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A TRIBO BIGNONIEAE (BIGNONIACEAE) NO PICO DO JABRE: TAXONOMIA E MORFOANATOMIA FOLIAR

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RAFAEL FRANCISCO LOPES SILVA

A TRIBO BIGNONIEAE (BIGNONIACEAE) NO PICO DO JABRE: TAXONOMIA E MORFOANATOMIA FOLIAR

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RESUMO

Com cerca de 393 espécies e 21 gêneros, Bignonieae Dumort. é a maior tribo entre os clados de Bignoniaceae, uma família com muitos táxons de importância econômica e etnobotânica. Bignonieae é o grupo com a maior diversidade morfológica entre as lianas neotropicais e tem uma distribuição que se limita entre o sul dos Estados Unidos e Sul da América do Sul. A tribo concentra seu centro de diversidade no Brasil,, com cerca de 327 espécies que ocorrem nas florestas úmidas e secas, incluindo os mais diversos ecossistemas associados, como as florestas de altitude, nos diferentes domínios fitogeográficos. Todas as espécies de Bignonieae são lenhosas, com folhas opostas, predominantemente 2-3-folioladas e folíolo terminal modificado em gavinhas simples, trífidas ou multífidas, flores vistosas, frutos capsulares e a anatomia do caule é anômala, apresentando quatro a 32 feixes de floema interrompendo o xilema. Este trabalho, foi realizado com o objetivo de conhecer a diversidade das espécies de Bignonieae na Floresta Estacional Semidecidual Montana do Pico do Jabre, Nordeste do Brasil, e adicionalmente, testar a anatomia foliar da tribo como suporte à sua taxonomia. Os resultados obtidos estão organizados em três capítulos e, consequentemente, três manuscritos, a serem submetidos a publicações em periódicos especializados. O primeiro capítulo apresenta um tratamento taxonômico para as 13 espécies de Bignonieae que ocorrem na área estudada, incluindo seis novos registros, sendo xx para a área, quatro para o estado da Paraíba, um novo registro para a Caatinga, que além de enriquecer os acervos dos herbários regionais, também ampliaram o número de registros e a distribuição dos gêneros e espécies da tribo Bignonieae para a área de estudo, para a caatinga e, consequentemente, para a Paraíba. Os outros dois capítulos apresentam resultados dos estudos anatômicos realizados para as 13 espécies de Bignonieae estudadas, sendo o segundo capítulo referente à anatomia foliar das epidermes e anexos epidérmicos, que forneceu caracteres qualitativos e quantitativos distintivos para separá-las nos níveis genérico e específico, como a anatomia dos complexos estomáticos, idioblastos e tricomas. O terceiro capítulo apresenta o padrão da anatomia foliar das Bignonieae do Pico do Jabre, cujos resultados evidenciam a presença de caracteres relevantes e diagnósticos nos níveis genérico e específico, especialmente a anatomia dos pecíolos e peciólulos, nervura principal, feixes vasculares, a morfologia qualitativa e quantitativa do mesofilo, e também a diversidade e distribuição dos idioblastos, complementados pela análise do UPGMA que corroborou com a eficácia dos caracteres anatômicos foliares como uma ferramenta adicional à taxonomia das espécies da tribo Bignonieae.

Palavras-chave: Lianas. Anatomia foliar. Floresta de altitude. Nordeste do Brasil.

ABSTRACT

With about 393 species and 21 genera, Bignonieae Dumort. it is the largest tribe among the clades of Bignoniaceae, a family with many taxa of economic and ethnobotanical importance. Bignonieae is the group with the highest morphological diversity among Neotropical lianas and has a distribution that is limited between the southern United States and southern South America. The tribe concentrates its center of diversity in Brazil, with about 327 species occurring in wet and dry forests, including the most diverse associated ecosystems, such as altitude forests, in different phytogeographic domains. All Bignonieae species are woody, with opposite leaves, predominantly 2-3-leaflets, the terminal leaflet is modified in a single, trifid to multifid tendril, showy flowers, capsular fruits and anomalous stem anatomy, with four to 32 phloem bundles interrupting the xylem. This work was carried out with the objective of access the diversity of Bignonieae species in the Montane Semideciduous Seasonal Forest of Pico do Jabre, Northeast Brazil, and additionally to test the leaf anatomy of the tribe in support of its taxonomy. The results obtained are organized as three manuscripts to be submitted to publications in specialized journals. The first manuscript presents a taxonomic treatment for the 13 species of Bignonieae that occur in the studied area, which besides enriching the collections of the regional herbaria, also expanded the number of new records, including six new records for the Pico do Jabre, four for Paraíba State and one for Caatinga, The other two manuscripts present results of the anatomical studies performed for the 13 species of Bignonieae of the studied area. The second manuscript deals with the anatomy of the leaf epidermis and epidermal appendages, which provided qualitative and quantitative and distinctive characters to separate them at the generic and specific levels, such as the anatomy of stomatal complexes, idioblasts and trichomes. The third manuscript presents the pattern of the leaf anatomy of the Bignonieae of the Pico do Jabre, whose results showed the presence of relevant and diagnostic characters at the generic and specific levels, especially the anatomy of the petioles and petiolules, the main vein, vascular bundles, the qualitative and quantitative morphology of mesophyll, as well as the diversity and distribution of idioblasts, complemented by UPGMA analysis, which corroborated the effectiveness of leaf anatomical traits as an additional tool to the taxonomy of Bignonieae species.

Keywords: Lianas. Leaf Anatomy. Altitude Forest. Northeast Brazil.

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1 Introdução Geral

Bignoniaceae está proximamente ligada a outras 15 famílias dentro de Lamiales (APG IV, 2016), compreendendo 827 espécies distribuídas em 82 gêneros (LOHMANN; ULLOA ULLOA, 2019). Com oito clados reconhecidos como tribos, os membros de Bignoniaceae tem distribuição predominantemente neotropical e compreendem em sua grande maioria formas arbóreas e lianescentes (OLMSTEAD et al., 2009).

Bignonieae, com 21 gêneros e aproximadamente 393 espécies, é o maior clado de Bignoniaceae (LOHMANN, 2006; LOHMANN; TAYLOR, 2014; OLMSTEAD et al., 2009), e o grupo com a maior diversidade morfológica entre as lianas neotropicais, com uma distribuição ampla e exclusiva do sul dos Estados Unidos ao norte do Chile e Argentina (LOHMANN, 2006). Suas espécies ocupam uma variedade de habitats úmidos e secos, desde as florestas tropicais do Atlântico e da Amazônia até florestas sazonalmente secas, como as Caatingas e Cerrado brasileiros e o Chaco (LOHMANN, 2006; LOHMANN et al., 2013). No Brasil, Bignonieae é representada por cerca de 327 espécies, encontradas nos diferentes Domínios Fitogeográficos (LOHMANN, 2015).

Gentry (1992) afirma que a identificação das espécies desse grupo torna-se mais complexa sem a presença dos caracteres reprodutivos e segundo Sousa-Baena et al. (2018) este apresenta uma grande variação foliar. Todos os membros da tribo Bignonieae são lenhosos, principalmente lianas com gavinhas (LOHMANN; TAYLOR, 2014) com folhas geralmente 2-3 folioladas, folíolo terminal modificado em gavinha única, bífida, trífida ou multífida (SOUSA-BAENA et al., 2014a, 2014b), e o fruto como cápsulas septicidas, com o septo paralelo às válvas dos frutos (OLMSTEAD et al., 2009). Seus membros têm a anatomia do caule anômala, com quatro a 32 feixes do floema interrompendo o xilema (SANTOS, 1995; OLMSTEAD et al., 2009). Suas flores são vistosas e, consequentemente, uma grande variedade de visitantes florais e polinizadores associados as espécies, os quais desempenharam um papel fundamental na diversificação da tribo (ALCANTARA; LOHMANN, 2010).

A anatomia vegetal é uma importante ferramenta para a taxonomia de muitas famílias (METCALFE; CHALK, 1979) e vem sendo a muito tempo empregada como suporte a sistemática e estabelecimento de relações filogenéticas (JUDD et al., 2009). Várias estruturas importantes, cujos caracteres se mostraram úteis na taxonomia de vários grupos de angiospermas, fornecem valor diagnóstico em diferentes níveis taxonômicos (DILCHER 1974; METCALFE; CHALK, 1979), como evidenciado nos trabalhos de Ahmad et al., (2010, 2015) para Andropogoneae e Paniceae, Araújo et al., (2013) para *Ficus*, Nurit-Silva e Agra

(2011), para *Solanum* sect. *Polytrichum*, Nurit-Silva et al. (2012) para *Solanum* sect. *Torva*, Pereira et al., (2018) para *Bauhinia* e *Schnella* e Sampaio et al. (2014) para *Solanum* sect. *Brevantherum*.

Em Bignoniaceae, trabalhos com espécies africanas (OGUNDIPE; WUJEK, 2004; UGBABE; AYODELE, 2008) e espécies brasileiras de ipês (SILVA et al., 2009) tem evidenciado o valor dos caracteres anatômicos como suporte a sua taxonomia. A anatomia do lenho tem corroborado e dado suporte as relações estabelecidas dentro da família (GEROLAMO; ANGIALOSSY, 2017; SANTOS, 2017), assim como em Bignonieae, revelando a importância e o potencial desses caracteres anatômicos, os quais sustentam a atual classificação da tribo e ajudam a compreender sua evolução (PACE et al., 2009; PACE et al., 2015). Estudos de anatomia foliar dentro de Bignonieae são pontuais, com enfoque principalmente no controle de qualidade de espécies medicinais (MAURO et al., 2007; PALIWAL, 1970; SOUZA et al., 2007; TRESVENZOL et al., 2010), e ainda mais escassos são aqueles de cunho taxonômico (GONZALEZ, 2013; FIRETTI-LEGGIERI et al., 2014) e evolutivo (NOGUEIRA et al., 2013; SOUSA-BAENA et al., 2014).

Muitas espécies de Bignonieae são também utilizadas na alimentação e na medicina popular (BRANDÃO et al., 2010; GENTRY, 1992; OLIVEIRA, 2014), o que reforça a necessidade da realização de trabalhos de anatomia foliar com o grupo, uma vez que as partes vegetativas são mais frequentemente utilizadas, nesses casos.

O Parque Estadual do Pico do Jabre é um dos principais brejos de altitude do Nordeste do Brasil (TABARELLI; SANTOS, 2004), parte do planalto da Borborema (ANDRADE-LIMA, 1960), sendo o ponto de maior altitude do Estado da Paraíba, e do Nordeste Setentrional, localizado a 1.197 m, entre os municípios de Maturéia e Mãe D'água, (SUPERINTENDÊNCIA DE ADMINISTRAÇÃO DO MEIO AMBIENTE - SUDEMA, 1994). É considerado uma área de extrema importância biológica (MAURY, 2002), bem como um hotspot de biodiversidade para prioridades de conservação (MYERS et al., 2000), caracterizada como uma Floresta Estacional Semidecidual Montana, de acordo com Tabarelli e Santos (2004).

Este trabalho foi realizado com o objetivo de avaliar a diversidade e distribuição das espécies Bignonieae no Pico do Jabre, além de encontrar parâmetros que forneçam suporte a taxonomia do grupo, através da anatomia foliar; levando em consideração a grande relevância do Pico do Jabre para a conservação da biodiversidade, bem como a lacuna no conhecimento de Bignoniae para a área. Nesse sentido, a dissertação está organizada em três capítulos: o primeiro retrata a riqueza de espécies da tribo e reconhece a sua distribuição na área; o segundo capítulo é a caracterização da epiderme foliolar das espécies que ocorrem no Pico do

Jabre, através da anatomia e da Microscopia eletrônica de varredura e o terceiro e último capítulo reconhece os padrões anatômicos foliares dessas mesmas espécies.

2 Referências

ALCANTARA, S.; LOHMANN, L.G. Evolution of floral morphology and pollination system in Bignonieae (Bignoniaceae). **American Journal of Botany**, Missouri, v. 97, n. 5, p. 782–796, 2010.

ANDRADE-LIMA, D. Estudos fitogeográficos de Pernambuco. **Arquivo do Instituto de Pesquisas Agronômicas de Pernambuco,** Recife, n. 5, p. 305-341, 1960.

APG IV. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. **Botanical Journal of the Linnean Society**, London, n. 181, p. 1-20, 2016.

BRANDÃO, G. C.; KROON, E. G.; SANTOS, J. R.; STEHMANN, J. R.; LOMBARDI, J. A.; OLIVEIRA, A. B. Antiviral activities of plants occurring in the state of Minas Gerais, Brazil. Part 2. Screening Bignoniaceae species. **Revista Brasileira de Farmacognosia**, Curitiba, n. 20, p. 742-750, 2010.

FIRETTI-LEGGIERI, F.; LOHMANN, L. G.; SEMIR, J.; DAMARCO, D.; CASTRO, M. M. Using leaf anatomy to solve taxonomic problems within the Anemopaegma arvense species complex (Bignonieae, Bignoniaceae). **Nordic Journal of Botany**, Sweden, 32, p. 620–631, 2014.

GENTRY, A. H. A synopsis of Bignoniaceae ethnobotany and economic botany. **Annals of Missouri Botanical Garden**, Missouri, n. 79, p. 53–64, 1992.

GEROLAMO, C. S.; ANGYALOSSY, V. Wood anatomy and conductivity in lianas, shrubs and trees of Bignoniaceae. **IAWA Journal**, Netherlands, v. 38, n. 3, p. 412-432, 2017.

GONZALEZ, A. M. Indumento, nectarios extraflorales y anatomía foliar em Bignoniáceas de la Argentina. **Boletín de la sociedad argentina de botânica**, Buenos Aires, n. 48, p. 221-245, 2013.

JUDD, W. S.; CAMPELL, C. S., KELLOGG, E. A., STEVENS, P. F.; DONOGHUE, M. J. **Sistemática vegetal um enfoque filogenético**. Porto Alegre: Artmed, 2009.

LOHMANN, L. G. Untangling the phylogeny of Neotropical lianas (Bignonieae, Bignoniaceae). **American Journal of Botany,** Missouri, n. 93, p. 304–315, 2006.

LOHMANN, L.G.; BELL, C.D., CALIÓ, M. F., WINKWORTH, R. C. Pattern and timing of biogeographical history in the Neotropical tribe Bignonieae (Bignoniaceae). **Botanical Journal of the Linnean Society**, London, v. 171, n. 1, p. 154-170, 2013.

LOHMANN, L.G.; TAYLOR, C. M. A new generic classification of Bignonieae (Bignoniaceae) based on molecular phylogenetic data and morphological synapomorphies. **Annals of Missouri Botanical Garden,** Missouri, n. 99, p. 348–489, 2014.

LOHMANN, L. Garcêz.; ULLOA ULLOA, Carmen. Onwards. **Bignoniaceae** in iPlants prototype Checklist, 2019. Disponível em: http://www.iplants.org. Acesso em: Janeiro de 2019.

MAURO, C.; PEREIRA, A. M. S.; SILVA, C. P., MISSIMA, J.; RINALDI, R.B. 2007. Estudo anatômico das espécies de cerrado *Anemopaegma arvense* (Vell.) Stellf. ex de Souza (catuaba), *Zeyheria montana* Mart. (bolsade-pastor) e *Jacaranda decurrens* Chamisso (caroba) – Bignoniaceae. **Revista Brasileira de Farmacognosia,** Curitiba, n. 17, p. 262-265, 2007.

MAURY, C. M. **Biodiversidade Brasileira: avaliação e identificação de áreas e ações prioritárias para conservação, utilização sustentável e repartição de benefícios da biodiversidade nos biomas brasileiros**. Brasília: Ministério do Meio Ambiente, 2002.

METCALFE, C. R.; CHALK, L. **Anatomy of dicotyledons**. London: Oxford University Press. 1979.

MYERS, N., MITTERMEIER, R. A., MITTERMEIER, C. G., DA FONSECA, G. A., KENT, J. 2000. Biodiversity hotspots for conservation priorities. **Nature**, London, v. 403, n. 6772, p. 853 – 858.

NOGUEIRA, A., EL OTRRA, J. H. L.; GUIMARÃES, E.; MACHADO, S. R.; LOHMANN, L. G. Trichome structure and evolution in Neotropical lianas. **Annals of Botany**, London, n. 112, p. 1331–1350, 2013.

OGUNDIPE, O. T.; WUJEK, D. E. Foliar anatomy on twelve genera of Bignoniaceae (Lamiales). **Acta Botanica Hungarica**, Budapest, n. 46, p. 337–361, 2004.

OLIVEIRA, G. G. **Estudos farmacognósticos de Adenocalymma imperatoris-maximilianii (wawra) L. G. Lohmann (Bignoneaceae) e atividade biológica**. Recife: Universidade Federal de Pernambuco, 2014.

OLMSTEAD, R. G.; ZJHRA, M. L.; LOHMANN, L. G., GROSE, S. O.; ECKERT, A. J. A molecular phylogeny of Bignoniaceae. **American Journal of Botany,** Missouri, n. 96, p. 1731–1743, 2009.

PACE, M. R.; LOHMANN, L. G.; ANGYALOSSY, V. The rise and evolution of the cambial variant in Bignonieae (Bignoniaceae). **Evolution & Development**, v. 11, n. 5, p. 465–479, 2009.

PALIWAL, G. S. 1970. Epidermal structure and ontogeny of stomata in some Bignoniaceae. **Flora**, Jena, v. 159, p. 124 - 132.

SANTOS, S. R. A atual classificação do antigo gênero *Tabebuia* (Bignoniaceae), sob o ponto de vista da anatomia da madeira. **Balduinia**, Santa Maria, n. 58, p. 10 – 24, 2017.

SILVA, A. M. L. D.; COSTA, M. F. B.; LEITE, V. G.; REZENDE, A. A.; TEIXEIRA, S. D. P. Anatomia foliar com implicações taxonômicas em espécies de ipês. **Hoehnea**, São Paulo, v. 36, n. 2, p. 329-338, 2009.

SOUSA-BAENA, M. S.; LOHMANN, L. G.; ROSSI, M.; SINHA, N. R. Acquisition and diversification of tendrilled leaves in Bignonieae (Bignoniaceae) involved changes in expression patterns of SHOOTMERISTEMLESS (STM), LEAFY/FLORICAULA (LFY/FLO), and PHANTASTICA (PHAN). **New Phytologist**, Lancaster, n. 201, p. 993 – 1008, 2014a.

SOUSA-BAENA, M. S.; SINHA, N. R.; LOHMANN, L. G. Evolution and development of tendrils in Bignonieae (Lamiales, Bignoniaceae). **Annals of Missouri Botanical Garden**, Missouri, n. 99, p. 323 – 347, 2014b.

SUPERINTENDÊNCIA DE ADMINISTRAÇÃO DO MEIO AMBIENTE. **Pico do Jabre**. João Pessoa: SUDEMA, 1994.

TABARELLI, Marcelo.; SANTOS, A. M. Melo. Uma breve história natural dos Brejos Nordestinos. In: PORTO, K. C., CABRAL, J. P.; TABARELLI. M (Org.). **Brejos de altitude de Pernambuco e Paraíba: história natural, ecologia e conservação**. Brasilia: Ministério do meio Ambiente, 2004. p. 17-24.

TRESVENZOL, L. M. F.; FIUZA, T. S.; REZENDE, M. H.; FERREIRA, H.D.; BARRA, M.T.F.; ZATTA, D. T.; PAULA, J. R. Morfoanatomia de *Memora nodosa* (Silva Manso) Miers, Bignoniaceae. **Revista Brasileira de Farmacognosia**, Curitiba, v. 20, n. 6, p. 833-842, 2010.

UGBADE, G. E.; AYODELE, A. E. 2008. Foliar epidermal studies in the Family Bignoniaceae Juss. in Nigeria. **African Journal of Agricultural Research**, n. 3, p. 154 - 166.

3 Capítulo I

Diversity and distribution of Bignonieae (Bignoniaceae) at Pico do Jabre

À ser Submetido a Phytotaxa

Diversity and distribution of Bignonieae (Bignoniaceae) at Pico do Jabre

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Abstract

The Bignoniaceae includes around 80 genera and 827 species constituting one of the most abundant and diverse plant families in the Neotropics. The family is divided into eight main clades, of which the tribe Bignonieae, with approximately 393 species, is the largest. Most members of Bignonieae are tendrillate lianas, although shrubs are also included in this lineage. The Pico do Jabre is located at 1,197 m of altitude, in the municipalities of Maturéia and Mãe D'água, representing the highest mountain in the state of Paraíba (Brazil). This mountain is covered by Semideciduous Montane Seasonal Forest and is considered a biodiversity hotspot. The relevance of the Pico do Jabre for biodiversity conservation, makes it a crucial location for biodiversity inventories. Here, we conducted inventories of tribe Bignonieae (Bignoniaceae) at Pico do Jabre in three different altitudinal classes. Overall, we documented nine genera and 13 species of Bignonieae at the Pico do Jabre. The most diverse genera were: *Tanaecium* (3 spp.), *Amphilophium* (2 spp.), and *Bignonia* (2 spp.). The genera *Anemopaegma, Cuspidaria, Dolichandra, Fridericia, Pyrostegia*, and *Xylophragma* are represented by one species each. Six species are new records for the Pico do Jabre, i.e., *B. ramentacea*, *B. sciuripabulum*, *F. pubescens*, *T. cyrtanthum*, *T. dichotomum*, and *X. heterocalyx*. Of these, two species are new records for the State of Paraíba: *T. cyrtanthum* and *X. heterocalyx*, the latter configuring a new record also for the Caatinga phytogeographic domain.

Key words: Bignonieae clade, Lamiales, Neotropical lianas, Flora of Brazil.

Introduction

The Bignoniaceae Jussieu (1789: 137) currently includes around 80 genera and 827 species (Lohmann & Ulloa Ulloa, 2019). This plant family represents an important component of Neotropical forests, where lianas from tribe Bignonieae Dumort (1829: 23), and trees from the Tabebuia alliance are the most abundant (Lohmann & Taylor 2014). Brazil is the center of diversity of this plant family (Gentry, 1980).

The Bignonieae, with approximately 393 species, is the largest clade within the family (Lohmann 2006, Olmstead *et al*. 2009, Lohmann & Taylor 2014). The tribe includes high ecological diversity with species occupying a broad range of habitats, ranging from wet Atlantic and Amazonian rainforests to seasonal dry habitats from the Brazilian Caatinga and Chaco (Lohmann 2006, Lohmann *et al*. 2013). In Brazil, Bignonieae is represented by ca. 308 species, found in all phytogeographical domains (Lohmann 2010).

All members of Bignonieae are woody, mostly lianas, with wood anatomy composed of four to thirty-two phloem wedges (Pace et al. 2009, 2015). The leaves are usually 2–3-foliolate with the terminal leaflet modified in simple, bifid, or multifid tendril (Sousa-Baena *et al*. 2014b). The flowers are showy flowers and visited by a broad range of floral visitors and pollinators (Alcantara & Lohmann 2010). The fruits are septicidal capsules with the septum parallel to the fruit valves (Olmstead *et al*. 2009).

Many species of Bignonieae have medicinal uses and are used by traditional peoples (Gentry 1992), including *Pyrostegia venusta* (Ker Gawl.) Miers (1863: 188), *Mansoa alliacea* (Lam.) A.H.Gentry (1979: 782), and *Arrabidaea chica* (Bonpl.) Verl. (1868: 154) [= *Fridericia chica* (Bonpl.) L.G.Lohmann (2014: 434)] (Stasi & Hiruma-Lima 2002), as well as *Tanaecium nocturnum* (Barb.Rodr.) Bureau & K.Schum. (1896: 185), *Martinella obovata* (Kunth). Bureau & K.Schum (1896: 161), *Pachyptera alliacea* (Lam.) A.H.Gentry (1973b: 236) [= *Mansoa alliacea* (Lam.) A.H.Gentry (1979: 782)], and *Cydista aequinoctialis* (L.) Miers (1863: 191) [= *Bignonia aequinoctialis* L. (1753; 623)] (Amorozo & Gély 1988).

The Pico do Jabre State Park is located at 1,197 m of altitude, in the municipalities of Maturéia and Mãe D'água, which include the highest within Paraíba State, Brazil (SUDEMA 1994). This mountain is covered by Semideciduous Montane Seasonal Forest (Tabarelli & Santos 2004), and is considered a biodiversity hotspot (Myers *et al*. 2000). The importance of Pico do Jabre for conservation, makes it a crucial location for biodiversity inventories (Mauri 2002). Despite its importance for the preservation of Atlantic Forest remnants, few studies to date have focused on its flora (Pontes & Agra 2001, Rocha & Agra 2002, Agra *et al.* 2004). Here, we conducted inventories of tribe Bignonieae (Bignoniaceae) in three different altitudinal classes of the Pico do Jabre (Paraíba, Brazil).

Materials and Methods

Study area

The Pico do Jabre State Park is a preserved area, established on the 19th October 1992 by Decree 14,843 (Cunha 2010). The park covers ca. 500 hectares and has been considered a priority area for conservation in Brazil (Ministry of the Environment, 2002). It is located on the eastern slope of the Borborema Plateau (Velloso et al. 2002), between the municipalities of Maturéia and Mãe D'água, state of Paraíba, Brazil (Cunha *et al*. 2013), under coordinates 07°15′18.4″ S and 037°23′13.1″ W. This park represents the highest point in the state of Paraíba, reaching 1,197 m high (Sudema 1994, Cunha *et al*. 2013). The Pico do Jabre is surrounded in the north by the Sertaneja Depression, in the east by the Cariri of Paraíba, and in the south by the Pajeú valley (Borges & Maciel 2003).

The Pico do Jabre is covered by Semideciduous Montane Seasonal Forests (Figure 1), mostly associated with dry forests, but also including rainforest elements (Rocha & Agra 2002, Agra *et al*. 2004, Cunha & Silva Junior 2014). According to Köppen's classification, the climate is warm and semi-humid AW type (Lima & Heckendorff 1985), with annual precipitation between 800-1000 mm (Cunha & Silva-Junior 2014).

Field work and taxonomic inventory

Twenty-four field expeditions were carried out to the Pico do Jabre, during the dry and rainy seasons of 2018 and 2019. The area was divided into three altitudinal classes for botanical collections and field observations: bottom (700—866m), intermediate (867—1033m), and top (1034—1200m). Specimens were treated according to usual procedures in plant taxonomy (Forman & Bridson 1989), and deposited at the Herbarium Prof. Jayme Coelho de Moraes (EAN), with duplicates sent to the Herbarium Prof. Lauro Pires Xavier (JPB), Herbarium of the University of São Paulo (SPF), and Herbarium of the Botanical Garden of Rio de Janeiro (RB), acronyms according to Thiers (2019). In addition, 53 specimens of Bignonieae previously collected in the park and deposited at EAN, JPB, MO, and NY herbaria (acronyms following Thiers 2019) were also analyzed.

All materials were identified using specialized literature (Gentry 1992, Lohmann & Pirani 1998, Fisher *et al*. 2004, Zuntini 2014, Fonseca *et al*. 2017, Silva *et al*. 2018), botanical descriptions available through "Flora of Brasil" website (2020) and comparisons with specimens deposited at EAN, JPB, NY, MO, RB, SP and SPF (acronyms follow Thiers 2019).

Morphological descriptions follow the general terminology of Radford *et al*. (1974) and Harris & Harris (2001), specific Bignonieae terms of Lohmann & Taylor (2014), trichome terminology of Nogueira *et al*. (2013) and, leaf venation of the Leaf Architecture Working Group (1999). The conservation status assessments follow IUCN guidelines (IUCN 2012) combined with the GeoCAT Tool (Bachman et al. 2011). Extent of occurrence (EOO) was used to categorize species. Population data have not been evaluated.

Results and Discussion

Diversity

The study of all specimens of Bignonieae from the Pico do Jabre, associated with the literature review led to the recognition of nine genera and 13 species, as follows:

Amphilophium crucigerum (L.) L.G.Lohmann (2008: 270), *Amphilophium paniculatum* Kunth (1818: 149), *Anemopaegma citrinum* Mart. ex DC. in de Candolle (1845: 189), *Bignonia ramentacea* (Mart. ex DC.) L.G.Lohmann (2014: 422), *Bignonia sciuripabulum* (Hovel.) L.G.Lohmann (2008: 272), *Cuspidaria lateriflora* (Mart.) DC. in de Candolle (1845: 179), *Dolichandra unguis-cati* (L.) L.G.Lohmann (2008: 273), *Fridericia pubescens* (L.) L.G.Lohmann (2014: 443), *Pyrostegia venusta* (Ker Gawl.) Miers, *Tanaecium cyrtanthum* (Mart. ex DC.) Bureau & K.Schum. (1896: 186), *Tanaecium dichotomum* (Jacq.) Kaehler & L.G.Lohmann (2019: 759), *Tanaecium parviflorum* (Mart. ex DC.) Kaehler & L.G.Lohmann (2019: 759), and *Xylophragma heterocalyx* (Bureau & K.Schum.) A.H.Gentry (1979: 778).

Of the 13 species recognized for the area, eight were cited on an earlier treatment of the Pico do Jabre (Agra *et al.* 2004), while six represent new records for the region, namely: *B. ramentacea*, *B. sciuripabulum*, *F. pubescens*, *T. cyrtanthum*, *T. dichotomum* and *X. heterocalyx*. Of these, *T. cyrtanthum* and *X. heterocalyx* are new records for the State of Paraíba, while *X. heterocalyx* is a new record for the Caatinga domain.

One species identified at the generic level (i.e., *Arrabidaea* sp.), in the previous treatment of the Bignoniaceae for the Pico do Jabre (Agra *et al.* (2004), was here shown to represent *F. pubescens*. Furthermore, materials previously identified as *Clytostoma binatum* (Thunb.) Sandwith [= *Bignonia binata* Thunb.] were here shown to correspond to two different species, *B. ramentacea* and *B. sciuripabuum*.

The genus with the highest richness at the Pico do Jabre is *Tanaecium* Sw. (1788: 91), with three species, followed by *Amphilophium* Kunth (1818: 451), and *Bignonia* L. (1753: 622), with two species each. The other six genera are represented by one species each: *Anemopaegma* Mart. ex Meisn. (1840: 300), *Cuspidaria* DC. (1838: 125), *Dolichandra* Cham. (1832: 657), *Fridericia* Mart. (1827: 7), *Pyrostegia* C. Presl (1845: 523), and *Xylophragma* Sprague (1905: 2770).

Morphology

The liana habit is the most common in the region, being found in eight species (Table 1). *Dolichandra unguis-cati* showed the thinnest stems and branches among all species studies. Leaves are 1-3-foliolated, with eight species showing 2-3-foliolated leaves, two species showing 1-2-foliolated leaves (*B. ramentacea* and *B. sciuripabulum*), one species showing exclusively 2-foliolated leaves (*D. unguis*-cati), and two species showing exclusively 3-foliolated leaves (*C. lateriflora* and *T. parviflorum*) (Table 1).

In most species, the terminal leaflet is modified into a tendril, except from *C. lateriflora* and *T. parviflorum*. This trait constitutes one of the most important characters for the recognition Bignonieae (Sousa-Baena et al., 2014a,b). Simple tendrils are found in eight species (Table 1), trifid tendrils in three species (*A. citrinum*, *D. unguis-cati* and *P. venusta*), and multifid tendrils in two species (*A. crucigerum* and *A. paniculatum*). Tendrils of *A. crucigerum* and *A. paniculatum* show adhesive disks at tips, while those of *D. unguis-cati* show uncinate apices.

Inflorescences vary from pauciflora, as observed in *T. parviflorum* (Fig. 8D) and *A. citrinum* (Fig. 3A), to densiflora as those found in *F. pubescens, P. venusta*, and *X. heterocalyx* (Fig. 7H). All species show infundibuliform corollas with inserted stamens, except from *P. venusta* which shows exserted stamens (Fig. 7A-B). Flowers lacking nectary disks but bearing conspicuous nectar-guides are observed in *B. ramentacea* (Fig. 4A) and *B. sciuripabulum* (Fig. 4E).

All species show sparse to dense lepidote indument and glandular and eglandular trichomes on leaves and tendrils. Three types of glandular trichomes are observed: (i) glandular-stipitate, generally on the corolla and other reproductive organs (pedicels and calyx of *T. dichotomum*); (ii) glandular-peltate**,** common on the leaves of all species studied; and (iii) glandular-patelliform/cupular, common on the basal portions of the abaxial surface of leaves of some species (e.g., *T. cyrtanthum*). Simple and branched eglandular trichomes were also documented. Simple eglandular trichomes are uniseriate and multicellular, and common on the leaves of all species. Branched eglandular trichomes are found on the leaves of *F. pubescens* and also in some reproductive portions of *X. heterocalyx*.

Distribution

Species of Bignonieae from the Pico do Jabre show a discontinuous distribution throughout the mountain range, occurring both in areas with deep soil and areas with great solar exposure on granitic rocks. Regarding the altitudinal classes, two species were collected and observed exclusively at the basal portions of the mountain (i.e., *C. lateriflora* and *T. dichotomum*), one exclusively at the intermediate portions of the mountain (i.e., *T. parviflorum*), and two exclusively at upper levels of the mountain (i.e., *A. crucigerum* and *P. venusta*). Furthermore, three species were found at the base to the intermediate portion (i.e., *F. pubescens, T. cyrtanthum* and *X. heterocalyx*), and five species (*A. paniculatum, A. citrinum, B. ramentacea, B. sciuripabulum* and *D. unguis-cati*) were broadly distributed throughout the mountain.

Taxonomy

Key for the identification of the Bignonieae Species from the Pico do Jabre

1. Plants with trifid or multifid tendrils 2

- Plants with simple tendrils 6

2. Stems and branches hexagonal; multifid tendrils with adhesive disks at the apex …..…… 3

- Stems and branches terete; trifid tendrils without adhesive disk at the apex 4

3. Calyx single; fruit with epicarp strongly muricate, not lepidote ....
.... *Amphilophium crucigerum*

- Calyx double; fruit with epicarp smooth, lepidote .... *Amphilophium paniculatum*

4. Calyx cupuliform, truncate; corolla light yellow to white-yellowish, opaque; fruit elliptic to sub-orbicular, inflated, up to 8.0 cm long, stipitate .... *Anemopaegma citrinum*

- Calyx campanulate, 5-lobed; corolla dark yellow or orange; fruit linear flattened, longer than 18 cm long, not stipitate 5

5. Tendrils with apex uncinate; calyx truncate; corolla yellow, shiny, infundibuliform; stigma and stamens inserted…... *Dolichandra unguis-cati*

- Tendrils not uncinate at the apex; calyx 5-lobed; corolla orange, opaque, narrowly tubular; stigma and stamens exserted ....………................................. *Pyrostegia venusta*

6. Fruit with epicarp echinate 7

- Fruit with epicarp smooth 8

7. Branches terete, not winged; leaves pubescent; inflorescence pauciflorae; corolla lobes oblong ..……..………………………………………………………….... *Bignonia ramentacea*

- Branches 4-angled, winged; leaves glabrous to glabrescent; inflorescence dense; corolla lobes rounded .... *Bignonia sciuripabulum*

8. Corolla white, tube narrow and long, above 10 cm long ……….…... *Tanaecium cyrtanthum*

- Corolla rose, pink or lilac, tube up to 4.0 cm long 9

9. Branches without interpetiolar glands 10

- Branches with interpetiolar glands 12

10. Petiole hexagonal, with glandular-stipitate trichomes; anthers reflexed forward; ovules in 2-series per locule .... *Cuspidaria lateriflora*

- Petiole terete, without glandular-stipitate trichomes; anthers straight; ovules in 1-serie per locule 11

11. Leaflets with margins entire; fruit epicarp villous ………………. *Tanaecium dichotomum*

- Leaflets crenate; fruit epicarp glabrescent .... *Tanaecium parviflorum*

12. Leaves lepidote-pubescent, trichomes simples, branched and peltate. *Fridericia pubescens*

- Leaves sparse-lepidote, trichomes peltate, branched trichomes absent ....
…………………………………………………….................… *Xylophragma heterocalyx*

1. *Amphilophium crucigerum* (L.) L.G. Lohmann, Nuevo Cat. Fl. Vasc. Venez. 270: 2008. (Fig. 2A–G).

Description:— Lianas; branches hexagonal; prophylls of axillary buds foliaceous. Leaves with 2–3-leaflets; tendrils trifid, with an adhesive disk at the apex; petiole 2.0–4.0 cm long; petiolules 0.5–2.8 cm long, canaliculate, pubescent, trichomes simple; leaflet blade 2.7–8.4 × 2.4–6.0 cm, cordiform to ovate, base sub-cordate to obtuse, apex cuspidate, sub-chartaceous to chartaceous, lepidote-pubescent on both sides, trichomes simple, peltate and patelliform/cupular, margin entire. Inflorescences in racemes terminal, flowers in pairs, opposite; pedicel terete, 3.0–5.0 mm long, lepidote-pubescent, trichomes peltate and simple; calyx, 0.7–1.2 cm long, tubulose, truncate, shortly 5–lobed, lobules acute, pubescent-lepidote outside, trichomes simple, peltate and patelliform/cupular, glabrous inside; corolla white, somewhat fleshy, yellowish at mouth, tube 2.3–2.7 cm long, tomentose outside, glandular inside, 5–lobed, 0.8–1.0 cm long; stamens inserted, the smaller 1.2–1.3 cm long, the largest 1.7–1.8 cm long, anthers ca. 3.0 mm long, 1-staminode, 5.5–6.0 mm long; ovary oblong-elliptic, 3.0–6.0 mm long, tomentose to villous; ovules 5–seriate per locule, style 2.5–2.7 cm long, glabrous, stigma 2.0–3.0 mm long; nectar disk cupuliform, 2.5–3.0 mm thick, pilose on the upper edge. Capsule elliptic to oblong-elliptic, 12.5–16.2 × 4.5–4.8 cm, strongly muricate; seeds numerous, 2.5–3.2 × 4.3–6.5 cm, papillose, winged, the wings papery, hyaline, transverse-elliptic, light beige to brownish.

Distribution and habitat:— *Amphilophium crucigerum* is broadly distributed throughout the Neotropics, from South of North America to South of South America (Pool 2007; Lohmann & Taylor 2014). It was recorded in all States of Brazil (Lohmann 2010). In the study area, *A.*

crucigerum is found in open areas, with great exposure to light, with branches growing through the rocky outcrops. This species was collected and observed at altitudes above 1.100m. According to Gentry (1973a), it is one of the most wide-ranging species of Bignoniaceae, from an ecological and geographical point of view, and its success is due mainly to the dispersion of its seeds.

Conservation status:— According to the IUCN criteria (2012), *A. crucigerum* is categorized as Least concern [LC], given its wide extent of occurrence (22,111,638,514 km²).

Notes:— *Amphilophium crucigerum* can be recognized by its trifid tendrils with an adhesive disk at the apex, corolla white to whitish (Fig. 2A-C), calyx truncate and 5–lobed (Fig. 2C), and fruits muricate (Fig. 2E). Its flowers are frequently visited by flies.

Phenology:— Flowering and fruiting were documented in February and April.

Ethnobotanical uses:— Fruits and seeds are used in the treatment of neuralgias; Seeds are combined with snake skin and it is used against headaches (Bye 1979). The seeds mixed with marrow's calf or deer are used against eyes diseases (Bye 1979).

Specimens examined:— BRAZIL. Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, North of the headquarters of Telpa, 07-10 February 1998, *Agra* et al. 5013, (JPB! MO!); *id.*, Pico do Jabre, close to the antennas, 1170 m, 07°15.140′ S and 037°23.107′ W, 15 April 2018, *Lopes 135* (EAN! JPB!).

2. *Amphilophium paniculatum* (L.) Kunth, Nov. Gen. Sp. 3: 149. 1818 [1819]. Fig. 3A–D.

Description:— Lianas, stems and branches 6-angled, lepidote-pubescent, trichomes peltate and simple; prophylls of axillary buds foliaceous. Leaves 2–3–leaflets; tendrils trifid, adhesive disk or not at the apex; petiole 1.2–4.0 cm long; petiolules 0.3–2.2 cm long, canaliculate, lepidote-pubescent, trichomes peltate and simple; blade leaflet 3.3–8.0 × 1.9–5.0 cm, ovate to elliptic, base cuneada, apex slightly acuminate to acuminate, chartaceous, lepidote to densely lepidote in both surfaces, the trichomes peltate, margins entire.

Inflorescences in thyrses, axillary; pedicel cylindrical, 3.0–8.0 mm long, glabrescent; calyx duplicate, cyathiform, the external 5–lobed, the lobes reflexed, 0.6–1.0 cm long, pubescent on both sides, inner sepals bi-labiate, acute, 1.0–1.5 cm long, pilose on both sides; corolla lilac to pink, yellow at mouth, somewhat fleshy, tube 2.5–3.0 cm long, glabrous inside, pilose outside, trichomes glandular-stipitate, 4–lobes, 0.6–1.1 cm long; stamens inserted, the smaller 1.2–1.3 cm long, the largest 1.9–2.0 cm long, anthers ca. 0.3 cm long, 1–staminode, ca. 4.0 mm long, ovary oblong-elliptic, 5.0–7.0 cm long, glabrous, ovules multiseriate per locule, style 1.7–1.8 cm long, glabrous, stigma 3.0–4.0 mm long; nectar disc cupuliform, ca. 1.0 mm thick, glabrous. Capsule oblong-elliptic, smooth, 7.5–9.5 × 4.2–4.5 cm, densely lepidote; seeds numerous, 2.0–4.4 × 1.0–1.4 cm, papillate, winged, the wings chartaceous and hyaline, transverse-elliptic, brown.

Distribution and habitat:— *Amphilophium paniculatum* is a Neotropical species registered from Mexico to South America, with a distribution similar to *A. crucigerum* (Lohmann & Taylor 2014). It is found in all States of Brazil (Lohmann 2010). In the Pico do Jabre, *A. paniculatum* was found near the highest levels, about 900 m altitude and occurs on the forest edges and in sandy substrate. The species is being referred here for the state of Paraíba for the first time.

Conservation status:— *Amphilophium paniculatum* is known from many locations and is categorized as Least concern [LC], according to IUCN criteria (2012), with a extent of occurrence of 18,579,512,343 km².

Notes:— The specimens of the Pico do Jabre are two old collections of *Agra et al*. (2688, 4873). It is a heliophyte plant, with deciduous tendrils and can be easily recognized by its double cyathiform calyx and the blade leaflets surfaces lepidote to dense lepidote. *A. paniculatum* can be easily differentiated from *A. crucigerum* mainly by its double calyx, corolla rose to lilac (Fig. 3A), and ovate-elliptic and smooth fruit (Fig. 2E), differently from

A. crucigerum that has simple calyx (Fig. 2C), corolla white to whitish (Fig. 2A–B and fruit muricate (Fig. 2E). Ants were observed visiting its flowers.

Phenology:— *Amphilophium paniculaum* was collected with flowers from January to February and fructified from March to July in the area studied.

Ethnobotanical uses:— No ethnobotany use was reported for *A. paniculatum.*

Specimens examined:— BRAZIL. Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, 800-1010 m, 07°11′10″ S, 037°25′53″ W, 28-30 January 1998, *Agra & Silva 4873* (JPB!); *id.*, Pico do Jabre, 1190 m, 07°11′10″ S, 037°08′22″ W, 25-27 February 1994, *Agra et al*. 2688 (JPB!).

Additional specimens examined:— BRAZIL. São Paulo: São José do Rio Preto/Mirassol, Ecological station of Northwest São Paulo, 20°48′36″ S, 049°22′50″ W, 1–22 August 1996, *Rezende 490/503* (SJRP!).

3. *Anemopaegma citrinum* Mart. ex DC**.**, Prod. IX. 189. Fig. 3E–I.

Description: Lianescent shrubs, branches irregularly cylindrical, glabrous to glabrescent; prophylls of axillary buds foliaceous. Leaves with 2–3–leaflets; tendrils trifid; petiole 1.1–6.5 cm long; petiolules 0.5–1.8 cm long, glabrescent to pilose; blade leaflet 3–11 × 1.7–4.8 cm, oblong-elliptic, base obtuse, apex acute to acuminate, chartaceous, adaxial side lepidote, abaxial side densely lepidote, trichomes peltate, in both surfaces, margin entire. Inflorescences in racemes, axillary; pedicels cylindrical, 0.5–1.5 cm long, glabrescent; calyx cupuliform, truncate, 0.6–1.0 cm long, glabrous to glabrescent outside and sparsely lepidote inside; corolla yellowish, somewhat fleshy, with sparsely glands on both surfaces, tube 3.0–5.7 cm long, with stipitate glandular trichomes, 5–lobes, 0.6–1.8 cm long; 4– (5!) stamens inserted, the smaller 1.6–2.5 cm long, the largest 2.5–3.5 cm long, anthers 3.0–4.0 cm long, 1–staminode, 0.6–1.0 cm long; ovary elliptic, 2.0–3.0 cm long, stipitate, lepidote, trichomes peltate, ovules 4–seriate per locule, style 1.6–4.0 cm long, glabrous, stigma 1,5–3,0 cm long; nectar disk pulvinate, 1.5–2.0 mm thick, glabrous. Capsule elliptic to sub-orbicular, 4.8–8.0 ×

2.5–5.4 cm, stipitate; seeds numerous, 2.0–3.0 × 3–3.8 cm, semicircular, winged, the wings membranaceous and hyaline.

Distribution and habitat:— *Anemopaegma citrinum* is an endemic species to South America found only in dry forests of Bolivia and Brazil (Lohmann & Taylor 2014). Its occurrence in Brazil has been recorded by Lohmann (2010) to the Northeast region (Maranhão, Piauí, Paraíba, Pernambuco and Bahia) and north of Minas Gerais. *A. citrinum* is found on the edges and inside to the forest on sandy substrates and on granitic rocks. It is the most widely distributed species in the study area, and was found from 700 m to the upper of Pico do Jabre.

Conservation status:— This species is categorized as Least Concern [LC] following the IUCN criteria. The EOO estimated for the species is 3,677,612.271 km².

Notes:— Young individuals of *A. citrinum* have trifoliolate leaves devoid of tendrils, whereas adult individuals have leaves 2–3–leaflets with or without tendrils. *A. citrinum* can be recognized by its opaque yellow corolla (Fig. 3F), the truncate calyx (Fig. 3H) and by its rounded-ellipsoid and smooth beige capsule (Fig. 3I). Floral visitors as ants and flies were observed in its flowers.

Phenology:— In the study area *A. citrinum* was collected with flowers from February to March and with fruits in September, October and December.

Ethnobotanical uses:— Species of this genus are known as “catuaba” in Brazilian folklore and it is used as a stimulant sexual (Souza *et al.* 2015).

Specimens examined:— Brazil. Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, 1190 m, 07°11′10″ S, 037°25′53″ W, 25-27 February 1994, *Agra et al*. 2629 (JPB!); *id*., 800-1010 m, 07°11′10″ S, 037°25′53″ W, 30 October 1997, A*gra & Sr. Paulo 4830* (JPB! MO!); *id*., 1200 m, 07°15’54” S, 037°22’33” W, 2 December 2017, *Cordeiro 1254* (EAN!); *id*., 1200 m, 07°15.150′ S, 037°23.069′ W, 13 March 2018, *Lopes 239* (EAN! JPB!); *id*., edge of the forest, 945 m, 07°15.553′ S, 037°23.160′ W, 18 September 2018, *Lopes 255* (EAN! JPB!).

4. *Bignonia ramentacea* (Mart. ex DC.) L.G.Lohmann Ann. Missouri Bot. Gard. 99(3): 422. 2014. Fig. 4A–C.

Description:— Lianas, branches cylindrical in young plant to slightly tetragonal when mature, lenticellate, pilose when young, trichomes simple; prophylls of the axillary buds triangular. Leaves with (1) –2–leaflets; tendrils simple; petiole 0.2–2.1 cm long; petiolules up to 1.3 cm long, pubescent, trichomes simple and glandular-peltate; blade leaflet 1.2–4.8 × 2.1–11.2 cm, elliptic to rounded at the base, apex apiculate, sub-chartaceous to chartaceous, surface abaxial densely lepidote, trichomes peltate, adaxial surface slightly lepidote, peltate and simple trichomes on the midrib, margins entire. Inflorescences in terminal cymes; pedicels cylindrical, 1.0–7.0 cm long, pubescent, trichomes similar to the petiole; calyx cupuliform, 5– (–7) –lobes, 0.8 to 0.9 cm long, pubescent externally, glabrescent inside, lobe apiculate at apex; corolla rose to purple, membranaceous, with conspicuous nectar guides, without glands, tube 3.5–4.5 cm long, sparsely lepidote-pubescent, the trichomes peltate and glandular-stipitate, 5–lobes, 1.5–2.5 cm long; stamens insert, the smaller 1.1–1.7 cm long, the largest with 1.7–2.5 cm long, anthers 8.0 cm long, 1–staminode, 9.0 mm long; ovary cylindrical, 2.9–3.0 mm long, glabrous, ovules 2–seriate per locule, style 2.6–3.2 cm long, pilose at the base, trichomes simples, stigma 2.0–3.0 mm long; nectar disk inconspicuous, glabrous. Capsule oblong, 1.7–3.0 × 5.0–9.5 cm, echinate, spines 7.0–8.0 mm long; seeds numerous, asymmetric, ca. 2.0 × 4.5 cm, brown, winged, the wings membranaceous and hyaline.

Distribution and habitat:— Zuntini (2014) refers to the occurrence of *B. ramentacea* in dry forests of Bolivia, Paraguay and Brazil, where it is found in the Caatinga and Cerrado vegetation, in the States of Bahia, Ceará, Mato Grosso do Sul, Minas Gerais, Paraíba, Pernambuco and Rio Grande do Norte. *B. ramentacea* is widely distributed in the study area, where is found at the base to the upper of the Pico do Jabre, growing at the margins and inside the forest.

Conservation status:— According to the IUCN criteria (2012), *B. ramentacea* is categorized as Least concern [LC] with a extent of occurrence estimated at 3,374,876.700 km². Considering that the species has a large EOO, but does not have many records, there may be a gap in the collections of the species in the area.

Notes:— *Bignonia ramentacea* resembles to *B. sciuripabulum*, from which can be distinguished by the smaller flowers, leaflet consistency, indument of petioles, and the leaflets in the young plant. In addition, the pedicels of *B. ramentacea* are densely pubescent in the young plant. The species shows strong variation in the corolla color, including in the same individual and in the same inflorescence.

Phenology:— Collected with flowers and fruits from June to July.

Ethnobotanical uses:— *Bignonia ramentacea* is known in folk medicine as "banheira", the decoction of its leaves is used against coughing through the gargle (Cartaxo *et al*. 2010).

Specimens examined:— BRAZIL. Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, north of Telpa's headquarters, going east, 900-1000 m, 07°11′10″ S, 037°25′53″ W, 12 July 1997, *Agra et al. 4022* (JPB! MO!); *id.*, margin of the first rock of the caboclo trail, 818 m, 07°15′56.8″ S, 037°23′07.3″ W, 08 June 2018, *Lopes 253* (EAN!).

5. *Bignonia sciuripabulum* (Hovel.) L.G. Lohmann Nuevo Cat. Fl. Vasc. Venez. 272–273. 2008. Fig. 4D–E.

Description:— Lianas, stem and branches tetra-angled, winged, lenticellate, glabrescent, trichome simple; prophylls of axillary buds triangular. Leaves with (1) –2–leaflets; tendrils simple; petiole 0.4–3.0 cm long; petiolule 0.4–1.4 cm long, glabrescent; blade leaflet 1.8–8.7 × 3.3–14.5 cm, elliptic to obovate, often asymmetrical, membranaceous to chartaceous, base rounded or aequilatera, apex acuminate, rare acute, surface abaxial lepidote, trichomes simple, sparse, surface adaxial with sparse trichomes peltate, margins entire. Inflorescences in terminal cymes; pedicels cylindrical, 1.5–4.7 cm long, lepidote; calyx cupuliform, 5–lobed, 0.8–1.1 cm long, the lobes apiculate at apex, pubescent, trichomes simples, glandular and peltate on the margin, corolla rose to purple, membranaceous, without glands, conspicuous nectar guides, tube 4.5–5.0 cm long, lepidote and pubescent externally and internally at the lobes, with peltate and simple trichomes, 5–lobes, 1.7–2.6 cm long; stamens inserted, the smaller 1.9–2.0 cm long, the largest 2.0–2.9 cm long, anthers 0.7–8.0 mm long, 1–staminode, 1.0 cm long; ovary cylindrical, 0.3–0.4 cm long, glabrous, ovules 2–seriate per locule, style 3.0–3.3 cm long, pilose, trichomes simple, glandular and eglandular trichomes at the base, stigma 3.0 mm long; nectar disk inconspicuous, glabrous, <1mm thick. Capsule oblong, 2.5–3.0 × 12.0–16.4 cm, echinate; seeds numerous, 1.5–1.7 × 4.7–4.9 cm, brown, winged, asymmetric, the wings membranaceous and hyaline.

Distribution and habitat:— According to Zuntini (2014), *B. sciuripabulum* is widely distributed in South America, occurring from Venezuela to Argentina. It is found in almost all states of Brazil and in different phytogeographic domains: Amazonia, Caatinga, Cerrado, Atlantic Forest and Pantanal. It is a common species of Bignoniae in Pico do Jabre, which occurs in sandy soil.

Conservation status:— *Bignonia sciuripabulum* is categorized as Least Concern [LC] following the IUCN criteria (2012). The species has a large EOO, estimated at 14,629,943,880 km².

Notes:— *Bignonia sciuripabulum* can be easily confused with *B. ramentacea*, from which can differentiated by its denser inflorescences covering the entire plant (Fig. 4D), its very showy and larger flowers, the rounded corolla lobes (Fig. 4E), and also by the leaflets acuminate at the apex.

Phenology:— The species was collected with flowers from December to January and March.

Ethnobotanical uses:— No ethnobotany use was reported for *B. sciuripabulum.*

Specimens examined:— BRAZIL. Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, South of the headquarters of Telpa, 700–800 m, 07°11′10″ S, 037°25′53″ W, 18 January 1997, *Agra et al. 3935* (JPB! MO!); *id.*, South of the headquarters of Telpa, 800–1010 m, 07°11′10″ S, 037°25′53″ W, 20-23 December 1997, *Agra et al. 4365* (JPB! MO!); *id.*, South of the headquarters of Telpa, 800–1010 m, 07°11′10″ S, 037°25′53″ W, 18–21 January 1998, *Agra et al. 4654* (JPB! MO!). Pico do Jabre, South of the headquarters of Telpa, 600–1197 m, 07°11′10″ S, 037°25′53″ W, 18–21 January 1998, *Agra et al. 4790*, (JPB! MO!); *id.*, edge of the forest, 1150 m, 07°15′37.2″ S, 037°23′24.8″ W, 13 March 2018, *Lopes 238* (EAN!).

Additional specimens examined:— BRAZIL. Bahia: Guaratinga, ao sul da Pedra do Cruzeiro do Sul, 8.7 km from São João do Sul, 16°35'49" S, 039°54′50" W, 25 September 2004, *Thomas 14257* (CEPEC!); Esplanada, Algodão, 12°10' S, 037°58′W, 12 December 2012, *Popovkin 1316* (HUEFS!).

6. *Cuspidaria lateriflora* (Mart.) DC.**,** DC**.** Prodr. 9: 179. 1845. Fig. 5A–I.

Description:— Lianas, branches cylindrical, striate, glabrous to pilose; prophylls of axillary buds triangular. Leaves 3–foliolate; tendrils simple; petiole 1.5–2.5 cm long, tomentose; petiolules 0.4–1.5 cm long, canaliculate, dense tomentose-lepidote, trichomes simple and peltate; blade leaflet 1.7–3.8 × 0.8–1.8 cm, ovate to elliptic, membranaceous, base obtuse, apex cuspidate, pubescent in both sides, trichomes simple, glandular-peltate and glandular-stipitate, margins entire. Inflorescence in raceme axillary; pedicels cylindrical, 3.0–7.0 mm long, pubescent, trichomes simple, glandular-stipitate and peltate; calyx tubular, 5–lobed, 5.0–8.0 mm long, glandular-pubescent outside, trichomes simple and glandular-stipitate, glabrescent or glabrous inside, lobes cuspidate at the apex; corolla pink, membranaceous, without glands, tube 2.5–3.3 cm long, tomentose, trichomes glandular-stipitate at the point of insertion of the stamens, lobes 0.7–1.2 cm long, trichomes glandular at the margin; stamens inserted, the smaller 1.2–1.4 cm long, the larger 1.5–1.7 cm long, anthers 2.0 mm long, forward-curved, 1-staminod, ca. 0.25 cm long; ovary linear-cylindrical, 0.25–0.3 cm long, pubescent, trichomes simple, ovules 2–seriate per locule, style 2.0–2.5 cm long, glabrous, stigma 2.0 mm long; nectar disk cupuliform, 0.5 mm thickness, glabrous. Capsule linear, compressed, 20–26 × 1.2–1.4 cm. Seeds not seen.

Distribution and habitat:— *Cuspidaria lateriflora* is a Neotropical species of South America and is found in Peru, Bolivia, Paraguay and Brazil (Lohmann & Taylor 2014). The species is found in the phytogeographical domains of Brazil as Amazonian, Caatinga, Cerrado and Atlantic Forest, in the dry and wet forests of (Lohmann & Taylor 2014). *C. lateriflora* is known in Pico do Jabre from only one specimen (*Agra et al. 3932*), which was collected between 700–850 m altitude on the edge of the forest. It is a heliophyte species, growing in sandy substrate.

Conservation status:— *Cuspidaria lateriflora* is categorized as Least Concern [LC] following the IUCN criteria (2012). The extent of occurrence estimated for the species is 6,927,794.811 km².

Notes:— *Cuspidaria lateriflora,* in vegetative state, can be easily confused with *Fridericia* and *Xylophragma* also found in Pico do Jabre, from which it can be distinguished by its anthers with forward-bending thecae, its smaller, ovate and membranaceous leaves and pubescent calyx.

Phenology:— Flowering material was collected in January.

Ethnobotanical uses:— No ethnobotany use was reported for *C. lateriflora*.

Specimens examined:— BRAZIL. Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, Edge of the forest, 700–800 m, 07°11′10″ S, 037°25′53″ W, 18 January 1997, *Agra et al. 3932* (JPB! MO!).

Additional specimens examined:— BRAZIL. Minas Gerais: Uberaba, 1848, *Regnelli 11149* (Isotype K!). Sergipe: Poço Redondo, Santa Rosa, Estrada para os quilombos, 345m alt., 31 October 2014, *J.M.P. Cordeiro et al. 505* (EAN!).

7. ***Dolichandra unguis-cati*** (L.) L.G. Lohmann, Nuevo Catálogo de la Flora Vascular de Venezuela 273. 2008. Fig. 4F–G.

Description:— Lianas, branches cylindrical, glabrous; prophylls of axillary buds subulate. Leaves with 2–leaflets; tendrils trifid, uncinate; petiole 1.3–5.0 cm long; petiolules 1.0–3.0 cm long, canaliculate, glabrous to glabrescent; blade leaflet 5.0–10 × 2.3–5.5 cm, elliptic, chartaceous, base obtuse or oblique, apex acuminate, laxo-lepidote, sparse trichomes peltate in both surfaces, margin crenate to dentate in the upper half of the leaflet when young. Inflorescences in thyrses, axillary; pedicel cylindrical, 1.9–5.0 cm long, glabrescent; calyx campanulate, truncate, 1.0–1.3 cm long, glabrous and sparsely lepidote, trichomes peltate and pateliform; corolla yellow, membranaceous, tube 4.3–5.1 cm long, pubescent, with trichomes simple and glandular-stipitate, 5–lobes, 1.5–2.1 cm long; stamens inserted, the smaller 1.2–2.5 cm long, the larger 1.9–2.5 cm long, anthers 3–8 mm long, 1–staminode, 0.5–1.5 mm long, ovary linear, 0.5–1.0 cm long, glabrous, ovules one seriate per locule, style 1.3–2.8 cm long, glabrous, stigma 2.0–3.0 mm long; nectar disk >1.0 mm long. Calyx persistent in fruit, campanulate, truncate, 1.0–1.3 cm long. Capsule linear compressed 28–45 × 0.9–1.0 cm. Seeds winged, oblong, 3.0–3.7 × 0.7–0.8 cm, brown, the wings membranaceous and hyaline.

Distribution and habitat:— According to Fonseca *et al*. (2017), *D. unguis-cati* has a continental distribution, from the west coast of Mexico to the North/Northeast of Argentina. It is widely distributed in Brazil in all phytogeographic domains. In Pico do Jabre, *D. unguis-cati* is found from the base to the top of the study area, on the edges of the forest, and also on the granitic rocks.

Conservation status:— According to Fonseca *et al*. (2017) this species is categorized as Least Concern [LC] following the IUCN criteria (IUCN 2012), with a extent of occurrence estimated at 29,900,950.163 km².

Notes:— Two species of *Dolichandra* occur in the State of Paraíba: *D. quadrivalvis* and *D. unguis-cati*, however, they can be easily differentiated by their fruits. In *D. quadrivalvis* the fruit is oblong, woody, and four-parted, while in *D. unguis-cati* it is linear, flattened and narrowed at both ends (Fonseca *et al*. 2017). *D. unguis-cati* is easily recognized by its trifid tendrils uncinate at the apex, its 2–foliate leaves and calyx persistent in fruit. Its adventitious roots are used for adherence of this species on the rocks. *D. unguis-cati* form well-established populations in Pico do Jabre, however, Fonseca *et al*. (2017) didn't refered samples from Pico do Jabre in the review of *Dolichandra*,

Phenology:— No flowering material of *D. unguis-cati* was collected at Pico do Jabre during our fieldwork, nor was present in the herbaria consulted, while fructified samples were observed from January to February, and in May and July. According to Fonseca *et al*. (2017), *D. unguis-cati* was observed with flowers from September to January in the southeastern region of Brazil.

Ethnobotanical uses:— Aerial parts of *D. unguis-cati* are used as an anti-inflammatory, anti-malarial, against venereal diseases (Duarte *et al*. 2000), and also is used against snakebite (Houghton & Osibogon 1993). Moreover, the species is used in folk medicine in Argentina against gastrointestinal and vaginal diseases, anuria and bloody urine (Hilbert 2001).

Specimens examined:— BRAZIL: Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, South of Telpa headquarters, 700–900 m, 07°11′10″ S, 037°25′53″ W, 12 July 1997, *Agra et al. 4113* (JPB! MO!); South of Telpa headquarters, up to 1997 m, 07°11′10″ S, 037°25′53″ W, 18–21 January 1998, *Agra et al. 4792* (JPB! MO!); *id*., 800-1010 m, 07°11′10″ S, 037°25′53″ W, 07–10 February 1998, *Agra et al. 5048* (JPB! MO!); *id*., Edge of the forest, 1084 m, 07°15.267' S, 037°23.250' W, 3 May 2018, *Lopes 246* (EAN! JPB!).

Additional specimens examined:— BRAZIL. Bahia: Ilhéus, CEPLAC/CEPEC – Quadra H, 14°45′27″ S, 039°13′50″ W, 10 November 2010, *Daneu et al. 418* (RB!).

8. *Fridericia pubescens* (L.) L.G.Lohmann Ann. Missouri Bot. Gard. 99(3): 443–444. 2014. Fig. 6A–H.

Description:— Liana, branches cylindrical, striated, pubescent; prophylls of axillary buds triangular. Leaves 2–leaflets; tendrils simple; petiole 1.3–5.0 cm long; petiolules up to 1.9 cm long, canaliculate, lepidote-pubescent, trichomes peltate and simple; blade leaflets 2.5–9.5 × 1.4–5.0 cm, oval-elliptic to oblong-elliptic, base oblique, apex acute, chartaceous, abaxial surface densely lepidote-pubescent, with simple, branched and peltate trichomes, adaxial surface lepidote-pubescent, trichomes simple, branched and peltate, margin entire. Inflorescences in thyrse, axillary or terminal; pedicels cylindrical, up to 2.0 mm long, densely pubescent, trichomes simple; calyx cupular, discreetly 5–lobed, lobes 1.5–3.0 mm (4.0 mm) long, lepidote-pubescent outside and glabrous inside, denticulate at apex lobe; corolla pinkish, membranaceous, without glands, tube 4.0–7.0 mm long, covered by trichomes simple outside, pilose at the upper half inside, trichomes simple and glandular-stipitate; stamens inserted, the smaller 2.0 mm long, the larger 3.0 mm long, anthers 1.5 mm long, 1–staminode, 1.5–1.7 mm long; ovary oblong, with 1.5 mm long, ovules 1–seriate per locule, style 2.0–3.0 mm long, glabrous, stigma 0.7 mm long; nectar disk pulvinate, 2.8–3.0 mm thick, glabrous. Capsule linear compressed, 13.5–26.5 × 0.4–0.9 cm, lepidote, trichomes peltate. Seeds not seen.

Distribution and habitat:— *Fridericia pubescens* is distributed from Mexico to South America found in dry to humid forests, according to Lohmann & Taylor (2014). In Brazil it occurs in almost all phytogeographical domains (except Pampa), and in all the States, except for Santa Catarina and Rio Grande do Sul (Flora of Brazil 2020, under construction). It is not very common species in the Pico do Jabre, it is known by two collections, one from 1993 and the other from 2009. Both collections from 800 to 1.160 m of altitudinal levels.

Conservation status:— According to the IUCN criteria (2012), this species is categorized as Least concern [LC], given its wide extent of occurrence (16,611,804,546 km²) covering different physiognomies.

Notes:— *Fridericia pubescens* can be distinguished from the others species in the study area by its most bi—leaflets, pubescent to dense-pubescent with simple and branched trichomes, and by its dense inflorescences. The leaves of *F. pubescens* shows a central scar, between the lateral leaflets, which is originated by a single central and deciduous tendril. The leaves are conspicuously discolor in the dry material of herbarium.

Phenology:— In the study area *F. pubescens* was collected with flowers from March to April.

Ethnobotanical uses:— Preparation of utensils (such as baskets) by traditional communities (Gentry 1992).

Specimens examined:— BRAZIL. Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, 800-1000 m, 07°11′10″ S, 037°25′53″ W, 16 April 1993, *Agra et al. 1984* (JPB!); *id*., 1157 m, 07°15′08″ S, 037°23′01″ W, 30 March 2009, *Agra et al. 7115* (JPB!).

Additional specimens examined:— BRAZIL. Minas Gerais: Viçosa, Agricultural College lands, Upper Chacha valley, 670m alt., 03 June 1930, *Mexia 4779* (K!). Minas Gerais. Ca. 27 km SE of Coroaci along Highway MG-109, 350m alt., 28 March 1976, *Davidse & Ramamoorthy 11474* (MO!).

9. *Pyrostegia venusta* (Ker Gawl.) Miers, Proc. Roy. Hot. Soc. London 3: 188. 1863. Fig. 7A–D.

Description:— Lianas, branches cylindrical, striated, glabrous to glabrescent; prophylls foliaceous. Leaves with 2–3–leaflets; tendrils trifid, not specialized at the apex; petiole 0.6–4.0 cm long; petiolules up to 1.2 cm long, canaliculate, blade leaflet 1.5–6.7 × 1–5.3 cm, elliptic to oval-elliptic, base rounded, apex cuspidate, abaxial surface densely lepidote, adaxial surface lepidote, trichomes peltate, entire margins. Inflorescences in panicles terminal; pedicels canaliculate, 0.6–2.1 cm long, glabrescent, trichomes simple; calyx persistent, campanulate, 5–lobed, 4.0–7.0 cm long, lepidote outside, trichomes peltate, glabrous to glabrescent inside, with trichomes simple at margins, cuspidate at the apex; corolla dark orange, membranaceous, without glands, tube 4.5–7.6 cm long, sparsely lepidote-glabrescent in both surfaces, trichomes peltate and simple, 5–lobed, the lobes 0.6–2.2 cm long, with trichomes simple at the margins; stamens exserted, the smaller 4.6–6.5 cm long, the larger 5.7–7.5 cm long, anthers 3.0–4.0 mm long, 1-staminode, 5.0–7.0 mm long; ovary linear oblong, 4.0–6.0 mm long, lepidote, trichomes peltate, ovules 2–seriate per locule, style 4.8–7.5 cm long, glabrous, stigma 2.0–3.0 mm long; nectar disk cupuliform, 2.0 mm long, glabrous. Capsule linear compressed, 18–28 × 0.9–1.5 cm, trichomes simple and patelliform-glandular, sparce. Seeds numerous, 0.8–1.2 × 2.0–3.0 cm, oblong, brown, winged, the wings membranaceous and hyaline.

Distribution and habitat:— Native to the South America and frequently cultivated throughout the tropics (Pool 2008). In Brazil *P. venusta* occurs in all states and in all phytogeographic domains (Lohmann 2010). In Pico do Jabre the species has a wide occurrence, with more individuals collected at the top.

Conservation status:— This species is categorized as Least Concern [LC] following the IUCN criteria. The extent of occurrence estimated for the species is 19,789,083.869 km². This species has been registered throughout Brazil, suggesting that its populations remain well established.

Notes:— *Pyrostegia venusta* can be easily recognized by its dense inflorescences with its showy, bright orange and infundibuliform corollas, which has the narrow tube, bi-labiate apex and by the two posterior erect lobes and reflexed the three anterior lobes. Moreover, the flowers has exserted stamens (Fig. 7A–B). Floral visitors such as hummingbirds and ants were frequently observed on *P. venusta*.

Phenology:— Plants of *P. venusta* were found flowering and fructified in September, and November to December.

Ethnobotanical uses:— *Pyrostegia venusta* is popularly known as “Cipó-de-São-João in Brazilian folk medicine, where its aerial parts are used as an infusion or decoction (Veloso *et al*. 2010). Its flowers and stems are used in the treatment of vitiligo and diarrheas, respectively (Ferreira *et al*. 2000). According to Kumar *et al*. (2013), the decoction of the aerial parts is also used against coughs and flus.

Specimens examined:— BRAZIL. Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, close to the antennas, at the top, 800-1010 m, 07°11′10″ S, 037°25′53″ W, 27-29 September 1997, *Agra et al*. *4218, 4353, 4356* (JPB! MO!); *id*., 20-23 December 1997, *Agra et al. 4371, 4398* (JPB! MO!); *id*., close to the antennas, at the top, 800–1010 m, 07°11′10″ S, 037°25′53″ W, 17-20 November 1997, *Agra & Silva 4480* (JPB! MO!); *id*., 1195 m, 07°15.182’ S, 037°23.077′ W, 18 September 2018, *Lopes 257* (EAN!).

10. *Tanaecium cyrtanthum* (Mart. ex DC.) Bureau & K.Schum. Flora Brasiliensis 8(2): 186. 1896. Figure 7E–G.

Description:— Lianescent shrub, semideciduous, branches cylindrical, lenticellate, sparsely lepidote, trichomes peltate, with interpetiolar glands; prophylls of axillary buds subulate and bromeliad-like. Leaves with 2–3–leaflets; tendrils simple, not specialized at the apex; petiole 0.6–4.3 cm long, lepidote; petiolule 0.1–1.6 cm long, lepidote-pubescent, trichomes peltate and simple; blade leaflet 1.5–5.4 × 0.8-3.5 cm, elliptic to a large elliptic, ovate to obovate, base rounded or sub-rounded, apex acute, cuspidate or emarginate, membranaceous to sub-chartaceous, abaxial and adaxial surfaces sparse lepidote-pubescent, trichomes simple and peltate, margin entire. Inflorescences in cymes, terminal; pedicels irregularly cylindrical, 4.0–8.0 mm long, sparsely to dense lepidote; calyx persistent, campanulate, irregularly 5–lobed, 4.0–8.0 mm long, cuspidate at the apex, lepidote, trichomes patelliform, showy, outside, short glandular trichomes inside; corolla white to whitish, membranaceous to slightly fleshy, without glands, tube 6.5–9.5 cm long, canescent outside to inside, trichomes simple, 5–lobes, 1.3–1.6 cm long.; stamens inserted, the smaller 1.1 cm long, the larger *ca.* 1.7 cm long, anthers 9.0 mm long, 1-staminode, 6.0 mm long; ovary cylindrical, 3.0 mm long, lepidote, trichomes peltate, ovules (>4) –seriate per locule, style 6.5–10.5 cm long, lepidote at the base, stigma 3.0 mm long; nectar disk globose, 3.0 mm long, glabrous. Capsule linear-cylindrical, 3.2–3.8 × 17.0–30.2 cm, lenticelate; seeds numerous, asymmetrical, 1.9–2.7 × 6.7–9.2 cm, winged, the wings membranaceous and hyaline, brownish.

Distribution and habitat:— According to Frazão and Lohmann (2019), *Tanaecium cyrtanthum* is a South American species that is distributed in dry forests, caatinga, cerrado and chaco of Bolívia, Brazil and Paraguay. In Brazil the species is distributed the States of Ceará, Rio Grande do Norte, Pernambuco, Bahia, Goiás and Mato Grosso do Sul (Frazão and Lohmann 2019). *T. cyrtanthum* is being referred here for the first time to Paraíba. It is known in the study area by only one recent collection (*R. Lopes 263*), collected up to 945 m of elevations at the forest edge, in sandy soil, where some individuals were observed.

Conservation status:— This species is categorized as Least Concern [LC] following the IUCN criteria (IUCN 2012) with a extent of occurrence estimated in 7,566,777.096 km². *T. cyrtanthum* is known by its disjunct distribution, where is found in different dry formations of South America.

Notes:— *Tanaecium cyrtanthum* is a semi-deciduous species when it is in flower, which can be easily recognized by its flowers with infundiliform and white corollas, with its long and thin tube (Fig. 7F–G), which fall easily leaving the stamens and the styles exposed (Fig. 7E). It is a rare species in the studied area, which is known only by a single and recent collection (*R. Lopes 263*). *T. cyrtanthum* is being referred here for the first time to state of Paraiba and also to Pico do Jabre.

Phenology:— The flowering plants were observed in the area in January.

Ethnobotanical uses:— No ethnobotany use was reported for *T. cyrtanthum.*

Specimens examined:— BRAZIL. Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, Ascent to left margin of the forest, about 900 m, 07º15’34.8” S, 037º23’08.4” W, 03 January 2018, *Lopes 263* (EAN).

Additional specimens examined:— BRAZIL. Rondônia: Nova Mamoré, Road line 31, towards the end of Serra dos Pacás Novos, on the side of the road - Quadra H, 14°45′27″ S, 039°13′50″ W, 11 May 2013, *H. Medeiros et al. 1239* (NY!). Goiás: São Domingos, Rio São Domingos, Dirt road between Vazante and São Domingos, 400m, 13°28′16″ S, 46°34′29″ W, 16 June 2000, *Oliveira et al. 1102* (K!).

11. *Tanaecium dichotomum* (Jacq.) Kaehler & L.G.Lohmann. Fig. 8A–C.

Description:— Lianescent shrub, deciduous, branches cylindrical, lenticelate, villous when young; prophylls of axillary buds triangular. Leaves with 2–3-leaflets; tendrils simple; petiole 1.7–5.2 cm long; petiolules 0.1–1.1 cm long, densely villous; blade leaflet 2.1–5.0 × 3.9–9.3 cm, elliptic to rombic, base oblique (leteral leaflets) to aequilatera (central leaflet), apex acute to retuse, subchartaceous to chartaceous, abaxial side villous, interspersed by patelliform and peltate trichomes, adaxial side sparsely villous with peltate trichomes, entire margins. Inflorescences in thyrse, axillary; pedicels cylindrical, 3.0–5.0 mm long, densely covered by glandular-stipitate and simple trichomes; calyx persistent, campanulate, 5–lobed, up to 1.2 cm long, covered by glandular-stipitate and non-glandular simple trichomes, cuspidate at the apex; corolla pink, white at mouth, membranaceous, without glands, tube 2.2–3.0 cm long, velutinous into the lobes and peltate trichomes inside the tube, 5-lobes, 1.3-2.0 cm long; stamens insert, minors 1.2–1.4 cm long, larger with 1.4–1.6 cm long, anthers 3.0–4.0 mm long, 1-staminode, 5.0–7.0 mm long; ovary cylindrical 2.0 mm long, with simple trichomes, ovules 1–seriate per locule, style 1.9–2.0 cm long, glabrous, stigma 1.0 mm long; nectar disk globose, 1.0 mm thick, glabrous. Capsule linear compressed, 11.5–19.5 × 1.5–1.2 cm, densely villous. Seeds not seen.

Distribution and habitat:— *Tanaecium dichotomum* is a Neotropical species with distribution from North America (Mexico), Central America to South America, where is found in found in many vegetation types, including all regions of Brazil (Frazão & Lohmann

2019). In Pico do Jabre *T. dichotomum* is known from only one recent collection (*Lopes 259*), at the base, in an area of flat and sandy soil.

Conservation status:— *Tanaecium dichotomum* has wide extent of occurrence, with 17,390,889,817 km² and is therefore categorized as Least concern [LC] according to IUCN criteria (2012).

Notes:— In the study area *T. dichotomum* can be easily recognized by its densely villous leaflets, the calyx with glandular-stipitate and simple trichomes that changes its color from light lilac to purple (Fig. 8B, and by its semi-deciduous leaves. In addition, few individuals were found in the area of Pico do Jabre.

Phenology:— Flowering and fructified material was collected in September.

Ethnobotanical uses:— No ethnobotany use was reported for *T. dichotomum.*

Specimens examined:— BRAZIL. Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, na base da estrada para o Pico do Jabre, 818 m, 07°15.808'S, 037°21.590'W, 19 September 2018, *Lopes 259* (EAN!).

12. *Tanaecium parviflorum* (Mart. ex DC.) Kaehler & L.G.Lohmann. Fig. 8D–F.

Description:— Lianescent shrub, branches cylindrical, lenticellate, pilose in the young plant, trichomes simple; prophylls of axillary buds triangular. Leaves with 3–leaflets; tendrils simple; petiole 0.5–1.6 cm long; petiolules 0.2–1.5 cm long, canaliculate, pubescent, simple trichomes; blade leaflet 0.9–2.3 × 1–4.5 cm, elliptic to obovate, base atenuate to oblique, apex acute or retuse, membranaceous to sub-chartaceous, abaxial surface sparsely lepidote-pubescent, trichomes peltate and simple, venation with simple trichomes, adaxial surface glabrous, margins crenate at the upper half. Inflorescences in thyrse, terminal; pedicels cylindrical, 6.0–9.0 mm long, pubescent; calyx tubular, 5–lobed, 4.0–6.0 mm long, tomentulose outside, lobes apiculate at apex; corolla light pink, membranaceous, 5–lobes, 1.0–2.0 cm long, the tube 3.0–4.0 cm long, covered by simple trichomes inside and outside;

stamens insert, the smaller 1.2–1.3 cm long, the largest with 1.7–1.8 cm long, anthers 3.0 mm long, 1-staminode, 4.0 mm long; ovary cylindrical, 2.0–3.0 mm long, pubescent, ovules 1–seriate per locule, style 1.7–2.2 cm long, glabrescent, stigma 2.0-3.0 mm long; nectar disk rounded, *ca*. 1.0 mm thick, glabrous. Capsules linear-oblong, compressed, 6.7–7.2 × 1.4–1.6 cm, glabescent. Seeds not seen.

Distribution and habitat:— *Tanaecium parviflorum* is an endemic species to the Brazilian flora, where occurs in caatinga vegetation of northeast region (Bahia, Ceará, Minas Gerais, Paraíba, Pernambuco), with disjunction in Mato Grosso do Sul, according to Frazão & Lohmann (2019). Specimens of *T. parviflorum* were collected on the roadside of Pico do Jabre, in the middle portion.

Conservation status:— Given its extent of occurrence (1,437,026,404 km²) in the dry forests of the Northeast region, especially, *T. parviflorum* is categorized as Least Concern [LC] following the IUCN criteria. *T. parviflorum* is known only by two collections, including a recent collection (*Lopes 240*), which justifies an assessment of the conservation status of this population.

Notes:— Two specimens of *T. parviflorum* were collected in Pico do Jabre and both samples have tri–leaflets leaves, which has the tendrils projected from the branches. Moreover, the leaflets crenulated in the ½ superior (Fig. 8F), the bi-labiate corolla with light pink color (Fig. 8D) and the and the smooth valvar fruits (Fig. 8E) are distinctive for this species.

Phenology:— Flowering and fruiting specimens were collected in Pico do Jabre in January and March.

Ethnobotanical uses:— *Tanaecium parviflorum* is popularly known in Brazil as "mama-de-cachorro”, and its branches are used as handmade baskets (Silva *et al*. 2007).

Specimens examined:— BRAZIL. Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, south of Telpa's headquarters, 600-1197 m, 07°11′10″ S, 037°25′53″ W, 18-21 January 1998, *Agra* *et al. 4791* (JPB! MO!); *id*., to the right margin of the forest, 982 m, 07°15′28.4″ S, 037°23′13.1″ W, 14 March 2018, *Lopes 240* (EAN! JPB!).

13. *Xylophragma heterocalyx* (Bureau & K.Schum.) A.H.Gentry Ann. Missouri Bot. Gard. 66(4): 778. 1979[1980]. Fig. 7H.

Description:— Liana, deciduous, stems and branches cylindrical, lenticelate, glabescent, trichomes simple; prophylls of axillary buds bromeliad-like. Leaves with 2–3–leaflets; tendrils simple; petiole 3.6–7.0 cm long; petiolules 0.2–2.1 cm long, glabrescent and sparsely lepidote, trichomes simple and lepidote; blade leaflet 3.1–4.9 × 7.9–14 cm, elliptic-lanceolate to ovate-lanceolate, base oblique, apex acute, sub-chartaceous to chartaceous, abaxial surface sparsely lepidote, trichomes patelliform on the blade, trichomes simple and glandular on the midrib, adaxial surface lepidote-glabrescent, trichomes patelliform and simple, margins entire. Inflorescences in panicles, axillary; pedicels irregularly cylindrical, 2.0–8.0 mm long, densely lanulose, trichomes simple and branched; calyx tubular, 5–lobed, 0.4–1.3 cm long, lanulose, trichomes simple and branched; corolla lilac inside and outside up to 5–lobes, yellow changing to and white after anthesis at mouth, membranaceous, without glands, tube 5-lobed, 0.9–2 cm long; up to 4.0 cm long, lanulose-lepidote outside, trichomes simple, branched and peltate, with stipitate trichomes at the insertion of the stamens, and patelliform and branched trichomes in the tube; stamens inserted, the smallest 1.3–1.5 cm long, the larger 1.9–2.1 cm long, anthers 3.0–4.0 mm long, 1-staminode, up to 3.0 mm; ovary cylindrical, 2.0–3.0 mm long, glabrous, ovules 6–seriate per locule, style 2.6–2.7 mm long, glabrous, stigma 2.0–3.0 mm long; nectar disk globose, ca. 1.0 mm thick, glabrous. Fruits and seeds not seen.

Distribution and habitat:— According to Lohmann and Taylor (2014), *X. heterocalyx* is an endemic species to Brazil and is found in Cerrado vegetation in eastern Brazil (Bahia, Espírito

Santo, Minas Gerais and Rio de Janeiro). It was collected in Pico do Jabre on the edges of the access to the road and inside the forest at elevations of 818 to 1028 m.

Conservation status:— *Xylophragma heterocalyx* is known from only six locations but is considered Least Concern (LC) given its wide extent of occurrence, with more than 600.000 km^2, and at different physiognomies where it occurs, including depressions and highland forests as Pico do Jabre.

Notes:— *Xylophragma heterocalyx* is a rare species in Pico do Jabre, it is known only by two recent collections, from 2018. The species can be easily recognized by its deciduous leaves when the plant is in flower, and by dense inflorescences with corollas that changes their color, from yellow to white. *X. heterocalyx* is a new record for the Caatinga, for the State of Paraíba and also for Pico do Jabre. Bees were observed visiting its flowers.

Phenology:— Flowering material was collected in September.

Ethnobotanical uses:— No ethnobotany use was reported for *X. heterocalyx*.

Specimens examined:—BRAZIL. Paraíba: Maturéia, Serra de Teixeira, Pico do Jabre, base of the road, 818 m, 07º15.808'S, 037º21.590 W, 19 September 2018, *Lopes 260* (EAN!, JPB!); *id*., close to the jiboia trail, 1028 m, 07º15'34.8" S, 037º23'08.4" W, 26 September 2018, *Lopes 261* (EAN!, JPB!).

Additional specimens examined:—BRAZIL. Paraíba: Sertãozinho, Sítio Canafístula, 15 December 2017, *Cordeiro 1256* (EAN! NY!).

Conclusions

This work presented relevant results to the study of the Bignonieae tribe in Brazil, whose results enriched the collections of regional herbaria, as well as expanding the number of new records and the distribution of genera and species of Bignonieae in Pico do Jabre, Paraíba and Brazil.

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References

Agra, M.F. & Nee, M. (1997) A new species of *Solanum* subgenus *Leptostemonum* (Solanaceae) from Northeast Brazil. *Brittonia* 49: 350—353. http:/doi.org/10.2307/2807835

Agra, M.F., Barbosa, M.R.V. & Stevens, W.D. (2004) Levantamento florístico preliminar do Pico do Jabre, Paraíba, Brasil. *In*: Porto, K.C., Cabral, J.J.P. & Tabarelli, M. (Eds) *Brejos de altitude em Pernambuco e Paraíba: História natural, Ecologia e Conservação*. Ministério do Meio Ambiente, Brasília, pp. 123-138.

Alcantara, S. & Lohmann, L.G. (2010) Evolution of floral morphology and pollination system in Bignonieae (Bignoniaceae). *American Journal of Botany* 97 (5): 782–796. http://doi.org/10.3732/ajb.0900182

Arbo, M.M. (2017) Neotypification of *Clytostoma sciuripabulum* Hovel. *PhytoKeys* 78: 17–21. (2017). http://doi.org/10.3897/phytokeys.78.10649

Amorozo, M. & Gély, A. (1988) Uso de plantas por caboclos do baixo Amazonas, Barcarena. *Boletim do Museu Paraense Emilio Goeldi*, Serie Botanica 4: 47-131.

Bachman, S., Moat, J., Hill, A.W., Torre, J. & Scott, B. (2011) Supporting Red List threat assessment with GeoCAT: geospacial conservation assessment tool. *Zookeys* 150: 117–126.

Baracho, G.S. & Siqueira, J.A. (2004) *Orthophytum jabrense* Baracho & J.A.Siqueira. *Vidalia* 2(1): 46–51.

Barrie, F.R., Reveal, J.L., Jarvis, C.E. & Gentry, A. H. (1991). Typification of *Bignonia crucigera* L. (Bignoniaceae). *Annals of Missouri Botanical Garden* 78: 264–265.

Borges, A.B.S. & Maciel, A. (2003) Bacia do Atlântico Norte/Nordeste. *In*: *II Simpósio Regional de Geografia*: "*perspectivas para o cerrado no século XXI*". Universidade Federal de Uberlandia. Instituto de Geografia.

Bureau, L.E.K. & Schumann, C. (1896) Bignoniaceae. *In*: Martius, K.F.P. & Eichler, A.W. *Flora brasiliensis*: *enumeratio plantarum in Brasilia hactenus detectarum*. J. Cramer, pp. 1-452.

Bye, R.A. (1979) An 1878 ethnobotanical collection from San Luis Potosi: Dr. Edward Palmer's first major mexican collection. *Economic Botany* 33: 135–162.

Candolle, A.P. (1845) Ordo CXXXIII. Bignoniaceae. *Prodromus Systematic Naturalis Regni Vegetabilis* 9: 142–248.

Cartaxo, S.L., Souza, M.M.A. & Albuquerque, U.P. (2010) Medicinal plants with bioprospecting potential used in semi-arid northeastern Brazil. *Journal of Ethnopharmacology* 131: 326–342. http://doi.org/10.1016/j.jep.2010.07.003

Chamisso, L.K.A. (1832) Plants in Expeditione Romanzoffiana et in herbarium regis observatis disserere pergitur—Bignoniaceae. *Linnaea* 7: 542–723.

Cunha, M.D.C (2010) *Comunidades de árvores e o ambiente na Floresta Estacional Semidecidual Montana do Pico do Jabre, PB*. PhD Thesis, Universidade de Brasília, Brasília. 303 pp.

Cunha, M.D.C., Silva Júnior, M.C. & Lima, R.B. (2013) A flora lenhosa na floresta estacional semidecídua montana do Pico do Jabre, PB. *Revista Brasileira de Ciências Agrárias* 8: 130-136. http://doi.org/10.5039/agraria.v8i1a2294

Cunha, M.D.C. & Silva Júnior, M.C. (2014) Flora e estrutura de floresta estacional semidecidual montana nos estados da Paraíba e Pernambuco. *Nativa* 2: 95–102. http://doi.org/10.14583/2318-7670.v02n02a06

Duarte, D.S., Dolabela, M.F., Salas, C.E., Raslan, D.S., Oliveiras, A.B., Nenninger, A., Wiedemann, B., Wagner, H., Lombardi, J. & Lopes, M.T. (2000) Chemical characterization and biological activity of *Macfadyena unguis-cati* (Bignoniaceae). *The Journal of Pharmacy and Pharmacology* 52: 347-352.

Dumortier, B.C.J. (1829) *Analyse de familles des plantes*. J. Casterman, Tournay.

Ferreira, D.T., Alvares, O.S., Houghton, P.J. & Braz-Filho, R. (2000) Chemical constituents from roots of *Pyrostegia venusta* and considerations about its medicinal importance. *Química Nova* 23: 42-46.

Fischer, E., Theisen, I. & Lohmann, L.G. (2004) Bignoniaceae. *In*: Kubitzki, K. & Kadereit, J.W (Eds) *The Families and genera of vascular plants*. *VII*. *Flowering plants*. *Dicotyledons*. *Lamiales* (*except Acanthaceae including Avicenniaceae*). Springer, Berlin, pp. 9–38.

Flora of Brazil 2020 under construction. Jardim Botânico do Rio de Janeiro. Available at: <http://floradobrasil.jbrj.gov.br/ >. Accessed on: Jan. 2020

Fonseca, L.H.M., Cabral, S.M., Agra, M.F. & Lohmann L.G. (2017) Taxonomic Revision of *Dolichandra* (Bignonieae, Bignoniaceae). *Phytotaxa* 301: 001–070. https://doi.org/10.11646/phytotaxa.301.1.1

Forman, L. & Bridson, D. (1989) *The herbarium handbook*. Kew: Royal Botanic Gardens. 214p.

Frazão, A., Lohmann, L.G. (2019) An updated synopsis of *Tanaecium* (Bignonieae, Bignoniaceae). *PhytoKeys* 132: 31–52.

Gentry, A.H. (1973a) Flora of Panama: Bignoniaceae. *Annals of the Missouri Botanical Garden* 60: 781–977. https://doi.org/10.2307/2395140

Gentry, A.H. (1973b) Generic delimitations of Central America Bignoniaceae. *Brittonia* 25: 226–242. https://doi.org/10.2307/2805585

Gentry, A.H. (1979) Additional generic mergers in Bignoniaceae. *Annals of Missouri Botanical Garden* 66: 778-787.

Gentry, A.H. (1980) Bignoniaceae, Part I, Tribes Crescentieae and Tourretieae. *Flora Neotropica* 25:1-131.

Gentry, A.H. (1992) Bignoniaceae, Part II. Tribe Tecomae. *Flora Neotropica Monograph* 25: 1–370.

Harris, J.G. & Harris, M.W. (2001) *Plant identification terminology*: *an illustrated glossary*. Spring Lake Publishing, Spring Lake, 206 pp.

Hilgert, N.I. (2001) Plants used in home medicine in the Zenta River basin, Northwest Argentina. *Journal of Ethnopharmacology* 76: 11–34.

Houghton, P.J. & Osibogun, I.M. (1993) Flowering plants used against snakebite. *Journal of Ethnopharmacology* 39: 1–29.

Howard, R.A. (1989) Bignoniaceae. *In*: Howard, R.A (Ed) *Flora of the Lesser Antilles*: *Leeward and Windward Islands*. Arnold Arboretum, Harvard University, Boston, pp. 312–226.

IUCN (2012) IUCN Red List Categories and Criteria: Version 3.1. Second edition. IUCN, Gland, Cambridge.

Jussieu, A.L. de (1789) *Genera plantarum: secundum ordines naturales disposita, juxta methodum in Horto regio parisiensi exaratam, anno M.DCC.LXXIV*. Herissant, Paris, 498 pp.

Kaehler, M., Michelangeli, F.A. & Lohmann, L.G. (2019) Fine tuning the circumscription of *Fridericia* (Bignonieae, Bignoniaceae). *Taxon* 68: 751—770.

Kumar, A., Asthana, M., Roy, P., Amdeka, S. & Singh, V. (2013) Phytochemistry and Phamacology of *Pyrostegia venusta*: A plant of family Bignoniaceae. *International Journal of Phytomedicine* 5: 257-261.

Kunth, C. (1818) Revision de la famille des Bignoniaceés. *Journal de Physique, de Chimie, d'Histoire Naturelle et des Arts* 87: 444–454.

Kunth, K.S. (1818) Bignoniaceae. *Nova Genera et Species Plantarum* 3: 132–154.

Leaf Architecture Working Group - LAWG (1999) Manual of leaf architecture: morphological description and categorization of dicotyledonous and net-veined monocotyledonous angiosperms. Smithsonian Institution, Washington. 67 pp.

Lima, P.J. & Heckendorff, W.D. (1985) Climatologia. *In*: *Atlas Geográfico da Paraíba*. Grafset, Editora Universitária, João Pessoa, 9 pp.

Linnaeus, C. (1753) Species Plantarum 2. Laurentii Salvii, Holmiae, 899 pp.

Lohmann, L.G., Bell, C., Calió, M.F. & Winkworth, R.C. (2013) Pattern and timing of biogeographic history in the neotropical tribe Bignonieae (Bignoniaceae). *Botanical Journal of the Linnean Society* 171: 154–170.

Lohmann, L.G. (2006) Untangling the phylogeny of Neotropical lianas (Bignonieae, Bignoniaceae). *Americam Journal of Botany* 93: 304–315.

Lohmann, L.G. (2008) Bignoniaceae. In: Hotchke, O., Berry, P. & Huber, O. (Eds.) *Nuevo Catálogo de la Flora Vascular de Venezuela*. Fundación Instituto Botánico de Venezuela, Caracas, pp. 270–278.

Lohmann L.G (2010) Bignoniaceae. *In*: Forzza R.C, Baumgartz J.F.A, Bicudo C.E.M, Carvalho Jr AA, Costa A, Costa D.P, Hopkins M, Leitman PM, Lohmann L.G, Maia L.C, Martinelli G, Menezes M, Morim M.P, Nadruz-Coelho M.A, Peixoto A.L, Pirani J.R, Prado J, Queiroz L.P, Souza VC, Stehmann J.R, Sylvestre L.S, Walter B.M.T &

Zappi D (eds.) Catálogo de Plantas e Fungos do Brasil. Jardim Botânico do Rio de Janeiro, Rio de Janeiro.

Lohmann, L.G. & Taylor, C.M. (2014) A new generic classification of tribe Bignonieae (Bignoniaceae). *Annals of Missouri Botanical Garden* 99 (3): 348-489. https://doi.org/10.3417/2003187

Lohmann, L.G. (2015) Bignoniaceae in Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Disponivel em: <http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB113365>.

Lohmann, L.G. & Pirani, J.R. (1998) Flora da Serra do Cipó, Minas Gerais: Bignoniaceae. *Boletim Botânico da Universidade de São Paulo* 17: 127–153.

Lohmann, L.G. & Ulloa, C. (2019) Bignoniaceae. *In*: *Checklist of the World*, MOBOT/NYBG/Kew Gardens. iPlants prototype Checklist. Available in: <http://www.iplants.org/>. Acess in 22 january 2019.

Martius, C.F.P.V. (1827) *Fridericia*, Novum Plantarum Genus, Friderico Guilelmo III. *Nova Acta Physico-medica Academiae Caesareae Leopoldino-Carolinae Naturae Curiosorum* 13: 7.

Martius, K.F.P., & Eichler, A.W. (1840) *Flora brasiliensis*: *enumeratio plantarum in Brasilia hactenus detectarum*. J. Cramer, 452 pp.

Maury, C.M. (2002) *Biodiversidade brasileira: avaliação e identificação de áreas e ações prioritárias para conservação, utilização sustentável e repartição de benefícios da biodiversidade nos biomas brasileiros*. Ministério do Meio Ambiente, Brasília, 404 pp.

Meisner, C.F. (1840) Bignoniaceae. *Plantarum vascularium genera secundum ordines naturales digesta* 1: 299–301.

Miers, J. (1863) Report on the plants collected by Mr. Weir, especially the Bignoniaceae. *Proceedings of the Royal Horticultural Society London* 3: 179–202.

Morison, R. (1699) *Plantae Historiae pars tertia*. Oxford.

Myers, J., Mittermeier, R.A., Mittermeiier, C.G., Fonseca, G.A.B. & Kent, J. (2000) Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.

Nasir, E. (1979) Bignoniaceae. *In* E. Nasir, E. & Ali, S.I. (eds), *Flora of West Pakistan*, 11 (131). Pakistan Agricultural Research Council, Islamabad, pp. 1–22.

Nogueira, A., El Otrra, J.H.L., Guimarães, E., Machado, S.R. & Lohmann, L.G. (2013) Trichome structure and evolution in Neotropical lianas. *Annals of Botany* 112: 1331–1350. http://doi.org/10.1093/aob/mct201

Olmstead, R.G., Zjhra, M.L., Lohmann, L.G., Grose, S.O. & Eckert, A.J. (2009) A molecular phylogeny of Bignoniaceae. *American Journal of Botany* 96: 1731–1743. http://doi.org/10.3732/ajb.0900004

Pontes, R.A.S. & Agra, M.F. (2001) Flora do Pico do Jabre, Paraíba, Brasil: Acanthaceae. *Leandra* 16: 51-60.

Pool, A. (2007) A revision of the genus *Pithecoctenium* (Bignoniaceae). *Annals of the Missouri Botanical Garden* 94: 622-643. https://doi.org/10.3417/0026-6493

Pool, A. (2008) A Review of the Genus *Pyrostegia* (Bignoniaceae). *Annals of the Missouri Botanical Garden* 95: 495-511.

Presl, C.B. (1845) Botanische Bemerkungrn. *Abhandlungen der Königlichen Böhmischen Gesellschaft der Wissenschaften* 3: 431-584.

Radford, A.E., Dickison, W.C., Massey. & Jr Bell, R. (1974) *Vascular plant systematics*. Harper & Row publishers, New York, 83 pp.

Rocha, E.A. & Agra, M.F. (2002) Flora do Pico do Jabre, Paraíba, Brasil: Cactaceae Juss. *Acta Botanica Brasilica* 16 (1): 1-8. http://dx.doi.org/10.1590/S0102-33062002000100004

Sandwith, N.Y. & Hunt, D.R. (1974) Bignoniáceas. *In* Reitz, P.R. (ed), *Flora Ilustrada Catarinense*, Vol. 1. Conselho Nacional de Pesquisas, Itajaí, Santa Catarina, pp. 1–172.

Santos, L.L., Santos, L.L., Alves, A.S.A., Oliveira, L.S.D. & Sales, M.F.D. (2013) Bignoniaceae Juss. no Parque Nacional Vale do Catimbau, Pernambuco. *Rodriguésia* 64: 479-494.

Schumann, K.M. (1894) Bignoniaceae. Die Natürlichen Pflanzenfamilien 4: 189–252.

Silva, L.R., Silva-Castro, M.M. & Conceição, A.S. (2018) Bignoniaceae in the Raso da Catarina Ecoregion, Bahia, Brazil. *Biota Neotropica* 18: 1-22. http://dx.doi.org/10.1590/1676-0611-BN-2017-0466

Silva, T.M.S., Da Silva, T.G., Martins, R.M, Maia, G.L.A., Cabral, A.G.S., Camara, C.A., Agra M.F. & Barbosa-Filho, J.M. (2007) Molluscicidal activities of six species of Bignoniaceae from north-eastern Brazil, as measured against Biomphalaria glabrata under laboratory conditions. *Annals Tropical Medicine Parasitology* 101: 359–365. http://doi.org/10.1179/136485907X176427

Solereder, H. (1908) *Systematic Anatomy of the Dicotyledons*. *A Handbook for Laboratories of Pure and Applied Botany*. Clarendon Press, Oxford, 665 pp.

Sousa-Baena, M.S., Lohmann, L.G., Rossi, M., and Sinha, N.R. (2014a). Acquisition and diversification of tendrilled leaves in Bignonieae (Bignoniaceae) involved changes in expression patterns of SHOOTMERISTEMLESS (STM), LEAFY/FLORICAULA (LFY/FLO), and PHANTASTICA (PHAN). *New Phytologist* 201: 993–1008. http://doi.org/10.1111/nph.12582

Sousa-Baena, M.S., Sinha, N.R., and Lohmann, L.G. (2014b) Evolution and development of tendrils in Bignonieae (Lamiales, Bignoniaceae). *Annals of Missouri Botanical Garden* 99: 323–347.
https://doi.org/10.3417/2011018

Souza-Baena, M.S., Lohmann, L.G., Hernandes-Lopes, J. & Sinha, N.R. (2018a) The molecular control of tendril development in angiosperms. *New Phytologist* 218(3): 944-958.

https://doi.org/ 0.1111/nph.15073

Souza-Baena, M.S., Sinha, N.R., Hernandes-Lopes, J. & Lohmann, L.G. (2018b) Convergent Evolution and the Diverse Ontogenetic Origins of Tendrils in Angiosperms. *Frontiers in plant Science* 9: 1-19.

Souza, A.V.V., Oliveira, F.J.V., Bertoni, B.W., França, S.C. & Pereira, A.M.S. (2015) Enraizamento in vitro de catuaba (*Anemopaegma arvense* (Vell.) Stell. ex Souza), uma planta medicinal do Cerrado. *Revista Brasileira de Plantas Medicinais* 17: 51–58.

Sprague, T.A. (1905) *Xylophragma* Sprague. *Icones Plantarum* 28: 2770.

Stasi, L.C. & Hiruma-Lima, C.A. (2002) *Plantas medicinais na Amazônia e na Mata Atlântica*. Editora Unesp, São Paulo, 604 pp.

Superintendência de Administração do Meio Ambiente (SUDEMA). (1994) *Pico do Jabre*. João Pessoa.

Swartz, O.P. (1788) XLIV. *Tanaecium*. *Nova genera & species plantarum, seu, Prodromus descriptionum vegetabilium: maximam partem incognitorum quæ sub itinere in Indiam Occidentalem annis* 1783-1787 6: 1-158.

Tabarelli, M. & Santos, A.M.M. (2004) Uma breve história natural dos Brejos Nordestinos. *In*: Porto, K.C., Cabral, J.P. & Tabarelli. M (Eds.). *Brejos de altitude de Pernambuco e Paraíba: história natural, ecologia e conservação*. Ministério do meio Ambiente, Brasília, pp. 17-24.

Thiers, B. (2019) [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/science/ih/.

Tucker, G.C. (2008) *Cyperus Alvesii* (Cyperaceae), a New Species from Northeastern Brazil, *Harvard Papers in Botany* 13: 237–240.

Vasconcelos Sobrinho, J. (1971) *As regiões naturais do Nordeste, o meio e a civilização*. Conselho de Desenvolvimento de Pernambuco, Recife. 441 pp.

Veloso, C.C., Bitencourta, A.D., Cabral, L.D., Franqui, L.S., Dias, D.F., dos Santos, M.H., Soncini, R. & Giusti-Paiva, A. (2010) *Pyrostegia venusta* attenuate the sickness behavior induced by lipopolysaccharide in mice. *Journal of Ethnopharmacology* 132: 355-358.

Velloso, A.L., Sampaio, E.V.S.B. & Pareyn, F.G.C. (2002) *Ecorregiões propostas para o bioma caatinga*. Associação Plantas do Nordeste; The Nature Conservancy do Brasil, Recife. 81 pp.

Verlot, P. (1868) *Revue Horticole* 40: 154.

Zuntini, A.R (2014) *Revisão e Filogenia de Bignonia L. (Bignonieae, Bignoniaceae)*. PhD Thesis, Universidade de São Paulo, São Paulo. 309 pp.

Table 1. Morphological characters of the Bignonieae species of the Pico do Jabre. Legends: conspicuous nectar guides = CNG, bromeliad-like = bl, foliaceous= f, subulate = s, triangular = t.

Species	Characters											
	Habit	Interpetiolar glands	Prophyll type	Leaflets number	Leaflet margin	Tendril type	Tendril apex	CNG	Calyx	Corolla	Corolla fauce	Stipite of ovary	Stamens
A crucigerum	Liana	absent	f	2—3	entire	multifid	adhesive disk	absent	simple	white	yellow	absent	inserted
A paniculatum	Liana	absent	f	2—3	entire	multifid	adhesive disk	absent	double	lilac to pink	yellow	absent	inserted
A citrinum	Lianescent shrub	absent	f	2—3	entire	trifid	simple	absent	simple	yellow	yellow	present	inserted
B ramentacea	Liana	absent	t	1—2	entire	simple	simple	present	simple	rose to purple	variega ta	absent	inserted
B sciuripabulum	Liana	absent	t	1—2	entire	simple	simple	present	simple	rose to purple	variega ta	absent	inserted
C lateriflora	Liana	absent	t	3	entire	simple	simple	absent	simple	pink	pink	absent	inserted
D unguis-cati	Liana	absent	s	2	entire to dentate	trifid	uncinate	absent	simple	yellow	yellow	absent	inserted
F pubescens	Liana	present	t	2—3	entire	simple	simple	absent	simple	pink	pink	absent	inserted
P venusta	Lianescent shrub	absent	f	2—3	entire	trifid	simple	absent	simple	orange	orange	absent	exserted
T cyrthantum	Lianescent shrub	present	t	2—3	entire	simple	simple	absent	simple	white	white	absent	Sub-exserted
T dichotomum	Lianescent shrub	absent	t	2—3	entire	simple	simple	absent	simple	pink	white	absent	inserted
T parviflorum	Lianescent shrub	absent	t	3	partially crenate	simple	simple	absent	simple	whitish to pink	whitish	absent	inserted
X heterocalyx	Liana	present	bl	2—3	entire	simple	simple	absent	simple	lilac	white or yellow	absent	inserted

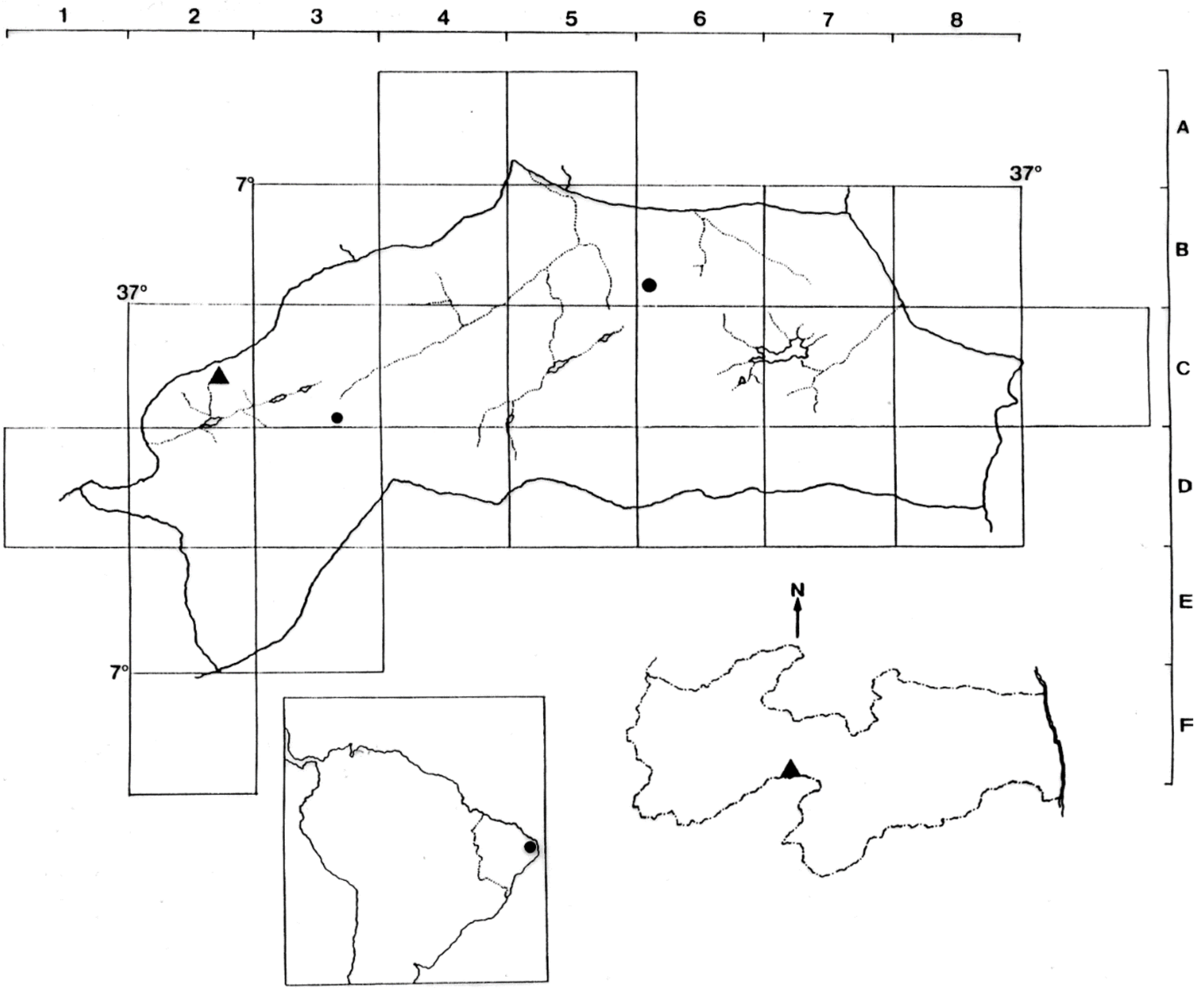

Figure 1. Study area: Pico do Jabre in Municipality of Maturéia, State of Paraíba, Brazil.

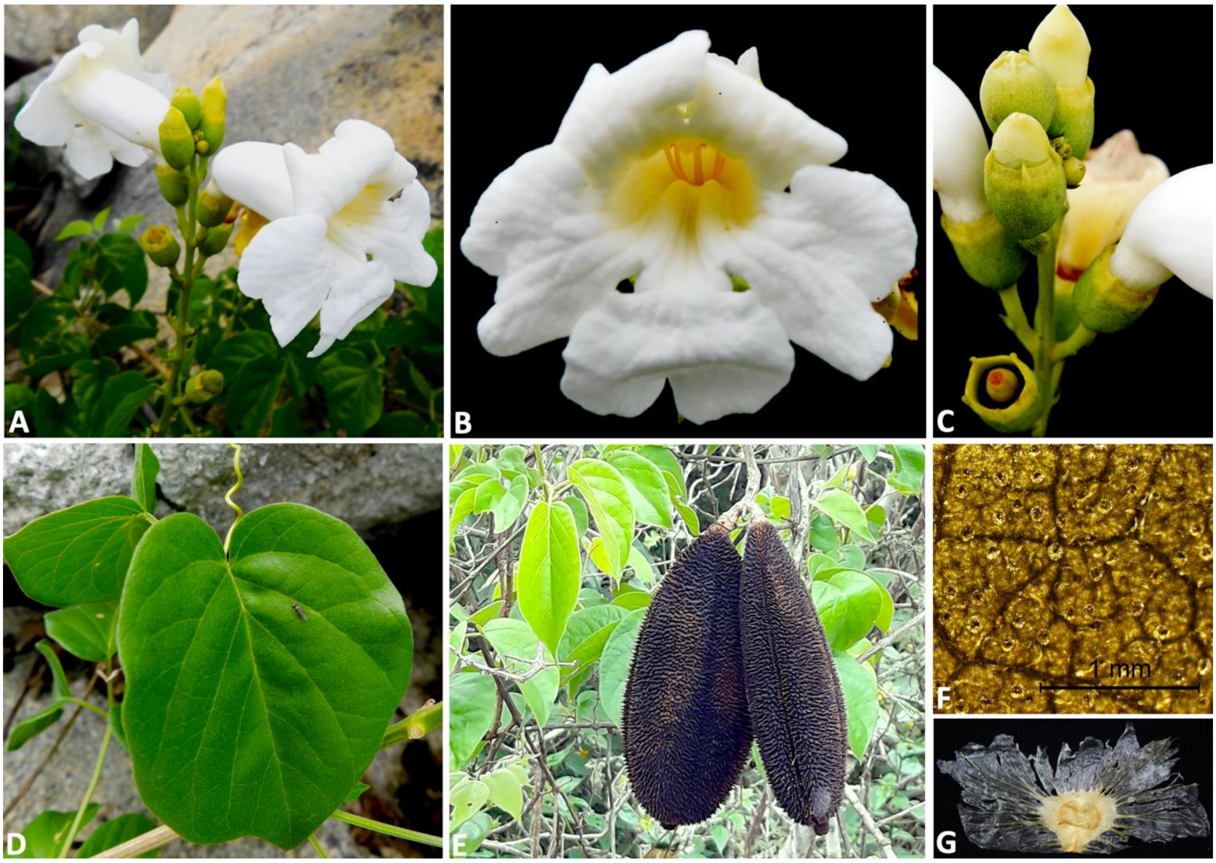

Figure 2. A—G. *Amphilophium crucigerum* (L.) L.G. Lohmann, from *Lopes 135*: A. Inflorescence; B. Isolated flower; Inflorescence with calyx detail; D. Isolated leaflet; E. Fruits; F. Detail of leaf indument; G. Seed. Photos by R. Lopes.

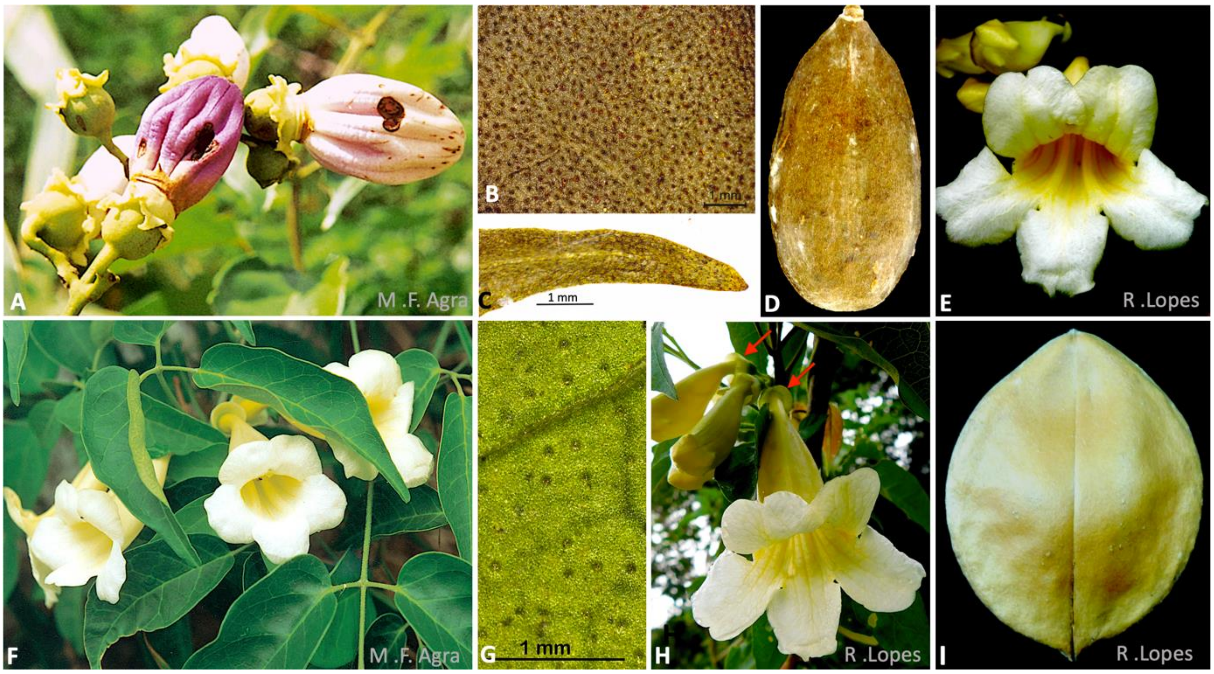

Figure 3. A—D. *Amphilophium paniculatum* (L.) Kunth, from *Agra et al*. *2688*: A. Inflorescence; B. Detail of leaf indument; C. apex of the leaf; D. Fruit. E—I. *Anemopaegama citrinum* Mart. ex DC.: E. Isolated flower, from *Lopes 239*; F. Flowered branch, from *Agra et al. 2629*; G—I. From *R. Lopes 255*: G. Detail of the abaxial leaf indument; H. Flower with calyx detail; I. Fruit.

Figure 4. A—C. *Bignonia ramentacea* (Mart. ex DC.) L.G.Lohmann. A—C. From *Lopes 253*: Flower; B—C . Fruit: B. Detail of seeds in the fruit, from *Agra et al. 4022*; C. Fruit in plant; D—E. *Bignonia sciuripabulum* (K. Schum.) L.G. Lohmann, from *Agra et al. 4365*: D. Flowered plant; E. Inflorescence with flowers; F—G. . *Dolichandra unguis-cati* (L.) L.G. Lohmann: F. Detail of inflorescence; G. Detail of leaf seed. Photo C, courtesy of MO. Photos F, courtesy of Joel Cordeiro.

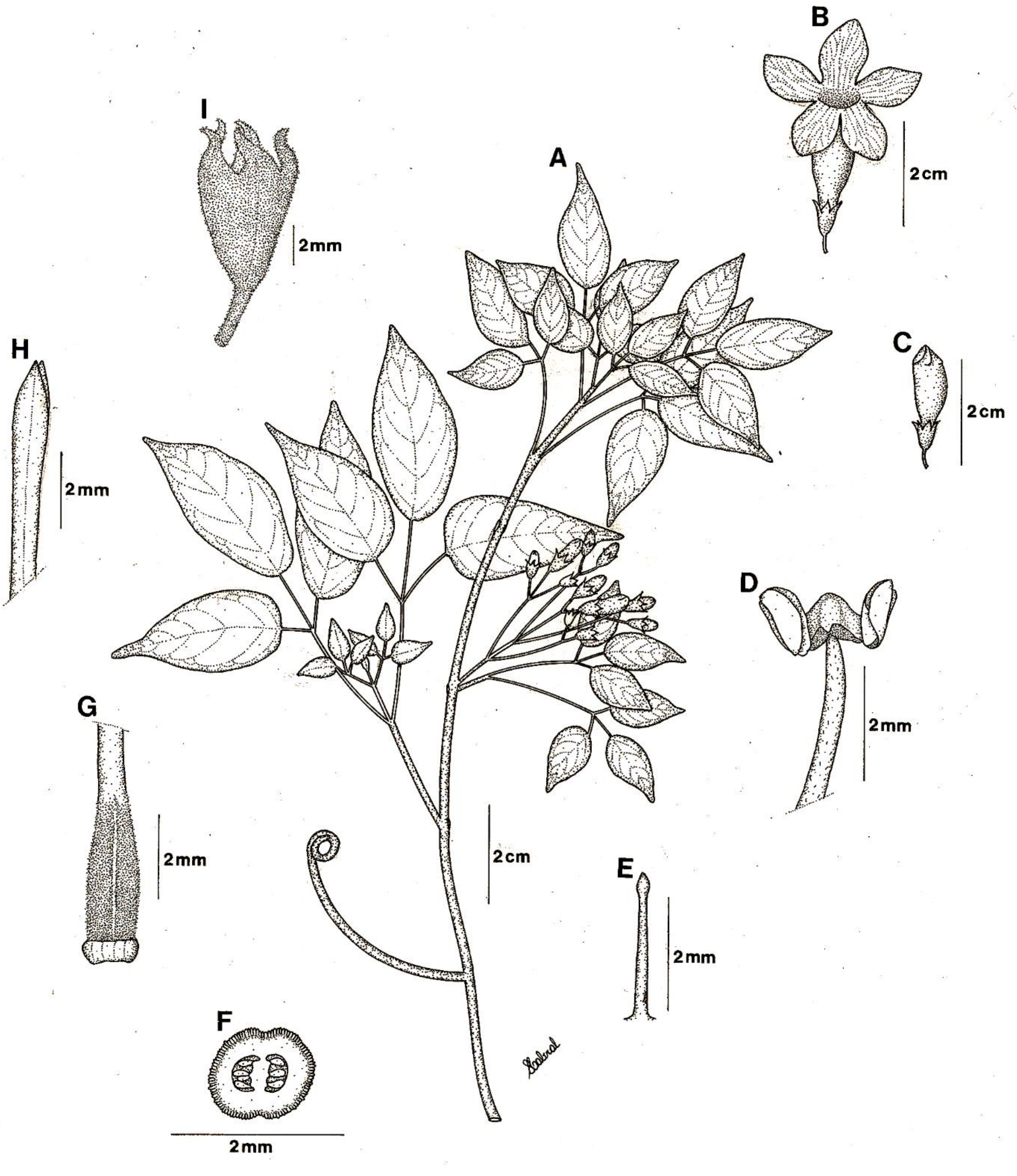

Figure 5. *Cuspidaria lateriflora* (Mart.) DC. A—I. From *Agra et al. 3932*: A. Flowered branch; B. Flower; C. Bud; D. Stamen; E. Style; F. Ovary in transverse section; G. Ovary and nectary; H. Detail of stigma; I. Calyx.

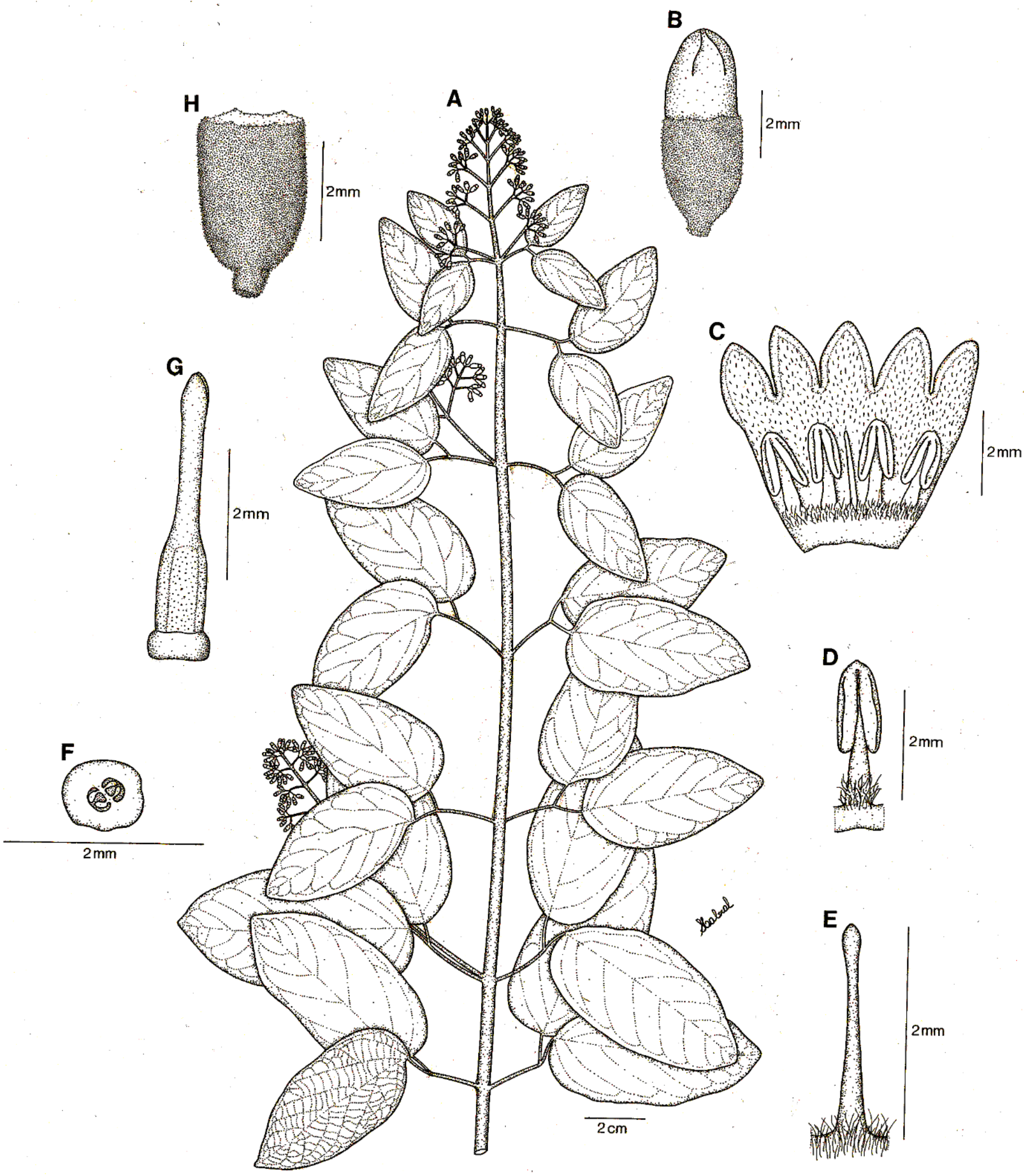

Figure 6. *Fridericia pubescens* (L.) L.G.Lohmann. A—F. from *Agra et al. 1984*: A. Flowered branch; B. Bud; C. Corolla with stamens detail; D. Stamen; E. Style; F. Ovary in transverse section; G. Gynoecia and nectary; H. Detail of calyx.

Figure 7. A—F. *Pyrostegia venusta* (Ker Gawl.) Miers: A. Flowers, from *Agra et al. 4371*; B—D. From *Lopes 257;* Detail of flowers; C. Fruits; D. Isolated seed; E—G. *Tanaecium cyrtanthum* (Mart. Ex DC.) Bureau & K.Schum., from *R. Lopes 263*: E. Branch with bud flowers and leaves; F. Flower isolated; G. Inflorescence; H. *Xylophragma heterocalyx* (Bureau & K.Schum.) A.H.Gentry, from *R. Lopes 261*: K. Inflorescence with the fowers with the corolla's fauce of different colors.

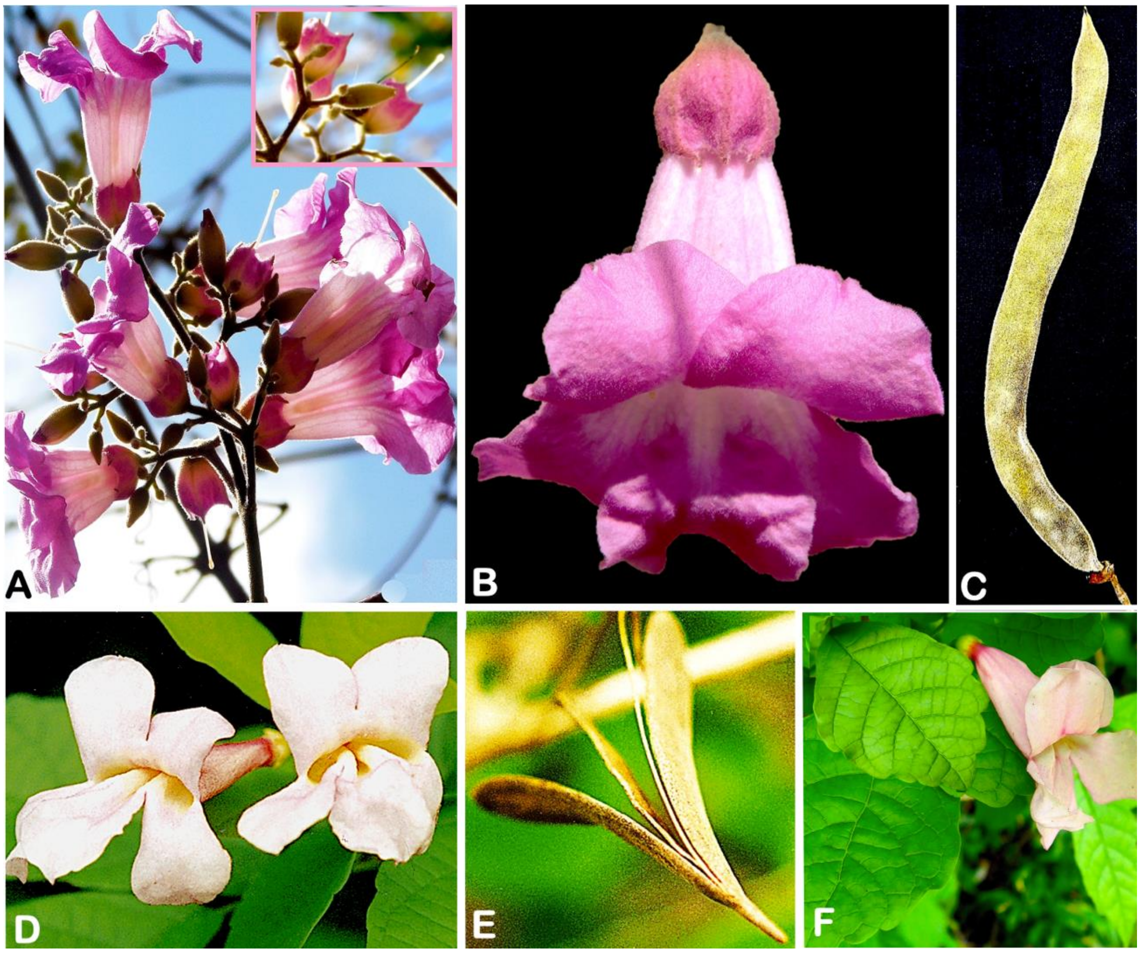

Figure 8. A—C. *Tanaecium dichotomum* (Jacq.) Kaehler & L.G.Lohmann, from *Lopes 259*: A. Inflorescence and calyx detail; B. Flower; C. Fruit. D—F. *Tanaecium parviflorum* (Mart. ex DC.) Kaehler & L.G.Lohmann. H—J. From *Agra et al. 479*: D. Detail of inflorescence; E. Fruit; F. Leaves and flower. Photos A—C and F by R. Lopes. Photos D and E by M. F. Agra.

4 Capítulo II

Leaf epidermis characterization and its taxonomic significance of 13 species of Bignonieae (Bignoniaceae) growing in Pico do Jabre, Paraíba, Brazil

À ser Submetido a Botany

Leaf epidermis characterization and its taxonomic significance of 13 species of Bignonieae (Bignoniaceae) growing in Pico do Jabre, Paraíba, Brazil

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Abstract

In this work we carried out a study of the micromorphology of the leaflet epidermis of 13 species of Bignoniae of Pico do Jabre, a Montane Forest in State of Paraíba, Brazil, in order to characterize and find differential parameters for its taxonomy. The study was performed using light and scanning electron microscopy for the qualitative and quantitative analysis of leaf epidermis and their appendages. The species studied showed epidermal cells with straight, curved and sinuous anticlinal walls, hypostomatic leaves, crystals idioblasts (crystal sand, prismatic crystals, raphides and styloids), although, raphides and styloids were observed only in *Amphilophium crucigerum* and *Fridericia pubescens*. Moreover, glandular (stipitate, pateliform and peltate) and non-glandular (dendritic and simple) trichomes were observed on the epidermis, as well as different types of epicuticular waxes on the epidermal cells, stomata and trichomes, and the cuticle varied from smooth to striate. Ten different types of stomata were observed, being more than one type of stomata in each species. The stomatal index varying from 6.21% in *Bignonia ramentacea* to 23.52% in *Tanaecium parviflorum*, and the stomatal density from 76 stomata/mm² in *Pyrostegia venusta* to 753 stomata/mm² in *T. parviflorum*. The leaf epidermis anatomy provided a set of distinctive characters to separate the species studied and as support to its taxonomy, mainly by the stomata, idioblasts and trichomes.

Key words: epicuticular waxes, idioblasts, leaf anatomy, micromorphology, Neotropical lianas.

Introduction

Bignonieae Dumort is the largest neotropical clade of Bignoniaceae Juss., with 21 genera and 393 species (Lohmann and Taylor 2014), of which 327 occur in Brazil, mainly in Amazonia, Atlantic Forest and also in the dry forest domain (BFG 2015). According to Gentry (1980), these Brazilian domains are considered as the center of diversity of the group.

The Bignonieae clade is formed predominantly by lianas and woody species with the greatest morphological diversity among neotropical lianas (Lohmann 2006). The monophyly of the group is supported by molecular, morphological and anatomical characters. Morphological and anatomical synapomorphies can be observed in the modified terminal leaflet in tendril, septicidal capsules, and by the irregular stem growth, leading to the formation of four to 32 phloem wedges that interrupt the xylem (Santos 1995; Lohmann and Taylor 2014).

Anatomical characters constitute an important tool for the taxonomy of vegetative organs of flowering plants (Metcalfe 1946,1968; Metcalfe and Chalk 1950, 1979; Dickison et al. 1975). Leaf epidermis anatomy has revealed important characters that have proven their usefulness in the taxonomy of distinct groups of angiosperm, providing diagnostic value at different levels. For Carlquist (1961), the leaf is perhaps the most varied organ of angiosperms, and these anatomical variations are often closely related to the generic and specific level, sometimes familiar.

The anatomy of the leaf epidermis has revealed several important structures whose characters have been shown to be useful in the taxonomy of various groups of vascular plants, providing diagnostic value at different taxonomic levels (Dilcher 1974; Metcalfe and Chalk 1979). According to Dickison et al. (1975), epidermal characters in leaf anatomy are among the characters that have proven to be of systematic value and are of potential phylogenetic significance (Judd et al. 2009; Dilcher 1974; Metcalfe and Chalk 1979), which has allowed the identification of plants and the resolution of taxonomic problems in different groups of vascular plants, such as ferns (Shah et al. 2018, 2019) and angiosperms (e.g., Porto et al. 2016; Attar et al. 2018; Kandemir et al. 2019, among others). Among the relevant characters of the leaf epidermis stand out the morphology of cuticle and epicuticular waxes on the epidermis (Barthlott 1998), as well as the presence of inorganic idioblasts of different types of crystals (raphides, druses and crystals sand) and lithocysts, besides the epidermal appendages, with different types of stomata and trichomes, as already shown by Zoric et al. (2009) to *Trifolium*, Porto et al. (2011) for *Cissampelos*, Nurit-Silva and Agra (2011) for *Solanum* sect. *Polytrichum*, Nurit-Silva et al. (2012) for the *Solanum* sect. *Torva*, for *Solanum* sect *Brevantherum* and Atalay et al. (2016) for *Lamium*, among others. In addition, leaf anatomic studies have supported the identification of medicinal plants such as Shaheen et al. (2019) and Silva et al. (2019), who studied *Senna* and *Byronima sericea*, for example.

Furthermore, in several groups, foliar epidermal characters have been shown to be valuable for systematics, as evidenced for species of and Sapindaceae (Onuminya and Adediran 1998), and for the subfamilies of Caryophyllaceae (Ullah et al. 2018a, 2018b), Athyriaceae (Shah et al. 2018), *Baccharis* (Budel et al. 2018) and *Mallotus* (Kadiri, et al. 2019).

The value of epidermal characters as support for the taxonomy of Bignoniaceae were realized for some African species (Ogundipe and Wujek 2004; Ugbabe and Ayodele 2008) and for the Brazilian species of "ipês" by Silva et al. (2009). Moreover, the wood anatomy of Bignoniaceae has corroborated and supported the relationships established within the family (Gerolamo and Angialossy 2017; Santos 2017), as well as in Bignonieae tribe, revealing the importance and the potential of the anatomical studies for the current classification of tribes of Bignoniaceae and in understanding its evolution (Pace et al. 2009; Pace et al. 2015). In addition to these works, other studies were conducted focusing on the quality control of medicinal species by Mauro et al. (2007) and Souza et al. (2007), as well as on the epidermis structure (Gonzalez 2013), ontogeny of the stomata (Paliwal 1970), and also with a taxonomic implication (Nogueira et al. 2013; Firetti-Leggieri et al. 2014; Sousa-Baena et al. 2014).

The identification of the Bignoniae taxa is more complex without the presence of reproductive traits (Gentry 1992), due to the great diversity and different patterns of morphological variation, sometimes requiring the analysis of additional diagnostic characters, according to Lohmann (2006).

The presence of many species with ethnobotanical uses in Bignoniae, especially in traditional folk medicine (Gentry 1992), reinforces the need for greater knowledge of their leaf anatomy, since most parts of the plants are only known to have their vegetative parts used as medicines.

In this work we carried out a study of the leaf epidermis micromorphology of 13 species of Bignoniae, belonging to nine genera, from the Pico do Jabre, aiming the need for a better understanding of the of the leaf epidermis anatomy of Bignoniae, in order to find additional parameters for its characterization, as well as additional support for Bignoniae taxonomy.

Materials and methods

Plant material

The plant material of 13 species of Bignonieae (Table 1) was collected at Pico do Jabre, municipality of Maturéia, the highest point of the State of Paraíba and the northern of Northeast region of Brazil, reaching up to 1,197 m of altitude. The vegetation of the area is mainly associated with dry forest with elements of wet forest (Rocha and Agra 2002; Agra et al. 2004; Cunha and Silva-Junior 2014).

Part of the material collected was pressed and dried, according to the usual techniques for herbaria (Bridson and Forman 1992) and, subsequently, deposited at the Herbarium Prof. Jayme Coelho de Morais (EAN) of the Federal University of Paraíba (UFPB), and duplicates were deposited at the JPB, MO, RB and SPF herbaria, acronyms according Thiers (2019). Leaf samples were selected and collected from adult plants, from third to fifth node, from three individuals of each species and, subsequently, were fixed in AFA (50%) for 48h, according to Johansen (1940), and preserved in ethanol (70%).

Leaf epidermis

Samples of fresh and dried leaves of 13 species of Bignonieae (Table 1) were analyzed, being samples of 15 specimens of each. The dried samples were rehydrated, according to Smith and Smith (1942). Samples of leaves with two and three leaflets were prepared by standard transverse and paradermic sections (on the adaxial and abaxial surfaces), and then clarified by sodium hypochlorite (2%), washed in distilled water and neutralized by acetic acid (1%). The paradermic sections were stained with safranin (0.25%), according to Franklin (1945). The transverse sections were stained with Safrablue, modified by Bukatsch (1972). All sections were mounted on semi-permanent slides, analyzed and micrographed under light microscopy (Leica DM750, Switzerland) coupled with a digital camera (Leica ICC50 HD).

The trichomes terminology is according Payne (1978) and Nogueira et al. (2013), and the classification of the epidermis follows Dilcher (1974).

For the Scanning Electron Microscopy (SEM) analyses, dehydrated samples of about 0.5 cm^2 of the median portion of leaflet (abaxial and adaxial) of each species were attached in aluminum stubs using double-faced adhesive tape, metallized with gold, examined and micrographed them by SEM (JEOL JSM-5600) at 15 KV. The terminology of the epicuticular waxes is according to Barthlott et al. (1998).

Stomata type and stomatal indexes

Three leaves were analyzed for each species with two or three leaflets, the number of epidermal cells and stomata were taken from two distinct fields of each leaflet, which were observed in the same ocular, in a total of 18 fields analyzed for each species (n = 18). The classification of the morphology of the stomata followed Dilcher (1974).

The index and stomatal density were obtained using Anati Quanti software (Aguiar et al. 2007) by light microscopy. The statistical analyzes were performed by GraphPad Prism 7.00 software. The quantitative data were submitted to analysis of variance (ANOVA) *F* in one way with statistical significance determined by the Tukey method ($p < 0.05$).

Results

Leaflet epidermis

The Bignoniae species studied showed three patterns of anticlinal cell walls of the leaflets epidermis, in frontal view: curved, straight and sinuous. All data on the leaflets epidermis are compiled on the Table 2. The anticlinal cell walls were predominantly sinuous and observed in eleven species, being five species on the both surfaces: *Dolichandra unguis-cati* (Fig. 2E and 2F), *Fridericia pubescens* (Fig. 2G and 2H), *Tanaecium dichotomum* (Fig. 3E and 3F), *Tanaecium parviflorum* (Fig. 3G and 3H) and *Xylophragma heterocalyx* (Fig. 3Iand 3J). In five species the sinuous pattern was observed only on the abaxial surface: *Anemopaegma citrinum* (Fig. 1F), *Bignonia sciuripabulum* (Fig. 2B), *Cuspidaria lateriflora* (Fig. 2D), *Pyrostegia venusta* (Fig. 3B, and *Tanaecium cyrtanthum* (Fig. 3D). In *Amphilophium crucigerum* (Fig. 1A) the sinuous pattern of anticlinal cell walls is only on the adaxial surface.

The anticlinal cell walls pattern varied in different species and also on the both surfaces of a same species, as was observed in *A. crucigerum* (Figs. 1A and 1B), *A. citrinum* (Figs. 1E and 1F), *B. sciuripabulum* (Figs. 2A and 2B), *C. lateriflora* (Figs. 2C and 2D), *F. pubescens* (Figs. 2G and 2H) and *T. cyrtanthum* (Figs. 3C and 3D).

The pattern straight of anticlinal cell walls leaflets epidermis was observed in six species, being *Amphilophium paniculatum* (Figs 1C and 1D) and *Bignonia ramentacea* (Figs. 1G and 1H), showed straight pattern on the both leaflet surfaces. *A. citrinum* (Fig. 1E), *B. sciuripabulum* (Fig. 2A), *C. lateriflora* (Fig. 2C) and *P. venusta* (Fig. 3A) showed the straight pattern only on the adaxial surfaces.

The curved pattern of anticlinal cell walls leaflets epidermis was observed in one of the surfaces only, on the adaxial surfaces of *A. citrinum* (Fig. 1E) and *T. cyrtanthum* (Fig. 3G), and on the abaxial surface of *A. crucigerum* (Fig. 1B).

With respect to the thickening of the cell walls, eight species showed thicker anticlinal cell walls on the adaxial surface in relation to the abaxial surface: *A. paniculatum* (Fig. 1C), *B. ramentacea* (Fig. 1G), *B. sciuripabulum* (Fig. 2A), *C lateriflora* (Fig. 2C), *D. unguis-cati* (Fig. 2E), *T. parviflorum* (Fig. 3A), *P. venusta* (Fig. 3A) and *X heterocalyx* (Fig. 3I). The presence of pits was observed at the angles of the anticlinal cell walls on the adaxial surface of *A. citrinum* (Fig. 1E).

In transverse section, all species showed tabular cells of the leaflet epidermis in both surfaces, being narrower on the abaxial surface as observed in *B. sciuripabulum* (Fig. 4A), for example.

Types of trichomes

Non-glandular and glandular trichomes were observed on the epidermis of all species of Bignonieae analyzed in this work (see Table 2). Two distinct classes of non-glandular trichomes were observed: simple, uniseriate (Figs. 1B, 4B, 5A, 5B, 6C, 6D, 6G and 6H), and branched trichomes (Fig. 4C). The simple trichomes varying in number of cells, from two to six cells and also by the type of cuticle covering them, thick, smooth, striate and rougous. In addition, cuticular warts were also present on some simple trichomes. Three types of glandular trichomes were observed in the Bignonieae species: stipitate (Fig. 4D), peltate (Figs. 4E and 4F) and patelliform/cupular (Figs. 4G and 4H).

Simple trichomes were observed on the blade leaflets surfaces of nine species belonging to eight genera. They were observed on the both leaflet surfaces of eight species: *A. crucigerum* (Figs. 1B, 5A and 5B), *A. citrinum*, *B. ramentacea*, *C. lateriflora* (Figs. 6C and 6D), *T. dichotomum* (Figs. 7E and 7F), *T. parviflorum* (Figs. 7G and 7H), *F. pubescens* (Figs. 6G and 6H) and *X. heterocalyx*; they also were observed on the abaxial leaflet surface of *P. venusta*. Simple trichomes with cuticular warts were present on the both surfaces of *A. crucigerum* (Figs. 5A and 5B) and *C. lateriflora* (Figs. 6C and 6D), and on the abaxial surface of *T. parviflorum* (Fig. 7H). Branched trichomes were observed only on the both leaflets surfaces of *F. pubescens* (Fig. 4C).

The glandular-stipitate trichomes were observed in four species from three genera, on the adaxial surfaces of *C. lateriflora* (Fig. 4D), *T. dichotomum*, *F. pubescens,* and on the both surfaces of *T. parviflorum* (Fig 4E). All species showed glandular-peltate trichomes on both leaflets blade surfaces (Table 3), as observed in *A. crucigerum* (Figs. 5A and 5B), *A. paniculatum* (Figs. 1D, 5C and 5D), *A. citrinum* (Fig. 5E), *B. ramentacea* (Figs. 5G and 5H), *B. sciuripabulum* (Figs. 6A and 6B), *C. lateriflora*, *D. unguis-cati* (Figs. 6E and 6F), *T. dichotomum* (Fig. 7F), *T. parviflorum* (Fig.

7G), *F*. *pubescens*, *P*. *venusta* (Figs. 7A and 7B), *T*. *cyrtanthum* (Figs. 7C and 7D) and *X*. *heterocalyx* (Figs. 7I and 7J).

Glandular-patelliform/cupular trichomes were observed on the abaxial surface of all species studied, as observed in *T*. *dichotomum* (Fig. 4G) and *A*. *citrinum* (Fig. 5F), for example, and on the both surfaces of *A*. *paniculatum* (Fig. 4H). The type of glandular-peltate trichome was observed in higher density on both surfaces of *A*. *paniculatum*.

Inorganic idioblasts

Other important character observed in the leaf epidermis of the Bignoniae species studied was the presence of inorganic idioblasts of different types, which were observed in nine species (Table 3). Of these, prismatic crystals were observed in the epidermal cells of the both surfaces of seven species: *A*. *crucigerum*, *C*. *lateriflora* (Fig. 2C), *D*. *unguis-cati*, *F*. *pubescens* (Fig. 2G) *T*. *cyrtanthum*, *T*. *dichothomum* (Fig. 3E) and *T*. *parviflorum*. In *Bignonia ramentacea* the prismatic crystals were present only on the adaxial leaflet surface, and in *P*. *venusta* they were observed only on the abaxial surface.

Crystals sand were observed in the epidermis of six genera and eight species. Three species, *A*. *crucigerum* (Fig. 1A), *D*. *unguis-cati* and *T*. *cyrtanthum*, showed crystals sand in the both surfaces of leaf epidermis. *Cuspidaria lateriflora* (Figs. 2C and 2D), *F*. *parviflora* and *P*. *venusta* showed crystals sand only in the abaxial surface. On the other hand, *Bignonia ramentacea* (Fig. 1G) and *T*. *dichotomum*, showed crystals sand only in the adaxial surfaces.

The presence of druses were observed only in the adaxial surface of *P*. *venusta* (Fig. 3A), and idioblasts as raphides were observed in the intracellular spaces of the adaxial surface of *A*. *crucigerum* (Fig. 1A) only. Crystals as styloids were observed in the adaxial surface of *F*. *pubescens* (Fig. 2G).

Types of stomata and stomatal indexes

All species showed hypostomatic leaflets epidermis. Different types of stomata were observed in the same leaflet, the number varied from four to nine. The Table 3 shows all different types of stomata observed on the leaflet epidermis of all species. The largest number of types of stomata was observed in the genus *Bignonia*, which showed nine types in *B. ramentacea* (Fig. 1H) and seven in *B. sciuripabulum* (Fig. 2B). Two species showed six types of stomata each, *Anemopaegma citrinum* (Fig. 1F) and *T. dichotomum* (Fig. 3F). Five species showed the lowest number, four different types of stomata: *A. crucigerum* (Fig. 1B), *A. paniculatum* (Fig. 1D), *C. lateriflora* (Fig. 2D), *D. unguis-cati* (Fig. 2F) and *P. venusta* (Fig. 3B).

The anomotetracytic type was predominant and observed in all 13 species (Figs. 1D, 1H, 2F, 2H, 3B and 3D). Anomocytic stomata were observed in twelve species (Figs. 1B, 1F, 2B, 2F, 3B, 3D, 3F, 3J), except in *F. pubescens.* The anisocytic type was present in ten species, except in *A. crucigerum*, *A. paniculatum* and *C. lateriflora.* The brachyparacytic stomata type was present in ten species, but were not present in two species of *Amphilophium* (*A. crucigerum and A. paniculatum*) and *D. unguis-cati*. The staurocytic pattern (Fig. 1F) was recorded in nine species, and the cyclocytic type (Fig. 1D) was observed in five species (see Table 3). Hemiparacytic stomata (Fig. 3H) were present in five species, and the paracytic type stomata was present in species of *Fridericia* (Fig. 2H) and *Tanaecium* (Fig. 3F), while brachyparahexacytic stomata (Fig. 2B) were observed only in *Bignonia* species, which represents um character differential for the genus and its species. The amphicyclocytic pattern was observed exclusively in *B. ramentacea* (Fig. 1H), constituting um character distinctive for this species.

Stomatal complexes were observed in all species,throughout the epidermis or in an part, where the subsidiary cells share two or more stomata, as was observed in *A. crucigerum* (Fig. 1B), *A. paniculatum* (Fig. 1D), *C. lateriflora* (Fig. 2D), *T. cyrthanthum* (Fig. 3D) and *T. parviflorum* (Fig. 3H), for example.

In transverse section all 13 species of Bignoniae showed stomata at the level of the epidermal cells as was observed in *B. sciuripabulum* (Fig. 4A), for example. Although, three species also showed stomata above the level of epidermal cells, when the ostiole are opened, as observed in *A. paniculatum* (Fig. 4I), *C. lateriflora* and *P. venusta*.

Data from stomatal indices (SI) were observed under light microscopy and are presented in the Table 3 and in Figure 8A. The lowest index 6.21% was observed in *B. ramentacea* and the highest 23.52% in *T. parviflorum.* Species with the closest values of stomatal index were from *Tanaecium*, *T. dichotomum* and *T. cyrtanthum*, with 20.28% and 20.30%, respectively.

The stomatal density showed a great variation among the studied species also (Table 3 and Fig. 8B), the highest density was observed in *T. parvilorum*, which showed 753 stomata/mm², while *A. citrinum* and *P. venusta* have the lowest density value with averages of 76 to 81 stomata/mm², respectively. In addition, *D. unguis-cati* and *X. heterocalyx* have very close stomatal density values, with 92.6 estomata/mm² and 93.2 estomata/mm², respectively.

Epidermal cuticle and epicuticular waxes

Bignonieae species showed smooth and striated cuticles on the leaflets epidermis, trichomes and also on the edges of stomata. Striated cuticle was observed on the epidermis of eight species. Of these, four species belonging different genera showed striate cuticle on the both surfaces, they were: *A. crucigerum* (Figs. 5A and 5B), *A. citrinum* (Figs. 5E and 5F), *F. pubescens* (Figs. 6G and 6H) and *P. venusta* (Figs. 7E and 7F). Two species, *D. unguis-cati* (Fig. 6F) and *T. cyrtanthum* (Fig. 7H), showed striate cuticle only on the abaxial surface, and *A. paniculatum* (Fig. 5C) and *C. lateriflora*, (Fig. 6C) only on the adaxial surface.

Different features of epicuticular waxes were observed on the leaflets epidermis surfaces, trichomes and stomata, most of them on a single phyllo-plane, such as waxes syntopism. Epicuticular waxes as platelets were observed on at least one surface of the leaflets epidermis of all 13 species (Table 4). The type as threads was observed on the blade leaflets of seven species, being *T. dichotomum* on the adaxial surface; *A. citrinum* (Fig. 5F) and *B. sciuripabulum* (Fig. 6B) showed only on the abaxial surfaces; and in four species, *A. paniculatum* (Figs. 5C and 5D), *B. ramentacea*

(Fig. 5H), *D. unguis-cati* (Fig. 6F), and *X. heterocalyx* (Figs. 7I and 7J), they have on the both surfaces.

The type of epicuticular waxes as coiled rodlets were present on the blade leaflets epidermis of six species (Table 4), as follows: on the adaxial surface of *A. paniculatum* (Fig. 5C), *D. unguis-cati* (Fig. 6E) and *T. parviflorum* (Fig. 7G); on the abaxial surface of *A. citrinum* (Fig. 5F) and *B. sciuripabulum* (Fig. 6B); and, in both surfaces of *X. heterocalyx* (Figs. 7I and 7J). The type of epicuticular waxes as crusts were observed on the adaxial blade leaflets surfaces of ten species (Table 4).

The presence of epicuticular waxes as granules was observed on the both surfaces of the leaflet epidermis of eight species (see Table 4), as observed in *A. paniculatum* (Figs. 5C and 5D); and also on the adaxial surface of four species: *B. sciuripabulum* (Fig. 6A), *C. lateriflora* (Fig. 6C), *F. pubescens* (Fig. 6G) and *T. cyrtanthum* (Fig. 7C); and, on the abaxial surface of *A. citrinum* (Fig. 5F). Epicuticular waxes as fissured layers were observed on of *A. paniculatum* and *T. cyrtanthum*. In addition, epicuticular waxes also were present on the surfaces of simple trichomes of four species: *A. crucigerum* (Figs. 5A and 5B), *C. lateriflora* (Figs. 6C and 6D), *F. pubescens* (Fig. 6G) and *T. dichotomum* (Fig. 7E).

Discussion

The predominance of epidermis with sinuous anticlinal cell walls on the abaxial surface of 11 species is a character that may be related to the environment, character observed for other species of *Dolichandra* and *Fridericia* by González (2013), *Pyrostegia venusta* by Duarte (2007) and González (2013) and *Tanaecium* by Souza et al. (2007), unlike that observed in African species of Bignoniaceae studied by Ogundipe and Wujek (2004) and Ugbabe and Ayodele (2008), which showed epidermis with anticlinal cell walls straight and curved, respectively.

The presence of epidermis with strongly sinuous anticlinical cell walls on the both surfaces of the leaflets was observed in species of *Fridericia*, *Tanaecium* and *Xylophragma*, which are genera with taxonomic affinities. The straight anticlinal cell walls pattern observed on the adaxial surface of *Anemopaegma citrinum* also was referred by Mauro et al. (2007) and Firetti-Ligieri et al. (2014) for other Brazilian species of *Anemopaegma*. The curved anticlinal cell walls on the adaxial surface and sinuous on the abaxial surface observed in *Tanaecium cyrtanthum* was a pattern previously recorded by Souza et al. (2007) for *Arrabidaea mutabilis* Bureau ex K.Schum., now as *Tanaecium mutabile* (Bureau ex K.Schum.) L.G.Lohmann (Lohmann and Taylor 2014).

According to Stace (1965a), anticlinical cell walls constitute a mesomorphic character, whose environmental conditions such as humidity play a significant role in determining the pattern of anticlinical cell walls. The influence of light on the environment also influences the anatomy of the leaf epidermis, according to studies carried out in various environmental conditions, such as the level of light and relative humidity recorded in different groups of angiosperms, such *Rosa multiflora* (Capellades et al. 1990), *Alchornea triplinervia* (Rôças et al. 2001) and *Erythroxylum ovalifolium* (Mantuano et al. 2006). Although, on the other hand, anticlinical cell walls do not constitute a character exclusively influenced by climate and habitat, and this can be applied to different anticlinal cell walls pattern observed in the 13 Bignonieae species studied, they are associated with similar environmental conditions, all are lianas and are exposed to intense sunlight.

Epidermal attachments, such as trichomes, exhibit great variation within Bignoniaceae, in particular by their position and structure (Seibert 1948). In this work, epidermis analyzed of 13 species showed five different types of trichomes, glandular and non-glandular, corroborating with the observations of Metcalfe and Chalk (1950) and also with Nogueira et al. (2013) for Bignonieae species.

The taxonomic contribution of the trichomes morphology was relevant at specific level and was differential for four species: *F. pubescens* with an exclusive type of branched trichomes; *C. lateriflora*, *F. pubescens* and *T. dichotomum* with glandular stipitate trichomes on the adaxial surface, and *T. parviflorum* with stipitate trichomes on both surfaces of the leaflet epidermis.

According to Nogueira et al. (2013), Glandular and non-glandular trichomes are extremely common in genera and of Bignonieae.

Inorganic idioblasts is a character already registered for Bignoniaceae in previous works by Metcalfe and Chalk (1950) and Gardner (1977). However, the presence of inorganic idioblasts as raphides and styloids are new in *A. crucigerum* and *F. pubescens*, respectively, and also in Bignonieae. According to Gardner (1977) and Prychid and Rudall (1999), inorganic idioblasts, such as calcium oxalate crystals, are products of secondary metabolism in response to defense of pathogens and herbivores, in addition to being part of species physiology, according to Cutler et al. (2008).

Often the presence of these cell inclusions may represent valuable taxonomic characters (Franceschi and Horner 1980), as already was showed for some groups of monocotyledons (Prychid and Rudall 1999; Prychid et al. 2003). In the Bignoniae species analyzed in the present work, druses, raphids and styloids have a taxonomic relevance due to the specificity of the occurrence and the different types characteristic for each species. In addition, there are few records of inorganic idioblasts in the leaflet epidermis of Bignonieae species. Metcalfe and Chalk (1950) recorded the presence of nuclear crystalloids in the leaflet epidermis of *Arrabidea* species, and Duarte (2007) observed the presence of druses in the leaflet epidermal cells of *P. venusta*. Thus, in this work we have expanded the record of different types of crystals in different species for the epidermal characterization for Bignonieae, as well as for Bignoniaceae.

All species of Bignonieae are hypostomatic and, according to Metcalfe and Chalk (1950), this is the pattern to Bignoniaceae. In contrast, Santos et al. (2009), Gonzalez (2013) and Firetti-Ligieri et al. (2014) recorded amphiestomatic leaves in species of Bignoniaceae of the tribe Tecomeae (*Tecoma*), *Tabebuia* alliance (*Tabebuia* and *Handroanthus*), and also in Bignonieae (*Anemopaegma*).

According to Metcalfe e Chalk (1950), stomata have varying amounts of subsidiary cells in Bignoniaceae, including Bignonieae. In our work we observed ten different types of stomata in all

13 species of Bignonieae, based on the classification of Dilcher (1974), which allowed a more refined analysis for the stomatal complexes. Five new types of stomata are being recorded here for the first time in Bignoniaceae, as follow: amphicyclocytic, anomotetracytic, brachyparacytic, brachyparahexacytic and hemiparacytic stomata.

Brachyparahexacytic stomata were observed only on the leaflets epidermis of *Bignonia* species (*B. ramentacea* and *B. sciuripabulum*) constitute a distinctive character for this genus and its species. In addition, *B. ramentacea* also showed the type of amphyciclocyclic stomata, that is a character differential for this species. The presence of paracytic stomata only in species of *Fridericia* and *Tanaecium* (*T. dichotomum* and *T. parviflorum*) is a character already registered by Metcalfe and Chalk (1950) as one of the few groups of Bignoniaceae to present this type of stomata. In other species, the types of stomata did not have taxonomic relevance, since there is an overlap of the types.

Diacytic stomata were common in leaflet epidermis of African Bignoniaceae (Ogundipe and Wujek 2004; Ugbabe and Ayodele 2008), but without record for Bignonieae. The type of anomocytic stomata are the most cited for different Bignoniaceae clades, as observed in the works by Mauro et al. (2007), Dousseau et al. (2008), Duarte and Jurgensen (2008), Ortolane et al. (2008) and Gonzalez (2013), corroborating this work, since the anomocytic is less common only than the anomotetracytic.

Regarding the stomatal index and density, it was possible to verify that species of the same genus share closer values (Table 3), as well as species of different genera, but that are taxonomically close, according to the treatment of Lohmann (2006) and Lohmann and Taylor (2014), i.e. *Fridericia*, *Tanaecium* and *Xylophragma*. On the other hand, *F. pubescens*, *T. cyrtanthum*, *T. dichotomum* and *T. parviflorum* with the high index, exceeding 20%, and stomatal density, exceding 381 stomata / mm², can be easily separated from the others with a maximum stomata index of 12% and density of 212 stomata/mm² (Table 3).

Salisbury (1927) questioned the influences of stomatal frequency, whether internal or external factors, like humidity e.g., plants with higher stomatal frequencies are common in xeric environments. In addition, Xu and Zhou (2008) proved the influence of different environmental factors on the stomatal density and suggest that the water deficit leads to its increase. This factors can explain the presence of a higher density and stomatal index observed in our work, however, it does not explain the lower index and stomatal density in species such as *X*. *heterocalyx*, collected in the same area and altitude of those with the highest indexes.

Our results suggest that not only environmental and habitat influences are responsible for the presence of these stomatal indexes and density, and other factors may be involved, for example, genetic factors. These indexes were useful for separating *Fridericia* and *Tanaecium* among these species, however, considering that the material comes from the same area, and that we did not compare specimens from different locations to state more accurately if there is taxonomic potential, we suggest using them so with caution.

The smooth and striated cuticle patterns observed in Bignonieae of the present study are in agreement with the Bignoniaceae pattern, as already recorded by Metcalfe and Chalk (1950) and Paliwal (1970). The presence of a thick cuticle on the leaf epidermis in the most Bignonieae species studied here, mainly in straight anticlinal cell walls, than in a thinner cuticle that is more frequently associate as an indicator of climate or habitat. The thickening of cell walls in species growing in very dry habitats has the function of protecting the internal structures of the leaves in unfavorable environments (Kraus 1949). According to Wilkinson (1979), it should be used with caution as a taxonomic character. In addition, this is a character associated with the decrease in light intensity in the photosynthetic tissue (Rudall 2007).

The presence of epicuticular waxes observed in all 13 species of Bignoniae showed different patterns of epicuticular waxes and syntopism, which is the occurrence of different types of epicuticular waxes in the same leaf epidermis, according to Barthlot et al. (1998). Epicuticular waxes in Bignoniaceae family were referred mainly in chemical studies (Alubito et al. 2002;

Olubunmi and Gabriel 2010). Morphologic and taxonomic implications of epicuticular waxes as reported by Ogundipe and Wujek (2004) for African species are less frequent.

According Barthlot et al. (1998), the presence and different morphological types of epicuticular waxes can constitute a support for taxonomic studies, presenting diagnostic value in the characterization of the leaf epidermis. Epicuticular waxes on the leaf and stem epidermis are considered as a protection against biotic and abiotic aggressions (Ahmad et al. 2015) and play an important role in structuring the epidermal surface on a sub-cellular scale, according to Barthlot et al. (2017).

Epicuticular waxes as granules were the most common type, about 92% (12 spp.) were observed only on the adaxial surface and about 69% (9 spp.) only on the abaxial surface on the leaflets epidermis of 13 Bignonieae species, representing about 92% (12 spp.). It is a common type of epicuticular waxes and were observed also in different taxonomic groups of African Bignoniaceae belonging to the genera: *Crescentia*, *Haplophragma*, *Kigelia*, *Markhamia*, *Newbouldia*, *Parmentiera*, *Rhodocolea*, *Spathodea*, *Stereospermum*, *Tabebuia* and *Tecomaria* (Ogundipe and Wujek, 2004). It is a kind of epicuticular waxes no exclusively found in species of the Bignonieae tribe. Epicuticular waxes as threads were also observed on the leaf epidermis of some African species by Ogundipe and Wujek (2004).

Although there is a great variety of epicuticular waxes on the leaf epidermis, even in the same species, in the 13 species of Bignonieae analyzed here, due to its low exclusivity it is a character of little taxonomic importance for the species of our work. According to Wilkinson (1979, the presence and thickness of the cuticle is a character determined by the environmental factor and doesn’t has taxonomic importance.

Conclusions

The anatomy of the epidermis of the leaflets of the 13 species of Bignonieae from Pico do Jabre showed a set of distinctive characters to separate them, mainly by the stomata morphology, types of idioblasts and morphoypes of trichomes, which provided an additional tool to support the Bignonieae taxonomy**.**

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References

Agra, M.F., Barbosa, M.R.V., and Stevens, W.D. 2004. Levantamento florístico preliminar do Pico do Jabre, Paraíba, Brasil. *In* Brejos de altitude em Pernambuco e Paraíba: História natural, Ecologia e Conservação. *Edited by* K.C. Porto., J.J.P. Cabral and M. Tabarelli, Ministério do Meio Ambiente, Brasilia. pp. 123-138.

Aguiar, T.V., Sant'anna-Santos, B.F., Azevedo, A.A., and Ferreira, R.S. 2007. ANATI QUANTI: software de análises quantitativas para estudos em anatomia vegetal. Planta Daninha, 25(4): 649-659.

Ahmad, H.M., Rahman, M.U., Ali, Q., and Awan, S.I. 2015. Plant cuticular waxes: a review on functions, composition, biosyntheses mechanism and transportation. Life Sci. J. 12: 60-67.

Atalay, Z., Celep, F., Bara, F., and Dogan, M. 2016. Systematic significance of anatomy and trichome morphology in *Lamium* (Lamioideae; Lamiaceae). Flora, 225: 60-75. doi:10.1016/j.flora.2016.10.006

Barthlott, W., Neinhuis, C., Cutler, D., Ditsch, F., Meusel, I., Theisen, I., and Wilhelmi, H. 1998. Classification and terminology of plant epicuticular waxes. Bot. J. Linn. Soc. 126: 227-236.

Barthlott, W., Mail, M., Bhushan, B., and Koch, K. 2017. Plant Surfaces: Structures and Functions for Biomimetic Innovations. Nano-micro Lett. 9:1-40. doi: 10.1007/s40820-016-0125-1

BFG - The Brazil Flora Group 2015. Growing knowledge: an overview of Seed Plant diversity in Brazil. Rodriguésia, 66: 1085-1113. doi: 10.1590/2175-7860201566411

Bridson, D., and Forman, L. 1992. The herbarium handbook. Kew: Royal Botanic Gardens.

Budel, J.M., Raman, V., Monteiro, L.M., Almeida, V.P., Bobek, V.B., Heiden, G., Takeda, I.J.M., and Khan, I.A. 2018. Foliar anatomy and microscopy of six Brazilian species of *Baccharis* (Asteraceae). Microsc. Res. Techniq. 1-11. doi: 10.1002/jemt.23045

Bukatsch, F. 1972. Azul de Astra e Safranina. *In* Manual Básico de Métodos em Morfologia Vegetal. *Edited by* J. Kraus and M. Arduin. Edur, Seropédica, Rio de Janeiro.

Capellades, M., Fontarnau, R., Carulla, C., Debergh, P. 1990. Environment influences anatomy of stomata and epidermal cells in tissue-cultured *Rosa multiflora*. J, Am. Soc. Hortic. Sci. 115: 141-145.

Cunha, M.D.C., and Silva-Júnior, M.C. 2014. Flora e estrutura de floresta estacional semidecidual montana nos estados da Paraíba e Pernambuco. Nativa, 2: 95–102. doi: 10.14583/2318-7670.v02n02a06

Cutler, D.F. 1969. Cuticular markings and other epidermical features in Aloe leaves. Notes Jodrell Laboratories, 6: 21-27.

Cutler, D.F., Botha, C.E.J., and Stevenson, D.W. 2008. Plant anatomy: an applied approach. Blackwell Publishing.

Dickison, W.C. 2000. Integrative Plant Anatomy. San Diego: Academic Press.

Dilcher, D.L. 1974. Approaches to the identification of angiosperm leaf remains. Bot. Rev. 40: 1-157.

Duarte, M.R., and Jurgensen, I. 2007. Diagnose Morfoanatômica de Folha e Caule de *Pyrostegia venusta* (Ker Gawl.) Miers, Bignoniaceae. Lat. Am. J. Pharm. 26: 70-75.

Firetti-Leggieri, F., Lohmann, L.G., Semir, J., Damarco, D., and Castro, M.M. 2014. Using leaf anatomy to solve taxonomic problems within the *Anemopaegma arvense* species complex (Bignonieae, Bignoniaceae). Nord. J. Bot. 32: 620–631. doi: 10.1111/j.1756-1051.2013.00275.x

Franceschi, V.R., and Horner, H.T. 1980. Calcium oxalate crystals in plants. Bot. Rev. 46: 361-427.

Franklin, G.L. 1945. Preparation of thin sections of synthetic resins and wood-resin composites, and a new macerating method for wood. Nature, 155, 51.

Gentry, A.H. 1992. A synopsis of Bignoniaceae ethnobotany and economic botany. Ann. Missouri Bot. Gard. 79: 53–64.

Gardner, R.O. 1977. Systematic distribution and ecological function of the secondary metabolites of the Rosidae-Asteridae. Biochem. Syst. Ecol. 5: 29-35.

Gonzalez, A.M. 2013. Indumento, nectarios extraflorales y anatomía foliar em Bignoniáceas de la Argentina. B. Soc. Argent. Bot. 48: 221-245.

Johansen, D.A. 1940. Plant Microtechnique. Mc. Graw-Hill Book. New York.

Judd, W.S., Campell, C.S., Kellogg, E.A., Stevens, P.F., and Donoghue, M.J. 2009. Sistemática vegetal um enfoque filogenético. Artmed, Porto Alegre.

Kadiri, A.B., Ayodele, A.E., and Olowokudejo, J.D. 2019. Leaf epidermis of the African genus *Mallotus* Lour. (Euphorbiaceae) section Rottleropsis Müll. Arg. and its systematic value. Webbia, 1-11. https://doi.org/10.1080/00837792.2019.1589742

Krauss, B.H. 1949. Anatomy of the vegetative organs of the pineapple, *Ananas comosus* (L.) Merr. (Continued) II. The leaf. Bot. Gaz. 110(3): 333-404.

Lohmann, L.G. 2006. Untangling the phylogeny of Neotropical lianas (Bignonieae, Bignoniaceae). Am. J. Bot. 93: 304–315.

Lohmann, L.G., and Taylor, C.M. (2014). A new generic classification of Bignonieae (Bignoniaceae) based on molecular phylogenetic data and morphological synapomorphies. Ann. Missouri Bot. Gard. 99: 348–489. https://doi.org/10.3417/2003187

Mantuano, D.G., Barros, C.F., Scarano, F.R. 2006. Leaf anatomy variation within and between three" restinga" populations of *Erythroxylum ovalifolium* Peyr:(Erythroxylaceae) in Southeast Brazil. Braz. J. Bot. 29: 209 - 215.

Mauro, C., Pereira, A.M.S., Silva, C.P., Missima, J., Ohnuki., and Rinaldi, R.B. 2007. Estudo anatômico das espécies de cerrado *Anemopaegma arvense* (Vell.) Stellf. ex de Souza (catuaba), *Zeyheria montana* Mart. (bolsade-pastor) e *Jacaranda decurrens* Chamisso (caroba) – Bignoniaceae. Rev. Bras. Farmacogn. 17: 262-265.

Metcalfe, C.R., Chalk, L. 1950. Anatomy of the dicotyledons: leaves, stem and wood in relation to taxonomy, with notes on economic uses. Claredon Press, Oxford.

Metcalfe, C.R., and Chalk, L. 1979. Anatomy of dicotyledons. London: Oxford University Press.

Nogueira, A., El Otrra, J.H.L., Guimarães, E., Machado, S.R. and Lohmann, L. G. 2013. Trichome structure and evolution in Neotropical lianas. Ann. Bot. 112: 1331–1350. doi:10.1093/aob/mct201

Nurit-Silva, K., Agra, M.F. 2011. Leaf epidermal characters of *Solanum* sect. *Polytrichum* (Solanaceae) as taxonomic evidence. Microsc. Res. Techniq. 74: 1186–1191. doi: 10.1002/jemt.21013

Nurit-Silva, K., Costa-Silva, R., Basílio, I.J.L.D., and Agra, M.F. 2012. Leaf epidermal characters of Brazilian species of *Solanum* section *Torva* as taxonomic evidence. Botany, 90: 806–814. doi:10.1139/B2012-046

Ogundipe, O. T., and Wujek, D.E. 2004. Foliar anatomy on twelve genera of Bignoniaceae (Lamiales). Acta Bot. Hung. 46: 337–361.

Olmstead, R.G., Zjhra, M.L., Lohmann, L.G., Grose, S.O., and Eckert, A.J. 2009. A molecular phylogeny of Bignoniaceae. Am. J. Bot. 96: 1731–1743. doi:10.3732/ajb.0900004

Ortolani, F.A., Mataqueiro, M.F., Moro, J.R., Moro, F.V., and Damião-Filho, C.F. 2008. Morfo-anatomia de plântulas e número cromossômico de *Cybistax antisyphilitica* (Mart.) Mart. (Bignoniaceae). Acta Bot. Bras. 22: 345-353.

Porto, N.M., Figueiredo, R.C.B.Q., Oliveira, A.F.M., Agra, M.F. 2011. Leaf epidermal characteristics of *Cissampelos* L. (Menispermaceae) species from Northeastern Brazil. Microsc. Res. Techniq. 74, 370–376. doi: 10.1002/jemt.20918

Prychid, C.J., and Rudall, P.J. 1999. Calcium oxalate crystals in monocotyledons: a review of their structure and systematics. Ann. Bot. 84: 725-739.

Prychid, C.J., Rudall, P.J., and Gregory, M. 2003. Systematics and biology of silica bodies in monocotyledons. Bot. Rev. 69: 377-440. doi: 10.1016/j.sajb.2014.06.004

Rocha, E.A., and Agra, M.D.F. 2002. Flora of the Pico do Jabre, Paraíba, Brazil: Cactaceae Juss. Acta Bot. Bras. 16: 15-21.

Rôças, G., Scarano, F.R. and Barros, C.F. 2001. Leaf anatomical variation in *Alchornea triplinervia* (Spreng.) Müll. Arg. (Euphorbiaceae) under distinct light and soil water regimes. Bot. J. Linn. Soc. 136: 231-238.

Rudall, P. 2007. Anatomy of flowering plants – an introduction to structure and development. New York*:* Cambridge University Press.

Saladoye, M.O. 1982. Leaf epidermal studies in the African genus *Baphia* Lodd. and related genera (Papilionoideae-Sophoreae). Bull. Jard. Bot. Natl. Belg. 415-437.

Salisbury, E.J. 1927. On the cause and ecological significance of stomatal Frequency with special reference to the woodland Flora. Phil. Trans. Roy. Soc. Lond. Ser. B. 216: 1-65.

Sampaio, V.S., Araújo, N.D., and Agra, M. F. (2014). Characters of leaf epidermis in *Solanum* (clade Brevantherum) species from Atlantic Forest of Northeastern Brazil. S. Afr. J. Bot. 94, 108-113. doi:10.1016/j.sajb.2014.06.004

Santos, G. M. A. 1995. Wood Anatomy, Chloroplast DNA, and Flavonoids of the Tribe Bignonieae (Bignoniaceae). Ph.D. Dissertation, University of Reading, Reading, U.K.

Seibert, R. J. (1948). The use of glands in a taxonomic consideration of the family Bignoniaceae. Ann. Missouri Bot. Gard. 35, 123–137.

Shah, S.N., Ahmad, M., Zafar, M., Razzaq, A., Malik, K., Rashid, N., and Zaman, W. 2018. Foliar epidermal micromorphology and its taxonomic implications in some selected species of Athyriaceae. Microsc. Res. Techniq. 81: 902-913. doi: 10.1002/jemt.23055

Silva, A. M. L., Costa, M. F. B., Leite, V. G., Rezende, A. A., and Teixeira, F. P. 2009. Anatomia foliar com implicações taxonômicas em espécies de ipês. Hoehnea, 36, 329-338.

Smith, F.H., and Smith, E.C. 1942. Anatomy of the inferior ovary of *Darbya*. Am. J. Bot. 29: 464 – 471.

Souza, L.A., Lopes, W.A.L., and Almeida, O.J.G. 2007. Morfoanatomia da plântula e do tirodendro de *Arrabidaea mutabilis* Bureau & K. Schum. (Bignoniaceae). Acta Sci. Biol. Sci. 29: 131-136.

Stace, C. A. (1965a) The significance of the leaf epidermis in the taxonomy of the Combretaceae I. A general review of tribal, generic and specific characters. Bot. J. Linn. Soc. 59: 229-252.

Stace, A.C. 1965b. Cuticular studies as an aid to plant taxonomy. Bull. Br. Mus. Nat. Hist. (Bot.) 4: 1-78.

Tresvenzol, L.M.F., Fiuza, T.S., Rezende, M.H., Ferreira, H.D., Barra, M.T.F., Zatta, D.T., and Paula, J.R. 2010. Morfoanatomia de *Memora nodosa* (Silva Manso) Miers, Bignoniaceae. Rev. Bras. Farmacogn. 20: 833-842. doi: 10.1590/S0102-695X2011005000002

Ugbade, G.E., and Ayodele, A.E. 2008. Foliar epidermal studies in the Family Bignoniaceae Juss. in Nigeria. Afr. J. Agric. Res. 3: 154-166.

Ullah, F., Zafar, M., Amhad, M., Sultana, S., Ullah, A., Shah, S. N., Mir, S. 2018a. Taxonomic implications of foliar epidermal characteristics in subfamily Alsinoideae (Caryophyllaceae). Flora, 242: 31–44. doi:10.1016/j.flora.2018.02.003

Ullah, F., Zaman, W., Papini, A., Zafar, M., Shah, S.N., Ahmad, Ullah, F., Zafar, M., Ahmad, M., Shah, S.N., Razzaq, A., Sohail, A., and Sultana, S. 2018b. A systematic approach to the investigation of foliar epidermal anatomy of subfamily Caryophylloideae (Caryophyllaceae). Flora, 246–247, 61–70. https://doi.org/10.1016/j.flora.2018.07.006

Wilkinson, H.P. 1979. Plant surface. *In* Anatomy of the Dicotyledon. *Edyted by* C.R. Metcalfe and L. Chalk. Claredon Press, Oxford, pp. 97–162.

Xu, Z., and Zhou, G. 2008. Responses of leaf stomatal density to water status and its relationship with photosynthesis in a grass. J. Exp. Bot. 59(12): 3317-3325. doi:10.1093/jxb/ern185

Zoric, L., Merkulov, L., Lukovic, J., Boza, P. and Polic, D. 2009. Leaf epidermal characteristics of *Trifolium* L. species from Serbia and Montenegro. Flora, 204: 198-209. doi:10.1016/j.flora.2008.02.002

Table 1. Specimens of species of Bignonieae used in the analysis of leaflet epidermis.

Species	**Vouchers** **Collectors and number (herbarium acronym)**
Amphilophium crucigerum (L.) L.G. Lohmann	*M.F. Agra et al. 5013* (JPB) *R. Lopes 135* (EAN) *R. Lopes 243* (EAN)
Amphilophium paniculatum (L.) Kunth	*M.F. Agra & P.C. Silva 4873* (JPB) *M.F. Agra et al. 2688* (JPB)
Anemopaegma citrinum Mart. ex DC.	*M.F. Agra et al. 2629* (JPB) *R. Lopes 239* (EAN) *R. Lopes 255* (EAN)
Bignonia ramentacea (Mart. Ex DC.) L.G.Lohmann	*M.F. Agra et al. 4022* (JPB) *R. Lopes 253* (EAN) *Lopes 254* (EAN)
Bignonia sciuripabulum (K. Schum.) L.G. Lohmann	*M.F. Agra et al. 3935* (JPB) *M.F. Agra et al. 4654* (JPB) *R. Lopes 238* (EAN)
Cuspidaria lateriflora (Mart.) DC.	*M.F. Agra et al. 3932* (JPB)
Dolichandra unguis-cati (L.) L.G. Lohmann	*M.F. Agra et al. 4113* (JPB) *M.F. Agra et al. 4792* (JPB) *R. Lopes 246* (EAN)
Fridericia pubescens (L.) L.G.Lohmann	*M.F. Agra et al. 1984* (JPB) *M.F. Agra et al. 7115*(JPB) *R. Lopes 256* (EAN)
Pyrostegia venusta (Ker: Gawl.) Miers	*M.F. Agra et al. 4371* (JPB) *M.F. Agra et al. 4398* (JPB) *R. Lopes 257* (EAN)
Tanaecium cyrtanthum (Mart. Ex DC.) Bureau & K.Schum.	*R. Lopes 263* (EAN)
Tanaecium dichotomum (Jacq.) Kaehler & L.G.Lohmann (in press)	*R. Lopes 259* (EAN)
Tanaecium parviflorum (Mart. ex DC.) Kaehler & L.G.Lohmann (in press)	*M.F. Agra et al. 4791* (JPB) *R. Lopes 240* (EAN)
Xylophragma heterocalyx (Bureau & K.Schum.) A.H.Gentry	*R. Lopes 260* (EAN) *R. Lopes 261* (EAN)

Table 2. Anticlinal cell walls and trichomes of leaflets epidermis of Bignonieae species. Legends: Cv = Curved, Br = Branched, Sn = Sinuous, Pt = Pateliform/cupular, Pl = Peltate, Sm = Simple, St = Stipitate, Sr = Straight.

Species	Anticlinal wall						Trichome								
	Adaxial surface			Abaxial surface			Adaxial surface				Abaxial surface				
	Cv	Sn	Sr	Cv	Sn	Sr	Br	Pl	St	Sm	Br	Pt	Pl	St	Sm
A. crucigerum	-	+	-	-	+	+	-	+	-	+	-	+	+	-	+
A. paniculatum	-	-	+	-	-	+	-	+	-	-	-	+	+	-	-
A. citrinum	+	-	+	-	+	-	-	+	-	+	-	+	+	-	+
B. ramentacea	-	-	+	-	-	+	-	+	-	+	-	+	+	-	+
B. sciuripabulum	-	-	+	+	+	-	-	+	-	-	-	+	+	-	-
C. lateriflora	-	-	+	+	+	-	-	+	+	+	-	+	+	-	+
D. unguis-cati	-	+	-	-	+	-	-	+	-	-	-	+	+	-	-
F. pubescens	+	+	-	-	+	-	+	+	+	+	+	+	+	-	+
P. venusta	-	-	+	-	+	-	-	+	-	-	-	+	+	-	+
T. cyrtanthum	+	-	+	-	+	-	-	+	-	-	-	+	+	-	-
T. dichotomum	-	+	-	-	+	-	-	+	+	+	-	+	+	-	+
T. parviflorum	-	+	-	-	+	-	-	+	+	+	-	+	+	+	+
X. heterocalyx	-	+	-	-	+	-	-	+	-	+	-	+	+	-	+

Table 3. Stomata types, stomatal indexes and density and inorganic idioblasts in species of Bignonieae. Legends: Af = Anficiclocytic, As = Anisocytic, An = Anomocytic, At = Anomotetracytic, Bp = Brachyparacytic, Bx = Brachyparahexacytic, Cc = Ciclocytic, Cs = Cristal sand, Dr = druse, Hp = Hemiparacytic, Pc= Prismatic cristal, Pr = Paracytic, Rp = Raphides = St = Staurocytic, St = Styloid cristals.

Species	Stomata type										Stomatal density (mm^2)	Stomatal index (%)	Inorganic idioblats									
													Adaxial surface					**Abaxial surface**				
	Af	As	An	At	Bp	Bx	Cc	Hp	Pr	Sc	SD	SI	Cs	Dr	Pc	Rp	St	Cs	Dr	Pc	Rp	St
A. crucigerum	-	-	+	+	-	-	+	-	-	+	111.5	8.12%	+	-	+	+	-	+	-	+	-	-
A. paniculatum	-	-	+	+	-	-	+	-	-	+	198	9.63%	-	-	-	-	-	-	-	-	-	-
A. citrinum	-	+	+	+	+	-	+	-	-	+	81.4	6.63%	-	-	-	-	-	-	-	-	-	-
B. ramentacea	+	+	+	+	+	+	+	+	-	+	126.2	6.21%	+	-	+	-	-	-	-	-	-	-
B. sciuripabulum	-	+	+	+	+	+	+	-	-	+	104.8	6.33%	-	-	-	-	-	-	-	-	-	-
C. lateriflora	-	-	+	+	+	-	-	+	-	-	212.3	11.75%	-	-	+	-	-	+	-	+	-	-
D. unguis-cati	-	+	+	+	-	-	-	+	-	+	92.6	8.44%	+	-	+	-	-	+	-	+	-	-
F. pubescens	-	+	-	+	+	-	-	-	+	+	381.3	21.36%	-	-	+	-	+	-	-	+	-	-
P. venusta	-	+	+	+	+	-	-	-	-	-	76.4	9.90%	-	+	-	-	-	+	-	+	-	-
T. cyrtanthum	-	+	+	+	+	-	-	+	-	-	473.9	20.30%	+	-	+	-	-	+	-	+	-	-
T. dichotomum	-	+	+	+	+	-	-	-	+	+	503.5	20.28%	+	-	+	-	-	-	-	+	-	-
T. parviflorum	-	+	+	+	+	-	-	+	+	-	752.9	23.52%	-	-	+	-	-	+	-	+	-	-
X. heterocalyx	-	+	+	+	+	-	-	-	-	+	93.2	6.85%	-	-	-	-	-	-	-	-	-	-

Table 4. Epicuticular waxes of Bignonieae species. Legends: Cro = Coiled rodlets, Cru = Crusts, Fil = Fissured layer, Gra = Granules, Pla = Platelets, Sml = Smooth layer, Thr = Threads.

Species	Epicuticular waxes													
	Adaxial surface							Abaxial surface						
	Cro	Cru	Fil	Gra	Pla	Sml	Thr	Cro	Cru	Fil	Gra	Pla	Sml	Thr
A. crucigerum	-	+	-	+	+	+	-	-	+	-	+	+	+	-
A. paniculatum	+	+	-	+	+	+	+	-	-	+	+	+	+	+
A. citrinum	+	+	-	-	+	+	-	+	+	-	+	-	+	+
B. ramentacea	-	-	-	+	+	+	+	-	+	-	+	+	+	+
B. sciuripabulum	-	+	-	+	+	+	-	+	+	-	-	-	+	+
C. lateriflora	-	+	-	+	+	-	-	-	+	-	-	-	-	-
D. unguis-cati	+	+	-	+	-	+	+	+	+	-	+	+	+	+
F. pubescens	-	-	-	+	+	+	-	-	+	-	-	-	+	-
P. venusta	-	+	-	+	+	+	-	-	+	-	+	+	+	-
T. cyrtanthum	+	+	-	+	+	+	-	+	-	+	-	+	+	-
T. dichotomum	-	-	-	+	+	+	+	+	+	-	+	+	+	-
T. parviflorum	+	+	-	+	+	+	-	-	+	-	+	-	+	-
X. heterocalyx	+	+	-	+	+	+	+	+	+	-	+	+	+	+

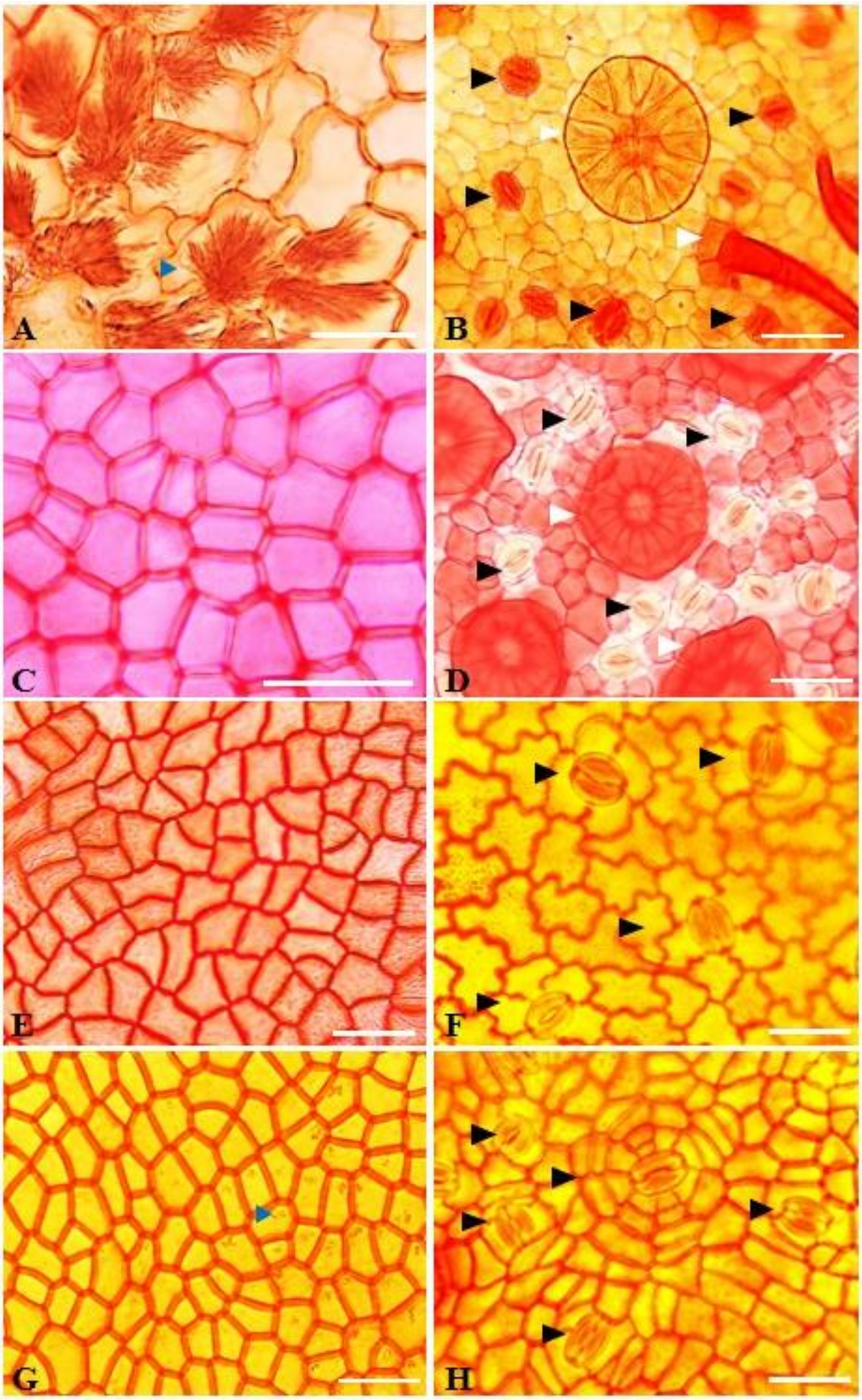

Figure 1. Leaflet epidermis on the adaxial and abaxial surfaces of Bignonieae: (A, B) *Amphilophium crucigerum*, from Lopes 243; (C, D) *Amphilophium paniculatum*, from Agra et al. 7112 (E, F) *Anemopaegma citrinum*, from Lopes 239; (G, H) *Bignonia ramentacea*, from Agra et al. 4022. Legends: Arrowhead: black = stomata, white = trichome, blue = idioblast (crystals sand and raphides). Scales: A-P – 50µm.

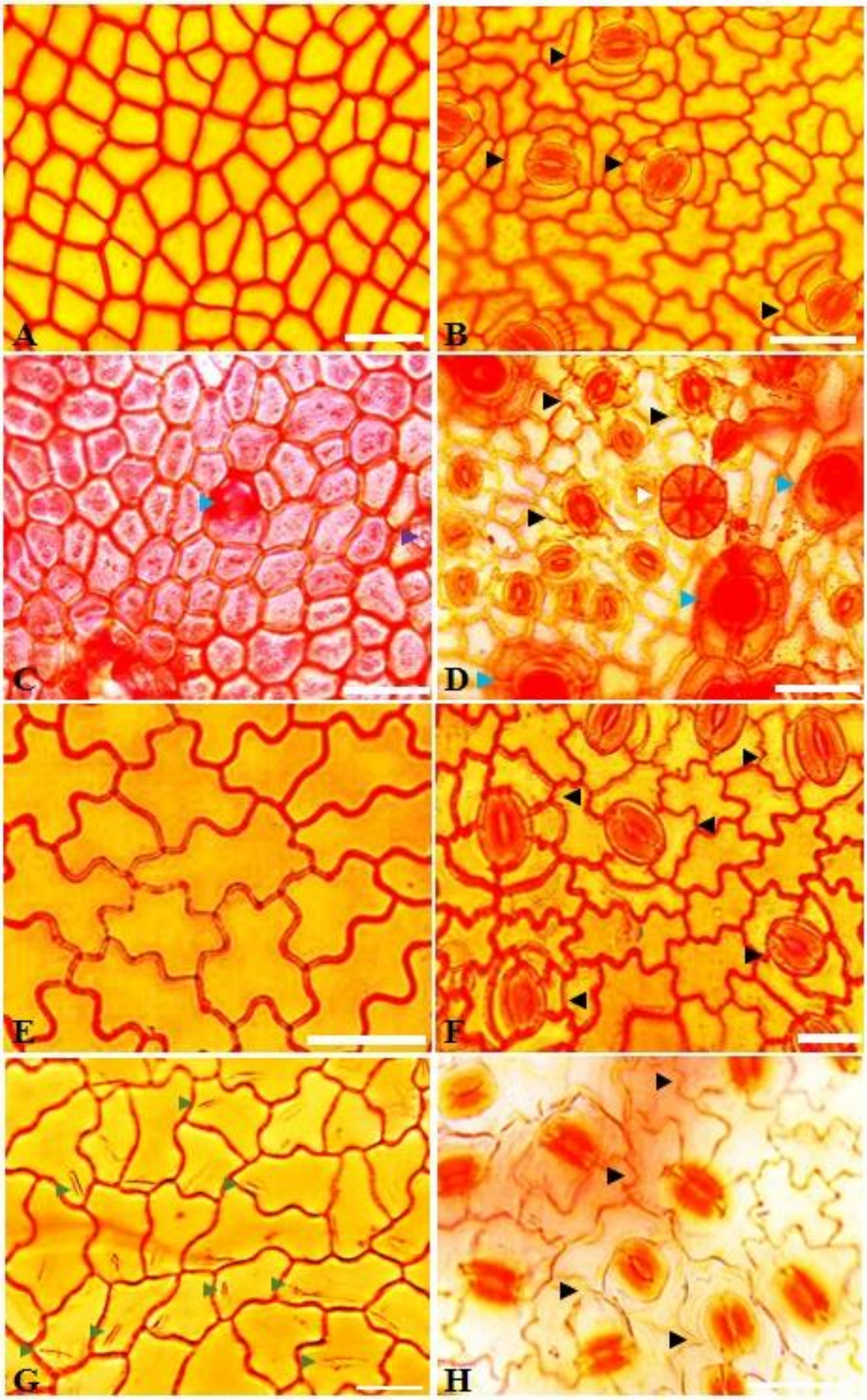

Figure 2. Leaflet epidermis on the adaxial and abaxial surfaces of Bignonieae: (A, B) *Bignonia sciuripabulum*, from Lopes 238; (C,D) *Cuspidaria lateriflora*, from Agra et al. 3932; (E,F) *Dolichandra unguis-cati*, from. Lopes 246; (G,H) *Fridericia pubescens*, from Lopes 256. Legends: Arrowhead: black = stomata, white =trichome. Scales: A—J = 50µm..

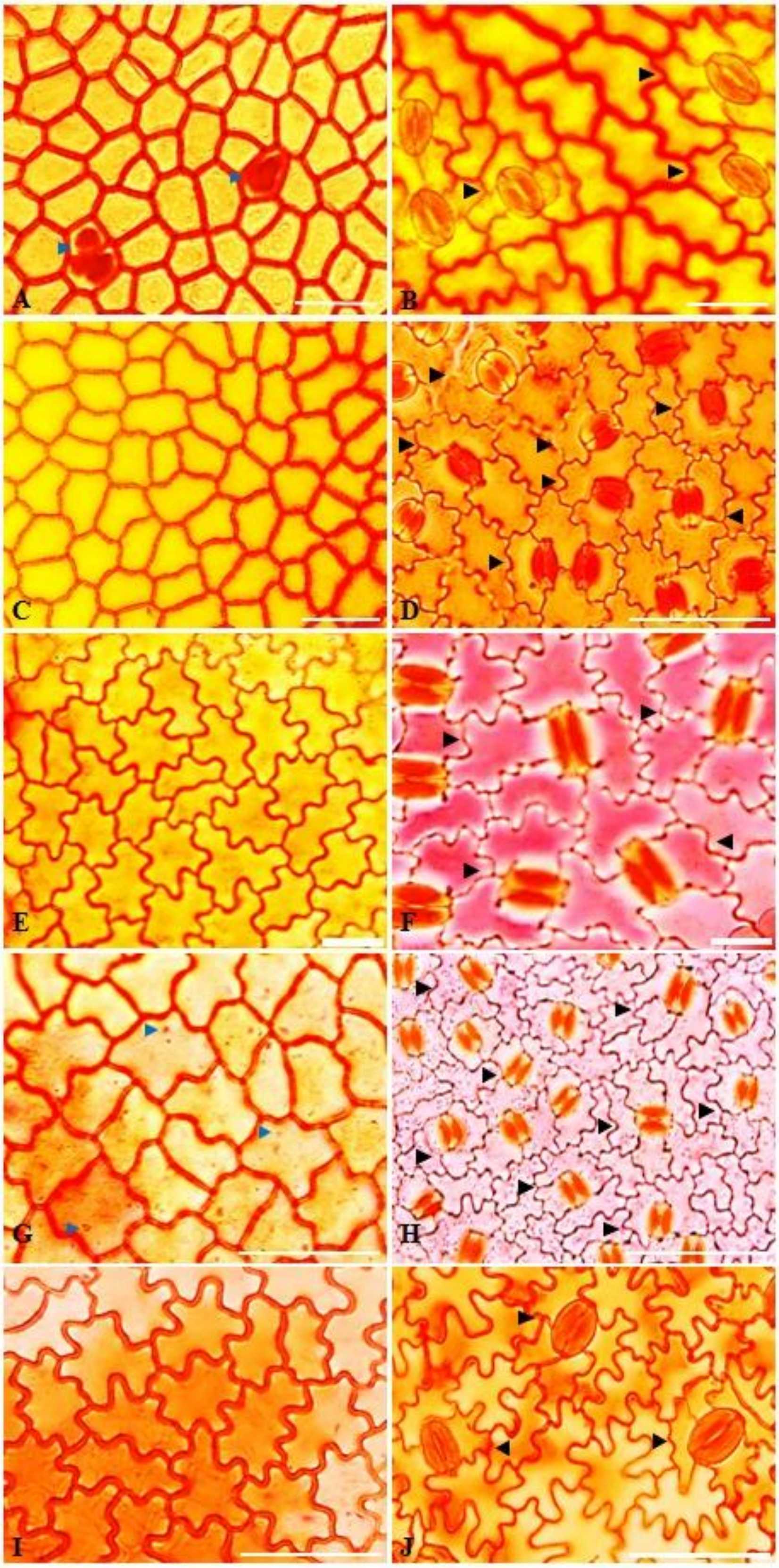

Figure 3. Leaflets epidermis on the adaxial and abaxial surface of Bignonieae: (A,B) *Pyrostegia venusta*, from Lopes 257; (C,D) *Tanaecium cyrtanthum*, from Lopes 263; (E,F) *Tanaecium dichotomum*, from Lopes 259; (G,H) *Tanaecium parviflorum*, from Lopes 240 (I,J) *Xylophragma heterocalyx*, from Lopes 261. Legends: Arrowhead: black = stomata, white =trichome, blue = idioblast (prismatic cristals and druses), green = styloid. Scales A = 100µm and B—J = 50µm.

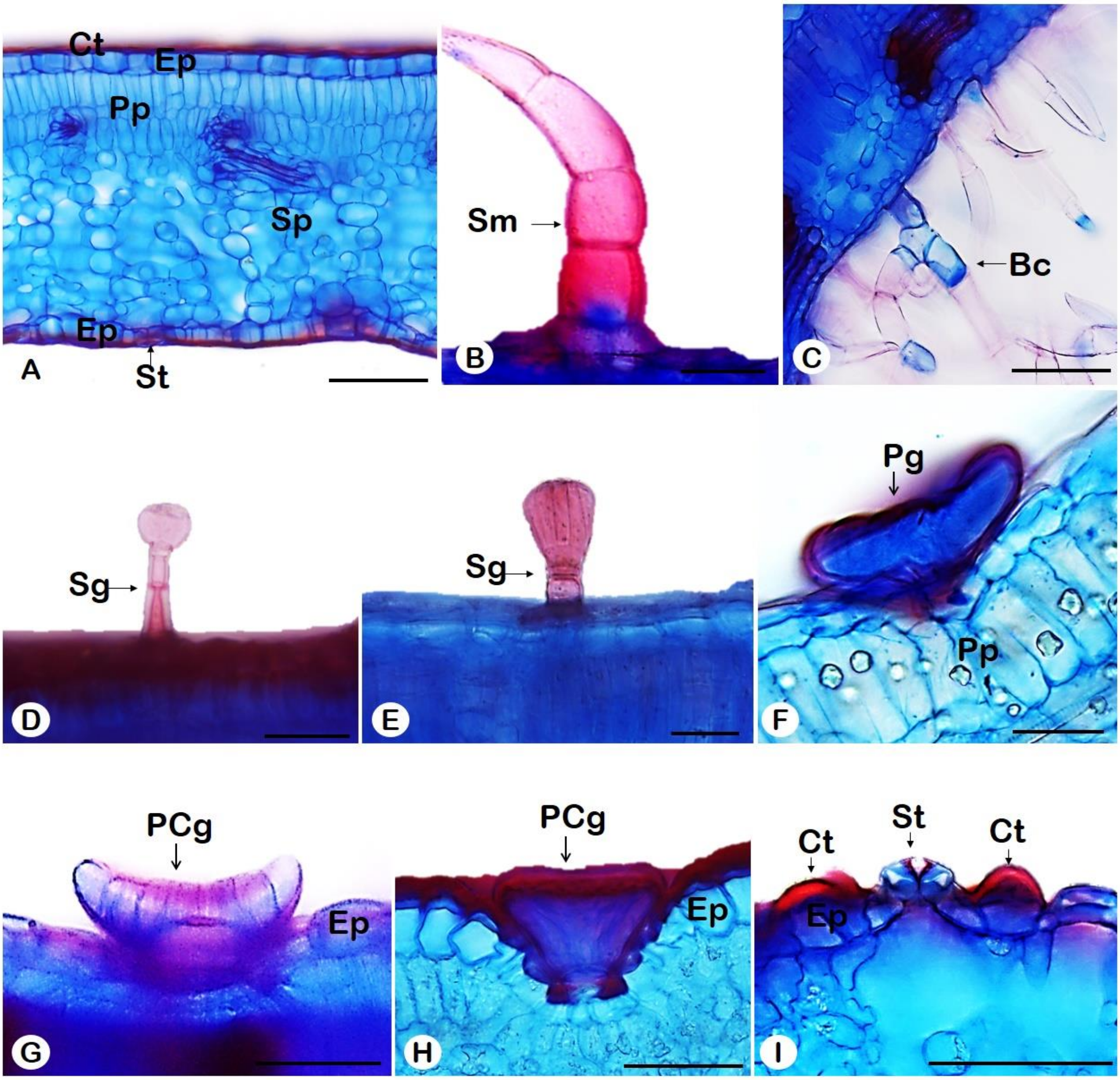

Figure 4. Epidermis and trichomes of blade leaflets in transverse sections: (A) Simple leaflet epidermis of *Bignonia sciuripabulum*, from Lopes 238; (B) Detail of simple trichome on the epidermis of *Fridericia pubescens*, from Lopes 256; (C) Branched trichomes on the abaxial surface of *Fridericia pubescens*, from Lopes 256; (D) Glandular-stipitate trichome on the leaflet of *Cuspidaria lateriflora*, from Agra et al. 3932; (E) glandular-peltate trichome on the leaflet of *Tanaecium parviflorum*, from Lopes 240; (F) Detail of peltate trichome on the adaxial surface of *Amphilophium crucigerum*, from Lopes 243; (G) Detail of patelliform/cupular trichome on the abaxial surface of *Tanaecium dichotomum*, from Lopes 259; (H) Detail of patelliform/cupular trichome on the adaxial surface of *Amphilophium paniculatum*, from Agra et al. 7112; (I) Stomata above at the level of epidermis in *Amphilophium paniculatum*, from Agra et al. 7112. Legends: Bc = Branched trichome, Ct = Cuticle, Ep = Epidermis, PCg = Patelliform/cupular trichome, Pg = Peltate-glandular trichome, Pp = Palisade parenchyma, Sg = Stipitate-glandular trichome, Sm = Simple trichome, Sp = Sponge parenchyma, St = Stomata, Tr = Trichome.

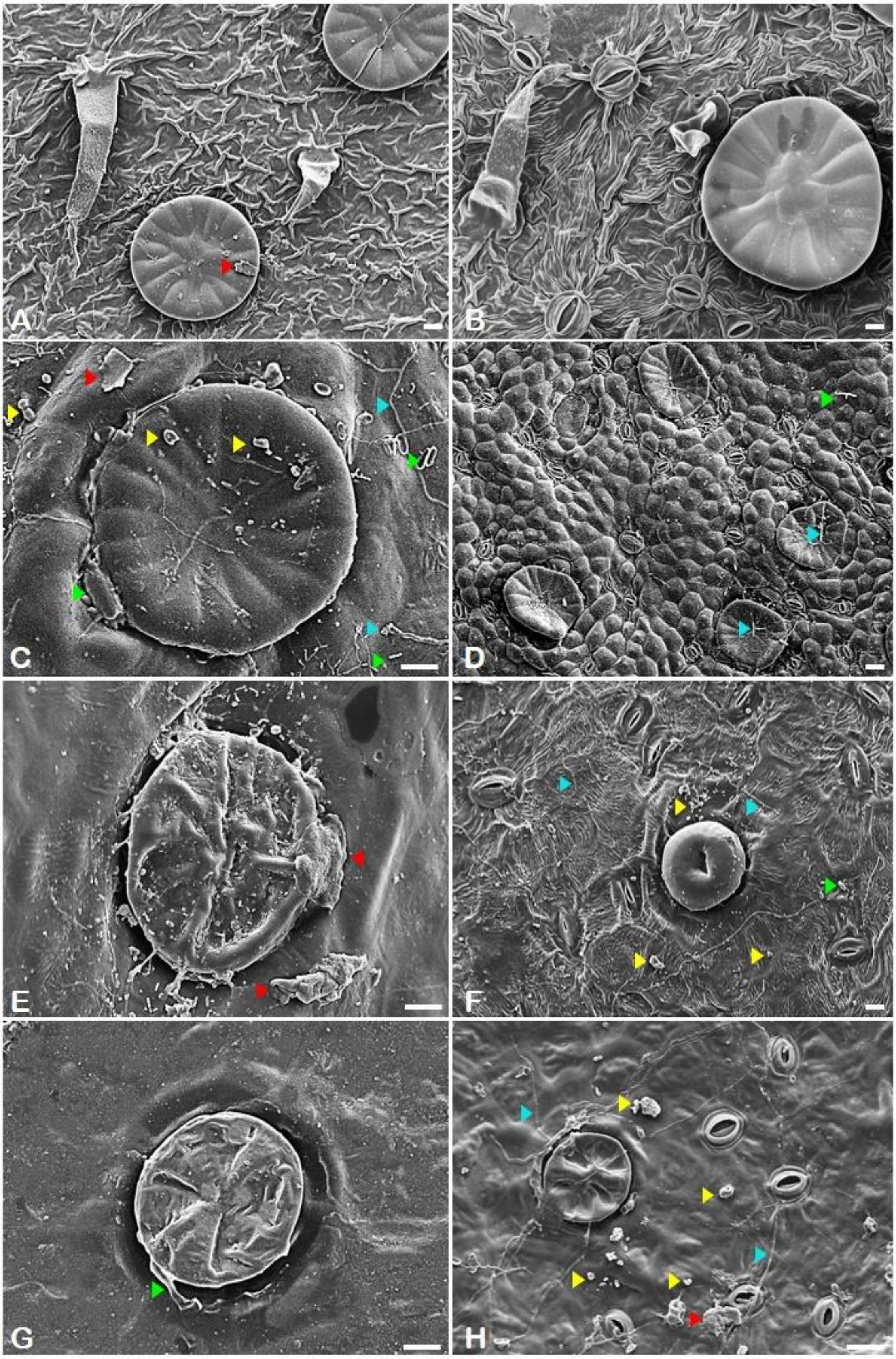

Figure 5. Adaxial and abaxial blade leaflets epidermis surfaces of Bignonieae by SEM: (A, B) *Amphilophium crucigerum*, from Lopes 135; (C, D) *Amphilophium paniculatum*, from Agra et al. 7112; (E, F) *Anemopaegma citrinum*, from Lopes 239; (G, H) *Bignonia ramentacea*, from Lopes 254. Legends: Arrowhead: green = coiled rodlets; yellow = granules; red = platelets; blue = threads. Scales: A—D = 20µm; B—C, E—H = 10µm.

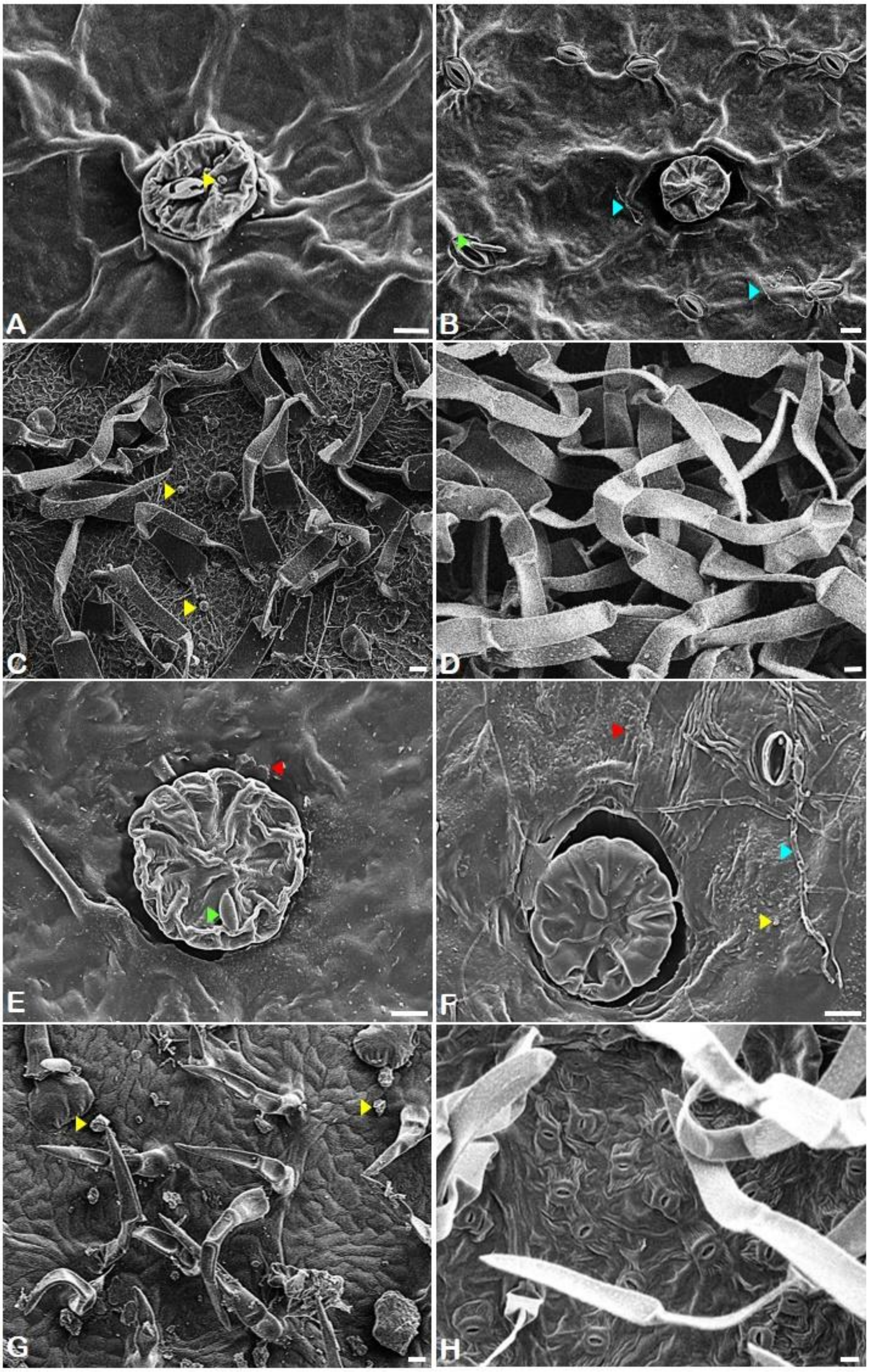

Figure 6. Adaxial and abaxial blade leaflets epidermis surfaces of Bignonieae by SEM: (A,B) *Bignonia sciuripabulum*, from Lopes 238; (C,D) *Cuspidaria lateriflora*, from Agra et al. 3932; (E,F) *Dolichandra unguis-cati*, from Lopes 246; (G,H) *Fridericia pubescens*, from Agra et al. 7115. Legends: Arrowhead: green = coiled rodlets; yellow = granules; red = platelets; blue = threads. Scales: A—F and H = 10µm; G = 20µm.

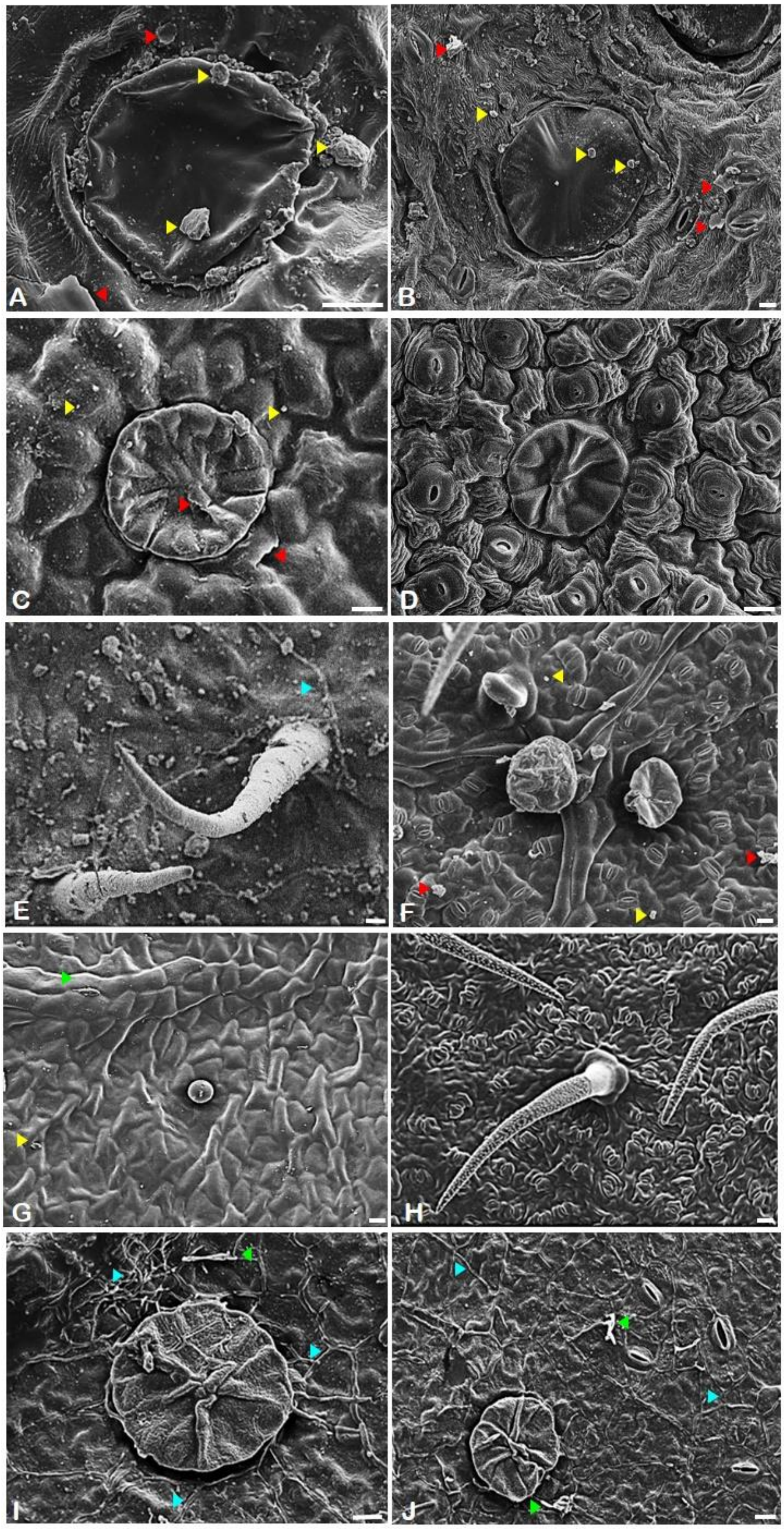

Figure 7. Blade leaflets epidermis on the adaxial and on the abaxial surfaces of Bignonieae by SEM: (A,B) *Pyrostegia venusta*, from Lopes 257 (C,D) *Tanaecium cyrtanthum*, from Lopes 263; (E,F) Tanaecium dichotomum, from Lopes 259 (G,H) *Tanaecium parviflorum*, from Lopes 240; (I,J) *Xylophragma heterocalyx*, from Lopes 261. Legends: Arrowhead: green = coiled rodlets; yellow = granules; red = platelets; blue = threads. Scales: A = 20µm; B—J = 10µm.

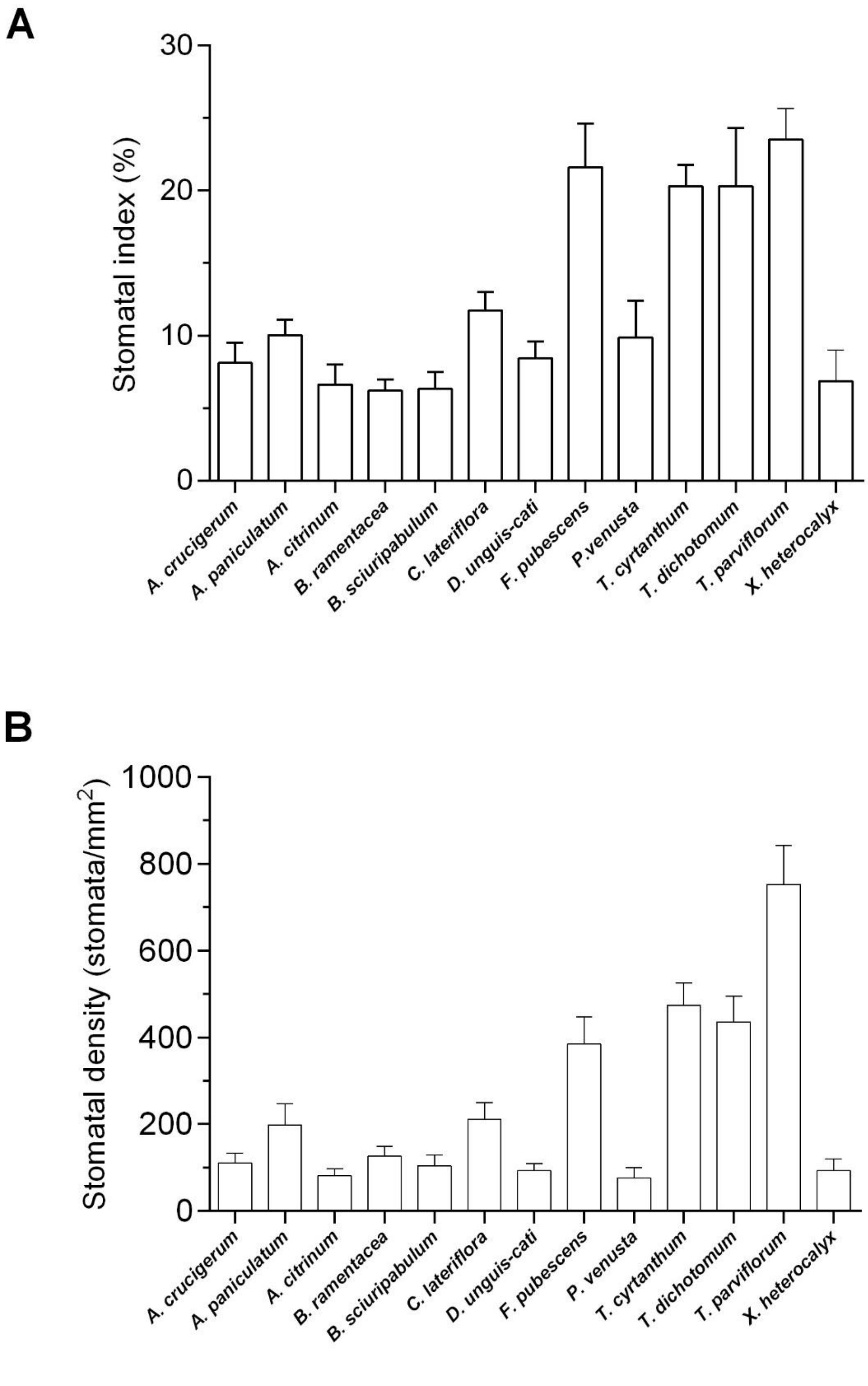

Figure 8. (A) Stomatal index and (B) stomatal density of species of Bignonie (Bignoniaceae).

5 Capítulo III

Padrões de anatomia foliar de Bignonieae (Bignoniaceae) em uma Floresta Estacional Semidecidual Montana do Nordeste do Brasil e suas Implicações Taxonômicas

À ser Submetido a Flora

Padrões de anatomia foliar de Bignonieae (Bignoniaceae) em uma Floresta Estacional Semidecidual Montana do Nordeste do Brasil e suas Implicações Taxonômicas

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Resumo = Bignoniae possui quase metade das espécies de Bignoniaceae, é o grupo mais diversificado entre as lianas neotropicais. O Brasil é considerado um dos principais centros de diversidade de Bignonieae, com cerca de 327 espécies, distribuídas em diferentes domínios fitogeográficos. Este trabalho foi realizado com o objetivo de encontrar parâmetros que suportem a taxonomia do grupo, com base na análise de espécies que ocorrem em uma Floresta Estacional Semidecidual Montana do Nordeste do Brasil. Secções paradérmicas das epidermes e transversais do mesofilo, bordo, nervura principal, pecíolo e peciólulo foram realizadas, à mão livre. Além disso, realizou-se uma análise de agrupamento UPGMA com base na matriz gerada, com dados de presença e ausência. Na análise das seções transversais, quatro tipos de tricomas e seis tipos de idioblastos inorgânicos foram registrados nas espécies de Bignonieae estudadas, encontrados em diferentes portes do folíolo. O bordo apresentou-se arredondado em seis espécies e agudo em outras seis. O mesofilo é dorsiventral, com variações na quantidade dos estratos parenquimáticos. A nervura principal é em sua maioria bicovexa (12 spp.) e uma espécie apresenta-se côncavo-convexa. O sistema vascular é colateral na nervura principal, com feixes de floema na porção adaxial das espécies. O parênquima paliçádico também está presente na porção adaxial da nervura principal de uma espécie. O pecíolo e peciólulo possuem diferentes formatos = desde circular, semicircular e hexagonal, principalmente. Seus feixes vasculares são colaterais, centrais e variaram em formato, sendo a maioria pentagonal e semicircular; apenas quatro espécies apresentaram feixes vasculares acessórios. As estruturas analisadas nas secções transversais apresentaram valor distintivo entre as espécies, com destaque para as nervuras, pecíolos e peciólulos. A análise UPGMA com os dados anatômicos foi compatível com a filogenia proposta para o grupo.

Palavras-chave: Anatomia foliar, Floresta de Altitude, Lianas, Pecíolo, Peciólulo.

Abstract = Bignoniae has almost half of Bignoniaceae species, is the most diverse group of neotropical lianas. Brazil is considered one of the main centers of diversity of Bignonieae, with about 327 species distributed in different phytogeographic domains. This work was carried out aiming to find parameters that support the group taxonomy, based on the analysis of species that occur in a Montana Semideciduous Seasonal Forest of Northeast Brazil. Paradermic sections of the epidermis and transverse mesophyll, edge, midrib, petiole and petiolule were performed by free hands. In addition, a UPGMA cluster analysis was performed based on the generated matrix, with presence and absence data. In the analysis of the transverse sections, four types of trichomes and six types of inorganic idioblasts were found in the studied Bignonieae species, found of different leaflet sizes. The border was rounded in six species and acute in other six. The mesophyll is dorsiventral, with variations in the amount of parenchymatic strata. The midrib is mostly biconvex (12 spp.) and one species is concave-convex. The vascular system is collateral in the midrib, with phloem bundles in the adaxial portion of the species. The palisade parenchyma was also present in the adaxial portion of the midrib of one species. The petiole and petiolule have different shapes = from circular, semicircular and hexagonal, mainly. Its vascular bundles are collateral, central and varied in shape, mostly pentagonal and semicircular; Only four species had accessory vascular bundles. The structures analyzed in the cross sections presented distinctive value among the species, with emphasis on the rib, petioles and petiolules. UPGMA analysis with anatomical data reflects the phylogeny of the group.

Keywords = Altitude forest, Leaflet anatomy, Lianas, Petiole, Petiolule.

1. Introdução

Bignoniaceae compreende cerca de 827 espécies e 82 gêneros (Lohmann e Ulloa Ulloa, 2019), evidenciando-se como um importante componente das florestas neotropicais (Olmstaed et al., 2009), onde concentra seu centro de diversidade (Gentry, 1980). Com quase metade das espécies da família (393 spp.), distribuídas em 21 gêneros, Bignonieae é seu maior clado (Lohmann e Taylor, 2014) e também o grupo com maior diversidade morfológica entre as lianas meotropicais (Lohmann, 2006).

Bignonieae é uma tribo original e exclusivamente americana (Lohmann et al., 2013), e tem sua maior diversidade na região sul do continente (Gentry, 1980), principalmente no Brasil, distribuindo-se em todos os domínios fitogeográficos e especialmente diversa na região amazônica e da Costa Atlântica e nas florestas sazonalmente secas (BFG, 2015). No Brasil ocorrem 327 espécies, sendo a região Nordeste uma das mais diversas, com cerca 126 espécies, que se distribuem em suas diferentes fitofisionomias (Flora do Brasil 2020, em construção).

As espécies de Bignonieae são lenhosas, geralmente lianas que apresentam folhas 2-3-folioladas, com folíolos terminais modificados em gavinhas 1-2-3-multífidas (Lohmann, 2006; Lohmann e Taylor, 2014) e cápsulas deiscentes com sementes frequentemente aladas, dispersas pelo vento (Fisher et al., 2004). A anatomia da tribo é marcada pelo crescimento anômalo do caule, com 4—32 feixes de floema interrompendo o xilema (Solereder, 1908; Santos, 1995; Olmstaed et al., 2009). Metcalfe e Chalk (1950), Dickson (2000), Cutler et al. (2008), entre outros, consideram a anatomia vegetal como uma ferramenta de valiosa contribuição à taxonomia, utilizando caracteres de diferentes estruturas para a delimitação de diferentes entidades taxonômicas, às quais, segundo Noronha e Scudeller (2011) podem ser de difícil identificação, especialmente se não apresentam material reprodutivo.

Caracteres anatômicos das folhas, principalmente epiderme, pecíolo, nervura e mesofilo, têm sido constantemente utilizados como suporte à taxonomia de diversos grupos e revelado grande potencial para resolver problemas taxonômicos, em diversas categorias, a exemplo de *Hypolytrum* Rich. (Alves et al., 2002), *Rhus* (Hernández e Terrazaz, 2006), *Ficus* (Araújo et al., 2013), *Solanum* (Nurit-Silva et al., 2012; Sampaio et al., 2014), *Lamium* (Atalay et al., 2016), *Microcos* (Shokefum et al., 2016), *Hopea* (Talip et al., 2017), *Bauhinia* e *Schnella* (Pereira et al., 2018), Andropogoneae e Paniceae (Ahmad et al., 2010, 2015), entre outros.

Em Bignonieaceae, a anatomia caulinar tem sido investigada e resultando em importantes contribuições taxonômicas para o grupo (Gasson e Dobbins, 1991; Gerolamo e Angyalossy, 2017; Jain e Singh, 1980; Pace et al., 2009, 2015; Santos 2017). Por outro lado, em menor escala, a anatomia foliar também tem sido utilizada como suporte à taxonomia de Bignoniaceae e tem mostrado ser relevante em resolver conflitos taxonômicos intra (Firetti-Leggieri et al., 2014) e intergenéricos (Silva et al., 2009), e auxiliando na identificação dos táxons em estágio vegetativo (Ogundipe e Wujek, 2004; Ugbabe e Ayodele, 2008; Gonzalez, 2013), assim como para a tribo Bignonieae (Firetti-Ligieri et al., 2014; Lopes-Silva et al., dados não publicados), embora estes sejam mais pontuais que aqueles com foco nas espécies de usos medicinais (Duarte, 2007; Mauro et al., 2007; Souza et al., 2007).

As Florestas Estacionais Semideciduais fazem parte do conjunto florestal ao Norte do Rio São Francisco (Tabareli e Santos 2004), e aquelas que possuem mais de 600m de altitude são consideradas Florestas Montanas (IBGE, 1985), muitas das quais são áreas prioritárias para conservação da biodiversidade, devido a sua alta importância biológica, como é o caso do Parque Estadual do Pico do Jabre (Maury et al., 2002). Este remanescente de Floresta Atlântica é uma área de grande diversidade e interesse para estudos em sua flora (Pontes e Agra, 2001; Rocha e Agra, 2002; Agra et al., 2004; Cunha et al., 2013; Cunha e Silva Júnior, 2014).

Diante do exposto, neste trabalho investigou-se os padrões anatômicos foliares de 13 espécies pertencentes a nove gêneros de Bignonieae, que ocorrem na Floresta Estacional Semidecidual Montana do Pico do Jabre, buscando contribuir com uma ferramenta adicional à taxonomia de Bignoniae.

2. Material e métodos

2.1. Área de estudo e material examinado

A Floresta Estacional Semidecidual Montana do Pico do Jabre, é um de brejo de altitude (Vasconcelos-Sobrinho, 1971), localizado na microrregião da Serra do Teixeira, entre os municípios de Maturéia e Mãe D'água, e é o ponto de maior altitude do estado da Paraíba e do Nordeste setentrional, atingindo 1197m. Em 1992, através do decreto 14.843, esta área com 500 hectares se tornou um Parque Estadual. A vegetação da área está associada principalmente as florestas secas (vegetação circundante), porém, contém também elementos de mata úmida (Rocha e Agra, 2002, Agra et al., 2004, Cunha e Silva Junior, 2014). E, de acordo com a classificação de Köppen, o clima da área é do tipo AW quente e semi-úmido (Lima e Heckendorff, 1985).

O estudo mais amplo realizado na área até então, foi desenvolvido por Agra et al. (2004), com o levantamento preliminar da flora do Pico do Jabre, resultando numa lista de 315 espécies de plantas. Posteriormente, trabalhos destinados a grupos específicos foram se consolidando, como para Acanthaceae (Pontes e Agra, 2001) e Cactaceae (Rocha e Agra, 2002). O material testemunho coletado de Bignonieae, encontra-se depositado nos herbários EAN e JPB, com duplicatas no MO, RB e SPF (acrônimos segundo Thiers 2019). A terminologia da morfologia dos tricomas seguiu a classificação proposta por Nogueira et al. (2013).

2.2. Anatomia foliar

Realizou-se o estudo da anatomia foliolar de 13 espécies pertencentes a nove gêneros = *Amphilophium crucigerum* (L.) L.G.Lohmann, *Amphilophium paniculatum* Kunth, *Anemopaegma citrinum* Mart. ex DC., *Bignonia ramentacea* (Mart. ex DC.) L.G.Lohmann, *Bignonia sciuripabulum* (Hovel.) L.G.Lohmann), *Cuspidaria lateriflora* (Mart.) DC., *Dolichandra unguis-cati* (L.) L.G.Lohmann, *Fridericia pubescens* (L.) L.G.Lohmann, *Pyrostegia venusta* (Ker Gawl.) Miers, *Tanaecium cyrtanthum* (Mart. EX DC.) Bureau & K.Schum, *Tanaecium dichotomum* (Jacq.) Kaehler & L.G.Lohmann, *Tanaecium parviflorum* (Mart. ex DC.) Kaehler & L.G.Lohmann and *Xylophragma heterocalyx* (Bureau & K.Schum.) A.H.Gentry. Foram selecionadas folhas do terceiro ao quinto nós, de três indivíduos de cada espécie, fixadas em FAA (Formaldeído-ácido-acético) por 48h e, posteriormente, armazenadas em etanol a 70% (Johansen, 1940). A caracterização epidérmica se deu após as secções paradérmicas de ambas as superfícies de lâmina foliolar serem clarificadas com hipoclorito de sódio a 2%, lavadas com água destilada e neutralizadas com ácido acético (1%), coradas com safranina (0.25%) e montadas em lâminas semipermanentes. A classificação estomática seguiu o proposto por Dilcher (1974).

Secções transversais das porções medianas dos pecíolos, peciólulos, nervuras principais, mesofilos e bordos foram realizadas, à mão livre, clarificadas com hipoclorito de sódio a 2%, lavadas com água destilada e neutralizadas com ácido acético (1%), posteriormente coradas com astra blue e safranina modificado por Bukatsch (1972) e montadas em lâminas semipermanentes. As lâminas foram analisadas e micrografadas ao microscópio óptico acoplado com câmera digital (Leica DFC295/Leica ICC50 HD).

A proporção dos parênquimas paliçádico e esponjoso foi estimada utilizando o Anati Quanti Software (Aguiar et al., 2007).

2.3. Análise de agrupamentos

Uma matriz com 90 caracteres anatômicos, incluindo caracteres da epiderme e seus anexos foi elaborada no Excel, baseando-se em sua presença e ausência, cujos dados foram utilizados para realizar uma análise de agrupamentos (UPGMA), baseando-se no coeficiente de similaridade de Jaccard, utilizando o Past software, versão 3.25.

3. Resultados

3.1. Epiderme

Todas as 13 espécies de Bignonieae do Pico do Jabre analisadas apresentaram-se hipoestomáticas com a epiderme unisseriada, com células tabulares, em secção transversal (Fig 1.). Os diferentes padrões observados na epiderme e seus anexos, como paredes celulares retas, curvas e mais frequentemente sinuosas, estão detalhados em Lopes et al. (Dados não publicados). A análise estomática resultou em 10 tipos diferentes de estômatos = anficiclocíticos, anisocíticos, anomocíticos, anomotetracíticos, braqueparacíticos, braqueparahexacíticos, ciclocíticos, estaurocíticos, hemiparacíticos e paracíticos. Foram observados cinco diferentes tipos de tricomas = simples, ramificados, glandular-estipitados, glandular-peltados e glandular-pateliformes/cupulares. Com relação à deposição de cutícula e à presença de ceras epicuticulares, sete padrões foram registrados nas espécies de Bignonieae, com sintopismo observados em todas as espécies (Lopes-Silva et al., dados não-publicados).

3.2. Mesofilo

O mesofilo apresentou padrão dorsiventral, registrado em todas as espécies, no entanto, variações foram observadas quanto ao número de estratos dos parênquimas paliçádico, esponjoso e plicado, como também na proporção desses tecidos em relação ao clorênquima e no tamanho das células epidérmicas. Na face adaxial as células da epiderme são geralmente maiores que as da superfície abaxial, diferença bem evidente em *C. lateriflora* (Fig. 1E), *T.*

dichotomum (Fig. 1F), *F. pubescens* (Fig. 1L), *P. venusta* (Fig. 1G) e *T. cyrtanthum* (Fig. 1H). Entetanto, *A. citrinum* (Fig.1A) e *D. unguis-cati* (Fig.1M) apresentaram células epidérmicas aparentemente isodiamétricas em ambas as superfícies.

Idioblastos inorgânicos foram registrados no mesofilo de todas as espécies, pelo menos um tipo de idioblasto em cada espécie (Tabela 2). Cristais prismáticos foram registrados em dez espécies = *A. crucigerum* (Fig. 1B), *A. paniculatum*, *A. citrinum*, *B. ramentacea* (Fig. 1J), *B. sciuripabulum*, *C. lateriflora*, *D. unguis-cati*, *T. dichotomum*, *T. parviflorum* e *T. cyrtanthum*. A presença de idioblastos do tipo de areia cristalina foi observada em *A. paniculatum, A. citrinum*, *T. cyrtanthum* e *X. heterocalyx*. Cristais esféricos foram observados em *A. crucigerum* (Fig. 1B), *D. unguis-cati*, *P. venusta* e *T. cyrtanthum*. Idioblastos do tipo estiloide foram registrados em quatro espécies = *B. ramentacea* (Fig. 1J), *B. sciuripabulum*, *T. dichotomum* e *F. pubescens* (ver Tabela 2). Drusas e também ráfides, foram observadas em uma única espécie cada, *P. venusta* (Fig. 2I e 5G) e *T. dichotomum,* respectivamente**.**

O parênquima paliçádico apresentou um número variado de estratos nas diferentes espécies analisadas, com 1 a 7 estratos (Tabela 2). O padrão uni-estratificado foi observado em *A. crucigerum* (Fig. 1B), *A. paniculatum* (Fig. 1C), *A. citrinum* (Fig. 1A) e *T. parviflorum,* (Fig. 1D)., e variou de 1—2-estratificado em *C. lateriflora* (Fig. 1E), *T. dichotomum* (Fig. 1F) e *P. venusta* (Fig. 1G). O tipo 2-estratificado foi registrado para apenas duas espécies = *T. cyrtanthum* (Fig. 1H) e *X. heterocalyx* (Fig. 1I). Variações de 2—3-estratificados foram observadas em *B. ramentacea* (Fig. 1J) e *B. sciuripabulum* (Fig. 1K). Variações de 2—4 estratificados foram observadas apenas em *F. pubescens* (Fig. 1L); e variações de 3—7-estratos, com células curtas, foi um caráter exclusivo para *D. unguis-cati* (Fig. 1M).

O parênquima esponjoso foi um caráter presente em 11 das 13 espécies analisadas, diferentemente de *T. parviflorum* (Fig. 1D) e *T. cyrtanthum* (Fig. 1H) que apresentaram parênquimas do tipo plicado, substituindo o esponjoso. O parênquima esponjoso variou de 3 a 8 estratos (Tabela 2), enquanto o parênquima plicado variou de 2—3-estratos em *T. parviflorum* (Fig. 1D), e de 3—5-estratos em *T. cyrtanthum* (Fig. 1H). No parênquima esponjoso de *Amphilophium* e *Bignonia,* assim como em *F. pubescens* e *X. heterocalyx* (Fig. 1I) as câmaras subestomáticas formam grandes espaços subepidérmicos.

A proporção entre os parênquimas paliçádico e esponjoso no clorênquima variou entre as diferentes espécies (Tabela 2). Observou-se que o parênquima paliçádico ocupa a maior parte do mesofilo em *D. unguis-cati*, *F. pubescens* e *T. cyrtanthum,* com média de 55.77%, 55.42% e 54.72%, respectivamente. Nas outras nove espécies, o parênquima esponjoso prevalece e ocupa a maior parte, assim como verificado para o parênquima plicado em *T. parviflorum*, que ocupa uma média de 55.10% do tecido. *B. ramentacea* (Fig. 1J) e *A. paniculatum* (Fig.

1C) são as espécies em que o parênquima esponjoso mais se destaca, com 79.70% e 74.41%, respectivamente.

3.3. Bordo

O bordo nas espécies de Bignonieae analisadas no presente tarabalho apresentou três formatos distintos = agudo, arredondado e recurvo (Tabela 2). O tipo agudo foi observado em *A. citrinum* (Fig. 3A), *B. ramentacea* (Fig. 3B), *B. sciuripaulum* (Fig. 3C), *C. lateriflora* (Fig. 3D), *T. dichotomum* (Fig. 3E) e *F. pubescens* (Fig. 3F); o tipo arredondado em *A. crucigerum* (Fig. 3G), *A. paniculatum* (Fig. 3H), *D. unguis-cati* (Fig. 3I), *P. venusta* (Fig. 3J), *T. parviflorum* (Fig. 3K) e *T. cyrtanthum* (Fig. 3L); o tipo recurvo foi observado em *X. heterocalyx* (Fig. 3M). Além disso, observou-se que algumas espécies (Fig. 3B, 3D, 3E, 3F, 3G 3I e 3L, por exemplo) apresentaram um feixe vascular próximo ao bordo.

3.4. Nervura principal

O contorno da nervura apresentou o padrão biconvexo em 12 espécies (Fig. 4), com uma variação observada apenas em *A. citrinum*, que pode apresentar-se levemente côncavo-convexa e *P. venusta* que apresentou-se côncavo-convexa (Fig. 4A). A epiderme das espécies é unisseriada e está recoberta por uma cutícula espessada nas paredes anticlinais e periclinais de *A citrinum* (Figs. 2A e 4B) e *B. ramentacea* (Fig. 4D) e anticlinais de *P. venusta* (Fig. 4A) e *A. paniculatum* (Fig. 4C), e *T. cyrtanthum* (Fig. 4H), enquanto nas demais espécies a cutícula é delgada. Em *D. unguis-cati* observou-se a presença de parênquima paliçádico na porção adaxial da nervura principal (Fig. 4J).

A epiderme da nervura principal (NP) possui quatro tipos de tricomas = tricomas simples, glandulares-estipitados, glandulares-peltados e pateliformes/cupulares. Tricomas simples, pluricelulares, unisseriados e glandulares-peltados estão distribuídos na região da nervura de todas as espécies. Tricomas simples estão presentes em maior densidade em *A. crucigerum*, C. *lateriflora* (Fig. 4F) e *F. pubescens* (Fig. 4M) e os glandular-peltados mais densos em *A. crucigerum e A. paniculatum* (Fig. 4C). Tricomas glandulares pateliformes/cupulares foram registrados exclusivamente na face abaxial da nervura principal de *T. parviflorum* (Fig. 4K); tricomas do tipo glandular-estipitados estão presentes na face adaxial de *C. lateriflora*, *F. dichotoma* e *F. pubescens*, e em ambas as faces da nervura de *T. parviflorum* (Fig. 4K).

Adjacente à epiderme, na superfície abaxial, observou-se dois a três estratos de colênquima, do tipo angular nas espécies de *Amphilophium*, *T. dichotomum*, *T. parviflorum*, *F. pubescens* e *T. cyrtanthum*, e colênquima do tipo lacunar foi registrado nas demais espécies. Quanto à presença de esclerênquima, observou-se em *A. citrinum* (Fig. 4B), *B.*

sciuripabulum (Fig. 4E) e *P. venusta* (Fig. 4A) a presença de feixes descontínuos de esclerênquima ao redor do floema. Em nove espécies, *B. ramentacea* (Fig. 4D), *B. sciuripabulum* (Fig. 4E), *C. lateriflora* (Fig. 4F), *D. unguis-cati* (Fig. 4J), *T. parviflorum* (Fig. 4K), *T. dichotomum* (Fig. 4L), *F. pubescens* (Fig. 4M), *T. cyrtanthum* (Fig. 4G) e *X. heterocalyx* (Fig. 4G), observou-se a presença de uma faixa esclerenquimática contínua circundando o floema (Tabela 3). Em duas espécies, *F. pubescens* (Fig. 4M) e *X. heterocalyx* (Fig. 4G), o esclerênquima circunda vários feixes de floema.

Todas as 13 espécies de Bignonieae (Tabela 3) estudadas apresentaram padrão vascular da nervura principal do tipo colateral, com o feixe central organizado em três formatos = em forma de arco, forma de U e circular. O feixe central em forma de arco foi observado nas seguintes espécies = *A. crucigerum* (Fig. 4I), *A. paniculatum* (Fig. 4C), *A. citrinum* (Fig. 4B), *B. ramentacea* (Fig. 4D) *B. sciuripabulum* (Fig. 4E), *C. lateriflora* (Fig. 4F), *T. cyrtanthum* (Fig. 4H) e *D. unguis-cati* (Fig. 4J). Feixe central em forma de U foi observado em quatro espécies = *P. venusta* (Fig. 4A), *T. parviflorum* (Fig. 4K), *T. dichotomum* (Fig. 4L), *F. pubescens* (Fig. 4M), estas três últimas com feixes floemáticos na face adaxial, circundados em sua maioria por esclerênquima, com a presença de células xilemáticas. Apenas uma espécie, *X. heterocalyx* (Fig. 4G), possui o feixe vascular com formato circular, totalmente circundado por esclerênquima.

A presença de idioblastos inorgânicos de formatos variados foi comum a todas as espécies estudadas, nas quais foram observados os seguintes tipos = cristais prismáticos, cristais esféricos, ráfides, areia cristalina e estiloides. Os idioblastos mais comumente observados foram cristais prismáticos, presentes em 11 espécies (ver Tabela 3), sem registro apenas para *T. cyrtanthum* e *X. heterocalyx*. Cristais esféricos foram registrados para cinco espécies = *A. crucigerum*, *A. paniculatum*, *A. citrinum*, *D. unguis-cati* e *P. venusta*. A presença de ráfides foi observada em cinco espécies = *B. ramentacea*, *B. sciuripabulum*, *T. dichotomum*, *T. parviflorum* e *T. cyrtanthum* (Fig. 2K). Estilóides foram observados apenas na periferia do esclerênquima de *B. ramentacea* e *B. sciuripabulum* e nas células parenquimáticas de *T. cyrtanthum*. A presença de idioblastos do tipo areia cristalina foi observada apenas nos parênquimas corticais de *A. citrinum* e *D. unguis-cati*.

3.5. Peciólulo

O contorno dos peciólulos das Bignonieae estudadas, em secção transversal, variou de semicircular levemente côncavo/convexo com projeções adaxiais, semicircular côncavo adaxial a semicircular plano adaxial. O tipo semicircular levemente côncavo/convexo com projeções adaxiais foi observado em cinco espécies = *B. ramentacea* (Fig. 5A), *B.*

sciuripabulum (Fig. 5B), *X. heterocalyx* (Fig. 5C), *A. paniculatum* (Fig. 5D) e *A. crucigerum* (Fig. 5E). O tipo semicircular côncavo adaxial (sulcado) foi predominante, observado em seis espécies = *C. lateriflora* (Fig. 5F), *P. venusta* (Fig. 5G), *T. cyrtanthum* (Fig. 5H), *A. citrinum* (Fig. 5I), *F. pubescens* (Fig. 5J) e *T. parviflorum* (Fig. 5K). O tipo semicircular plano adaxial, sem projeções na face adaxial, foi observado em apenas duas espécies = *T. dichotomum* (Fig. 5L) e *D. unguis-cati* (Fig. 5M).

A epiderme dos peciólulos apresentou-se uni-estratificada em todas as 13 espécies, revestida periclinalmente por uma cutícula espessada em *A. paniculatum* (Fig. 5D), *C. lateriflora* (Fig. 5F), *P. venusta* (Fig. 5G) e *A. citrinum* (Fig. 5I), e mais delgada nas demais espécies (Tabela 4). A presença de cutícula espessada depositada entre as paredes celulares anticlinais foi observada também em *A. citrinum* (2A).

Duas classes de tricomas foram observados nos peciólulos das espécies de Bignonieae estudadas = tricomas não-glandulares e tricomas glandulares (Tabela 4). Todas as 13 espécies apresentaram os peciólulos esparsos a densamente pilosos com tricomas glandular-peltados. Tricomas simples não-glandulares, unisseriados e pluricelulares foram registrados em todas as espécies, ocorrendo mais densamente em *A. crucigerum* (Fig. 5E), *C. lateriflora, F. pubescens* (Fig. 5J) e *T. dichotomum*. Tricomas glandular-estipitados foram observados apenas em *C. lateriflora*.

Adjacente à epiderme dos peciólulos evidenciou-se o córtex formado por colênquima do tipo angular, observado em nove espécies = *A. crucigerum, A. paniculatum, A. citrinum, F. dichotoma, T. parviflorum, F. pubescens, P. venusta, T. cyrtanthum* (Fig. 2L) e *X. heterocalyx.* Colênquima do tipo lacunar foi observado no córtex duas espécies, *C. lateriflora* e *D. unguis-cati,* enquanto em *Bignonia* (*B. ramentacea* e *B. sciuripabulum*) o córtex é formado apenas por parênquima fundamental.

Idioblastos inorgânicos foram observados nos peciólulos de dez espécies de Bignonieae (Tabela 4), exceto em três espécies, *C. lateriflora*, *F. pubescens* e *X. heterocalyx*. A presença de areia cristalina foi observada nas células colenquimáticas e parenquimáticas de duas espécies, *A. crucigerum* e *B. ramentacea*. Cristais prismáticos foram observados nos parênquimas corticais de seis espécies = *A. crucigerum, A. paniculatum, B. ramentacea, B. sciuripabulum, D. unguis-cati, T. parviflorum* e *T. cyrtanthum,* como também nos parênquimas medulares de *T. cyrtanthum* e *P. venusta* (Fig. 2J). Estiloides foram observados no parênquima de *A. citrinum*, *B. ramentacea* e *B. sciuripabulum*. Além disso, ráfides estão presentes nos parênquimas e nas endodermes de *A. citrinum, D. unguis-cati* e *T. dichotomum*. Cristais esféricos foram observados nas regiões colenquimática e parenquimática de *A.*

crucigerum e *A. citrinum*, como tambem na região parenquimática e medular de *T. cyrtanthum* (Fig. 2M).

O sistema vascular é colateral, com um único cilindro vascular central em 11 espécies (Tabela 4), exceto em *F. dichotoma* (Figs. 2G e 5L) e *F. pubescens* (Fig. 5J), que também apresentam dois feixes medulares acessórios cada, e em *X. heterocalyx* (Fig. 5C) com 1—(2)—feixes acessórios nas projeções adaxiais. A vascularização assume formato pentagonal em *Amphilophium* (Figs. 5D—E), circular em *D. unguis-cati* (Fig. 5M), em formato de U em *C. lateriflora* (Fig. 5F). Em nove espécies a organização do sistema vascular apresentou floema e xilema circundados por calotas descontinuas de esclerênquima (Tabela 4), como por exemplo *A. citrinum* (Fig. 5I) e *T. parviflorum* (Fig. 5K). Por outro lado, feixes de esclerênquima formam uma bainha contínua em quatro espécies = *T. dichotomum* (Fig. 5L), *F. pubecens* (Fig. 5J), *T. cyrtanthum* (Fig. 5H) e *X. heterocalyx* (Fig. 5C).

A região medular do peciólulo é constituída por células parenquimáticas de tamanhos variáveis e paredes celulares delgadas com poucos espaços intercelulares. Células de braquiesclereides foram observadas na porção medular de *A. citrinum* (Fig. 2B), constituindo-se em um caráter exclusivo para esta espécie.

3.6. Pecíolo

O formato do pecíolo das espécies de Bignonieae na região mediana, em secção transversal, variou de circular, semicircular côncavo adaxial, irregularmente pentagonal (com e sem projeções adaxiais) e hexagonal. O tipo circular foi observado em cinco espécies = *A. citrinum* (Fig. 6A), *T. dichotomum* (fig. 6B), *D. unguis-cati* (Fig. 6C), *F. pubescens* (Fig. 6D) e *T. cyrtanthum* (Fig. 6E). O tipo semicircular côncavo foi observado apenas em *T. parviflorum* (Fig. 6F). O padrão pentagonal foi comum a seis espécies, sendo três com projeções adaxiais, *B. ramentacea* (Fig. 6G), *B. sciuripabulum* (Fig. 6H) e *A. crucigerum* (Fig. 6I) e três espécies sem projeções adaxiais, são elas *A. paniculatum* (Fig. 6J), *P. venusta* (Fig. 6K) e *X. heterocalyx* (Fig. 6L). O padrão hexagonal foi observado apenas em *C. lateriflora* (Fig. 6M). A epiderme seguiu o mesmo padrão observado no mesofilo = uniestratificada em todas as 13 espécies e revestida por uma cutícula espessada em quatro espécies, *A. citrinum* (Fig. 6A), *C. lateriflora* (Fig. 6M), *D. unguis-cati* (Fig. 6C) e *P. venusta* (Fig. 6K), e delgada nas demais espécies (Tabela 5).

Três tipos de tricomas foram observados nos pecíolos das espécies de Bignonieae = tricomas glandular-peltados, glandular-estipitados e tricomas simples (Tabela 5). Todas as espécies possuem tricomas glandular-peltados, que também é o único tipo presente em *T. cyrtanthum* e *X. heterocalyx* (Tabela 5). Tricomas glandular-estipitados foram observados apenas no pecíolo de *C. lateriflora* (Fig. 6M). Tricomas simples, não-glandulares, foram registrados nos pecíolos de 11 espécies (Tabela 5).

O colênquima dos pecíolos das espécies estudadas foi de três tipos = angular, lacunar e lamelar. O tipo angular foi predominante, observado em 10 espécies (Tabela 5), como por exemplo, *F. pubescens* (Fig. 2H). O tipo lacunar foi comum a duas espécies, *C. lateriflora* e *X. heterocalyx*, e o tipo lamelar foi observado apenas em *D. unguis-cati*.

No pecíolo, o sistema vascular é do tipo colateral e segue o padrão observado na nervura central e nos peciólulos, formado por um único feixe vascular em 12 espécies. Entretanto, *C. lateriflora* (Figs. 2F e 6M) apresentou três feixes vasculares acessórios na face adaxial. Os feixes vasculares estão organizados nos seguintes formatos = arco, circular, semicircular, depresso-obovado, e pentagonal. O padrão circular foi comum a cinco espécies = *A. citrinum* (Fig. 6A), *T. dichotomum* (Fig. 6B), *D. unguis-cati* (Fig. 6C), *F. pubescens* (Fig. 6D) e *T. cyrtanthum* (Fig. 6E). O padrão pentagonal foi observado em cinco espécies = *B. ramentacea* (Fig. 6G), *A. crucigerum* (Fig. 6I), *A. paniculatum* (Fig. 6J), *P. veusta* (Fig. 6K) e *X. heterocalyx* (Fig. 6L); o padrão semicircular foi observado em *B. sciuripabulum* (Fig. 6E); o padrão depresso-obovado foi observado apenas em *T. parviflorum* (Fig. 6F) e o padrão em forma de arco observou-se em *C. lateriflora* (Fig. 6M). Na maioria das espécies observou-se uma sincronia em relação ao formato dos feixes vasculares e o formato de seus respetivos pecíolos. Feixes de esclerênquima formam uma camada descontínua envolvendo o floema na maioria das espécies, exceto em quatro espécies = *T. dichotomum* (Fig. 6B), *F. pubescens* (Fig. 6D), *T. cyrtanthum* (Fig. 6E) e *X. heterocalyx* (Fig. 6L), que presentam o floema circundado por uma camada contínua de esclerênquima. Além disso, observou-se nas espécies de *Bignonia* (*B. ramantaceae*, Fig. 6G) e *B. sciuripabulum*) presença de inclusões de cristais prismáticos e estilóides na próxim ao esclerênquima. Além disso, observou-se uma camada extra de esclerênquima que divide o floema de *B. ramantacea* (Figs. 2E e 6G).

Idioblastos inorgânicos dos tipos areia cristalina, cristais esféricos, cristais prismáticos, drusas, estiloides e ráfides foram observados nos pecíolos de 11 espécies de Bignonieae (Tabela 5), exceto em *F. pubescens* e *X. heterocalyx*. Cristais prismáticos foram observados em 10 espécies = *A. crucigerum, A. paniculatum, A. citrinum, B. ramentacea* (Fig. 2E), *B. sciuripabulum, C. lateriflora, D. unguis-cati, T. dichotomum, T. parviflorum* e *P. venusta*; cristais esféricos em quatro espécies = *A. crucigerum, A. citrinum, D. unguis-cati e T. cyrtanthum*; ráfides também em quatro espécies = *A. crucigerum* (Fig. 2C), *D. unguis-cati*, *T. dichotomum* e *T. cyrtanthum*. A presença de areia cristalina foi registrada em *A. crucigerum* e *P. venusta*; estiloides foram observados na proximidade do esclerênquima de *B. ramentacea*

(Fig. 2E) e *B. sciuripabulum*; e drusas foram registradas na medula de *A. crucigerum* (Fig. 2D)

Todas as espécies possuem medula parenquimática na porção central do pecíolo, formada por células de anisodiamétricas, com formatos circulares e paredes delgadas, raro com células esclerenquimáticas, como observado em *A. crinitum*, com braquiesclereides.

3.7. Análise de agrupamentos

O dendrograma gerado pela análise UPGMA apresentou alto coeficiente de correlação (0.88), e exibe a formação de dois principais grupos (Figura 7). No primeiro grupo observa-se as espécies de três gêneros proximamente ligados (*Fridericia, Tanaecium e Xylophragma*); no segundo grande grupo, seis gêneros (*Amphilophium, Anemopaegma, Bignonia, Cuspidaria, Dolichandra*, *Pyrostegia*,) foram mais similares entre si.

B. ramentacea e *B. sciuripabulum* se reuniram como espécies afins, proximamente ligadas à *C. lateriflora*, juntas essas três espécies formaram um agrupamento com *A. citrinum* e *P. venusta*, estas duas últimas como espécies proximamente relacionadas. *D. unguis-cati* se isolou e ficou mais próxima a outras cinco espécies, de três gêneros (*Amphilophium*, *Bignonia* e *Cuspidaria*). |As espécies de *Amphilophium* (*A. crucigerum* e *A. paniculatum*), também se agruparam como mais similares entre si. As maiores similaridades foram observadas para espécies que pertencem ao mesmo gênero = *Amphilophium* (*A. crucigerum* e *A. paniculatum*), e *Bignonia* (*B. ramentacea* e *B. sciuripabulum*) e para espécies que pertenciam ao mesmo gênero = *Fridericia* (*F. pubescens*) e *Tanaecium* (*T. dichotomum*)

4. Discussão

A análise anatômica das folhas das 13 espécies da tribo Bignoniae, revelou caracteres tradicionalmente apontados para a maioria dos membros da família, como, folhas hipoestomáticas, número variável de células subsidiárias envolvendo o estômato, mesofilo dorsiventral, feixe vascular colateral (Metcalfe e Chalk, 1950; Solereder, 1908), células em sua maioria com paredes anticlinais variando entre retas e sinuosas (González, 2013).

Wilkinson (1979) afirmou que os fatores ambientais influenciam na plasticidade das células epidérmicas, inferindo que estas podem apresentar paredes com sinuosidade mais acentuadas se desenvolvidas na sombra, ou paredes retas ou quase retas quando se desenvolvem sob incidência solar direta. Por outro lado, Barthlott (1981) defendeu que o contorno das células epidérmicas pode apresentar valor taxonômico. A caracterização estomática das espécies de Bignonieae do Pico do Jabre, baseada na proposta de Dickison (1974), apontou uma grande variedade de estômatos, os quais mostraram-se mais informativos para os gêneros *Bignonia* e *Fridericia*, que para os demais, prevalecendo os padrões anomotetracítico e anomocítico. Os tipos braquiparehexacíticos em *Bignonia* e paracíticos em *Fridericia* foram importantes para distinção de suas espécies. Estômatos anomocíticos já eram esperados estar entre os mais comuns nas espécies estudadas, uma vez que foi citado como padrão para Bignoniaceae, por Metcalfe e Chalk (1950). A presença de estômatos paracíticos também já foram referidos por Metcalfe e Chalk (1950) para *Arrabidaea* (incluindo *Fridericia*).

Diferentemente de outras espécies de Bignoniaceae e até de espécies de Bignonieae, que apresentam mesofilo isobilateral (González, 2013; Firetti-Ligieri et al., 2014), o padrão dorsiventral observado caracterizou as espécies de Bignonieae estudadas, do Pico do Jabre, corroborando com o observado por Solereder (1908) e Metcalfe e Chalk (1950) para Bignoniaceae. Diferenças no mesofilo que podem mostrar-se úteis na distinção das espécies estudadas, restringem-se à quantidade de estratos do parênquima e a presença de diferentes idioblastos inorgânicos. De acordo com Cutler et al. (2008), as condições ambientais não alteram os arranjos do mesofilo, que são controlados pelo genoma, ao contrário da quantidade de estratos do paliçádico, entretanto, por se tratar de um caráter que pode apresentar diferenças marcantes, este pode ser utilizado como suporte a identificação. Com relação as espécies de Bignonieae aqui estudadas, que se distribuem ao longo de diferentes gradientes altitudnais, a quantidade de estratos dos parênquimas paliçádico e esponjoso/plicado foi diferente nos diferentes gêneros e espécies, mostrando-se um caráter útil, principalmente quando associado a outros caráteres. A proporção entre os parênquimas do mesofilo não apresentou-se relevante para as espécies de Bignonieae aqui estudadas, visto que em seis espécies (*A. crucigerum*, *D. unguis-cati*, *T. parviflorum*, *F. pubescens*, *P. venusta* e *T. cyrtanthum*), ambos os parênquimas se aproximam dos 50% (ver tabela 2); divergindo claramente em proporção em apenas três espécies (*A. paniculatum*, *A. citrinum*, e *B. ramentacea*), nas quais o parênquima esponjoso ocupa mais de 69% da área do mesofilo.

Com relação aos tipos de tricomas, observou-se que os tricomas não-glandulares simples, unisseriados, e os glandular-peltados são comuns a todas as espécies, embora variando nas diferentes partes do folíolo. Tricomas glandulares-peltados, já foram reportados para 105 espécies de Bignonieae por Nogueira et al. (2013), assim como por Fróes et al. (2015), que registrou para *Amphilophium magnoliifolium* (Kunth) L.G. Lohmann, *Martinella obovata* (Kunth) Bureau e K. Schum e *Stizophyllum riparium* (Kunth) Sandwith). Entre as treze espécies estudadas, tricomas glandulares-pateliformes/cupulares foram registrados para *F. parviflora* e tricomas glandular-estipitados para quatro espécies (*C. lateriflora*, *T. dichotomum*, *T. parviflorum*, *F. pubescens*), caracteres por Nogueira et al. (2013) para seis dos 21 gêneros da de Bignonieae, como *Cuspidaria* e *Fridericia*, por exemplo, como também já descritos por Fróes et al. (2015) para *M. obovata*. Os tricomas mostraram-se importantes na distinção de três gêneros e quatro espécies = *Cuspidaria* (*C. lateriflora*), *Fridericia* (*F. pubescens*) e *Tanaecium* (*T. dichotomum* e *T. parviflorum*).

Em Bignonieae, a nervura principal diferiu essencialmente na configuração do feixe vascular central que apresentou-se em arco em oito espécies, em forma de U em quatro espécies e circular em apenas uma espécie, com algumas delas apresentando feixes floemáticos na face adaxial, comumente encontrados em espécies de Bignonieae (Souza et al., 2007; Firetti-Ligieri et al., 2014) e outras Bignoniaceae (Abbade et al. 2009; Gonzalez, 2013; Abdel-Wahab et al., 2015). Diferentemente das espécies de Bignonieae deste e de outros trabalhos (Souza, 2007; Gonzalez, 2013), as espécies africanas estudadas por Ogundipe e Wujek (2004) apresentaram contorno da nervura principal majoritariamente do tipo plano-convexo, com poucas espécies variando levemente até côncavo-convexo, diferenciando-se assim do padrão geralmente observado em Bignonieae. O parênquima paliçádico presente na face adaxial da nervura de *D. unguis-cati* trata-se de uma observação inédita e distintiva para a espécie, não relatada para outras espécies da tribo, no entanto, referido por Abdel-Wahab et al. (2015) em uma espécie da tribo Crescentieae (*Parmentiera cereifera* Seem), Portanto não se caracteriza como um caráter exclusivo de Bignonieae.

Pecíolos e peciólulos mostraram-se caráteres informativos na delimitação das espécies de Bignonieae, principalmente quanto ao contorno, configuração do feixe vascular e ocorrência de feixes vasculares acessórios, além da distribuição do esclerênquima e da presença de células diferenciadas, como braquiesclereídes. O sistema vascular do pecíolo, em especial, é considerado uma estrutura com grande potencial pelos taxonomistas, e tem sido utilizada no suporte à sistemática de diversos grupos (Deghan, 1982; Talip et al., 2017; Song e Hong, 2018). A importância taxonômica do pecíolo já foi referida por Solereder (1908) e Metcalfe e Chalk (1950), como também por outros autores que realizaram trabalhos com Bignoniaceae, como Trivedi e Khanna (1977), Ogundipe e Wujek (2004) e Firetti-Ligierii et al. (2014), que mostraram a relevância desta estrutura (pecíolo) como suporte a taxonomia de Bignoniaceae. O padrão apresentado pelas Bignonieae do pico do Jabre, cujos pecíolos apresentam o cilindro vascular colateral, corrobora com os registros de Metcalfe e Chalk (1950) para Bignoniaceae.

A presença de feixes vasculares acessórios adaxiais no pecíolo de *C. lateriflora* e no peciólulo, de *X. heterocalyx* é um caráter distintivo para estas espécies em relação às demais, no presente estudo. A ocorrência de feixes vasculares acessórios, não é um caráter exclusivo de Bignonieae, dentro da família, visto que em diferentes gêneros, como *Campsis*, *Kigelia*, *Jacaranda* e *Haplophragma*, pertencentes a diferentes clados de Bignoniaceae, tem-se registro

(Trivedi e Khanna, 1977), assim como em outros gêneros de Bignonieae, como *Anemopaegma* (Firetti-Liggieri et al., 2014). Outra espécie com caráter distintivo das demais foi *B. ramentacea*, com um feixe extra de esclerênquima dividindo o floema do pecíolo. Em *A. citrinum*, o parênquima medular dos pecíolos e peciólulos apresentaram células de braquiesclereídes, que se mostra como um diferencial para esta espécie. Assim como a presença de grandes cristais prismáticos em *P. venusta* e os feixes medulares acessórios nos peciólulos de *T. dichotomum e F. pubescens*, constituem caracteres distintivos, cujos registros ainda não haviam sido relatados para as referidas espécies, configurando-se em registros inéditos para as Bignoniaeae.

O agrupamento resultante dos dados anatômico-foliares, exibe um alto valor de suporte (0.88). Percebe-se que aquelas espécies que pertencem a um mesmo gênero, ou a gêneros próximos, (por exemplo *Anemopaegma* e *Pyrostegia*), agruparam-se como espécies afins, tendo em vista que, em sua maioria compartilham um maior número de características, como = tipos de estômato, contorno da nervura, peciólulo e pecíolo, assim como seus respectivos feixes vasculares. Na filogenia realizada por Lohmann (2006), também se percebe a proximidade das espécies de *Amphilophium*, agrupadas no clado Pithecoctenieae; assim como dos gêneros *Anemopaegma* e *Pyrostegia*, próximos de Pithecoctenieae, e com um alto valor de suporte.

Fridericia e *Tanaecium* tiveram duas de suas espécies mais proximamente agrupadas (*F. pubescens* e *T. dichotomum*), que compartilham alguns carácteres como o formato do pecíolo e dos feixes vasculares, como também a presença de feixes medulares nos peciólulos e o parênquima esponjoso, que constitui um conjunto de caracteres que as tornam com maior afinidade entre si, do que com as outras espécies de *Tanaecium* (*T. cyrtanthum* e T. *parviflorum*). No trabalho de Lohmann (2006), a maioria das espécies desse gênero estão incluídas no "verdadeiro clado *Arrabidaea*", pertencentes ao antigo, polifilético e complexo gênero *Arrabidaea,* com algumas espécies atualmente circunscritas também em outros gêneros, como *Cuspidaria, Tanaecium e Xylophragma.*

Nessa análise de agrupamento algumas espécies se isolam, como resultado de carácteres exclusivos de cada uma, como por exemplo o contorno do pecíolo, formato do feixe vascular, presença de tricomas estipitados e feixes vasculares acessórios em *C. lateriflora,* como também a presença de parênquima paliçádico na porção adaxial da nervura principal em *D. unguis-cati*. Na atual filogenia do grupo (Lohmann, 2006), *C. lateriflora* está posicionada no clado *Cuspidaria* s.l, dentro do grande clado *Arrabidaea* e clados aliados. Por outro lado, *Dolichandra* está no clado "garra de gato", em referência às suas gavinhas, apresenta uma relação de politomia com outros clados, de acordo com Lohmann(2006). Entretanto, o monofiletismo de *Dolichandra* é fortemente suportado por dados morfológicos e anatômicos (Fonseca e Lohmann, 2017), quando foram incluindos no grupo os gêneros *Macfadyena, Melloa* e *Parabignonia.*

5. Conclusões

A anatomia foliar das espécies de Bignonieae do Pico do Jabre evidenciou a presença de caracteres relevantes e distintivos para seus gêneros e espécies que, em conjunto, apoiam a taxonomia do grupo, especialmente a morfologia dos pecíolos e peciólulos, a configuração dos seus respectivos feixes vasculares e da nervura principal, como também a morfologia qualitativa e quantitativa dos parênquimas do mesofilo e a diversidade e distribuição dos idioblastos. A análise de agrupamento evidenciou-se que as relações estabelecidas pelos caracteres anatômicos corroboram com a filogenia já realizada para a tribo Bignonieae.

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Referências

Agra, M.F., Barbosa, M.R.V., Stevens, W.D., 2004. Levantamento florístico preliminar do Pico do Jabre, Paraíba, Brasil. In = Porto, K.C.; Cabral, J.J.P., Tabarelli, M. Brejos de altitude em Pernambuco e Paraíba: História natural, Ecologia e Conservação. Ministério do Meio Ambiente, Brasilia. pp. 123–138.

Aguiar, T.V., Sant'anna-Santos, B.F., Azevedo, A.A., and Ferreira, R.S., 2007. ANATI QUANTI: software de análises quantitativas para estudos em anatomia vegetal. Planta Daninha 25(4), 649–659.

Abbade, L.C., Oliveira Paiva, P.D., Paiva, R., Castro, E.M., Centofante, A.R., Oliveira, C., 2009. Anatomia foliar de ipê-branco (*Tabebuia roseo alba* (Ridl.) Sand.)-Bignoniaceae, proveniente do cultivo ex vitro e in vitro. Acta Sci. Biol. Sci. 31(3), 307–311.

Abdel-Wahab, N.M., Hamed, A.N., Khalil, H.E., Kamel, M.S., 2015. Leaf Morphoanatomy Studies of *Parmentiera cereifera* Seem., Family Bignoniaceae, Cultivated in Egypt. J. Pharmacogn. Phytochem. 3(6), 47–57.

Ahmad, F., Khan, M.A., Ahmad, M., Zafar, M., Arshad, M., Khan, A., Awan, M.R., 2010. Taxonomic utilization of anatomical characters in tribe Andropogoneae (Poaceae) based on transverse sections of leaves. J. Med. Plants Res. 4(14), 1349–1358.

Ahmad, F., Hameed, M., Ahmad, K.S., Ashraf, M., 2015. Significance of Anatomical Markers in Tribe Paniceae (Poaceae) from the Salt Range, Pakistan. Int. J. Agric. Biol. 17, 271–279.

Alves, M.V., Estelita, M.E.M., Wanderley, M.G.L., Thomas, W.W., 2002. Aplicaçõoes taxonômicas da anatomia foliar das espécies brasileiras de *Hypolytrum* Rich. (Cyperaceae). Rev. Bras. Bot. 25, 1–9.

Araújo, N.D., Coelho, V.P.M., Ventrella, M.C., Agra, M.F., 2013. Leaf anatomy and histochemistry of three species of *Ficus* sect. Americanae supported by light and electron microscopy. Microsc Microanal. 20(1), 296–304.

Atalay, Z., Celep, F., Bara, F., Dogan, M., 2016. Systematic significance of anatomy and trichome morphology in Lamium (Lamioideae; Lamiaceae). Flora 225, 60–75.

Barthlott, W., 1981. Epidermal and seed surface characters of plants: systematic applicability and some evolutionary aspects. Nord. J. Bot. 1(3), 345–355.

BFG - The Brazil Flora Group., 2015. Growing knowledge = an overview of seed plant diversity in Brazil. Rodriguésia 66, 1085–1113.

Bukatsch, F., 1972. Azul de Astra e Safranina. In = Kraus, J, Arduin, M. Manual Básico de Métodos em Morfologia Vegetal. Edur, Seropédica, Rio de Janeiro. p. 26.

Chimezie, E., Alozie, O.C., Ikechukwu, M.S., 2016. Importance of leaf, stem and flower stalk anatomical characters in the identification of *Emilia* Cass. International Journal of Plant & Soil Science 12, 1–12.

Cunha, M.C.L., Silva-Júnior, M.C., Lima, R.B., 2013. Fitossociologia do Estrato Lenhoso de uma floresta estacional semidecidual montana na Paraíba, Brasil. Cerne 19, 271–280.

Cunha, M.C.L., Silva-Júnior, M.C., 2014. Flora e estrutura de floresta estacional semidecidual montana nos estados da Paraíba e Pernambuco. Nativa 2, 95–102.

Cutler, D.F., Botha, C.E.J., Stevenson, D.W., 2008. Plant anatomy = an applied approach. Blackwell Publishing.

Dehgan, B., 1982. Comparative anatomy of the petiole and infrageneric relationships in *Jatropha* (Euphorbiaceae). Am. J. Bot. 69, 1283–1295.

Dickison, W.C., 2000. Integrative Plant Anatomy, first ed. Academic Press, San Diego.

Duarte, M.R., and Jurgensen, I., 2007. Diagnose Morfoanatômica de Folha e Caule de Pyrostegia venusta (Ker Gawl.) Miers, Bignoniaceae. Lat. Am. J. Pharm. 26, 70–75.

Firetti-Leggieri, F., Lohmann, L.G., Semir, J., Damarco, D., Castro, M.M., 2014. Using leaf anatomy to solve taxonomic problems within the *Anemopaegma arvense* species complex (Bignonieae, Bignoniaceae). Nord. J. Bot. 32, 620–631.

Fonseca, L.H.M., Lohmann, L.G., 2017. Taxonomic Revision of *Dolichandra* (Bignonieae, Bignoniaceae). Phytotaxa 301, 001–070.

Fróes, F.F.P.D.C., Gama, T.D.S.S., Feio, A.C., Demarco, D., 2015. Structure and distribution of glandular trichomes in three species of Bignoniaceae. Acta Amaz. 45(4), 347–354.

Gasson, P., Dobbins, D.R., 1991. Wood anatomy of the Bignoniaceae, with a comparison of trees and lianas. IAWA J. 12(4), 389–415.

Gentry, A.H., 1980. Bignoniaceae, Part I, Tribes Crescentieae and Tourretieae. Flora Neotropica 25, 1-131.

Gonzalez, A.M., 2013. Indumento, nectarios extraflorales y anatomía foliar em Bignoniáceas de la Argentina. Bol. Soc. Argent. Bot. 48, 221–245.

Hernández, A.R.A., Terrazas, T., 2006. Anatomía foliar y del pecíolo de especies del género *Hus* S. STR. (Anacardiaceae). Bol. Soc. Bot. Méx. 78, 95-106.

Instituto Brasileiro de Geografia e Estatística., 1985. Atlas nacional do Brasil = região Nordeste. IBGE = Rio de Janeiro.

Jain, D.K., Singh, V., 1980. Studies in Bignoniaceae. VII. Wood anatomy. Proceedings = Plant Sci. 89(6), 443–456.

Johansen, D.A., 1940. Plant Microtechnique. Mc. Graw-Hill Book, New York.

Lima, P.J., Heckendorff, W.D., 1985. Climatologia. In = Atlas Geográfico da Paraíba. João Pessoa = Grafset, Editora Universitária.

Lohmann, L.G., 2006. Untangling the phylogeny of Neotropical lianas (Bignonieae, Bignoniaceae). Am. J. Bot. 93, 304–315.

Lohmann, L.G., Bell, C.D., Calió, M.F., Winkworth, R.C., 2013. Pattern and timing of biogeographical history in the Neotropical tribe Bignonieae (Bignoniaceae). Bot. J. Linn. Soc. 171(1), 154–170.

Lohmann, L.G., Taylor, C.M., 2014. A new generic classification of Bignonieae (Bignoniaceae) based on molecular phylogenetic data and morphological synapomorphies. Ann. Mo. Bot. Gard. 99, 348–489.

Lohmann, L.G., Ulloa Ulloa, C., 2019. Bignoniaceae. *In* = Checklist of the World, MOBOT/NYBG/Kew Gardens. iPlants prototype Checklist. Available in = <http =//www.iplants.org/>. Acess in 22 january 2019.

Mauro, C., Pereira, A.M.S., Silva, C.P., Missima, J., Ohnuki., Rinaldi, R.B., 2007. Estudo anatômico das espécies de cerrado *Anemopaegma arvense* (Vell.) Stellf. ex de Souza (catuaba), *Zeyheria montana* Mart. (bolsade-pastor) e *Jacaranda decurrens* Chamisso (caroba) – Bignoniaceae. Rev. Bras. Farmacogn. 17, 262–265.

Maury, C.M., 2002. Biodiversidade brasileira: avaliação e identificação de áreas e ações prioritárias para conservação, utilização sustentável e repartição de benefícios da biodiversidade nos biomas brasileiros. Ministério do Meio Ambiente, Brasília.

Metcalfe, C.R., Chalk, L., 1950. Anatomy of dicotyledons. Vol. II. Clarendon Press, Oxford.

Nogueira, A., El Otrra, J.H.L., Guimarães, E., Machado, S.R. and Lohmann, L.G., 2013. Trichome structure and evolution in Neotropical lianas. Ann. Bot. 112: 1331–1350. doi:10.1093/aob/mct201

Noronha, N.M., Scudeller, V.V., 2011. Morfo-anatomia foliar de *Handroanthus barbatus* (E. Mey.) Mattos (Bignoniaceae). In = Santos-Silva, E.N.; Cavalcanti, M.J., Scudeller, V.V. BioTupé = Meio Físico, Diversidade Biológica e Sociocultural do Baixo Rio Negro, Amazônia Central. pp. 187–201.

Nurit-Silva, K., Costa-Silva, R., Basílio, I.J.L.D., Agra, M.F., 2012. Leaf epidermal characters of Brazilian species of *Solanum* section Torva as taxonomic evidence. Botany 90, 806–814.

Ogundipe, O.T., Wujek, D.E., 2004. Foliar anatomy on twelve genera of Bignoniaceae (Lamiales). Acta Bot. Hung. 46, 337–361.

Olmstead, R.G., Zjhra, M.L., Lohmann, L.G., Grose, S.O., Eckert, A.J., 2009. A molecular phylogeny of Bignoniaceae. Am. J. Bot. 96, 1731–1743.

Pace, M.R., Lohmann, L.G., Angyalossy, V., 2009. The rise and evolution of the cambial variant in Bignonieae (Bignoniaceae). Evol. Dev. 11(5), 465–479.

Pace, M.R., Lohmann, L.G., Olmstead, R.G., Angyalossy, V., 2015. Wood anatomy of major Bignoniaceae clades. Plant Syst. Evol. 301(3), 967–995.

Pereira, L.B.S., Costa-Silva, R., Felix, L.P., Agra, M.F., 2018. Leaf morphoanatomy of" mororó"(*Bauhinia* and *Schnella*, Fabaceae). Rev. bras. farmacogn. 28(4), 383–392.

Pontes, R.A., Agra, M.F., 2001. Flora do Pico do Jabre, Paraíba, Brasil = Acanthaceae. Leandra 16, 51–60.

Rocha, E.A., Agra, M.D.F., 2002. Flora of the Pico do Jabre, Paraíba, Brazil = Cactaceae juss. Acta Bot. Bras. 16, 15–21.

Sampaio, V.S., Araújo, N.D., Agra, M.F., 2014. Characters of leaf epidermis in *Solanum* (clade Brevantherum) species from Atlantic Forest of Northeastern Brazil. S. Afr. J. Bot. 94, 108–113.

Santos, G. M. A., 1995. Wood Anatomy, Chloroplast DNA, and Flavonoids of the Tribe Bignonieae (Bignoniaceae). Ph.D. Dissertation, University of Reading, Reading, U.K.

Santos, S.R., 2017. A atual classificação do antigo gênero *Tabebuia* (Bignoniaceae), sob o ponto de vista da anatomia da madeira. Balduinia 58, 10–24.

Silva, A.M.L., Costa, M.F.B., Leite, V.G., Rezende, A.A., Teixeira, F.P., 2009. Anatomia foliar com implicações taxonômicas em espécies de ipês. Hoehnea 36, 329–338.

Song, J.H., Hong, S.P., 2018. Comparative petiole anatomy of the tribe Sorbarieae (Rosaceae) provide new taxonomically informative characters. Nord. J. Bot. 36(5), njb-01702.

Souza, L.A., Lopes, W.A.L., and Almeida, O.J.G., 2007. Morfoanatomia da plântula e do tirodendro de *Arrabidaea mutabilis* Bureau & K. Schum. (Bignoniaceae). Acta Sci. Biol. Sci. 29, 131–136.

Tabarelli, M., Santos, A.M.M., 2004. Uma breve descrição sobre a história natural dos brejos nordestinos. Brejos de Altitude em Pernambuco e Paraíba, In = Porto, C.K., Cabral, P.J.J., Tabarelli, M. (Eds.), História Natural, Ecologia e Conservação. Ministério do Meio Ambiente, Universidade Federal de Pernambuco, Brasília, pp. 17–24.

Talip, N., Cutler, D.F., Puad, A.A., Ismail, B.S., Ruzi, A.R., Juhari, A.A., 2017. Diagnostic and systematic significance of petiole anatomy in the identification of *Hopea* species (Dipterocarpaceae). S. Afr. J. Bot. 111, 111–125.

Thiers, B., 2019. [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/science/ih/.

Trivedi, M.L., Khanna, V., 1977. Petiolar anatomy of certain members of Bignoniaceae. Proc. Natl. Acad. Sci. - Section B 85(2), 57–66.

Ugbade, G.E., Ayodele, A.E., 2008. Foliar epidermal studies in the Family Bignoniaceae JUSS. in Nigeria. Afr. J. Agric. Res. 3, 154–166.

Vasconcelos Sobrinho, J., 1971. As regiões naturais do Nordeste, o meio e a civilização. Conselho de Desenvolvimento de Pernambuco, Recife.

Wilkinson, H.P., 1979. Plant surface. In = Metcalfe, Chalk, L. Anatomy of the Dicotyledon. Claredon Press, Oxford, pp. 97–162.

Tabela 1. Amostras representativas das espécies de Bignonieae do Pico do Jabre, utilizadas na análise anatômica.

Species	**Material analisado** **Coletor(es) e número (acrônimo do herbário)**
Amphilophium crucigerum (L.) L.G. Lohmann	*M.F. Agra et al. 5013* (JPB); *R. Lopes 135* (EAN); *R. Lopes 243* (EAN)
Amphilophium paniculatum (L.) Kunth	*M.F. Agra & P.C. Silva 4873* (JPB); *M.F. Agra et al. 2688* (JPB)
Anemopaegma citrinum Mart. ex DC.	*M.F. Agra et al. 2629* (JPB); *R. Lopes 239* (EAN); *R. Lopes 255* (EAN)
Bignonia ramentacea (Mart. Ex DC.) L.G.Lohmann	*M.F. Agra et al. 4022* (JPB); *R. Lopes 253* (EAN); *Lopes 254* (EAN)
Bignonia sciuripabulum (K. Schum.) L.G. Lohmann	*M.F. Agra et al. 3935* (JPB); *M.F. Agra et al. 4654* (JPB); *R. Lopes 238* (EAN)
Cuspidaria lateriflora (Mart.) DC.	*M.F. Agra et al. 3932* (JPB)
Dolichandra unguis-cati (L.) L.G. Lohmann	M.F. Agra et al. 4113 (JPB); *M.F. Agra et al. 4792* (JPB); *R. Lopes 246* (EAN)
Fridericia pubescens (L.) L.G.Lohmann	*M.F. Agra et al. 1984* (JPB); *M.F. Agra et al. 7115*(JPB); *R. Lopes 256* (EAN)
Pyrostegia venusta (Ker: Gawl.) Miers	*M.F. Agra et al. 4371* (JPB); *M.F. Agra et al. 4398* (JPB); *R. Lopes 257* (EAN)
Tanaecium cyrtanthum (Mart. Ex DC.) Bureau & K.Schum.	*R. Lopes 263* (EAN)
Tanaecium dichotomum (Jacq.) Kaehler & L.G.Lohmann	*R. Lopes 259* (EAN)
Tanaecium parviflorum (Mart. ex DC.) Kaehler & L.G.Lohmann	*M.F. Agra et al. 4791* (JPB); *R. Lopes 240* (EAN)
Xylophragma heterocalyx (Bureau & K.Schum.) A.H.Gentry	*R. Lopes 260* (EAN); *R. Lopes 261* (EAN)

Tabela 2. Caracteres anatômicos dos bordos e mesofilos das espécies de Bignonieae do Pico do Jabre. (+) = Presença; (-) = ausência; Ac = Areia cristalina; Ce = Cristal esférico; Cp = Cristal prismático; Dr = Drusa; Es = Estiloide; Rf = Ráfide.

Espécie	Bordo (formato)	Mesofilo											
		Parênquima Paliçádico (nº. estratos)	Parênquima Esponjoso/Plicado (nº. estratos)	Tamanho do mesofilo (valores médios)			Idioblastos inorgânicos					
				Tamanho total (mm)	Esponjoso/Plicado %	Paliçádico %	Ac	Ce	Cp	Dr	Es	Rf
A. crucigerum	Arredondado	1	3-4	156.67	57.39%	42.61%	-	+	+	-	-	-
A. paniculatum	Arredondado	1	5-7	164.77	74.41%	25.59%	+	-	+	-	-	-
A. citrinum	Agudo	1	4-5	148.53	69.50%	30.50%	+	-	+	-	-	-
B. ramentacea	Agudo	2-3	6-7	189.30	79.70%	20.31%	-	-	+	-	+	-
B. sciuripabulum	Agudo	2-3	6-7	235.78	64.98%	35.03%	-	-	+	-	+	-
C. lateriflora	Agudo	1-(2)	7-8	174.60	60.73%	39.27%	-	-	+	-	-	-
D. unguis-cati	Arredondado	3-7	3-5	192.99	44.23%	55.77%	-	+	+	-	-	-
F. pubescens	Agudo	2-4	3-4	144.96	44.58%	55.42%	-	-	-	-	+	-
P. venusta	Arredondado	1-(2)	5-6	176.88	53.29%	46.71%	-	+	-	+	-	-
T. cyrtanthum	Arredondado	2	3-5	160.65	45.28%	54.72%	+	+	+	-	-	-
T. dichotomum	Agudo	1-2	3-5	128.26	64.52%	35.49%	-	-	+	-	+	+
T. parviflorum	Arredondado	1	2-3	85.14	55.10%	44.91%	-	-	+	-	-	-
X. heterocalyx	Recurvo	2	5-6	168.69	60.69%	39.31%	+	-	-	-	-	-

Tabela 3. Caracteres anatômicos da nervura principal das espécies de Bignonieae do Pico do Jabre. Legendas: Bi = Biconvexa; Cc = Côncavo; Ce = Cristais esféricos; Cp = Cristais prismáticos; Cv = Convexo; Es = Estiloides; Gp = Glandular peltado; Gc = Glandular pateliforme/cupular Gs = Glandular estipitado; Rf = Ráfides; Sm = tricoma simples.

Espécie	Caracteres																
	Forma	Formato do Feixe Vascular	Tipo de feixe vascular	Colênquima	Esclerênquima	Idioblastos inorgânicos				Tricomas							
										Face adaxial				Face abaxial			
						Ce	Cp	Et	Rf	Gp	Gc	Gs	Sm	Gp	Gc	Gs	Sm
A. crucigerum	Bi	Arco	Colateral	Angular	-	+	+	-	-	+	-	-	+	+	-	-	+
A. paniculatum	Bi	Arco	Colateral	Angular	-	+	+	-	-	+	-	-	+	+	-	-	+
A. citrinum	Bi e Cc	Arco	Colateral	Lacunar	Descontínuo	+	+	-	-	+	-	-	+	+	-	-	+
B. ramentacea	Bi	Arco	Colateral	Lacunar	Contínuo	-	+	+	+	+	-	-	+	+	-	-	+
B. sciuripabulum	Bi	Arco	Colateral	Lacunar	Contínuo	-	+	+	+	+	-	-	+	+	-	-	+
C. lateriflora	Bi	Arco	Colateral	Lacunar	Contínuo	-	+	-	-	+	-	+	+	+	-	-	+
D. unguis-cati	Bi	Arco	Colateral	Lacunar	Contínuo	+	+	-	-	+	-	-	+	+	-	-	+
F. pubescens	Bi	U	Colateral	Angular	Contínuo	-	+	-	-	+	-	+	+	+	-	-	+
P. venusta	Cc e Cv	U	Colateral	Lacunar	Descontínuo	+	+	-	-	+	-	-	+	+	-	-	+
T. cyrtanthum	Bi	Arco	Colateral	Angular lacunar	Contínuo	-	-	+	+	+	-	-	+	+	-	-	+
T. dichotomum	Bi	U	Colateral	Angular	Contínuo	-	+	-	+	+	-	+	+	+	-	-	+
T. parviflorum	Bi	U	Colateral	Angular	Contínuo	-	+	-	+	+	-	+	+	+	+	+	+
X. heterocalyx	Bi	Circular	Colateral	Lacunar	Contínuo	-	-	-	-	+	-	-	+	+	-	-	+

Tabela 4. Caracteres anatômicos dos peciólulos das espécies de Bignonieae do Pico do Jabre. Legendas: Ac – Areia cristalina; Ce = Cristal esférico; Circ = Circular; Cp = Cristal prismático; Es = Estiloide; = Ráfide; Gp = Glandular-peltado; Gs = Glandular-estipitado; Pent = Pentagonal; SCAD = Semicircular Côncavo Adaxial; SCPA = Semicircular côncavo/convexo com projeções adaxiais; SPAD = Semicircular Plano Adaxial; Semc = Semicircular; Sm = Tricoma simples.

Espécie	Caracteres													
	Contorno	Formato do Feixe vascular	Tipo de Feixe vascular	Colênquima	Esclerênquima	Cutícula	Idioblastos inorgânicos					Tricomas		
							Ac	Ce	Cp	Es	Rf	Gp	Gs	Sm
A. crucigerum	SCPA	Pent.	Colateral	Angular	Descontínuo	Delgada	+	+	+	-	-	+	-	+
A. paniculatum	SCPA	Pent.	Colateral	Angular	Descontínuo	Espessada	-	-	+	-	-	+	-	+
A. citrinum	SCAD	SCAD	Colateral	Angular	Descontínuo	Espessada	-	+	-	+	+	+	-	+
B. ramentacea	SCPA	Semc.	Colateral	-	Descontínuo	Delgada	+	-	+	+	-	+	-	+
B. sciuripabulum	SCPA	Semc.	Colateral	-	Descontínuo	Delgada	-	-	+	+	-	+	-	+
C. lateriflora	SCAD	U	Colateral	Lacunar	Descontínuo	Espessada	-	-	-	-	-	+	+	+
D. unguis-cati	SPAD	Circ.	Colateral	Lacnunar	Descontínuo	Delgada	-	-	+	-	+	+	-	+
F. pubescens	SCAD	Circ.	Colateral	Angular	Contínuo	Delgada	-	-	-	-	-	+	-	+
P. venusta	SCAD	SCAD	Colateral	Angular	Descontínuo	Espessada	-	-	+	-	-	+	-	+
T. cyrtanthum	SCAD	SCAD	Colateral	Angular	Contínuo	Delgada	-	+	+	-	-	+	-	+
T. dichotomum	SPAD	Circ.	Colateral	Angular	Contínuo	Delgada	-	-	+	-	+	+	-	+
T. parviflorum	SCAD	Circ.	Colateral	Angular	Descontínuo	Delgada	-	-	+	-	-	+	-	+
X. heterocalyx	SCPA	SCAD	Colateral	Angular	Contínuo	Delgada	-	-	-	-	-	+	-	+

Tabela 5. Caracteres anatômicos peciolares das espécies de Bignonieae do Pico do Jabre. Legendas: Ac = Areia cristalina; Ce = Cristal esférico; Circ = Circular; Cp = Cristal prismático; D-obv = Depresso-obovado; Dr - Drusa; Es = Estiloide; Hexg = Hexagonal; Rf = Ráfide; Gp = Glandular-peltado; Gs = Glandular-estipitado; Pent = Pentagonal; PPAD = Pentagonal com projeções adaxiais; PSPR = Pentagonal sem projeções adaxiais; Semc = Semicircular; Sm = Simples; SemC = Semicircular-côncavo.

	Caracteres														
Espécie	**Contorno**	**Formato do Feixe vascular**	**Tipo de Feixe vascular**	**Colênquima**	**Esclerênquima**	**Cutícula**	**Idioblastos inorgânicos**						**Tricomas**		
							Ac	**Ce**	**Cp**	**Dr**	**Es**	**Rf**	**Gp**	**Gs**	**Sm**
A. crucigerum	PPAD	Pent.	Colateral	Angular	Descontínuo	Delgada	+	+	+	+	-	+	+	-	+
A. paniculatum	PSPR	Pent.	Colateral	Angular	Descontínuo	Delgada	-	+	+	-	-	-	+	-	+
A. citrinum	Circ.	Semc.	Colateral	Angular	Descontínuo	Espessada	-	-	+	-	-	-	+	-	+
B. ramentacea	PPAD	Pent.	Colateral	Angular	Descontínuo	Delgada	-	-	+	-	+	-	+	-	+
B. sciuripabulum	PPAD	Semc.	Colateral	Angular	Descontínuo	Delgada	-	-	+	-	+	-	+	-	+
C. lateriflora	Hexg.	Arco	Colateral	Lacunar	Descontínuo	Espessada	-	-	+	-	-	-	+	+	+
D. unguis-cati	Circ.	Circ.	Colateral	Lamelar	Descontínuo	Espessada	-	+	+	-	-	+	+	-	+
F. pubescens	Circ.	Circ.	Colateral	Angular	Contínuo	Delgada	-	-	-	-	-	-	+	-	+
P. venusta	PSPR	Pent.	Colateral	Angular	Descontínuo	Espessada	+	-	+	-	-	-	+	-	+
T. cyrtanthum	Circ.	Circ.	Colateral	Angular	Contínuo	Delgada	-	+	-	-	-	+	+	-	-
T. dichotomum	Circ.	Circ.	Colateral	Angular	Contínuo	Delgada	-	-	+	-	-	+	+	-	+
T. parviflorum	SemC.	D-obv.	Colateral	Angular	Descontínuo	Delgada	-	-	+	-	-	-	+	-	+
X. heterocalyx	PSPR	Pent.	Colateral	Lacunar	Descontínuo	Delgada	-	-	-	-	-	-	+	-	-

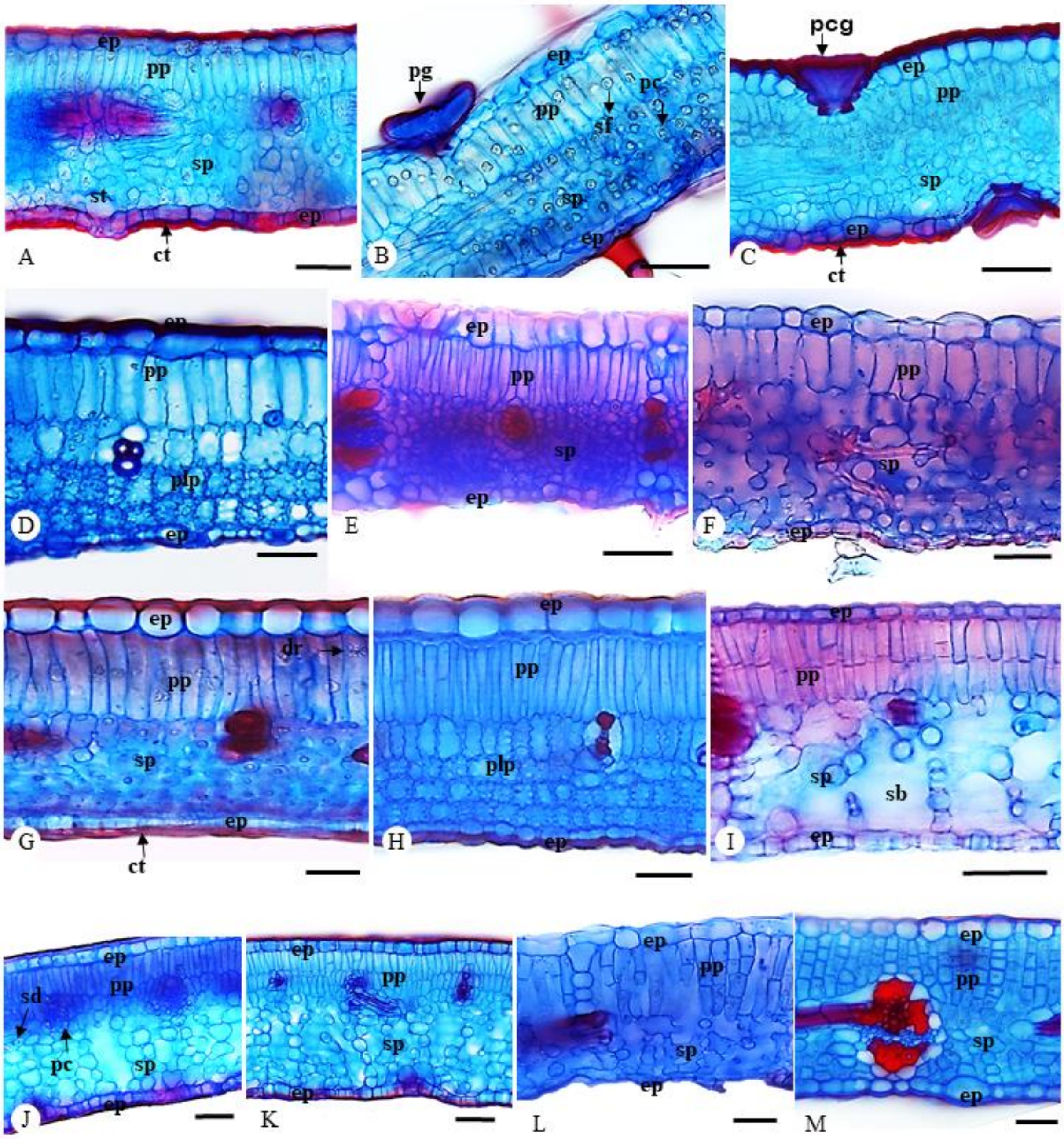

Figura 1. Secções transversais do mesofilo das espécies de Bignonieae do Pico do Jabre, **A.** *A. crucigerum* (*Lopes 243*). **B.** *A. paniculatum* (*Agra et al. 7112*). **C.** *A. citrinum*, (*Lopes 239*). **D.** *T. parviflorum*, (*Lopes 240*). **E.** *C. lateriflora*, (*Agra et al. 3932*). **F.** *T. dichotomum*, (*Lopes 259*). **G.** *P. venusta*, (*Lopes 257*). **H.** *T. cyrtanthum*, (*Lopes 263*). **I.** *X. heterocalyx*, (*Lopes 261*). **J.** *B. ramentacea*, (*Agra et al. 4022*). **K.** *B. sciuripabulum*, (*Lopes 238*). **L.** *F. pubescens*, (*Lopes 256*). **M.** *D. unguis-cati*, (*Lopes 246*). Legendas: sc = câmara subestomática; ct = cúticula; Dr = Drusa; ep = epiderme; vb = feixe vascular; pp = parênquima paliçádico; plp = parênquima plicado; sp = parênquima esponjoso; st = estômato; Pg = tricoma peltado; PCg = tricoma pateliforme/cupular; Sd = estilóide; Sf = cristal esférico. Escalas = A-F, H-J, L-M = 50µm; G, K = 100µm.

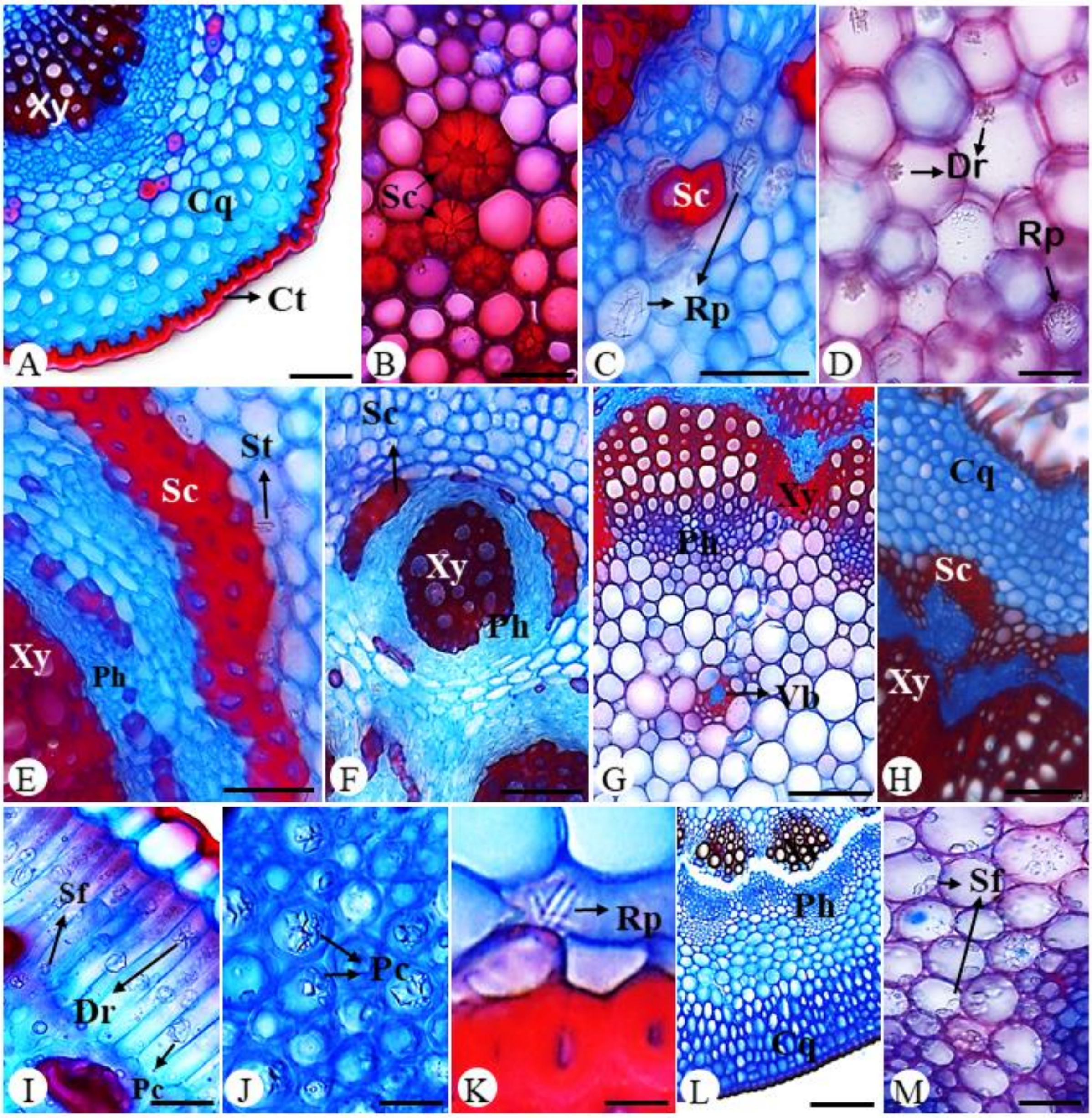

Figura 2. **A—B.** *A. citrinum* (*Lopes 239*): **A.** Colênquima angular e cutícula espessada na nervura principal; **B**. Braquiesclereídes na medula peciolular. **C—D.** Pecíolo de ***A. crucigerum*** (*Lopes 243*): **C.** Medula com drusas; **D**. Ráfides no parênquima; **E**. Pecíolo de *B. ramentacea* (*Agra et al. 4022*): Cristais e estilóides; **F.** Pecíolo de *C. lateriflora* (*Agra et al. 3932*): Feixes acessórios; **G**. Pecíolo de *T. dichotomum* (*Lopes 259*): Feixe medular acessório; **H.** Pecíolo de *F. pubescens* (*Lopes 256*): Colênquima angular; **I—J.** *P. venusta* (*Lopes 257*): **I**. Drusas no mesofilo; **J**. Cristais prismáticos na medulla no peciólulo; **K—M.** *T. cyrtanthum* (*Lopes 263*): **K**. Ráfides na nervura principal; **L**. Colênquima angular no peciólulo; **M.** Cristais esféricos na medula do peciólulo. **Legendas**: Br: Braquesclereide; Cq: Colênquima; Ct: Cutícula; Dr: Drusa; Pc: Cristal prismático; Ph: Floema; Rp: Ráfide; Sc: Esclerênquima; Sf: Cristal esférico; St: Estilóide; Vb: Feixe vascular; Xy: Xilema; Escalas: A-F, I, J, K, M = 50µm; G-H = 100µm; L = 200µm.

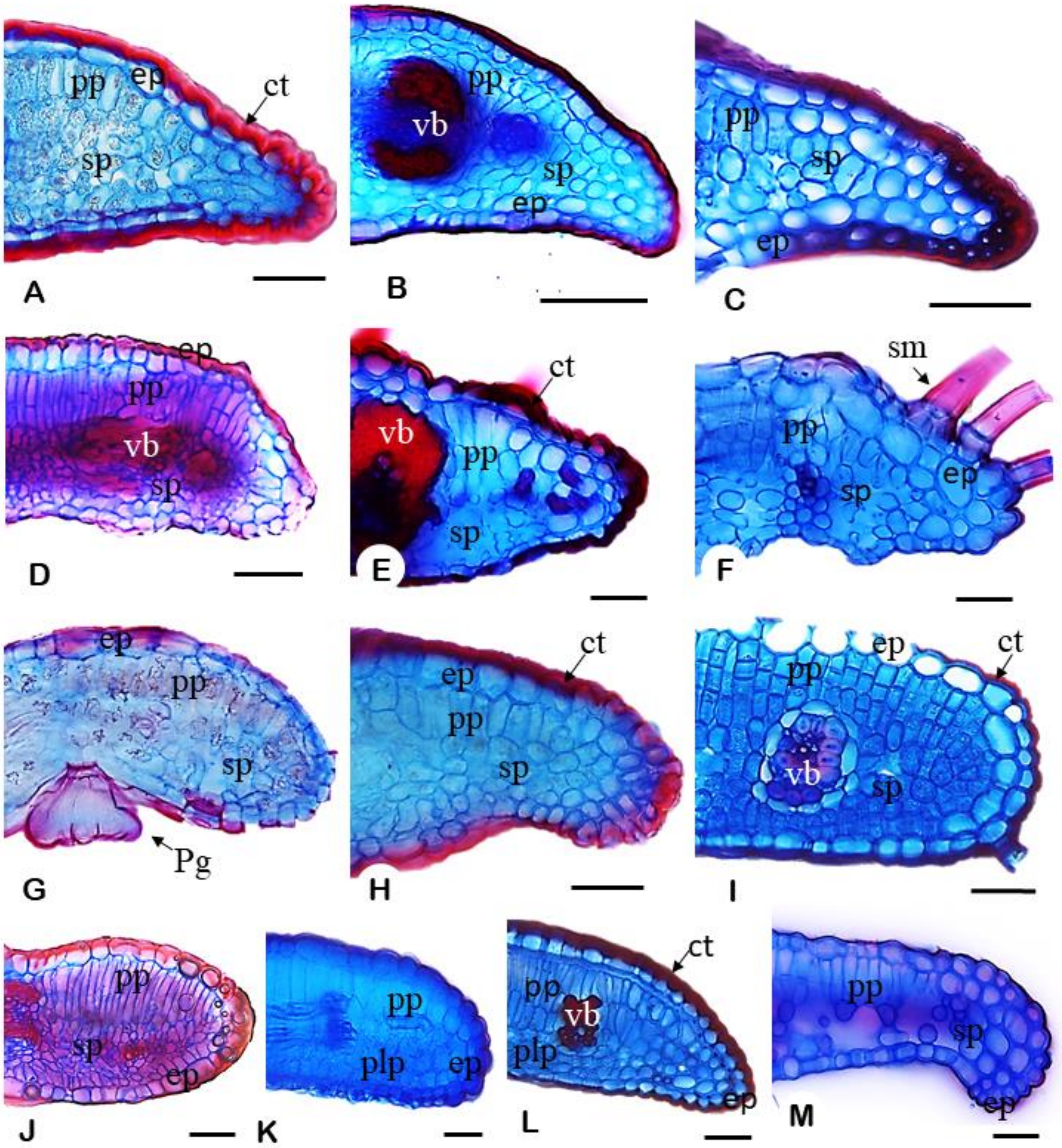

Figura 3. Secções transversais dos bordos das espécies de Bignonieae do Pico do Jabre, **A.** *A. citrinum* (*Lopes 239*). **B.** *B. ramentacea*, (*Agra et al. 4022*). **C.** *B. sciuripabulum*, (*Lopes 238*). **D.** *C. lateriflora*, (*Agra et al. 3932*). **E.** *T. dichotomum*, *Lopes 259*. **F.** *F. pubescens*, (*Lopes 256*). **G.** *A. crucigerum*, (*Lopes* 243). **H.** *A. paniculatum*, (*Agra et al. 7112*). **I.** *D. unguis-cati*, (*Lopes 246*). **J.** *P. venusta*, (*Lopes 257*). **K.** *T. parviflorum*, (*Lopes 240*). **L.** *T. cyrtanthum*, (*Lopes 263*). **M.** *X. heterocalyx*, (*Lopes 261*). **Legendas**: ct = Cutícula; ep = epiderme; plp = parênquima plicado; pp = Parênquima paliçádico; Pg = tricoma peltado; sp = parênquima esponjoso; sm = tricoma simples; vb = feixe vascular; Escalas = A-C, E-J, L-M = 50µm; D, K = 100µm.

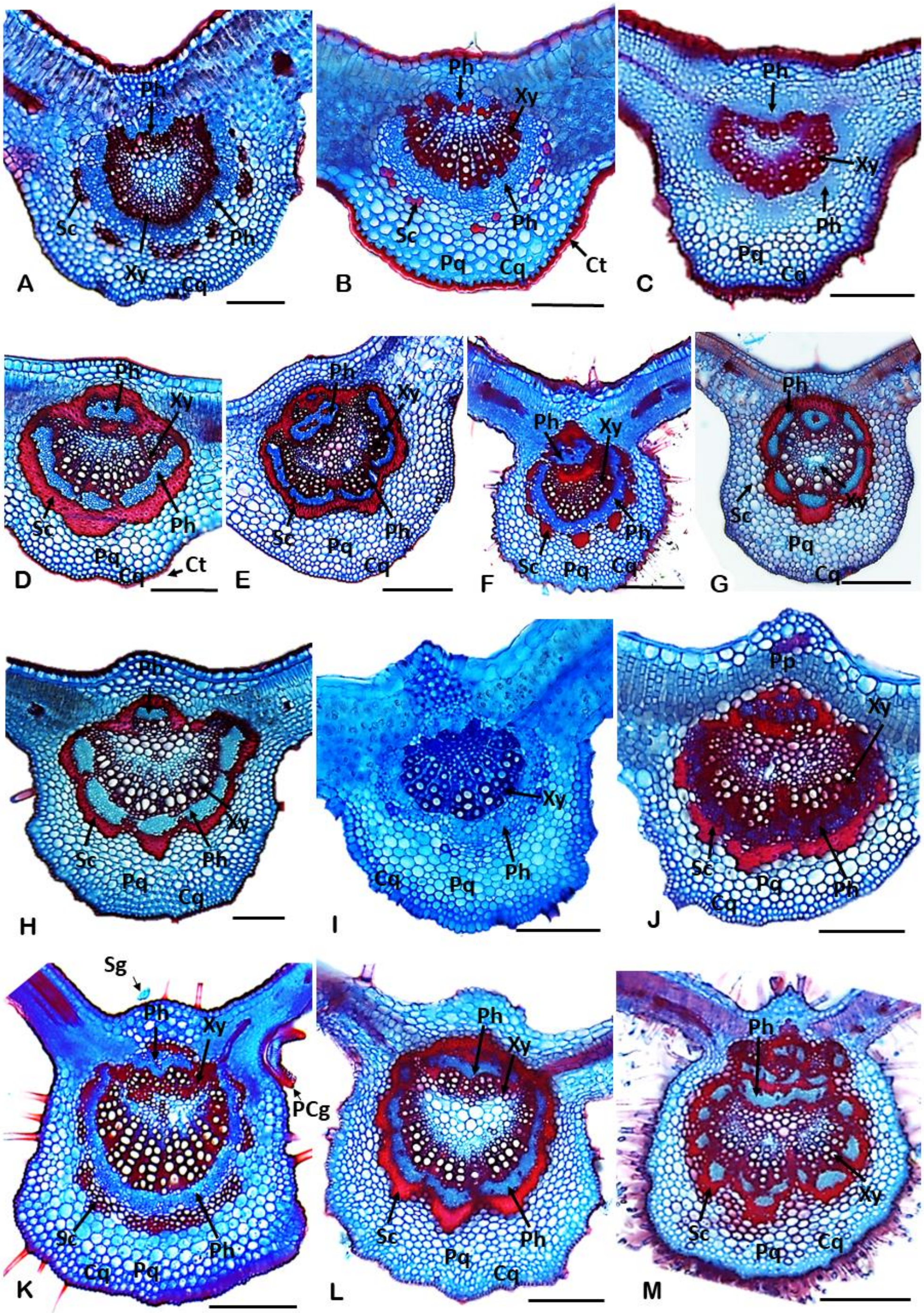

Figura. 4. Secções transversais da região mediana da nervura principal das espécies de Bignonieae **A.** *P. venusta* (*Lopes 257*). **B.** *A. citrinum*, (*Lopes 239*). **C.** *A. paniculatum*, (*Agra et al. 7112*). **D.** *B. ramentacea*, (*Agra et al. 4022*). **E.** *B. sciuripabulum*, (*Lopes 238*). **F.** *C. lateriflora*, (*Agra et al. 3932*). **G.** *X. heterocalyx*, (*Lopes 261*). **H.** *T. cyrtanthum*, (*Lopes 263*). **I.** *A. crucigerum*, (*Lopes 243*). **J.** *D. unguis-cati*, (*Lopes 246*). **K.** *T. parviflorum*, (*Lopes 240*). **L.** *T. dichotomum*, (*Lopes 259*). **M.** *F. pubescens*, (*Lopes 256*). **Legendas**: Cq = Colênquima; Ct = Cutícula; PCg = Tricoma pateliforme/cupular; Ph = Floema; Pp = Parênquima paliçádico; Pq = Parênquima; Sc = Esclerênquima; Sg = Tricoma estipitado; Xy = Xilema; Escalas = A, C, E, F, G, H, J, L, M = 200µm; B, D, I, K = 100µm.

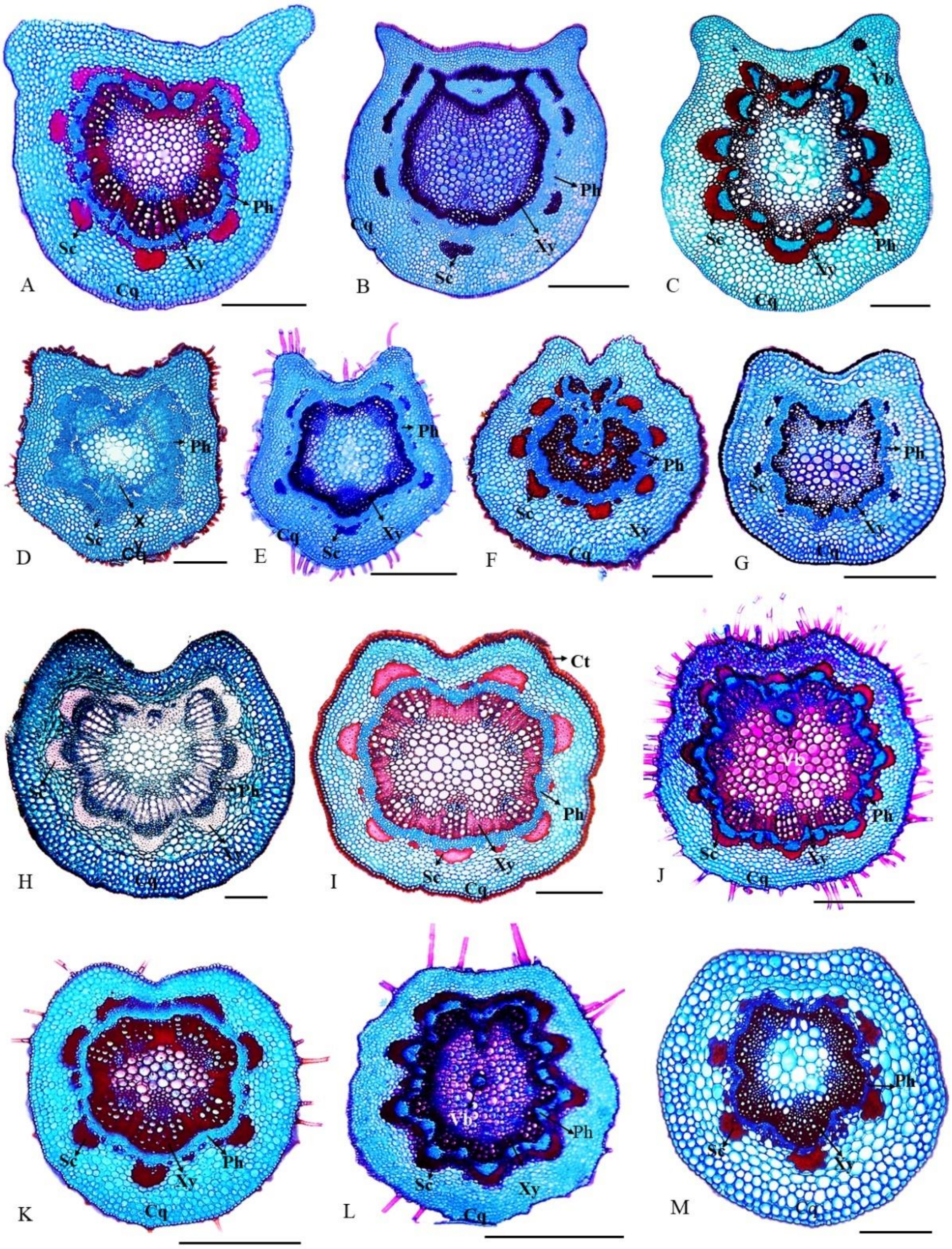

Figura 5. Secções transversais da região mediana dos peciólulos das espécies de Bignonieae do Pico do Jabre, Paraíba, Brasil. **A.** *B. ramentacea*, (*Agra et al. 4022*). **B.** *B. sciuripabulum*, (*Lopes 238*). **C.** *X. heterocalyx,* (*Lopes 261*). *A. citrinum*, (*Lopes 239*). **D.** *A. paniculatum*, (*Agra et al. 7112*). **E.** *A. crucigerum* (*Lopes 243*). **F.** *C. lateriflora*, (*Agra et al. 3932*). **G.** *P. venusta*, (*Lopes 257*). **H.** *T. cyrtanthum*, (*Lopes 263*). **I.** *A. citrinum*, (*Lopes 239*). **J.** *F. pubescens*, (*Agra et al. 7115*). **K.** *T. parviflorum*, (*Lopes 240*). **L.** *T. dichotomum*, (*Lopes 259*). **M.** *D. unguis-cati*, (*Lopes 246*). **Ct =** Cutícula; **Ph =** Floema; **Sc =** Esclerênquima; **Vb =** Feixe vascular; **Xy =** Xilema; Escalas = D, F, H, I, K, M = 200µm; A-C, G, J = 500µm; E, L = 1mm;

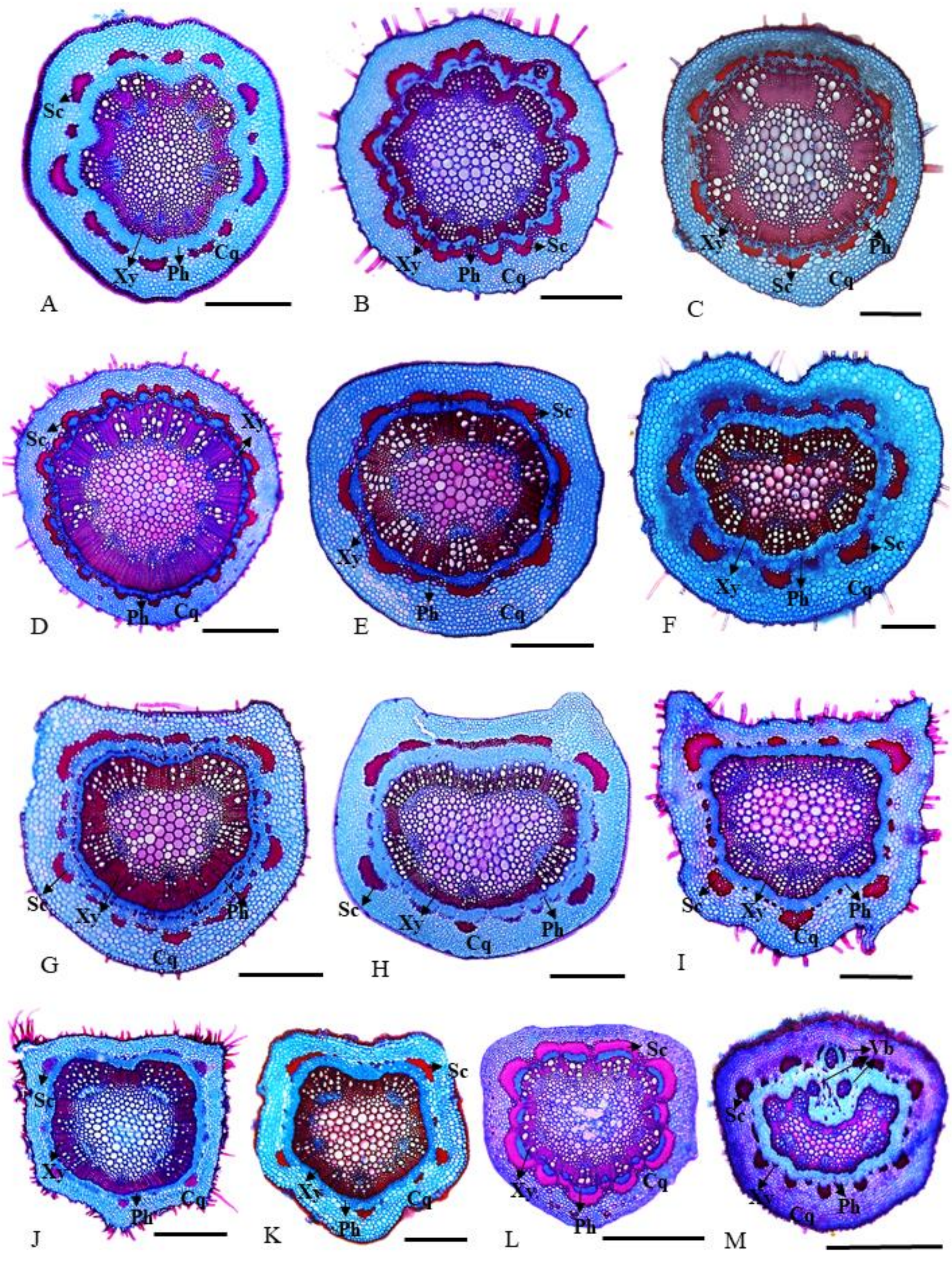

Figura 6. Secções transversais da região mediana dos pecíolos das espécies de Bignonieae do Pico do Jabre. **A.** *A. citrinum* (*Lopes 239*). **B.** *T. dichotomum*, (*Lopes 259*). **C.** *D. unguis-cati*, (*Lopes 246*). **D.** *F. pubescens*, (*Lopes 256*). **E.** *B. sciuripabulum*, (*Lopes 238*). **F.** *T. parviflorum*, (*Lopes 240*). **G.** *B. ramentacea*, (*Agra et al. 4022*). **H.** *C. lateriflora*, *Agra et al. 3932*. **I.** *T. cyrtanthum*, (*Lopes 263*). **J.** *A. crucigerum*, (*Lopes* 243). **K.** *A. paniculatum*, (*Agra et al. 7112*). **L.** *P. venusta*, (*Lopes 257*). **M.** *X. heterocalyx*, (*Lopes 261*). Legendas: Ph = Floema; Sc = Esclerênquima; Vb = Feixe vascular; Xy = Xilema; Escalas = C, F, K = 200µm; A, B, D, E, G, I, J = 500µm; H = 1mm; L-M = 2mm.

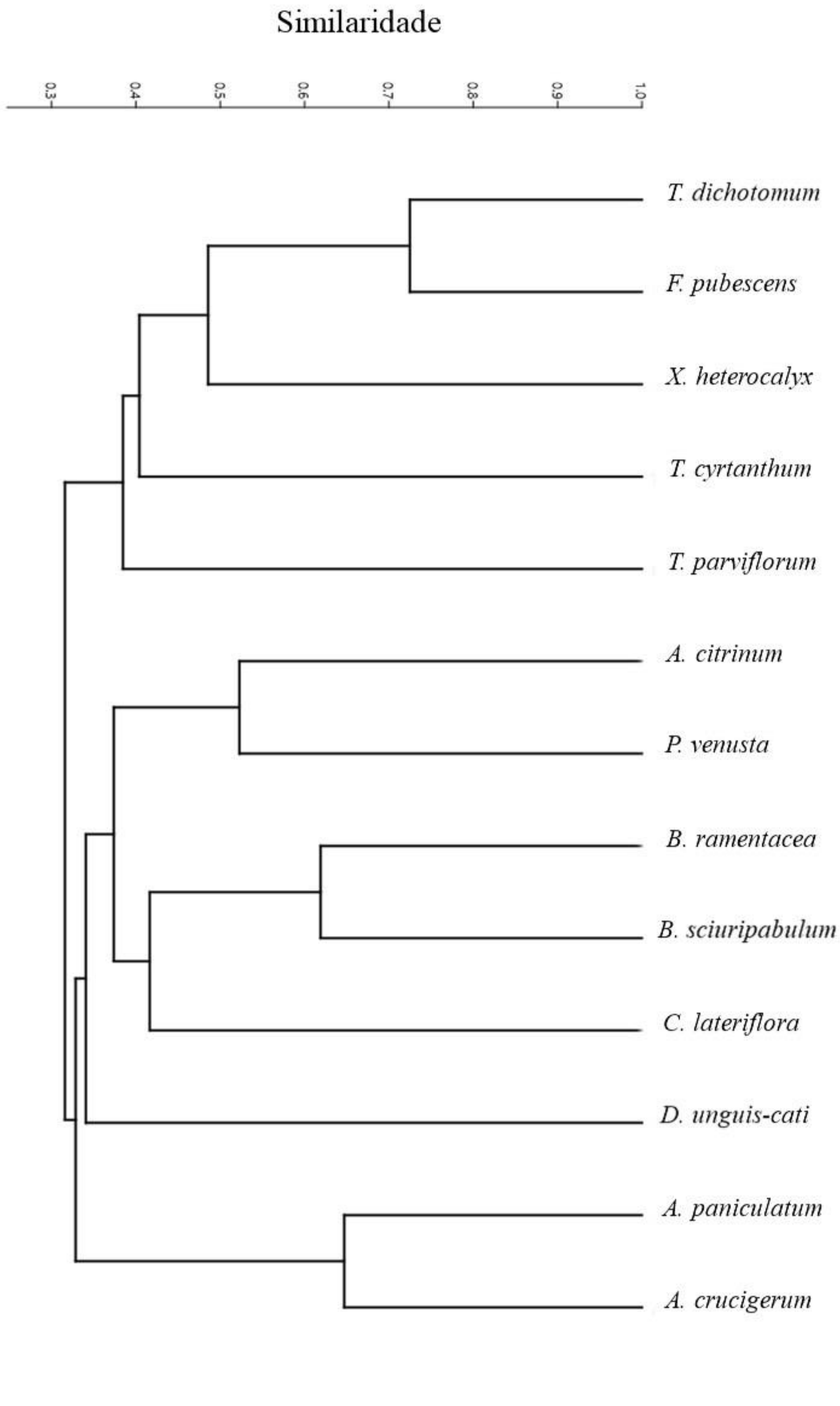

Figura 7. Análise de agrupamento UPGMA (Método de Agrupamento Não-ponderado Utilizando Médias Aritméticas) de 13 espécies de Bignonieae, baseado em dados anatômicos foliares.

6 Considerações Finais

Este trabalho representa uma importante contribuição para a flora da Paraíba, ampliando as coleções dos seus principais herbários (EAN e JPB); o número de registros da tribo Bignonieae para o estado (quatro spp.) e para o Pico do Jabre (seis spp.); assim como a distribuição de algumas dessas espécies.

Sobre a anatomia foliar, conclui-se que, o uso dessa ferramenta em Bignonieae apresentou resultados satisfatórios, no que concerne a efetividade em utilizá-la como suporte a taxonomia do grupo. Verificou-se que as espécies de Bignonieae do Pico do Jabre, possuem caracteres anatômico-foliares distintivos, quanto a epiderme e outras estruturas, como mesofilo, nervura principal, peciólulo e pecíolo. Representando além disso, um adicional a caracterização anatômica de Bignonieae e consequentemente de Bignoniaceae.

Anexo I – Normas *Phytotaxa*

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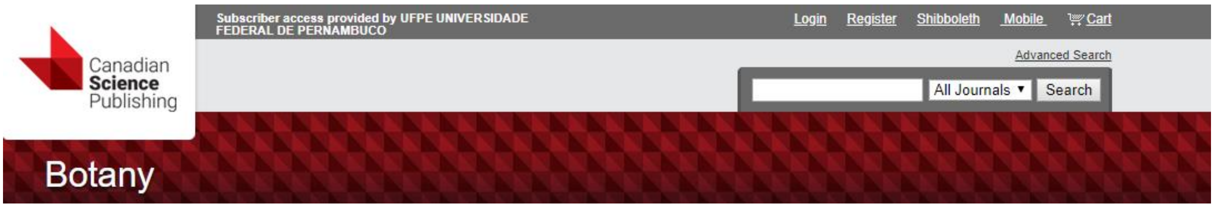
Anexo II – Normas *Botany*



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The Journal publishes articles, notes, methods papers, commentaries, and reviews, in English or French. Manuscripts must be clearly and concisely written such that the length is commensurate with the amount of new information presented. An article reports results of a substantial, completed work; we suggest a length of no more than 10,000 words. A note is a brief report of a small experiment or taxonomic proposal; it should be less than 14 double spaced manuscript pages (4,200 words) including tables and figures, and be organized as much as possible like articles, with formal headings.

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Anexo III – Normas *Flora*

FLORA

Morphology, Distribution, Functional Ecology of Plants

AUTHOR INFORMATION PACK

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