



Flora of Espírito Santo, Brazil

Flora of Espírito Santo: Bonnetiaceae

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Abstract

Bonnetia stricta is the only species of Bonnetiaceae in eastern Brazil, where it occurs in the states of Alagoas, Bahia, Espírito Santo, Rio de Janeiro and Sergipe. It is easily recognized by the alternate, spiral leaves grouped at the apex of the branches and showy white to pink flowers with numerous stamens. As a contribution to the Flora of Espírito Santo project, this study provides a description, illustrations, taxonomic comments and a distribution map of the specimens of *B. stricta* from the state.

Key words: Atlantic Forest, *Bonnetia*, clusioid clade, Malpighiales.

Resumo

Bonnetia stricta é a única espécie de Bonnetiaceae que ocorre no leste do Brasil, mais especificamente nos estados de Alagoas, Bahia, Espírito Santo, Rio de Janeiro e Sergipe. A espécie é facilmente reconhecida pelas folhas alterno-espíraladas e agrupadas no ápice dos ramos, além de flores vistosas brancas a rosadas com muitos estames. Como contribuição ao projeto Flora do Espírito Santo, este trabalho fornece a descrição, ilustrações, comentários taxonômicos e mapa de distribuição dos espécimes do estado.

Palavras-chave: Floresta Atlântica, *Bonnetia*, clado clusioide, Malpighiales.

Introduction

Bonnetiaceae comprise 35 species divided into three genera: *Archytaea*, with only two species endemic to Amazonian forest; *Ploiarium*, with three species distributed in Southeast Asia and the Pacific Islands; and *Bonnetia*, with 30 neotropical species predominantly distributed in the Guiana Shield (Stevens 2001 onwards; Weitzman *et al.* 2007; Ruhfel *et al.* 2011). The family was recovered as the sister group of Clusiaceae, within the clusioid clade in Malpighiales (Ruhfel *et al.* 2011). Bonnetiaceae and Clusiaceae have entire, fleshy, glabrous leaves and flowers with slightly succulent, white to pinkish petals. Even sterile, these families can be distinguished by the alternate, spiral leaves and absence of an exudate in Bonnetiaceae (vs. opposite leaves and presence of an exudate in Clusiaceae).

Studies about Bonnetiaceae have focused on several areas of botany, such as anatomy (*e.g.*, Baretta-Kuipers 1976; Dickison & Weitzman 1996, 1998), karyotyping (*e.g.*, Oginuma & Tobe 2013) and phytochemistry (*e.g.*, Kubitzki *et al.* 1978; Bennett *et al.* 1990). For taxonomy, the family was monographed for Flora of the Venezuelan Guyana (Weitzman 2005) and listed in the Catálogo de Plantas y Líquenes de Colombia (Bernal *et al.* 2019). For Brazil, it was monographed for the Flora do Brasil 2020 project (Barbosa-Silva 2020) and is treated in local floras [*e.g.*, for Bahia (Costa *et al.* 2010) and Rio de Janeiro (Accardo Filho 2004)]. Additionally, species of the family are frequently on lists for different environments in floristic studies [*e.g.*, Araújo *et al.* (2008), on a list of angiosperms in *campos nativos* in northern Espírito Santo; Cardoso *et al.* (2017), on a list of Amazonian

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species; and Amorim *et al.* (2009), on a list of angiosperms in montane forest remnants in southern Bahia]. In Brazil, Bonnetiaceae are more diverse in Amazonian forest, with seven species, and only *Bonnetia stricta* (Nees von Esenbeck 1821: 338) Nees von Esenbeck & Martius (1824: 37) occurs in the eastern part of the country (Barbosa-Silva 2020).

Material and Methods

The family and genus descriptions are based on classic studies (*i.e.*, Kobuski 1948; Stevens 2001 onwards; Weitzman *et al.* 2007). The species description is based only on specimens from Espírito Santo, available on the SpeciesLink (<<http://www.splink.org.br>>) and Reflora (<<http://reflora.jbrj.gov.br>>) platforms, and photographs from the field. Flower and fruit measurements were taken from specimens from the VIES herbarium (acronym following Thiers, continuously updated). Information on the habitat and height of the specimens was obtained from specimen labels. The distribution map was produced on the SimpleMappr website (Shorthouse 2010) and is based on the specimens that have geographic coordinates. One specimen from each municipality is listed in the specimens selected.

Results and Discussion

Bonnetiaceae

The habit of Bonnetiaceae can vary between shrubs and small trees and the plants lack an exudate. The leaves are alternate and spiral, densely grouped at the apex of the branches, and have minutely toothed margins and conspicuously ascending veins. The pedicels have two prophylls or several bracts subtending the flowers. The flowers are bisexual, pentamerous, actinomorphic, usually showy, and can be solitary or in an axillary inflorescence. The calyx and corolla are free or connate, usually concave, contorted and unequal to each other. The calyx is imbricate in bud and the predominantly white or pink corolla is convoluted in bud. The stamens are numerous and free or adnate to the base of the ovary. The filaments are slender and the anthers are small and rimose. Staminodes are absent. The gynoecium is composed of a 3(–5)-locular ovary, which has several ovules per locule and axial placentation, and the stigma has a rounded-papillate surface. The septicidal capsules have a central column and the seeds have scarce endosperm (Stevens 2001 onwards; Weitzman *et al.* 2007).

Bonnetia

The species of *Bonnetia* are trees or shrubs (Fig. 1a). The leaves are coriaceous to chartaceous, entire, often asymmetrical, always shiny and glabrous, and grouped at the apex of the branches (Fig. 1b-c). The flowers are axillary, solitary or with up to three flowers per inflorescence (Fig. 1d-e). The bracteoles can be foliar or not (Fig. 1e). The sepals and petals are free, and the sepals are persistent on the fruit. The stamens are numerous with different degrees of fusion at the base of a 3(–4)-locular ovary (Fig. 1d-f), which develops into a capsule with small, cylindrical seeds.

Bonnetia has 30 species. Only three species, including *Bonnetia stricta*, occur outside the Guiana Shield region, which is the center of origin and dispersion of the genus (Ruhfel *et al.* 2011). Most species are limited by elevation and restricted to areas above 2,000 meters (Weitzman *et al.* 2007). However, elevation is not a barrier to *B. stricta*, which occurs in high elevation areas, such as montane forests (Amorim *et al.* 2009) and *campos rupestres* (Costa *et al.* 2010), and in lowland forests, such as *florestas de tabuleiros* (Araújo *et al.* 2008; Peixoto *et al.* 2008; Souza *et al.* 2016).

Bonnetia stricta (Nees) Nees & Mart., Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12(1): 37, pl. 6. 1824. Figs. 2-3

Shrubs or trees, up to 3 m tall in *restinga* and ca. 15 m tall in forests; exudate absent. Leaves symmetrical, alternate, spiral, grouped at the apex of branches, 6.1–11.2 × 2–4.3 cm, spatulate to obovate, the base attenuate, the apex obtuse to rounded, slightly retuse, the margin minutely toothed, strongly revolute *in sicco*, glabrous on both surfaces, coriaceous, light green *in vivo*, bright, young leaves brownish to copper colored *in sicco*, old leaves dark brown *in sicco*; petioles subsessile, up to 5 mm long. Flowers solitary or grouped in cymose inflorescences with 2–3 flowers each, axillary; peduncles 4.5–5.2 cm long; bracteoles 2, 0.6–1 × 0.5 cm long, ovate, green with reddish margins, persistent; pedicels 0.8–1.2 mm long; sepals 5, 0.7–1 × 0.5–0.7 cm, the base truncate, the apex obtuse, glabrous, persistent, green with reddish margins; petals 5, 1.9–2.6 × 0.9–1.5(–1.9) cm, flabelliform, pinkish abaxially, pinkish or white with pinkish macules adaxially; stamens ∞, 0.3–0.6 cm long, heterodynamous, not fasciculate, yellow; gynoecium 4-carpellate, ovules ∞ per locule, ca. 2 cm long, styles elongated,

stigmas papillose. Capsules $1.5\text{--}2.7 \times 1.7\text{--}2.5$ cm, green when immature, brownish when mature, ovoid, acuminate.

Specimens selected: Conceição da Barra, área 135 da Aracruz Celulose S.A., 23.VI.1992, fl., *O.J. Pereira et al.* 3555 (HUEFS, VIES). Guarapari, Lagoa do Milho, 31.VIII.1982, fl., *O.J. Pereira et al.* 134 (HUEFS, VIES). Linhares, Reserva Florestal Vale do Rio Doce,

15.X.1992, fl., *G. Hatschbach et al.* 58133 (VIES). Presidente Kennedy, restinga entre as rodovias ES-060 e 261, 21.IV.2009, fr., *A.M. Assis & M.D.S. Demuner* 2008 (MBML). São Mateus, Bairro Liberdade, 27.III.2010, fr., *M. Ribeiro et al.* 113 (VIES). Sooretama, Reserva Biológica de Sooretama, 15.IX.2014, fl., *G.S. Siqueira* 994 (CVRD). Vila Velha, Rodovia do Sol, ES-060, 31.VIII.1982, fl., *O.J. Pereira et al.* 135 (VIES).



Figure 1 – a-f. General morphology of *Bonnetia* – a-b. *Bonnetia roraimae* – a. habit; b. shrub with flowers; c-d. *Bonnetia sessilis* – c. branch with floral buds; d. flower; e-f. *Bonnetia stricta* – e. inflorescence with floral buds and flowers; f. flower. Photos: a-d. Alexey Yakovlev; e. Gustavo Shimizu; f. Lucas C. Marinho.

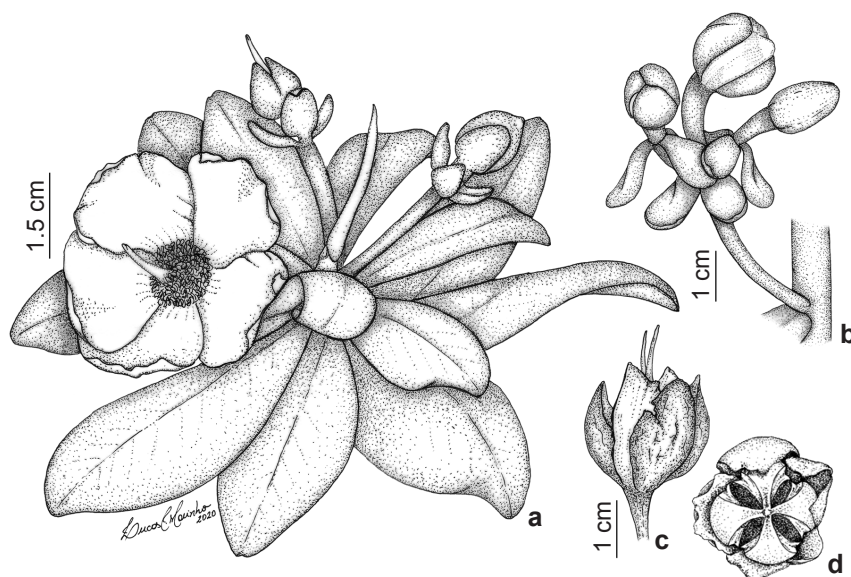


Figure 2 – a-d. *Bonnetia stricta* – a. branch with floral buds and flower at anthesis; b. floral buds; c. mature fruit in lateral view; d. mature fruit in frontal view. [Drawing by Lucas C. Marinho from a. *Siqueira 994*; b. unvouchered plant from Bahia state; c. *Ribeiro 113*; d. modified from Costa *et al.* (2010)].

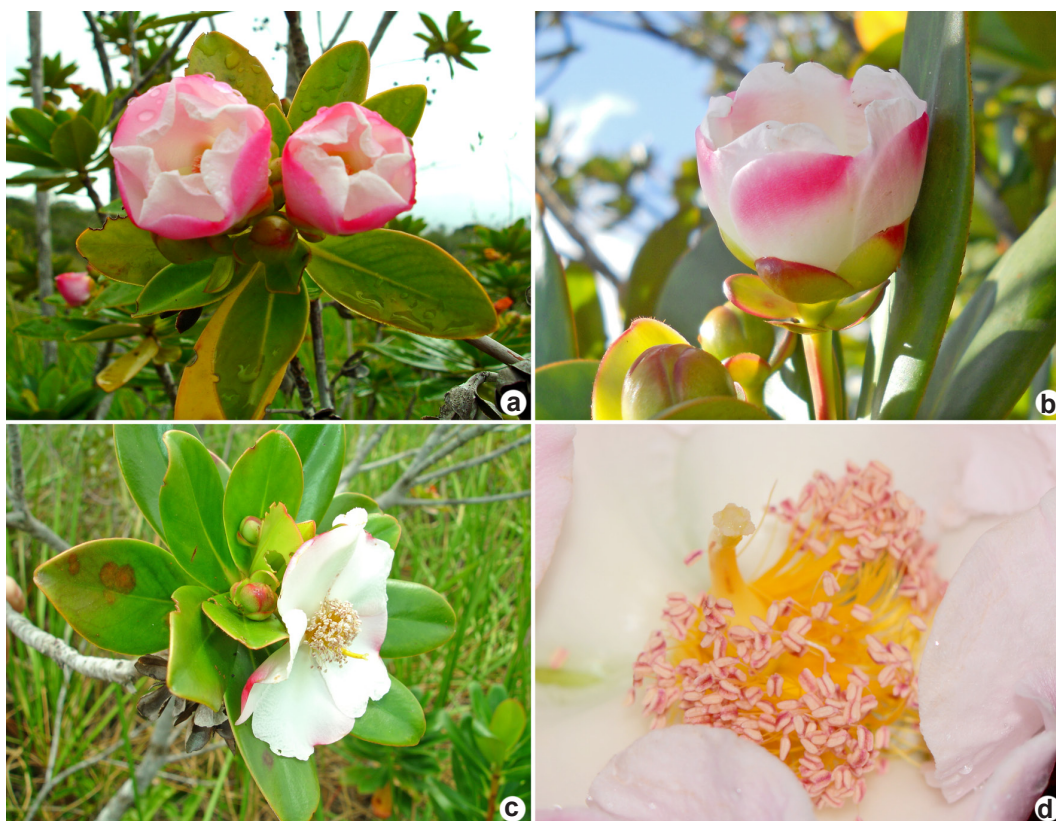


Figure 3 – a-d. *Bonnetia stricta* – a. floral buds in front view; b. floral bud in lateral view; c. flower at anthesis; d. detail of stamens and gynoecium. (a. and c. by Geovane Siqueira, from *Siqueira 994*; b. and d. by Lucas C. Marinho, from unvouchered plants from Bahia state).

Bonnetia stricta occurs in several vegetation types in Espírito Santo and is usually associated with water courses and sandy areas of *florestas de tabuleiros* (“tableland forests”, Peixoto *et al.* 2008; Souza *et al.* 2016). This species is also found in *campos nativos* [sandy substrates covered by herbs or short shrubs (Araújo *et al.* 2008)], *muçunungas* [sandy soil covered by smaller trees with an open canopy (Peixoto *et al.* 2008)] and *várzeas* [permanently flooded areas (Rolim *et al.* 2016)]. The species is also tolerant of saline soils, such as those of dunes and *restinga* (Pereira 1990) where it occurs associated with fields of Ericaceae, and disturbed environments in urban areas (Fig. 4). Due to its wide distribution in Espírito Santo, the species was listed as least concern (LC) by Dutra *et al.* (2019).

In addition to its geographic distribution, *Bonnetia stricta* can be distinguished from other species of the genus by the lax inflorescence and styles divided at the apex. Here I follow the Flora do Brasil 2020 project (Barbosa-Silva 2020) and consider the name *B. anceps* Martius (1826: 115), which has been mistakenly applied in studies in Espírito Santo, as a synonym of *Bonnetia stricta*. A complete identification key to Bonnetiaceae is in Barbosa-Silva (2020). Vernacular name: abricó-do-nativo.

Acknowledgments

I thank Geovane Siqueira (CVRD herbarium) and Alexey Yakovlev, for the beautiful photographs

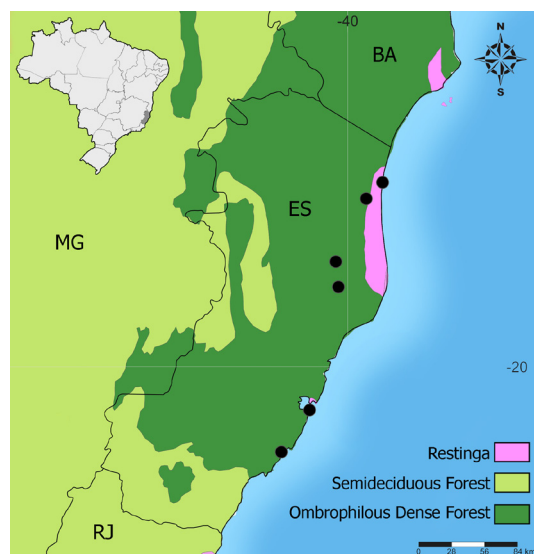


Figure 4 – Distribution map of *Bonnetia stricta* in Espírito Santo state, Brazil.

of *Bonnetia*; Julia Guarnier (VIES herbarium), for the help with some details in the description; Nathan Smith, for the English revision; and Dr. Grênivel Costa (HURB herbarium) and an anonymous reviewer, for their invaluable contributions.

References

- Accardo Filho MAP (2004) Theaceae no estado do Rio de Janeiro. Master's Dissertation. Museu Nacional. Universidade Federal do Rio de Janeiro, Rio de Janeiro. 112p.
- Amorim AM, Jardim JG, Lopes MMM, Fiaschi P, Borges RAX, Perdiz RO & Thomas WW (2009) Angiospermas em remanescentes de Floresta Montana no sul da Bahia, Brasil. *Biota Neotropica* 9: 313-348.
- Araújo DSD, Pereira OJ & Peixoto AL (2008) Campos nativos at the Linhares forest reserve, Espírito Santo, Brazil. In: Thomas WW (ed.) *The Atlantic coastal forest of Northeastern Brazil*. The New York Botanical Garden Press, New York. Pp. 371-385.
- Barbosa-Silva RG (2020) Bonnetiaceae. In: *Flora do Brasil 2020*. Instituto de Pesquisas Jardim Botânico do Rio de Janeiro. Available at <<http://reflora.jbrj.gov.br/reflora/floradobrasil/FB63>>. Access on 28 July 2020.
- Baretta-Kuipers T (1976) Comparative wood anatomy of Bonnetiaceae, Theaceae and Guttiferae. In: Baas P, Bolton AM & Catling DM (eds.) *Wood structure in biological and technological research*. Leiden Botanical Series 3: 76-101.
- Bennett GJ, Lee H-H & Lowrey TK (1990) Novel metabolites from *Ploiarium alternifolium*: a bixanthone and two anthraquinolixanthones. *Tetrahedron Letters* 31: 751-754.
- Bernal R, Gradstein SR & Celis M (2019) Catálogo de plantas y líquenes de Colombia. Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá. Available at <<http://catalogoplantasdecolombia.unal.edu.co>>. Access on 1 December 2020.
- Cardoso D, Sarkinen T, Alexander S, Amorim AM, Bittrich V, Celis M, Daly DC, Fiaschi P, Funk VA, Giacomini LL, Goldenberg R, Heiden G, Iganci J, Kelloff CL, Knapp S, Cavalcante de Lima H, Machado AFP, Santos RM, Mello-Silva R, Michelangeli FA, Mitchell J, Moonlight P, Moraes PLR, Mori SA, Nunes TS, Pennington TD, Pirani JR, Prance GT, Queiroz LP, Rapini A, Riina R, Rincon CAV, Roque N, Shimizu GH, Sobral M, Stehmann JR, Stevens WD, Taylor CM, Trovo M, van den Berg C, van der Werff H, Viana PL, Zartman CE & Forzza RC (2017) Amazon plant diversity revealed by a taxonomically verified species list. *Proceedings of the National Academy of Sciences* 114: 10695-10670.
- Costa GM, São-Mateus WMB, Oliveira RP & Giulietti AM (2010) Flora da Bahia: Bonnetiaceae. *Sitientibus série Ciências Biológicas* 10: 77-79.
- Dickison WC & Weitzman AL (1996) Comparative

- anatomy of the young stem, node and leaf of Bonnetiaceae, including observations on a foliar endodermis. *American Journal of Botany* 83: 405-418.
- Dickison WC & Weitzman AL (1998) Floral morphology and anatomy of Bonnetiaceae. *The Journal of the Torrey Botanical Society* 125: 268-286.
- Dutra VF, Guarnier JC, Firmino AD, Tuler AC, Peixoto AL, Kameyama C, Saiter FZ, Barroso FG, Siqueira GS, Heiden G, Shimizu GH, Lima HC, Dias HM, Gomes JML, Trarbach J, Rossini J, Marinho LC, Simonelli M, Ribeiro M, Barros PHD, Santos PMLA, Goldenberg R & Cardoso WC (2019) Angiospermas eudicotiledôneas ameaçadas de extinção no estado do Espírito Santo. *In: Fraga CN, Formigoni NH & Chaves FG (eds.) Fauna e flora ameaçadas de extinção no estado do Espírito Santo*. Instituto Nacional da Mata Atlântica, Santa Teresa. 432p.
- Kobuski CE (1948) Studies in the Theaceae-XVII. A review of the genus *Bonnetia*. *Journal of the Arnold Arboretum* 29: 393-413.
- Kubitzki K, Mesquita AAL & Gottlieb OR (1978) Chemosystematic implications of xanthenes in *Bonnetia* and *Archytaea*. *Biochemical Systematics and Ecology* 6: 185-187.
- Nees von Esenbeck CGD (1821) Reise des Prinzen von Neuwied. *Flora oder Botanische Zeitung* 4: 294-304.
- Nees von Esenbeck CGD & Martius CFP (1824) Beitrag zur Flora Brasiliens. *Nova Acta Physico-medica Academiae Caesareae Leopoldino-Carolinae Naturae Curiosorum Exhibentia Ephemerides sive Observationes Historias et Experimenta* 12: 1-54.
- Oginuma K & Tobe H (2013) A new chromosome number for Bonnetiaceae (Malpighiales). *Acta Phytotaxonomica et Geobotanica* 63: 55-157.
- Peixoto AL, Silva IM, Pereira OJ, Simonelli M, Jesus RM & Rolim SG (2008) Tabuleiro Forests North of the Rio Doce: their representation in the Vale do Rio Doce Natural Reserve, Espírito Santo, Brazil. *In: Thomas WW (ed.) Memoirs of the New York Botanical Garden* 100: 313-344.
- Pereira OJ (1990) Caracterização fitofisionômica da restinga de Setiba, Guarapari, ES. *In: Anais do II Simpósio de Ecossistemas da Costa Sul e Sudeste Brasileira: estrutura, função e manejo*. Academia de Ciências do estado do São Paulo, São Paulo. Pp. 207-257.
- Rolim SG, Peixoto AL, Pereira OJ, Araujo DSD, Nadruz M, Siqueira G & Menezes LFT (2016) Angiospermas da Reserva Natural Vale, na Floresta Atlântica do norte do Espírito Santo. *In: Rolim SG, Menezes LFT & Srbeq-Araujo AC (eds.) Floresta Atlântica de Tabuleiro: diversidade e endemismos na Reserva Natural Vale*. Vol. 1. Editora Rona, Belo Horizonte. Pp. 167-230.
- Ruhfel BR, Bittrich V, Bove CP, Gustafsson MHG, Philbrick CT, Rutishauser R, Xi Z & Davis CC (2011) Phylogeny of the Clusioid clade (Malpighiales): evidence from the plastid and mitochondrial genomes. *American Journal of Botany* 98: 306-325.
- Shorthouse DP (2010) SimpleMappr, an online tool to produce publication-quality point maps. Available at <<https://www.simplemappr.net>>. Access on 26 September 2020.
- Souza WO, Machado JO, Tognella MMP & Alves-Araújo A (2016) Checklist de Angiospermas do Parque Estadual de Itaúnas, Espírito Santo, Brasil. *Rodriguésia* 67: 571-581.
- Stevens PF (2001 onwards) Angiosperm Phylogeny Website. Versão 12, Julho 2012 [and more or less continuously updated since]. Available at <<http://www.mobot.org/MOBOT/research/APweb/>>. Access on 28 July 2020.
- Thiers B [continuously updated] Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. Available at <<http://sweetgum.nybg.org/science/ih/>>. Access on 28 July 2020.
- Weitzman AL (2005) Bonnetiaceae. *In: Steyermark JA, Berry PE, Yatskievych K & Holst BK (eds.) Flora of the Venezuelan Guayana*, Vol. 9: Rutaceae-Zygophyllaceae. Missouri Botanical Garden Press, St. Louis. Pp. 313-324.
- Weitzman AL, Kubitzki K & Stevens PF (2007) Bonnetiaceae. *In: Kubitzki K (ed.) The families and genera of vascular plants*. Flowering plants. Eudicots: Berberidopsidales, Buxales, Crossosomatales, Fabales p.p., Geraniales, Gunnerales, Myrtales p.p., Proteales, Saxifragales, Vitales, Zygophyllales, Clusiaceae alliance, Passifloraceae alliance, Dilleniaceae, Huaceae, Picramniaceae, Sabiaceae. Vol. 9. Springer, Berlin. Pp. 194-201.

Specimens List

Araújo D 362. Assis AM 2008, 3416. Bianchi RC 12. Coelho R 53. Colletta GD 284. Duarte AP 8869. Farias GL 77. Ferreira VBR 104. Flores TB 941. Folli DA 1698, 5127. Giaretta AO 203, 584, 893, 1060. Hatschbach G 58133, 68352. Kuhlmann JG 195, 6673. Lombardi JA 9650. Lucas EJ 896. Martins RFA 36. Meirelles J 567. Peixoto AL 345, 362. Pereira OJ 134, 135, 162, 1107, 1141, 3023, 3555, 3780, 4178, 4442, 4678, 6182. Pirani JR 2615. Ribeiro M 113. Romão GO 1239. Siqueira GS 994. Sousa S (VIES 24728). Sucre D 8397. Valadares RT 883. Weinberg B 643.

Area Editor: Dra. Valquíria Dutra

Received in September 22, 2020. Accepted in January 19, 2021.



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