsal surface foveolate.

Ilustrations:—Cabral & Bacigalupo (1997): 874, fig. 10; this study, fig. 1.

Phenology:—Flowering from August to April and fruiting in April.

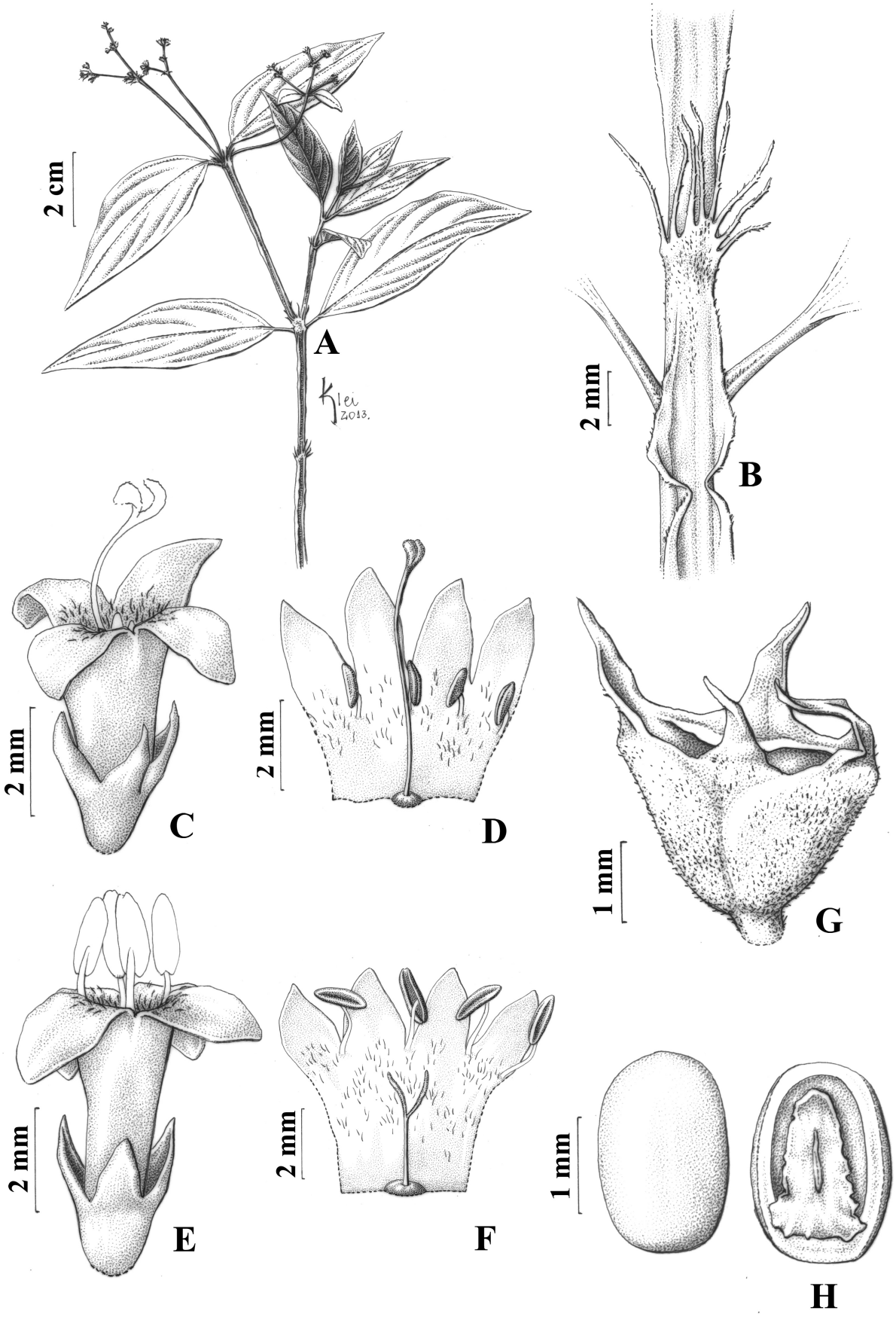

FIGURE 1. *Galianthe vaginata*. **A.** Habit. **B.** Stipule. **C–D.** Long-styled flower. **E–F.** Short-styled flower. **G.** Fruit. **H.** Seed. (A–B, G–H, from *Carmo 24*; C–D, from *Carmo 141*; E–F, from *Carmo 142*). Illustration by Klei Sousa.

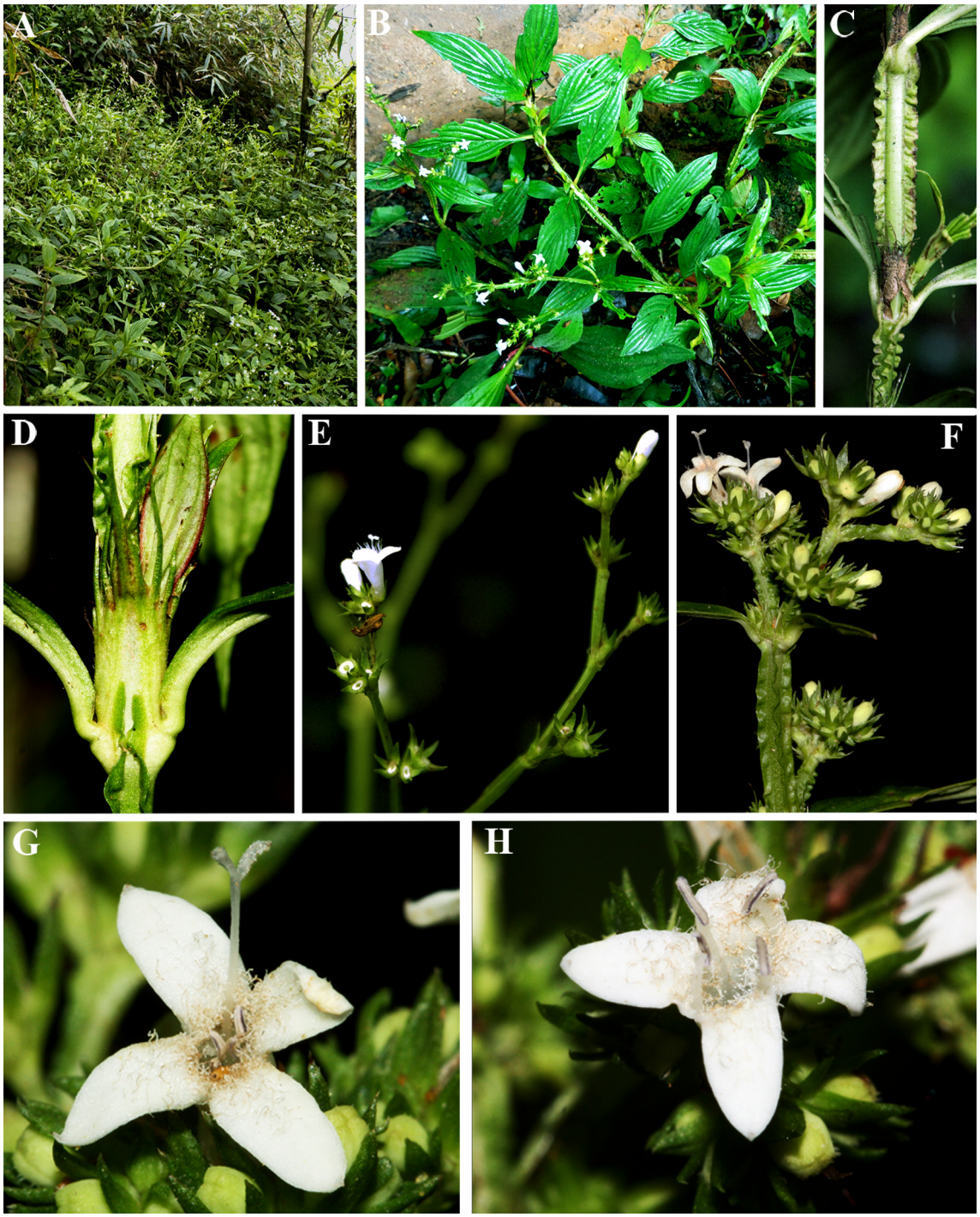

FIGURE 2. *Galianthe vaginata*. **A.** Population. **B.** Individual. **C.** Stem with deciduous stipules at basal nodes. **D.** Stipule. **E–F.** Inflorescences. **G.** Long-styled flower. **H.** Short-styled flower. (A–B, photographs by João Afonso Martins do Carmo; C–H, photographs by André Olmos Simões).

Distribution and ecology:—*Galianthe vaginata* is endemic to montane areas in Southeast Brazil, occurring at elevations from ca. 1,200 to 2,000 m. It occurs at six localities in the Serra da Mantiqueira (Fig. 3A–F) and one in the Serra do Mar (Fig. 3G): (A) Serra do Lopo, municipality of Extrema (MG); (B) district of Monte Verde, municipality of Camanducaia (MG); (C) Parque Estadual Campos do Jordão, municipality of Campos do Jordão (SP); (D) São Francisco dos Campos, municipality of Delfim Moreira (MG); (E) Serra Fina, municipality of Itamonte (MG); (F) Parque Nacional do Itatiaia (MG and RJ); and (G) municipality of Cunha (SP). Subpopulations are composed by a few to many individuals, which can be found solitary to aggregate (Fig. 2A–B). The species occurs in the *campos de altitude* vegetation, rocky outcrops and along trails in montane rainforest, generally in areas where the formation of mist is common and substrate is moist.

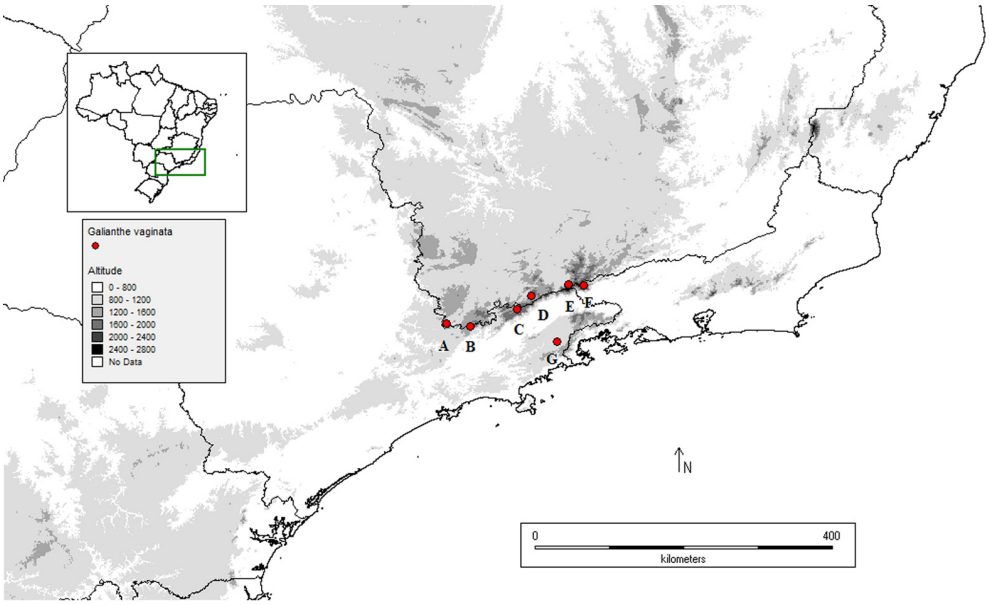

FIGURE 3. Distribution map of *Galianthe vaginata*. **A.** Serra do Lopo, municipality of Extrema (MG). **B.** District of Monte Verde, municipality of Camanducaia (MG). **C.** Parque Estadual Campos do Jordão, municipality of Campos do Jordão (SP). **D.** São Francisco dos Campos, municipality of Delfim Moreira (MG). **E.** Serra Fina, municipality of Itamonte (MG). **F.** Parque Nacional do Itatiaia (MG and RJ). **G.** Municipality of Cunha (SP).

Conservation status:—*Galianthe vaginata* was assessed as Endangered (EN B1ab(iii)+2ab(iii)) by Zappi *et al.* (2013). We expand the distribution of the species and record it in two Conservation Units, Parque Estadual Campos do Jordão and Parque Nacional do Itatiaia. Nevertheless, the IUCN (2014) states that the criteria for the threatened categories are to be applied to a taxon whatever the level of conservation action affecting it. We estimate the EOO and AOO, ca. 6487 km^2 and 32 Km^2, respectively (.kml file available at http://figshare.com/s/6c197a305f1b11e5ad6c06ec4b8d1f61). These results differ in regards to the threshold of the B criterion for a species to be considered Endangered (EOO <5000 Km^2 and AOO <500 Km^2). Area of occupancy reflects the fact that species are often habitat specialists, and will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats (IUCN 2014). This is the case for *G. vaginata*, which presents a fragmented distribution in specific habitats in montane areas, between the two largest urban centers in Brazil, Rio de Janeiro and São Paulo. Therefore, for the purposes of this evaluation, this species should still be considered Endangered (EN B2ab(iii)), based on its AOO, severe fragmentation of its subpopulations and continuous decline in extent and quality of habitat, due to its continuous degradation by anthropogenic fires, land use as pastures, and timber extraction in forested areas (Zappi *et al.* 2013).

Specimens examined:—BRASIL. **Minas Gerais:** Camanducaia, Monte Verde, 20 Sep 2001, *L.D. Meireles 608* (UEC), 16 October 2001, *L.D. Meireles 640* (UEC), Pedra Partida, 2,080 m, 20 January 1996, *Longhi-Wagner & Witten 2887a* (ICN), Platô, 22°53'15"S, 46°1'55"W, 22 August 2015, *J.A.M. Carmo 401* (UEC), trilha para a Pedra do Selado, 12 Apr 2012, *J.A.M. Carmo 24* (UEC), trilha para o Platô, 24 January 2013, *J.A.M. Carmo 105* (UEC), 18 December 2013, *J.A.M. Carmo 140, 141, 142* (UEC), trilha para Pedra Redonda, 9 September 2012, *J.A.M. Carmo 71, 72, 74* (UEC); Delfim Moreira, São Francisco dos Campos, 7 June 1950, *M. Kuhlmann 3378* (SP); Extrema, estrada para a trilha das pedras, 11 October 2014, *G. Piassa 26* (UEC); Itamonte, Hotel Casa Alpina, ao lado da estação meteorológica da cota 2100, 2100 m, 22°22'56"S, 44°49'9"W, 29 January 2011, *T.A. Batista 265* (ESAL, UEC), 2000 m, 22°22'27"S, 44°49'1"W, 19 February 2004, *L.D. Meireles 1467* (UEC). **Rio de Janeiro:** Itatiaya, 13 May ?, *H. Luederwaldt s.n.* (SP 11378); Parque Nacional do Itatiaia, 30 November 1985, *D. Cesar 682* (RB). **São Paulo:** Campos do Jordão, January 1944, *E. Friderich S. J. s.n.* (PACA 27764, paratype); Parque Estadual de Campos do Jordão, Parque dos Lagos, São Bento do Sapucaí, subindo 9 km na trilha em direção ao charco, 12 October 1999, *L.O. Anderson 109* (UEC); Parque Estadual de Campos do Jordão, 9 April 2000, *L.O. Anderson 00/34* (UEC); Cunha, margens da Cachoeira do Barracão, 15 December 1996, *J.P. Souza 931* (ESA).

Discussion:—The description of *G. vaginata* is here complemented by several features not previously observed, as bracts, short-styled flowers, fruits and seeds, as well as previously unobserved morphological variations, which are here described and illustrated for the first time (Fig. 1). Following our morphological analysis, we confirm the positioning of this species in *Galianthe* subg. *Ebelia*, as proposed by Cabral & Bacigalupo (1997), because of the septicidal capsules with indehiscent mericarps and the ellipsoid, unwinged seeds (Fig. 1G–H). Deciduous stipules at

basal nodes were observed (Fig. 2C), as they fall off by fragmentation before the leaves, and seems to be associated with the formation of axillary branches. Inflorescence peduncle and the distance between the fascicles vary in length (Fig. 2E–F), and heterostyly was confirmed for this species. Both long-styled and short-styled floral morphs were observed within the same population (Fig. 2G–H). The conspicuously winged stems and the pubescent stipules (Fig. 1B, Fig. 2C–D) of *G. vaginata* are useful diagnostic characters that can be used to distinguish it from *G. polygonoides* (holotype *D.L.S. Braga 1741* [RB!]), which also presents tubular stipular sheaths covering part of the internode above the corresponding leaf pair.

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