Rodriguésia 73: e01692021. 2022
http://rodriguesia.jbrj.gov.br
DOI: http://dx.doi.org/10.1590/2175-7860202273110

Original Paper

Flora of Ceará, Brazil: Rhamnaceae

Maria Vitória Coutinho Cordeiro da Silva[1], *Luana Mateus de Sousa*[2,6], *Rayane de Tasso Moreira Ribeiro*[3], *Raimundo Luciano Soares Neto*[4] & *Maria Iracema Bezerra Loiola*[2,5,7]

Abstract

We present the floristic-taxonomic and distribution survey of the family Rhamnaceae as part of the "Flora of Ceará: knowing to conserve" project. The survey was based on the analysis of morphological characters of specimens gathered during field expeditions and from herbaria collections, as well as the specialized literature. Rhamnaceae is represented by ten species in Ceará State belonging to five genera: *Colubrina* (2), *Crumenaria* (1), *Gouania* (3), *Rhamnidium* (1), and *Sarcomphalus* (3). The species were encountered in various phytophysiognomies, but especially occur in Seasonal Semideciduous Forests (Mata Seca) and the Coastal Zone Vegetation Complex (Lowland Semideciduous Forest). The species with the highest number of records was *Sarcomphalus joazeiro*, occurring in 62 municipalities. Seven species were encountered in 14 legally protected conservation areas in Ceará. *Colubrina cordifolia*, *Rhamnidium molle*, and *Crumenaria decumbens* occur exclusively in the Caatinga domain, with the first two being endemic to northeastern Brazil. Identification keys, morphological descriptions, comments on distributions, ecology, phenology, and uses of the species are provided, as well as maps and illustrations.

Key words: diversity, *Gouania*, Rosales, *Sarcomphalus*.

Resumo

O estudo objetivou realizar o levantamento florístico-taxonômico e a distribuição dos representantes da família Rhamnaceae, como parte do projeto "Flora do Ceará: conhecer para conservar". O trabalho foi embasado na análise de caracteres morfológicos de amostras obtidas em campo, coleções de herbário e bibliografias especializadas. No território cearense, Rhamnaceae está representada por dez espécies pertencentes a cinco gêneros: *Colubrina* (2), *Crumenaria* (1), *Gouania* (3), *Rhamnidium* (1) e *Sarcomphalus* (3). As espécies foram registradas em diferentes fitofisionomias, mas ocorrem preferencialmente na Floresta Estacional Semidecídua (Mata Seca) e no Complexo Vegetacional da Zona Litorânea (Mata de Tabuleiro). O táxon com o maior número de registros foi *Sarcomphalus joazeiro*, ocorrendo em 62 municípios. Sete espécies foram registradas em 14 Unidades de Conservação do Ceará. *Colubrina cordifolia*, *Rhamnidium molle* e *Crumenaria decumbens* ocorrem exclusivamente no domínio da Caatinga e as duas primeiras espécies são endêmicas da região Nordeste. Chaves de identificação, descrições morfológicas, comentários sobre distribuição, ecologia, fenologia e usos, mapas e ilustrações das espécies são apresentados.

Palavras-chave: diversidade, *Gouania*, Rosales, *Sarcomphalus*.

[1] Universidade Federal do Ceará, Centro de Ciências, Depto. de Biologia, Lab. Sistemática e Ecologia Vegetal, Campus do Pici, Fortaleza, CE, Brazil. ORCID: <https://orcid.org/0000-0002-2753-2096>.

[2] Universidade Federal do Ceará, Centro de Ciências, Prog. Pós-graduação em Ecologia e Recursos Naturais, Campus do Pici, Fortaleza, CE, Brazil.

[3] Field Museum, Keller Science Action Center, Field Guides Initiative, Chicago, IL, United States. ORCID: <https://orcid.org/0000-0001-6006-598X>.

[4] Universidade Federal do Ceará, Centro de Ciências, Prog. Pós-graduação em Ecologia e Recursos Naturais, Campus do Pici, Fortaleza, CE, Brazil. ORCID: <https://orcid.org/0000-0002-5643-9464>.

[5] Universidade Federal do Ceará, Centro de Ciências, Depto. Biologia, Lab. Sistemática e Ecologia Vegetal, Campus do Pici, Fortaleza, CE, Brazil. ORCID: <https://orcid.org/0000-0003-3389-5560>.

[6] ORCID: <https://orcid.org/0000-0003-1415-3297>.

[7] Author for correspondence: iloiola@ufc.br

Introduction

Rhamnaceae comprises 1,000 species globally, included within 52 genera with cosmopolitan geographic distributions, although they are predominantly encountered in the tropics (with some species in the temperate regions) (Hauenschild *et al*. 2018; Lima *et al*. 2020). Its representatives have habits varying from trees to herbs and climbers; the sepals have a prominent midvein on the adaxial surface, petals unguiculate, convolute, cuculate or shell-shaped, stamens opposite the petals, and a nectariferous disk surrounding the receptacle (Lima & Giulietti 2006).

The family is considered an ancient taxon, with diversification dating back to the Cretaceous, circa 94 m.y.a (Crepet *et al*. 2004), with 25 described fossils evenly distributed over time (Correa *et al*. 2010; Chen *et al*. 2017). Rhamnaceae is monophyletic, and has been the focus of molecular phylogenetic studies (based on nuclear, plastidial, and mitochondrial genetic sequences) that have contributed to the elucidation of infrafamilial circumscriptions (Richardson *et al*. 2000a; Kellermann & Udovicic 2008; Hauenschild *et al*. 2016).

The family was initially placed within the order Rhamnales, together with Vitaceae and Leeaceae, in traditional classification systems of flowering plants (Hutchinson 1964; Takhtajan 1969; Dahlgren *et al.* 1980; Cronquist 1981, 1988). The current classification, however, recognizes the family as subordinated to Rosales, and related to Barbeyaceae, Cannabaceae, Dirachmaceae, Elaeagnaceae, Moraceae, Rosaceae, Ulmaceae, and Urticaceae (Stevens 2001; APG IV 2016). Three main clades have been identified within Rhamnaceae: Rhamnoideae, including more than 300 species; Ziziphoideae (more than 600 species); Ampeloziziphoids (approx. 10 species) (Richardson *et al*. 2000b).

Species of Rhamnaceae are utilized by human populations in northeastern Brazil for different purposes. *Sarcomphalus joazeiro* (Mart.) Hauenschild is used in popular medicine as an expectorant (Araújo & Agra 2018) and to treat bronchitis and gastric ulcers (Lorenzi & Matos 2002); it also has ornamental uses for providing shade, and is planted along streets and in gardens (Lorenzi 2020). *Hovenia dulcis* Thunberg., an Asian species, is commonly used in urban landscaping and produces edible pseudo-fruits (Souza & Lorenzi 2019). *Colubrina glandulosa* Perkins is used in woodworking as well as in civil, hydraulic, and naval construction due to the excellent quality of its wood (Carvalho 2005).

Rhamnaceae is represented by 14 genera and approximately 50 species in Brazil, of which 15 are endemic (Lima *et al*. 2020). In the Northeast region, the family is represented by five genera and approximately 20 species, of wich 10 occur in the state of Ceará. Its species were studied while preparing the flora of São Paulo State, with 15 recorded taxa (Lima & Giulietti 2005). Local floras of Brazil's northern and south-eastern regions include the Ducke Reserve in Amazonas, with seven species (Lima 2006b), the Grão-Mogol (Lima 2006a) and Serra do Cipó in Minas Gerais State (Lima 2011), which cite two and one species respectively. Rhamnaceae species are cited in floristic lists for northeastern Brazil in: Mirandiba/Pernambuco - *Crumenaria decumbens* Mart. and *Ziziphus cotinifolia* Reissek (Lima 2009); Arcoverde/Pernambuco (Barbosa *et al.* 2012) - *Rhamnidium molle* Reissek; Entre Rios/Bahia (Alves *et al.* 2015) - *Ziziphus platyphylla* Reissek; Cajazeiras/Paraíba (Pereira *et al.* 2012) - *Ziziphus joazeiro* Mart.; Picos/Piauí (Rocha *et al.* 2016) - *Z. joazeiro* and Macaíba/Rio Grande do Norte (Ucella Filho *et al.* 2017) - *Z. joazeiro*. It is noteworthy that a phylogenetic study by Hauenschild *et al*. (2016), based on molecular genetic sequences, evidenced that individuals recognized within *Ziziphus* are restricted to Asia; those authors also proposed the reestablishment of *Sarcomphalus*, comprising species previously identified as *Ziziphus* in the Neotropics.

Although Rhamnaceae is an important component for the flora of Ceará state, with significant biological and cultural importance, its representatives are mentioned in only a few floristic lists (Silva *et al*. 2012; Loiola *et al*. 2015, 2020; Silveira *et al*. 2020a, b). Continuing the studies of the Project "Flora of Ceará: knowing to conserve", we carried out a floristic-taxonomic survey of Rhamnaceae species to better understand the diversity of this group and to expand our knowledge of its geographic distribution there.

Material and Methods

Studies were made of specimens obtained during field expeditions, as well as of collections in the EAC, HCDAL, IPA, HUVA herbaria, the online database collections of ALCB, ASE, CEN, ESAL, FURB, HDELTA, HUEFS, HVASF, INPA, JPB, MAC, MBM, NY, R, UEC and UFP herbaria (acronyms in accordance with Thiers (continuously

updated), and the non-indexed CSTR and HST herbaria.

The species were identified in accordance with the morphological features of specimens observed *in loco*, comparative analyses of exsiccates, photographs of type collections, and consultations of the specialized literature (Jussieu 1789; Johnston 1971; Johnston & Soares 1972; Lima 2000; Lima & Giulietti 2006; Richardson *et al*. 2000b; Medan & Schirarend 2004). The morphological terminology used here follows Harris & Harris (2001). Additional specimens from other Brazilian states were included to complement the descriptions for some taxa when samples collected in Ceará were incomplete with respect to their floral or fruit features.

Geographic distribution maps were elaborated using QGIS software (2020). Specimens without original geographic coordinates were georeferenced using their municipal coordinates and the "geoLoc" tool (CRIA 2021).

The vegetation types where the species occurred were based on the classification system of Figueiredo (1997) for Ceará state and the Technical Manual of the Brazilian Vegetation (IBGE 2012): Vegetation Complex of the Coastal Zone (comprising Pioneer Psammophilous Vegetation, Forest behind Dunes, and Lowland Semideciduous Forests), Neotropical Savanna (Cerrado), Semideciduous Seasonal Forest (mata seca), Steppic Savanna (caatinga and/or carrasco), Dense Ombrophilous Forest (mata úmida), Forest Savanna (cerradão), and Vegetation under Fluvial and/or Lacustrine Influence (mata ciliar). Information concerning the vegetation type, popular names, and flowering and fruiting periods were obtained from the exsiccate labels.

Freehand ink drawings were made and digitized to prepare the plates in an image editing program. The Canva platform was used to create the photographic plate.

Results and Discussion

A total of 10 species of Rhamnaceae, representing five genera, were recorded for Ceará state: *Colubrina cordifolia* Reissek, *C. glandulosa*, *Crumenaria decumbens*, *Gouania blanchetiana* Miq, *G. colurnifolia* Reissek, *G. polygama* (Jacq.) Urb., *Rhamnidium molle*, *Sarcomphalus joazeiro*, *S. platyphyllus* (Reissek) Hauenschild, and *S. undulatus* (Reissek) Hauenschild. As for the conservation status, only *Colubrina glandulosa* and *Gouania blanchetiana* were evaluated and classified as LC = least concern, that is, abundant and widely distributed species (CNCFLORA 2022).

Seven species were recorded in Semideciduous Seasonal Forest, Vegetation Complex of the Coastal Zone (Lowland Semideciduous Forest), and Dense Ombrophilous Forest. *Colubrina cordifolia*, *Crumeria decumbens*, *Gouania colurnifolia* and the three species of *Sarcomphalus* occur in Steppic Savanna. *Colubrina cordifolia* and *S. joazeiro* were recorded in Forest Savanna. *Crumenaria decumbens*, *G. colurnifolia*, *S. joazeiro*, and *S. undulatus* occur in Vegetation under Fluvial and/or Lacustrine Influence. Only *C. cordifolia* was recorded in Savanna vegetation. The taxon with the highest number of records was *Sarcomphalus joazeiro* (62 municipalities). *Rhaminidium molle* had only two records from the 1950s, which indicates the need for more intensive sampling efforts in the areas where it was previously collected, as well as in other sites with similar environmental conditions within Ceará.

Seven species were recorded in 14 legally protected Conservation Areas in Ceará: the Missão Velha Environmental Protection Area (1); Dunas da Lagoinha Environmental Protection Area (2); Pacoti River Environmental Protection Area (1); Aiuaba Ecological Station (1); Pecém Ecological Station (1); Araripe-Apodi National Forest (1); Quixadá Monoliths Natural Monument (1); Ubajara National Park (2); Timbaúbas Municipal Natural Park (1); Serra das Almas Private Natural Heritage Reserve (2); Cocó State Park (1); Fazenda Trussú Private Natural Heritage Reserve (1), Pedra da Andorinha Wildlife Refuge (1), and Fazenda Não Me Deixes Private Natural Heritage Reserve (1).

Taxonomic treatment

Rhamnaceae Juss., Gen. Pl.: 376. 1789.

Herbs, shrubs, trees or lianas, unarmed or spinescent, with or without tendrils. Stipules lateral or intrapetiolar, elliptic, lanceolate, oblong or lanceolate. Leaves simple, alternate, opposite or subopposite, membranaceous, carthaceous or coriaceous, margin entire or serrate, with or without glands on the abaxial surface. Inflorescences in panicle, thryse or umbel. Flowers 5-merous, usually not showy, bisexual and/or unisexual, actinomorphic, diclamydeous; sepals with a prominent midvein on the adaxial surface; petals convolute, cucullate or shell-shaped; stamens in numbers equal to the petals, anthers

rimose; nectariferous disk crassous, slender or membranaceous, glabrous, pubescent or velutinous; ovary superior, semi-inferior or inferior, 2–3-carpelar, 2–3-locular, one ovule per locule. Fruits drupe, capsule, or winged schizocarp; seeds ovate, oblong, obovate or ellipsoid.

Identification key of the species of Rhamnaceae occurring in Ceará

1. Herbs or lianas; ovary inferior; winged fruits.
   2. Herbs decumbent; inflorescences pauciflorous; fruits with trichomes papillose ..... 2.1. *Crumenaria decumbens*
   2’. Lianas; inflorescences densiflorous; fruits glabrescent or velutinous.
      3. Branches pubescent; stipules lobed..... 3.1. *Gouania blanchetiana*
      3’. Branches velutinous; stipules entire.
         4. Leaves chartaceous; fruits velutinous ..... 3.2. *Gouania colurnifolia*
         4’. Leaves membranaceous; fruits pubescent, except in the wings ..... 3.3. *Gouania polygama*

1’. Trees or shrubs; ovary superior or semi-inferior; fruits non-winged.
   5. Plants unarmed; leaf blade with glands and margin entire.
      6. Leaves membranaceous; stipules intrapetiolar; fruits drupe.....4.1. *Rhamnidium molle*
      6’. Leaves chartaceous; stipules lateral; fruits capsule.
         7. Leaf with abaxial surface densely velutinous; nectariferous disk plane ..... 1.1. *Colubrina cordifolia*
         7’. Leaf with abaxial surface pubescent to velutinous; nectariferous disk sulcate..... 1.2. *Colubrina glandulosa*
   5’. Plants spinescent; leaf blade without glands and margin serrate.
      8. Spines slender; leaf margin ondulate and serrate.....5.3. *Sarcomphalus undulatus*
      8’. Spines stout; leaf margin plane and serrate.
         9. Stipules lanceolate..... 5.1. *Sarcomphalus joazeiro*
         9’. Stipules ovate to oblong.....5.2. *Sarcomphalus platyphyllus*

1. *Colubrina* Rich *ex* Brongn., Ann. Sci. Nat. 10: 368. 1827. nom. cons.

Trees or shrubs unarmed; young branches velutinous or tomentose, ferrugineous, adult branches glabrous to glabrescent, lenticellate, ferrugineous. Stipules lateral, elliptic. Leaves opposite or subopposite, petiolate, ovate or elliptic, base rounded, apex acuminate, acute or obtuse, cordate or obtuse, margin entire, chartaceous, adaxial surface velutinous to pubescent or glabrescent, abaxial surface pubescent or densely velutinous, with glands atropurpureous, conspicuous, discoid, basal on each side of the petiole and/or submarginal; venation actinodromous. Inflorescences in thyrse, densiflorous, velutinous, ferrugineous. Flowers monoclinous and diclinous (staminate), morphologically similar to monocline flowers, except for styloids; 5-merous, velutinous, ferrugineous; sepals patent; petals convolute; 5 stamens, anthers ovate or subrounded; nectariferous disk conspicuous, crass, sulcate or plane; ovary superior or semi-inferior, 3-carpelar, 3-locular, 3 ovules, 1 ovule per locule. Fruits non-winged. septicidal capsule, globose, glabrous or glabrescent. Seeds obovate or subespherical, arillate.

1.1. *Colubrina cordifolia* Reissek, *Fl. bras.* 11(1): 98, tab. 25, fig. 2. 1861. Figs. 1a; 2a-d

Shrubs or trees 1.5–7 m tall; young branches velutinous. Stipules 4–5 mm long, elliptic. Petiole 0.5–1.3 cm long. Leaves 4–13 × 2–8 cm, ovate, base cordate to obtuse, apex acute to obtuse, margin entire, slightly ondulate, chartaceous, adaxial surface glabrescent or velutinous to pubescent, opaque, abaxial surface densely velutinous with 1–6 glands discoid, submarginal. Thyrse densiflorous, 7–15 flowers per inflorescence; peduncle 1–4 mm long. Flowers 5–7 mm long, monoclinous: pedicel ca. 2 mm long; sepals ca. 1.5–2 × 1 mm; petals ca. 1–1.5 mm long; claw 0.2–0.3 mm long; anthers subrounded; nectariferous disk plane; ovary ca. 2 mm wide, obovate, style free.

Flowers staminate with filiform styloid. Capsule 1–2.1 cm long, globose, glabrous to glabrescent, fructiferous pedicel 1.2–1.5 cm long, velutinous. Seeds 5–6 mm long, obovate.

Selected examined material: Araripe, Chapada do Araripe, 07°12'45"S, 40°02'46"W, 14.IV.2015, fl., *T.L. Costa & M.A. Chagas* 72 (IPA). Barbalha, 07°33'36"S, 39°25'12"W, 23.V.2014, fl., *M. Mayer* (EAC 56775). Campos Sales, Salitre, 10.II.1984, fl., *A. Fernandes & M.A. Figueiredo* (EAC 12300, JPB 43105). Crateús, Reserva Particular do Patrimônio Natural Serra das Almas, 19.VI.2003, fl. and fr., *R.C. Costa* (EAC 35127). Crato, Floresta Nacional do Araripe-Apodi, 25.V.1999, fl. and fr., *A.M. Miranda & D. Lima 3429* (EAC, HST, HUEFS, JPB, MAC). Guaraciaba do Norte, 26.V.1981, fl., *A. Fernandes & P. Martins* (EAC 10356). Nova Olinda, 07°05'30"S, 39°40'50"W, 10.III.2008, fl., *W.N. Ferreira* (HCDAL 4346). Novo Oriente, Planalto da Ibiapaba, 28.III.1990, fl., *F.S. Araújo* 40 (EAC, JPB). Santana do Cariri, Guritiba, 27.VII.2004, fl. and fr., *A.S.F. Castro 1517* (EAC). São Benedito, Chapada da Ibiapaba, 20.VII1989, fl., *A. Fernandes et al.* (EAC 15789). Ubajara, Planalto da Ibiapaba, 25.IV.1994, fl. and fr., *F.S. Araújo* 672 (EAC, HCDAL).

Colubrina cordifolia is a notably distinct species, characterized by its leaves having the abaxial surfaces densely velutinous, with submarginal foliar glands, and plane nectariferous disk.

Colubrina cordifolia is endemic to northeastern Brazil, occurring in the states of Bahia, Ceará, Pernambuco, and Piauí (Lima *et al.* 2020). In Ceará, the species has been recorded in 11 municipalities in Savanna, Dense Ombrophilous Forest, Forest Savanna, and Steppic Savanna phytophysiognomies. The species has been recorded in two Conservation Areas: Araripe-Apodi National Forest and Serra das Almas Private Natural Heritage Reserve.

The species was collected flowering from February to July, and fruiting from April to July.

The popular names are guachumbo, imbiriba assú, joão vermelho.

1.2. *Colubrina glandulosa* Perkins, Bot. Jahrb. Syst. 45: 465-466. 1911. Figs. 1a; 2e-h

Shrubs or trees 5–15 m tall; young branches tomentose. Stipules 3–5 mm long, elliptic. Petiole 0.8–1.5 cm long. Leaves 6.5–17 × 3.5–9 cm, ovate to elliptic, base rounded to cordate, apex acute to acuminate, margin entire, revolute, chartaceous,

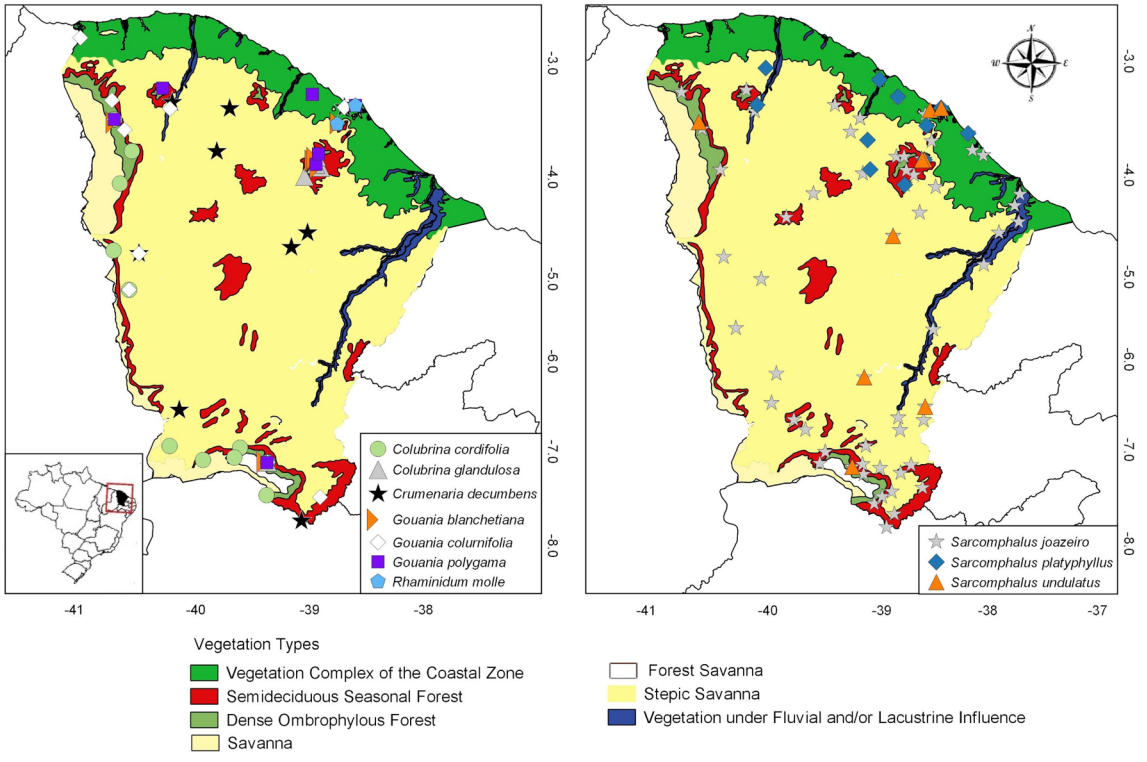

Figure 1 – a-b. Geographic distribution of Rhamnaceae in Ceará – a. *Colubrina*, *Crumenaria*, *Gouania*, and *Rhamnidium*; b. *Sarcomphalus* spp.

adaxial surface glabrous to glabrescent, shiny, abaxial surface pubescent to velutinous with 1–2 glands discoid, basal, near to petiole and 3–10 glands submarginal. Thyrse densiflorous 10–40 flower per inflorescence; peduncle 1–6 mm long. Flowers 4–5 mm long, monoclinous: pedicel 2–2.5 mm long; sepals 1.5–1.8 × 1 mm; petals ca. 1.5 mm long; claw 0.1–0.2 mm long; anthers ovate; nectariferous disk sulcate, margin crenate; ovary ca. 2 mm wide, subglobose to globose, style free at apex. Flowers staminate with filiform styloid. Capsule 1–1.5 cm long, globose, glabrous; fructiferous pedicel 3.5–7 mm long. Seeds 4–4.5 mm long, subglobose, biconvex.

Selected examined material: Aratuba, Sítio Brejo, 14.V.1980, fl., *P. Martins & E. Nunes* (EAC 8609). Baturité, 21.VI.1976, fl., *A. Fernandes & F.J.A. Matos* (EAC 2786). Crato, Chapada do Araripe, 07°14'03"S, 39°24'33"W, 26.IV.2017, fr., *N.B. Campos 62* (HCDAL). Fortaleza, Bairro Alagadiço Novo, 7.V.1999, fl., *A.S.F. Castro 689* (EAC). Guaramiranga, Sítio Guaramiranga, 04°17'49"S, 38°55'59"W, 9.IX.1989, fr., *V.S. Gomes et al. 1205* (EAC). Pacoti, Serra de Baturité, 16.X.1961, fr., *M.A. Figueiredo* (EAC 18470).

Two subspecies are recognized in Brazilian territory: *Colubrina glandulosa* subsp. *glandulosa* and *C. glandulosa* subsp. *reitzii* (Lima *et al*. 2020) and both occur in Ceará. The first has leaves membranaceous (*vs*. chartaceous), abaxial surface glabrescent (vs. pubescent to velutinous), wavy margin (*vs*. revolute) and pedicels 2–3 mm long (*vs*. 5–6 mm).

The species is widely distributed in Brazil, occurring in the states of Maranhão, Ceará, Paraíba, and Pernambuco in northeastern Brazil (Lima *et al*. 2020). It was recorded in six municipalities in Ceará, in Dense Ombrophilous Forest, Semideciduous Seasonal Forest, and the Vegetation Complex of the Coastal Zone (Lowland Semideciduous Forest).

The species was collected with flowers in April and May, and with fruits in April, September and October.

These species are used in comercial wood, ornamental, reforestation (Montagna & Reis 2011).

The popular names aresobraji, sobrasil, sobraju, saraguari.

2. *Crumenaria* Mart., Nov. Gen. Sp. pl. 2(1): 68., t. 160. 1826.

2.1. *Crumenaria decumbens* Mart., Nov. Gen. sp. pl. 2(1): 68., t. 160. 1826. Figs. 1a; 2i-j

Herbs 20–35 cm tall, decumbent, unarmed, tomentose; branches cylindric, striate. Stipules ca. 2 mm long, lateral, lanceolate, margin with trichomes simple. Petiole 0.8–1 mm long. Leaves 1–3 × 0.6–2.8 cm, simple, ovate, base cordate to obtuse, apex acute or apiculate, margin entire or serrate, membranaceous, adaxial surface with pappilose trichomes simple, abaxial surface glabrous, glands absent; venation actinodromous. Inflorescences umbelliform, axillary, pauciflorous, usually 1–3-flora; bracts linear, prematurely deciduous. Flowers 2–3 mm long, monoclinous and diclinous (staminate), 5-merous, with pubescent hypanthium; pedicel 0.6–0.8 mm long; calyx tube 1–1.4 mm long, with trichomes; lobes with acute apex; petals 0.4–0.6 mm long, cuculate, unguiculate petal ca. 0.2 mm long; anthers ovate; nectariferous disk membranaceous, glabrous, plane; ovary obovate, inferior, 3-carpelar, 3-locular, one ovule per each locule, 3 style, free to the distal half, stigma obtuse. Schizocarps 5–7 mm long, winged, pubescent, obovate, with pappilose trichomes simple, fructiferous pedicel 2–3 mm long. Seeds 2.5–3 mm long, obovate, brown.

Selected examined material: Aiuaba, 06°43'09''S, 40°16'48''W, 9.IV.1997, fl. and fr., *L.W. Lima-Verde* 620 (EAC 43717). Caucaia, 03°44'10"S, 38°39'11"W, 11.V.2005, fl., *M. Oliveira & A. Galileu* 1725 (UFP). Crateús, 28.IV.2007, fl. and fr., *L.P Amaral Neto et al*. 85 (EAC). Irauçuba, 03°44'46"S, 39°46'59"W, 21.IV.2001, fl. and fr., *G.B. Oliveira* (EAC 31804). Penaforte, Sítio Baixio dos Couros, 07°48'45"S, 39°04'32"W, 15.II.2011, fl. and fr., *A.L. Alves 30* (HVASF). Quixadá, Reserva Particular do Patrimônio Natural Fazenda Não Me Deixes, 8.V.2000, fl. and fr., *R.C. Costa* (EAC 32021). Quixeramobim, Assentamento Vista Alegre, 22.III.2014, fl. and fr., *L.Y. Oliveira* 149 (CEN). Santa Quitéria, 04°10'09"S, 39°54'36"W, 14.V.2016, fl., *I.S.A. Cardins 187* (IPA). Sobral, Fazenda Macapá, 20.V.1989, fl. and fr., *A. Fernandes* (EAC 16651).

Crumenaria decumbens is distinct from other Rhamnaceae species occurring in Ceará by its herbaceous decumbent habit, leaves highly developed in relation to other taxa of the genus, inflorescence umbelliform, pauciflorous, usually with one to three flowers, and schizocarps obovate with papillose trichomes.

Crumenaria decumbens is found only within the Caatinga domain, in the states of Alagoas, Bahia, Ceará, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, and in northern Minas Gerais (Lima *et al*. 2020). It has been recorded in nine municipalities in Ceará, occurring preferentially in Steppic Savanna, but also in the Vegetation Complex of the Coastal Zone (Lowland Semideciduous Forest) and Semideciduous Seasonal Forest. The species

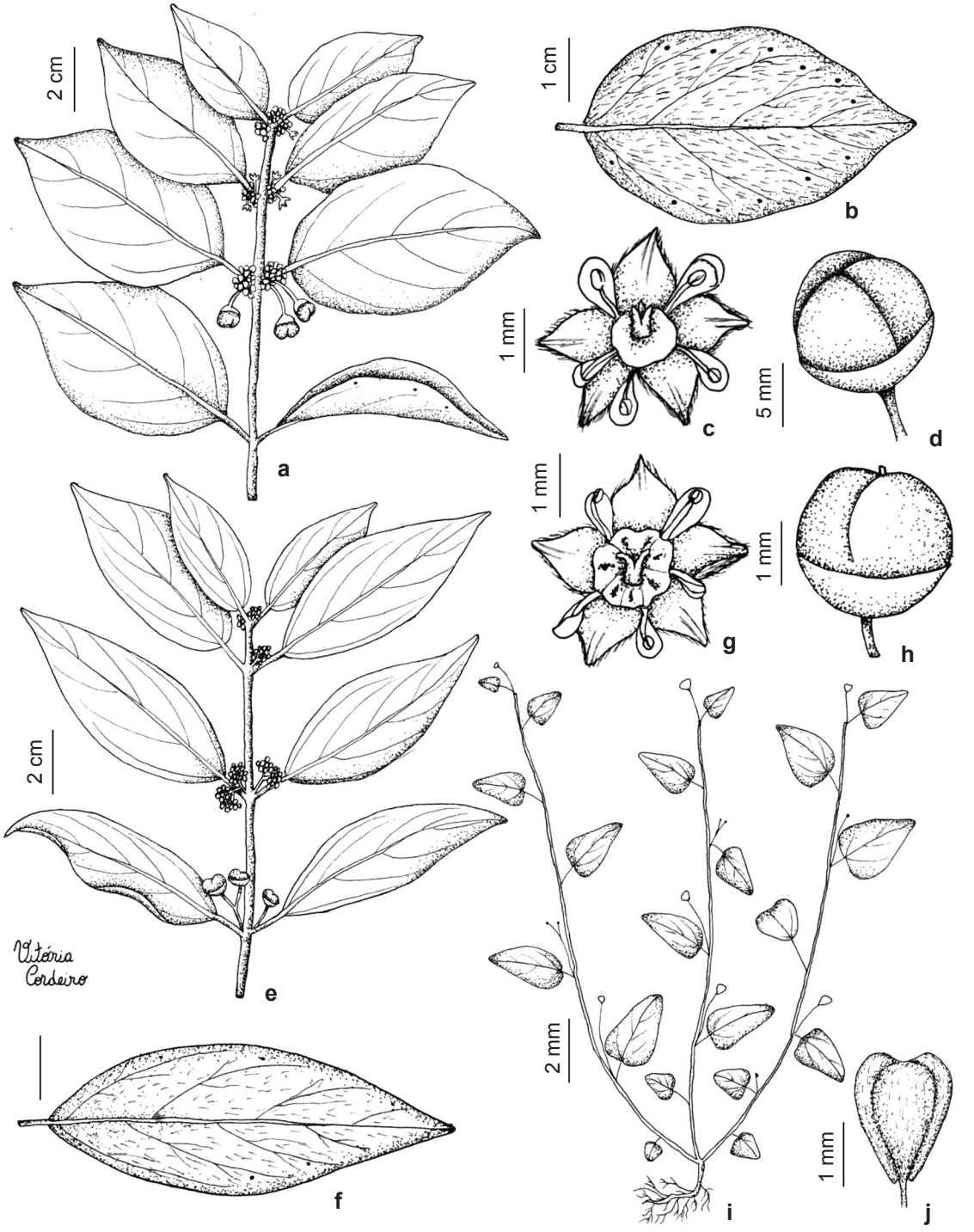

Figure 2 – a-d. *Colubrina cordifolia* – a. branch with buds and fruits; b. leaf details; c. monoclinous flower; d. fruits. e-h. *Colubrina glandulosa* – e. branch with buds and fruits; f. leaf details; g. monoclinous flower; h. fruits. i-j. *Crumenaria decumbens* – i. branch with buds and fruits; j. fruits. (a-d. *A.S.F. Castro* 1517; e-h. *A.S.F. Castro 689*; i-j. *R.C. Costa* (EAC 32019).

has been recorded in the Fazenda Não Me Deixes Private Natural Heritage Reserve.

The species was flowering and fruiting in February and May.

3. *Gouania* Jacq., Select. Stirp. Amer. Hist.: 263. 1763.

Lianas sarmentose, unarmed; branches cylindric or subangular, velutinous or pubescent; tendrils axillary at the base of inflorescences, velutinous or pubescent. Stipules lateral, entire or lobed, velutinous to glabrescent. Leaves simple, alternate, peciolate, ovate or elliptic, apex acute, acuminate or obtuse, base acute, cordate, subcordate or obtuse, margin serrate and/or entire, each ridge ending in a conspicuous gland, glabrous or pubescent, membranaceous or chartaceous; venation actinodromous. Inflorescences paniculiform, axillary, densiflorous. Flowers monoclinous and e diclinous (staminate), 5-merous; sepals triangular, patent, sometimes erect; petals convolute or cuculate; 5 stamens, filaments laminar, anthers ovate or subrounded; nectariferous disk membranaceous, glabrous or pubescent on the proximal margin; ovary inferior, 3–carpelar, 3–locular, one ovule per locule, 3 style, free or livres or partially connate. Schizocarp 3-winged, mericarp with logitudinal wings, velutinous to glabrescent. Seeds obovate to elliptic, brown.

3.1. *Gouania blanchetiana* Miq., Linnaea 22: 797-798. 1849. Figs.1a; 3a-c

Lianas; branches cylindric, pubescent; tendrils pubescent. Stipules 3–5 mm long, lobed, pubescent. petiole ca. 1 cm long. Leaves 4.5–8.5 × 2.5–5 cm, ovate to elliptic, base cordate to obtuse, apex acuminate, margin serrate, chartaceous, adaxial surface and abaxial surface pubescent, glands marginal pubescent at apex. Flowers 4–4.5 mm long, pubescent; pedicel ca. 2 mm long; sepals 1–1.2 m long, petals ca. 1 mm long, convolute; stamens ca. 1.4 mm long, anthers ovate to subrounded; nectariferous disk pubescent, prominent on the proximal margin; ovary 1–1.5 mm wide, obovate; style 1–1.2 mm long, connate in the proximal half. Schizocarp 8–10 mm long, glabrous to glabrescent, wings 4–5 mm wide; fructiferous pedicel 3.5–4 mm long. Seeds 3–3.5 mm long, obovate.

Selected examined material: Baturité, 1860, fl. and fr., *F.F. Allemão & M. Cysneiros 315* (R). Crato, Macaíbas, 27.VII.2001, fr., *E.R. Silveira* (EAC 30842). Guaramiranga, subida da Serra, 1.I.1996, fr., *A.S.F. Castro 83* (EAC). Ibiapina, Planalto da Ibiapaba, 03°53'05"S, 40°53'42"W, 27.XII.2013, fl. and fr., *E.B. Souza et al. 2947* (EAC). Maranguape, Serra de Aratanha, 14.VI.1996, fl., *A.S.F. Castro 198* (EAC). Pacoti, Sítio Olho d'Água dos Tangarás, 04°14'07"S, 38°54'59"W, 17.XI.2015, fl., *L.W. Lima-Verde* (EAC 59677).

Gouania blanchetiana is distinct from other Rhamnaceae species occurring in Ceará by having branches cylindric, pubescent to glabrescent; leaves chartaceous, stipules lobate, and nectariferous disk pubescent along the proximal margin.

The species have a Neotropical distribution, ranging from northern South America to southeastern Brazil, in French Guiana, Suriname, Venezuela, Ecuador, and Columbia (GBIF 2021). In Brazil, *Gouania blanchetiana* is distributed in four northern states (Amazonas, Amapá, Pará, Tocantins) and in all states in the northeastern and southeastern regions (Lima *et al*. 2020). The species has been recorded in six municipalities in Ceará, in Semideciduous Seasonal Forest and Dense Ombrophilous Forest.

The species was collected with flowers in April, November, and December, and with fruits in January, July and December.

The popular name is cipó-de-caçuá.

3.2. *Gouania colurnifolia* Reissek, *Fl. bras.* 11(1): 107. 1861. Figs.1a; 3d-f

Lianas; branches subangular, velutinous; tendrils velutinous. Stipules 7–8 mm long, entire, velutinous. Petiole 0.5–1 cm long. Leaves 4–8 × 3–6.5 cm, discolorous, ovate, base subcordate, apex obtuse to acute, margin entire on the proximal half and serrate on the distal half, chartaceous, adaxial surface velutinous to pubescent, abaxial surface velutinous, glands marginal glabrous. Flowers 2–3 mm long, velutinous; pedicel 0.7–1 mm long; sepals ca. 1 mm long; petals ca. 1 mm long, cucullate; stamens ca. 1 mm long, anthers ovate; nectariferous disk glabrous, distal margin lobate; ovary ca. 1 mm wide, obovate, style ca. 0.7 mm long, free except in the base. Schizocarp 0.8–1 cm long, velutinous, wings 1–2 mm wide; fructiferous pedicel 0.6–1 mm long, velutinous. Seeds 3–4 mm long, obovate.

Selected examined material: Brejo Santo, 07°34'49"S, 38°53'30"W, 17.III.2010, fl. and fr., *D. Araújo 1398* (HVASF). Caucaia, 29.IV.1998, fl., *R.C.M. Dourado* (EAC 26336). Chaval, pedra da Carnaúba, 03°02'58"S, 41°15'17W, 10.VI.2016, fr., *E.B. Souza et al.* 4271 (EAC, HUEFS). Cratéus, Reserva Particular do Patrimônio Natural Serra das Almas, 8.V.2002, fr.,

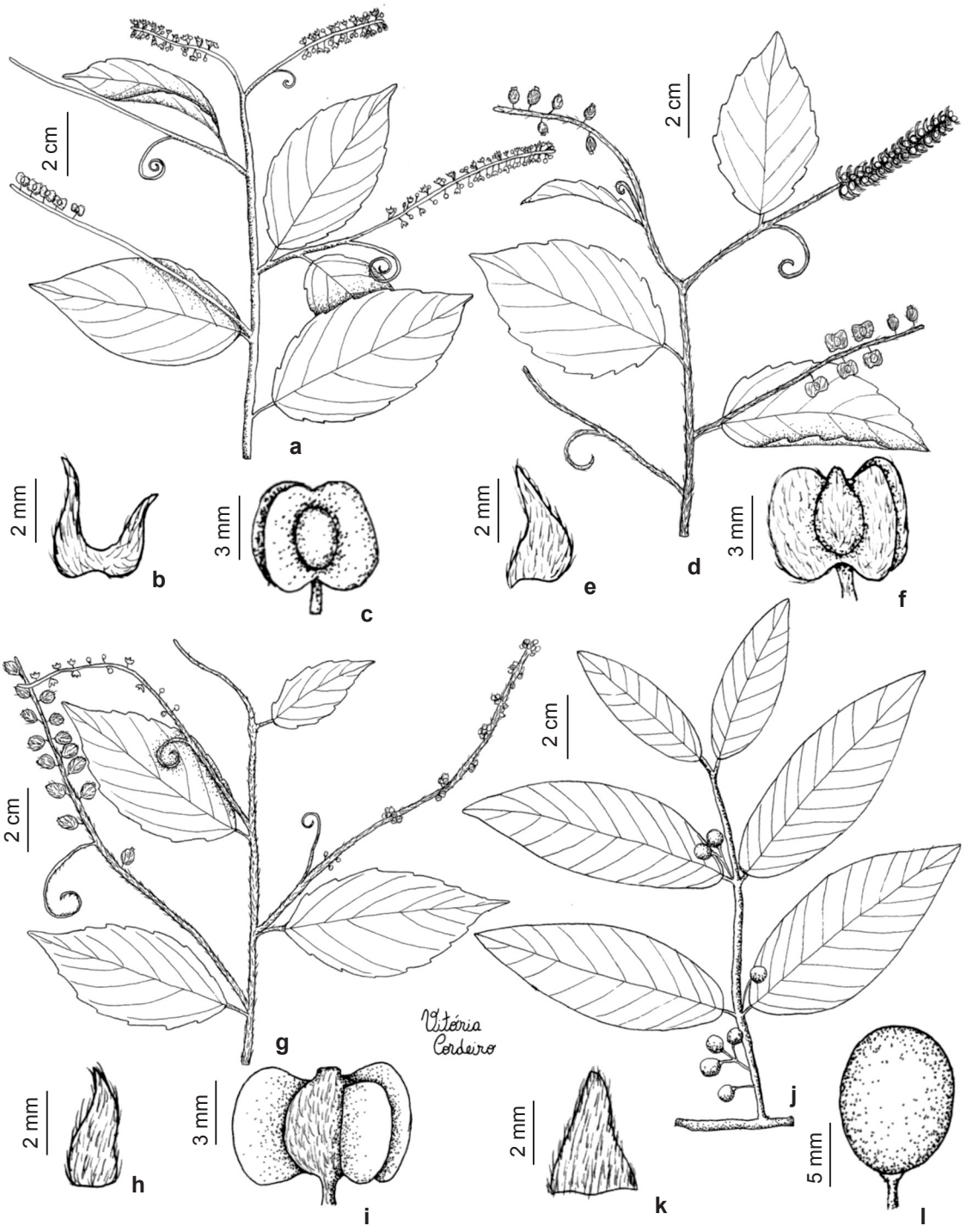

Figure 3 – a-c. *Gouania blanchetiana* – a. branch with inflorescences and fruits; b. stipule; c. fruits. d-f. *G. colurnifolia* – d. branch with inflorescences and fruits; e. stipule; f. fruits. g-i. *G. polygama* – g. branch with inflorescences and fruits; h. stipule; i. fruits. j-l. *Rhamnidium molle* – j. branch with fruit; k. stipule; l. fruits. (a-c. *E. Silveira* (EAC 39433), *L.W. Lima-Verde* (EAC 59677); d-f. *F.F. Araújo* 242, *M.I.B. Loiola et. al.* 1909; g-i. *J.C.M.S.M. Sobczak* 595, *A. Fernandes* (EAC 48575); j-l. *A.M. Miranda* 5336).

F.S. Araújo & L.C. Girão 1577 (EAC). Crato, Prov. Ceará, 07°14'03.8"S, 39°24'33.1"W, X.1838, fl., *G. Gardner 1523* (NY). Graça, 03°57'24"S, 40°49'13"W, 18.VI.2017, fr., *F.F. Araújo 242* (EAC, HUEFS). Novo Oriente, Planalto da Ibiapaba, 13.VII.1991, fr., *F.S. Araújo 487* (EAC). Sobral, Serra da Meruoca, 21.VI.2003, fr., *E.R. Silveira* (EAC 32538). Tianguá, subida da Serra, 03°40'00"S, 40°56'39"W, 7.VI.2012, fr., *M.I.B. Loiola et al.* 1909 (EAC). Ubajara, Jaburuna, Planalto da Ibiapaba - Sul, 03°51'16"S, 40°55'16"W, 21.VII.1994, fr., *F.S. Araújo 22715* (UEC).

Gouania colurnifolia may be confused with *G. polygama,* as both species have branches subangulous and velutinous; *G. colurnifolia*, however, has chartaceous leaves (*vs*. membranaceous), a glabrous nectariferous disk (*vs*. pubescent along the proximal margin), and fruits velutinous (*vs*. glabrescent).

The species is distributed only in South America; occurring in Brazil, Guyana, and Venezuela (Lima & Giulietti 2006). The species occurs in northern and northeastern Brazil (Lima *et al.* 2020) and has been recorded in 10 municipalities in Ceará in the Vegetation Complex of the Coastal Zone (Lowland Semideciduous Forest), Dense Ombrophilous Forest, Steppic Savanna, and Vegetation under Fluvial and/or Lacustrine Influence. It has been recorded only in the Serra das Almas Private Natural Heritage Reserve.

The species was collected with flowers in March, April and December, and fruits in March, May, June and July.

3.3. *Gouania polygama* (Jacq.) Urb, Symb. Antill. (Urban). 4(3): 378-379. 1910. Figs. 1a; 3g-i

Lianas; branches subangular, velutinous; tendrils velutinous. Stipules 6–8 mm long, entire, velutinous. Petiole 0.8–1.5 cm long. Leaves 5–9 × 3–5 cm, elliptic, apex acute to acuminate, base obtuse to acute, margin serrate, membranaceous, adaxial surface pubescent to velutinous, abaxial surface velutinous, glands marginal glabrous. Flowers 2–4 mm long, velutinous; pedicel ca. 1 mm long; sepals ca. 1 mm long; petals ca. 1 mm long, cucullate; stamens ca. 1 mm long, anthers ovate; nectariferous disk pubescent along the proximal margin, margin proximal lobate; ovary 1–1.5 mm wide, obovate to elliptic, style ca. 0.8 mm long, connate in the proximal half. Schizocarp 0.8–1 cm long, pubescent except in the wings, wings 4–5.5 mm wide; fructiferous pedicel 1–1.5 cm long. Seeds 3–4 mm long, elliptic.

Selected examined material: Crato, 07°14'03"S, 39°24'33"W, 6.VIII.1986, fl., *V.C. Lima 271* (IPA). Fortaleza, Barra do Ceará, 6.VII.1960, fl., *L. Almeida* (EAC 2002). Guaramiranga, Morro Alto Redondo, 10.VIII.1993, fr., *M.R.L. Oliveira* (EAC 21355). Meruoca, Santo Antônio, Serra da Meruoca, 8.V.1978, fl., *A. Fernandes* (EAC 48575). Pacoti, 04°09'49"S, 38°52'07"W, 30.IV.2017, fl. and fr., *J.C.M.S.M Sobczak* (EAC 60611). São Gonçalo do Amarante, 15.V.2011, fl., *A.S.F. Castro* (EAC 49130). Ubajara, entrada do Parque Nacional de Ubajara, 03°50'17"S, 40°53'53"W, 26.IV.2012, fl., *M.I.B. Loiola et al. 1546* (EAC).

Gouania polygama is a remarkable species, characterized by having membranaceous leaves, nectariferous disk pubescent along the proximal margin, and fruits pubescent, except the wings.

Gouania polygama ranges from Mexico to southern Brazil (Lima & Giulietti 2006). The taxon is distributed in all Brazilian states having Amazonia, Cerrado, or Atlantic Forest phytogeographic domains (Lima *et al*. 2020). The species has been recorded in seven municipalities in Ceará state, in the Vegetation Complex of the Coastal Zone (Lowland Semideciduous Forest), Semideciduous Seasonal Forest, and Dense Ombrophilous Forest. The species has been collected in only one Conservation Area in Ceará, the Ubajara National Park.

The species was collected with flowers in April and August, and with fruits in August.

The popular name is jacarei.

4. *Rhamnidium* Reissek, Fl. bras. (Martius) 11(1): 94, t. 31 (1861).

4.1. *Rhamnidium molle* Reissek *in* Mart., Fl. bras. 11(1): 95. 1861. Figs. 1a; 3j-l

Shrubs or trees 4–6 m, unarmed; young branches velutinous, adult branches glabrescent, lenticellate. Stipules ca. 2 mm long, intrapetiolar, velutinous, deciduous. Petiole 2–4 mm compr., velutinous. Leaves 4–10 × 1.5–3.5 cm, simple, opposite or subopposite, elliptic to oblong, base obtuse, apex acute to obtuse, margin revolute, membranaceous, adaxial surface pubescent, shiny, abaxial surface velutinous with trichomes whitish and glands dark punctiform; venation eucamptodromous. Thyrse densiflorous, axillary, velutinous. Flowers 2–4 × 2–3.5 mm, monoclinous, velutinous, 5-merous; pedicel 3–6 mm long; sepals ca. 2 mm long, erect; petals ca. 1 mm long, cucullate; unguiculate petal ca. 0.2 cm long; 5 stamens ca. 1.5 cm long, anthers oblong; ovary ca. 1 mm wide, elliptic, superior, 2-carpelar, 2–1-locular, 2 ovules; 2 style ca. 0.8 cm long, connate, stigma

oblique. Fruits non-winged. septicidal capsule, globose, glabrous or glabrescent. Seeds obovate or subespherical, arillate.

Drupe 0.8–2 × 0.4–1 cm, ellipsoid, glabrous, green when imature, vinaceous when ripe; fructiferous pedicel 3–5 mm long.

Selected examined material: Fortaleza, mata do Diogo-Cocó, 14.XI.1954, fl., *A. Ducke* (EAC 1018). Maranguape, Serra de Maranguape, 1.XII.1955, fl., *A. Fernandes & A. Lima* (EAC 1542).

Additional examined material: BRAZIL. ALAGOAS: Água Branca, RVS do Craunã e do Padre, 09°15'53.5"S, 37°53'15.2"W, 5.II.2014, fr., *M.C.S. Mota et al. 12349* (MAC). BAHIA: Bom Jesus da Lapa, 13°15'32"S, 43°25'11"W, 10.II.2000, fr., *L.P. de Queiroz et al. 5804* (HUEFS). PARAÍBA: São José dos Cordeiros, RPPN Fazenda das Almas, 07°28'14"S, 36°53'53.6"W, 11.III.2007, fl., *M.R. Barbosa et al. 3150* (JPB). PERNAMBUCO: Custódia, 08°05'15"S, 37°38'35.2"W, 8.XII.1988, fl. and fr., *M.J.N. Rodal & E.M.N. Ferras 51859* (UEC). RIO GRANDE DO NORTE: Jucurutu, RPPN Stoessel de Britto, 06°02'02"S, 37°01'13"W, 20.XII.2007, fl., *A.A. Roque 379* (JPB). SERGIPE: Poço Verde, 10°42'28"S, 38°10'58"W, Fazenda Santa Maria da Lage, 16.XI.2010, fl., *E.V.R. Ferreira et al. 217* (ASE). PIAUÍ: Palmeira do Piauí, Rod. PI-130, 08°43'37"S, 44°14'09"W, 27.XI.2005, fl., *A.M. Miranda 5336* (MAC 53902).

Rhamnidium molle is characterized by having leaves membranaceous and bifacial, with the adaxial surface shiny and abaxial surface velutinous, with trichomes whitish, punctiform glands, and inflorescences in thyrses.

Rhamnidium molle is endemic to northeastern Brazil, occurring in the states of Bahia, Ceará, Paraíba, Pernambuco, Piauí, and Rio Grande do Norte in the Caatinga phytogeographic domain (Lima *et al.* 2020). Only two collections, made in the 1950s, are known from Ceará, in the Vegetation Complex of the Coastal Zone (Lowland Semideciduous Forest), and Semideciduous Seasonal Forest.

The species was collected flowering and fruiting in November and December.

The popular names are mussanga, mussananga, viuvinha.

5. *Sarcomphalus* P.Browne, Civ. Nat. Hist. Jamaica: 179. 1756.

Shrubs or trees, spinescent; branches thicks, sinuate or slender; spines straight, stout or slender. Stipules lateral, ovate, oblong or lanceolate. Leaves simple, alternate, petiolate, ovate to elliptic, base cordate, rounded, obtuse or acute, apex acuminate or acute, margin serrate, plane or ondulate, membranaceous or chartaceous to coriaceous, glands absent; venation acrodromous, the two arched or straight side veins. Inflorescences in thyrse, axillary, congested or laxous. Flowers monoclinous or diclinous (staminate), 5-merous; sepals greenish, deltoid, patent; petals yellow-greenish; unguiculate petal long, laminar; stamens reflexed, filament laminar, anthers ovate; nectariferous disk slender, slightly sulcate; ovary superior, glabrous, 2–3-carpelar, 2–3-locular, 2–3 ovules, 1 ovule per locule; style glabrous, free in the distal half or only at the apex. Fruits non-winged, drupe, globose or ellipsoid. Seeds 1–2 ovate.

5.1. *Sarcomphalus joazeiro* (Mart.) Hauenschild, Taxon 65(1): 56. 2016. Figs. 1b; 4a-e

Trees 4–10 m; branches thicks, glabrous to glabrescent, lenticellate; spines 1–2 cm long, straight, stout. Stipules 1–1.7 mm long, lanceolate. Petiole 0.5–1 cm long. Leaves 3–7.5 × 3–6 cm, ovate to elliptic, base cordate to obtuse, apex acuminate to acute, margin serrate, plane, membranacenous (when young) and chartaceous to coriaceous (at maturity). Thyrse congested, 10–30 flowers per inflorescence. Flowers 3–6 mm long, monoclinous; pedicel 1.5–3.5 mm long; sepals 1.1–1.5 mm long, deltoid; petals 1–1.5 mm long, conchiform; nectariferous disk slender; ovary ca. 1 mm wide, glabrous, globose, 2-carpelar, 2-locular, style free at the distal half. Flowers staminate with styloid free and erect in the distal half. Fruits 1–2 cm long, globose, glabrous, lenticellate; fructiferous pedicel 3–4.5 mm long.

Selected examined material: Acarape, 04°13'26"S, 38°42'28"W, 28.IX.2020, fl., *L.M. Sousa* 22 (EAC). Aiuaba, Estação Ecológica de Aiuaba, 10.IV.2014, fr., *C. Lima* & *T. Renato* (EAC 56036). Antonina do Norte, 06°46'30"S, 39°59'21"W, 3.III.2015, fl., *F.F.S. Sousa 32* (JPB). Apuiarés, 12.XI.2011, fl., *A.S.F. Castro 2555* (EAC). Aquiraz, trilha das Sucurujubas, 03°58'28"S, 38°16'43"W, 15.I.2016, fr., *A.P Negreiros et al.* 15 (EAC). Aracati, 04°33'43"S, 37°46'12"W, 23.X.2020, fl., *L.M. Sousa* 29 (EAC). Aracoiaba, 04°22'23"S, 38°48'40"W, fl., 22.I.2021, *M.I.B. Loiola* 2854 (EAC). Arneiroz, 11.IV.2016, fr., *A.M.C. Araújo 4* (EAC). Assaré, 06°52'28"S, 39°52'30"W, fl., *D.A. Ribeiro* (HCDAL 8346). Aurora, estrada de barro, 15.I.2008, fl., *A.M. Miranda et al.* 5605 (ALCB, HST). Barbalha, margem do rio Oití, 22.X.1965, fl., *J.S. Sobrinho 115* (IPA). Barro, Pitombeira dos Luiz, 07°12'32"S, 38°52'01"W, 12.II.2015, fr., *A.P. Fontana et al. 9027* (HUEFS). Baturité, 10.III.2010, fr., *A.M.M. Carvalho* (EAC 46859). Beberibe, 04°10'48"S, 38°07'51"W, 23.X.2020, fl., *L.M. Sousa* 27 (EAC). Brejo Santo, Sítio Ipueiras, Chapada do Araripe, 07°28'54"S, 39°01'47"W, 29.XI.2017, fl. and

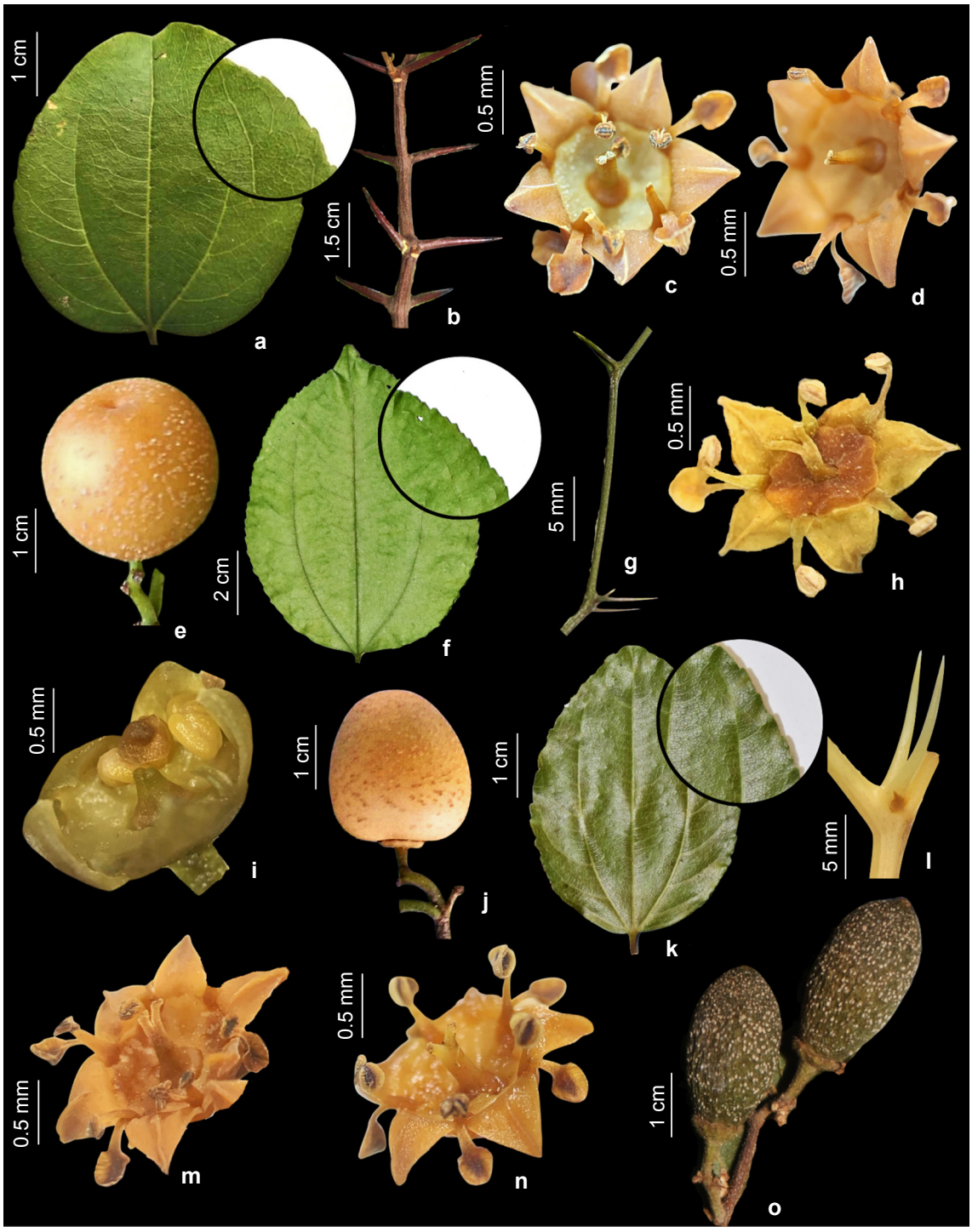

Figure 4 – a-e. *Sarcomphalus joazeiro* – a. leaf; b. spines; c. monoclinous flower; d. diclinous (staminate) flower; e. fruits. f-j. *S. platyphyllus* – f. leaf; g. spines; h. monoclinous flower; i. diclinous (staminate) flower; j. fruits. k-o. *S. undulatus* – k. leaf; l. spines; m. monoclinous flower; n. diclinous (staminate) flower; o. fruits. (a-e. *L.M. Sousa & M.I.B. Loiola* 01; f-j. *L.M. Sousa* 40; k-o. *L.M. Sousa* 18).

fr., *J.C. Andrade* (HCDAL 13346). Canindé, 11.II.1989, fl., *M.A. Figueiredo et al.* (EAC 17171). Capistrano, Serra de Baturité, 5.VIII.1993, *J.B.L.P. Medeiros & F.S. Araújo* (EAC 21518). Caridade, Povoado do Pendanga, 04°11'41"S, 38°58'58"W, 29.IX.2009, fl., *A.C. Bezerra 86* (EAC). Caririaçu, Parque da Macaúba, 07°02'00"S, 39°17'00"W, 18.IV.2009, fr., *A.C.B. Santos et al.* (HCDAL 4435). Cascavel, 04°07'51"S, 38°14'09"W, 20.XI.2020, fl., *L.M. Sousa* 30 (EAC). Caucaia, 03°46'48"S, 38°42'00"W, 21.X.2013, fl., *W. Batista 13* (EAC). Cratéus, Reserva Particular do Patrimônio Natural Serra das Almas, 27.II.2002, fr., *F.S. Araújo & S.F. Vasconcelos 1354* (EAC). Crato, 7°14'19"S, 39°24'58"W, 18.IV.2012, fl. and fr., *F.N. Bezerra et al. 01* (HCDAL). Fortaleza, Parque Estadual do Cocó, 03°74'51"S, 38°48'63"W, 13.XII.2019, fl., *F.F.S. Lopes & S.M. Morais* (EAC 64241). Guaiúba, 04°02'24"S, 38°38'13"W, 20.XI.2020, fl., *L.M. Sousa* 38 (EAC). Ibaretama, Fazenda Triunfo, 04°44'34"S, 38°45'14"W, 27.III.2012, fl. and fr., *A. Uhlmann* 569 (FURB). Ibiapina, 03°55'24"S, fl., *A.S.F. Castro* 2573 (EAC). Iguatu, Reserva Particular de Patrimônio Natural da Fazenda Trussu, 06°21'34"S, 39°17'55"W, 15.I.2018, fr., *P.H.G. Bezerra & B.G. Lima* (ESAL 30433). Independência, Escola Família Agrícola Dom Fragoso, 29.III.2014, fl., *A.C. Cavalcante 133* (CEN). Ipaumirim, S of Itó, 13.II.1985, fl., *H. Gentry 50083* (NY). Ipu, Bica do Ipu, 04°19'20"S, 40°42'38"W, 21.IV.2019, *A.S. Sousa 8* (HDELTA). Itaiçaba, 04°40'26"S, 37°49'19"W, 21.X.2020, fl., *L.M. Sousa* 33 (EAC). Itapajé, 03°41'13"S, 39°35'09"W, 21.VIII.2020, fl., *L.M. Sousa* 09 (EAC 64546). Jaguaribe, margem da estrada, 10.III.1997, fl., *F.S. Cavalcanti* (EAC 24728). Jaguaruana, 04°50'02"S, 37°46'51"W, 24.X.2020, fl., *L.M. Sousa* 32 (EAC). Jardim, Distrito de Jardimirim, 07°36'00"S, 39°12'01"W, 12.XII.2012, fl. and fr., *R.A. Silva 2400* (HVASF). Jati, Sítio Santana, 07°42'05"S, 39°00'09"W, 29.I.2013, fl., *D.G. Oliveira 879* (HVASFw367). Juazeiro do Norte, Parque Ecológico das Timbaúbas, 07°12'47"S, 39°18'55"W, 13.I.2010, fr., *G.C. Alves et al. 04* (HCDAL). Lavras da Mangabeira, 06°45'12"S, 38°57'51"W, 2.XI.2008, fl., *A.L. Jorge & J.J. Santana 05* (HCDAL). Mauriti, 07°26'36"S, 38°43'31"W, 4.VIII.2009, fl., *J.G. Carvalho-Sobrinho* 10 (HVASF). Meruoca, Sítio São Gonçalo, 12.V.2018, fr., *A.F.B. Silva* 204 (EAC). Milagres, 07°17'52"S, 38°56'26"W, 24.X.2011, fl., *C.G. Silva* (CSTR 3065). Missão Velha, Área de Proteção Ambiental Cachoeira da Missão Velha, 07°13'21"S, 39°08'38"W, 18.VIII.2011, fl., *E. Melo et al. 10212* (HCDAL, HUEFS). Monsenhor Tabosa, margens do Rio Poti, 23.X.1997, fl., *A. Fernandes* (EAC 25941). Nova Olinda, 07°05'31''S, 39°40'50"W, 18.I.2013, fl., *D.A. Ribeiro* (HCDAL 9836). Ocara, 04°29'27"S, 38°35'49"W, 22.I.2021, fl., *M.I.B. Loiola* 2859 (EAC). Pacoti, 04°11'37"S, 38°54'26"W, 22.X.2003, *V. Gomes et al. 982* (EAC). Paraipaba, Área de Proteção Ambiental Dunas da Lagoinha, 19.X.2003, fl., *Djane* (EAC 33019, HUEFS 80731). Penaforte, Sítio Cabloco, 07°49'45"S, 39°04'46"W, 12.III.2013, fr., *D.G. Oliveira 950* (HVASF). Pentecoste, Fazenda Experimental Vale do Curú, 03°49'06"S, 39°20'19"W, 17.VI.2015, fl., *C.C. Oliveira 18* (EAC). Porteiras, 07°31'50"S, 39°07'21"W, 8.X.2018, fl., *A.P. Fontana 10404* (HUEFS). Quixadá, Monumento Natural dos Monólitos de Quixadá, 04°58'17"S, 39°00'55"W, 5.IX.2017, fr., *E.D. Lozano et al. 3788* (MBM). Redenção, 04°12'57"S, 38°44'07"W, 11.X.2015, fl., *J.C.M.S.M. Sobczak* 112 (EAC). Russas, 04°56'47"S, 38°73'88"W, 10.XII.2018, fl. and fr., *L.Q.V. Braga et al.* (EAC 62448). Santa Quitéria, 04°33'16"S, 39°47'47"W, 22.IV.2012, fr., *J. Paula-Souza et al. 10757b* (SPF). Santana do Cariri, 07°12'15"S, 39°44'05"W, 23.I.2014, fl. and fr., *B.M.T. Walter et al. 6604* (CEN, EAC, UFP). São Gonçalo do Amarante, Estação Ecológica do Pecém, 8.XII.2011, fr., *R.G. Ferreira* (EAC 50533). Sobral, Refúgio da Vida Silvestre Pedra da Andorinha, 04°04'17"S, 39°59'59"W, 8.XI.2017, fl., *E.B. Souza 4844* (EAC, HUEFS). Tabuleiro do Norte, Olho d'água da Bica, 05°15'15"S, 38°07'29"W, 11.III.2014, fl., *L.M. Versieux 674* (HUEFS). Tauá, 05°51'96"S, 40°32'89"W, 17.V.2015, fr., *H.G.A. Loiola* (EAC 58097). Umari, 06°38'52"S, 38°42'00"W, 21.VIII.2020, fl., *L.M. Sousa 08* (EAC). Viçosa do Ceará, X.1909, fl., *A. Lisbôa* (INPA 12450).

Sarcomphalus joazeiro resembles *S. undulatus* by the overall arrangement of its branches and by fruits lenticellate. *Sarcomphalus joazeiro*, however, bears leaves that are chartaceous when mature (*vs*. membranaceous), with margins finely serrate and flat (*vs*. serrate and undulate), stipules lanceolate (*vs*. ovate), thyrse congested, 10–30 flowers per inflorescence (*vs*. lax, 5–10 flowers), and fruits globose (*vs*. ellipsoid).

Sarcomphalus joazeiro is endemic to northeastern Brazil in the states of Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, and Sergipe in the Caatinga phytogeographic domain (Lima *et al*. 2020). The species is widely distributed in Ceará, having been recorded in 62 municipalities in the Vegetation Complex of the Coastal Zone (Lowland Semideciduous Forest), Semideciduous Seasonal Forest, Dense Ombrophilous Forest, Forest Savanna, Steppic Savanna, and Vegetation under Fluvial and/or Lacustrine Influence. It has been collected in 10 Conservation areas in Ceará: the Dunas da Lagoinha Environmental Protection Area, Missão Velha Environmental Protection Area, Aiuaba Ecological Station, Pecém Ecological Station, Quixadá Monoliths Natural Monument, Timbaúbas Ecological Park, Cocó State Park, Pedra da Andorinha Wildlife Refuge, Fazenda Trussú Private Natural Heritage Reserve, and the Serra das Almas Private Natural Heritage Reserve.

The species was collected with flowers from August to March, and with fruits from November to May.

The species is used in popular medicine, ornamental, recovery of degraded areas, wood (Araújo & Agra 2018).

The popular names are joá-mirim, joazeiro, juá-de-boi, juá-de-espinho, juá-fruta, juazeiro, laranja-de-vaqueiro, loquiá.

5.2. *Sarcomphalus platyphyllus* (Reissek) Hauenschild, Taxon 65(1): 57. 2016.

Figs. 1b; 4f-j

Trees 9–15 m; branches sinuate, striate, spinescent; spines 0.8–3 cm long, straight, stout. Stipules 1.5–2 mm long, ovate to oblong. Petiole 0.8–1.6 cm long. Leaves 7–13 × 3.5–7 cm, ovate, apex acuminate to acute, base rounded to obtuse, margin serrate, plane, chartaceous to coriaceous. Thyrse congested, 5–30 flowers per inflorescence. Flowers 4–5 mm long, monoclinous; pedicel 1.5–3 mm long; sepals 1.2–1.6 mm long, deltoid; petals 1.4–1.5 long, conchiform; unguiculate petal 0.9–1 mm long; nectariferous disk slightly sulcate; ovary ca. 1 mm wide, glabrous, globose, 2–3-carpelar, 2–3-locular, style free above distal half. Flowers staminate with styloid erect. Fruits ca. 2 cm long, globose, glabrous, lenticellate; fructiferous pedicel ca. 4 mm long.

Selected examined material: Acarape, 04°13’26”S, 38°42’28”W, 20.XI.2020, fl., *L.M. Sousa* 40 (EAC). Aquiraz, Área de Proteção Ambiental do Rio Pacoti, 03°83’56”S, 38°40’84”W, 11.X.2018, fl., *S.T. Rabelo & M.S.D. Branco 114* (EAC). Canindé, 04°19’12”S, 39°14’24”W, 11.II.2014, fr., *W. Batista* 238 (EAC). Capistrano, Serra do Vicente, 18.X.1979, fl., *E. Nunes & A.J. Castro* (EAC 7127). Fortaleza, Campus do Pici, 22.I.2016, fl., *G.S. Pinto* 203 (EAC). General Sampaio, 6.VIII.1998, *A. Fernandes* (EAC 26857). Maranguape, Gereraú, 1.VII.2001, fl., *A.S.F. Castro* 995 (EAC). Meruoca, 31.X.1999, fl., *A. Fernandes* (EAC 28567). Paraipaba, Área de Proteção Ambiental de Dunas da Lagoinha, 19.X.2003, fl., *D.V. Azevedo* (EAC 22019). São Gonçalo do Amarante, Pecém, 21.X.2007, fl., *M.F. Moro et al. 271* (EAC). Sobral, São José do Torto, 14.XI.2011, fl., *A.S.F. Castro 2556* (EAC).

Sarcomphalus platyphyllus is distinct from other species of Rhamnaceae found in Ceará by its large leaves (7–13 × 3.5–7 cm), stipules ovate to oblong, and styles free above distal half.

The species is endemic to Brazil, occurring in the northeastern (Alagoas, Bahia, Ceará, Pernambuco, and Rio Grande do Norte) and southeastern regions (Espírito Santo and Rio de Janeiro) of that country (Lima *et al*. 2020). It has been recorded in 11 municipalities in Ceará, in the Vegetation Complex of the Coastal Zone (Lowland Semideciduous Forest), Semideciduous Seasonal Forest, Steppic Savanna, and Vegetation under Fluvial and/or Lacustrine Influence. It has been collected in two Conservation Areas: Pacoti River Environmental Protection Area and the Dunas da Lagoinha Environmental Protection Area.

The species was collected with flowers in January, July, October and November, and with fruits in February.

The popular names are joazeiro, juazeiro.

5.3. *Sarcomphalus undulatus* (Reissek) Hauenschild, Taxon 65(1): 57. 2016.

Figs. 1b; 4k-o

Shrubs or trees 4–7 m; branches slender, brown, glabrous to glabrescent, spinescent; spines 3–4 mm long, straight, slender. Stipules 1.3–2 mm long, ovate. Petiole 0.5–1 cm long. Leaves 5–9 × 3.8–7 cm, ovate to elliptic, apex acute, base rounded to acute, margin serrate and ondulate, membranaceous. Thyrse laxous, 5–20 flowers per inflorescence. Flowers 4.8–6 mm long, monoclinous; pedicel ca. 2 mm long; sepals 1.2–1.5 mm long, deltoid; petals 1.1–1.5 mm long, conchiform; unguiculate petal ca. 0.8 mm long; nectariferous disk slender, slightly sulcate; ovary ca. 1 mm wide, globose, glabrous, 2-carpelar, 2-locular, style free at the apex. Flowers staminate with filiform styloid. Fruits 1–1.5 cm long, elliptic, glabrous, lenticellate; fructiferous pedicel 0.3–0.6 cm long.

Selected examined material: Acarape, 04°13’26”S, 38°42’28”W, 28.IX.2020, fl., *L.M. Sousa* 23 (EAC). Caucaia, Cumbuco, 8.X.1999, fl., *L.Q. Matias* 209 (EAC). Crato, Villa do Crato, 07°14’19”S, 39°24’58”W, 1938, fl., *G. Gardner 1522* (NY). Fortaleza, 15.X.1999, fl., *G.N. Maia* (EAC 28561). Iguatu, Sítio Catingueira, 06°18’21”S, 39°05’43”W, 15.III.2017, fr., *A.M. Rodrigues* (EAC 60248). Quixadá, 28.IX.1992, fl., *L.P. Félix* (EAC 19846). Redenção, 04°13’33”S, 38°43’50”W, 28.IX.2020, fr., *L.M Sousa* 18 (EAC). Ubajara, Planalto da Ibiapaba, Parque Nacional de Ubajara, 14.IX.1998, *A. Fernandes* & *E. Nunes* (EAC 27499). Umari, 06°38’52”S, 38°42’00”W, 21.VIII.2020, fl., *L.M. Sousa 07* (EAC).

Sarcomphalus undulatus is characterized by having leaves membranaceous, with margins serrate and undulate; stipules ovate; thyrse lax, with 5–20 flowers, and fruits ellipsoid. It is similar to *Sarcomphalus joazeiro*; to differentiate between the species, refer to the comments above concerning the latter taxon.

Sarcomphalus undulatus is endemic to Brazil, being distributed in the central-western, northeastern, and southeastern regions of that country in the Cerrado, Caatinga, and Atlantic Forest phytogeographic domains (Lima *et al*. 2020). The samples collected in the Federal District and Rio de Janeiro State were probably cultivated. The species was recorded in nine municipalities in Ceará, in the Vegetation Complex of the Coastal Zone (Lowland Semideciduous Forest), Semideciduous Seasonal Forest, Dense Ombrophilous Forest, and Steppic Savanna. It has been collected only in the Ubajara National Park conservation area.

The species was collected with flowers in August and October, and with fruits in March and September.

The species is used as edible, and for forage (Santos 2006).

The popular names are joazeiro, juazeiro, joá mirim.

Acknowledgments

We are grateful for the scholarship awarded by CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) for the first author. To PPGERN/PROAP, for the financial contribution for the field expeditions. LMS is grateful to CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), for the schorlaship (Financial Code 001). RTMR to the Pernambuco Research Foundation - FACEPE, for the Postdoctoral scholarship granted (Process BFP-0160-2.03/20); RLSN to FUNCAP by the Postdoctoral scholarship granted (Process PD2-0175-00083.01.01/20); MIBL to CNPq, for the research productivity scholarship granted (Process 308685/2020-2).

References

Alves M, Oliveira RB, Teixeira SR, Guedes MLS & Roque N (2015) Levantamento florístico de um remanescente de Mata Atlântica no litoral norte do estado da Bahia, Brasil. Hoehnea 42: 581-595.

APG IV - Angiosperm Phylogeny Group (2016) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society 181: 1-20.

Araújo ND & Agra MF (2018) Grupos de uso e as espécies prioritárias: *Ziziphus joazeiro*. *In*: Coradin L, Camillo J & Pareyn FGC (eds.) Espécies nativas da flora brasileira de valor econômico atual ou potencial: plantas para o futuro: Região Nordeste. Ministério do Meio Ambiente, Brasília. Pp. 961-968.

Barbosa MD, Maragon LC, Feliciano ALP, Freire FJ & Duarte GMT (2012) Florística e fitossociologia de espécies arbóreas e arbustivas em uma área de Caatinga em Arcoverde, PE, Brasil. Revista Árvore 36: 851-858.

Brongniart AT (1827) Annales des Sciences Naturelles 10: 368, t. 15, f. 3.

Carvalho PER (2005) Circular Técnica 106: Sobrasil. Embrapa Florestas. Available at <https://www.embrapa.br/busca-de-publicacoes/-/publicacao/314155/sobrasil>. Access on 28 October 2021.

Chen YS, Meseguer AS, Godefroid M, Zhou Z, Zhang JW, Deng T & Sun H (2017) Out-of-India dispersal of *Paliurus* (Rhamnaceae) indicated by combined molecular phylogenetic and fossil evidence. Taxon 66: 78-90.

CNCFLORA - Centro Nacional de Conservação da Flora (2022) Lista Vermelha. Available at <http://www.cncflora.jbrj.gov.br/portal/pt-br/listavermelha>. Access on 10 March 2022.

Correa E, Jaramillo C, Manchester S & Gutierrez M (2010) A fruit and leaves of rhamnaceous affinities from the late Cretaceous (Maastrichtian) of Columbia. American Journal of Botany 97: 71-79.

Crepet WL, Friis EM & Gandolfo MA (2004) Fossil evidence and phylogeny: the age of major angiosperm clades based on mesofossil and macrofossil evidence from Cretaceous deposits. American Journal of Botany 91: 1666-1682.

CRIA - Centro de Referência em Informação Ambiental (2021) *species*Link. Available at <http://splink.cria.org.br/tools?criaLANG=pt>. Access on 18 May 2021.

Cronquist A (1981) An integrated system of classification of flowering plants. Columbia University Press, New York. 1262p.

Cronquist A (1988) The evolution and classification of flowering plants. Ed. 2. The New York Botanical Garden, New York. 555p.

Dahlgren RMT, Clifford HT & Yeo PF (1980) A revised system of classification of the angiosperms. Botanical Journal of the Linnean Society 80: 91-124.

Figueiredo MA (1997) A cobertura vegetacional do Ceará: unidades fitoecológicas. *In*: Ceará, Atlas do Ceará. Edições IPLANCE, Fortaleza. Pp. 28-29.

GBIF - Global Biodiversity Information Facility (2021) Available at <https://www.gbif.org/>. Access on 11 November 2021.

Harris JG & Harris MV (2001) Plant identification terminology: an illustrated glossary. 2nd ed. Spring Lake Publishing, Utah. 2016p.

Hauenschild F, Matuszak S, Muellner-Riehl AN & Favre A (2016) Phylogenetic relationships within the cosmopolitan buckthorn family (Rhamnaceae) support the resurrection of *Sarcomphalus* and the

description of *Pseudoziziphus* gen. nov. Taxon 65: 47-64.

Hauenschild F, Favre A, Michalak I & Muellner-Riehl AN (2018) The influence of the Gondwanan breakup on the biogeographic history of the *ziziphoids* (Rhamnaceae). Journal of Biogeography 45: 2669-2677.

Hutchinson J (1964) The genera of flowering plants (Angiospermae) based principally on the Genera plantarum of G. Bentham and J. D. Hooker - Dicotyledones. Vol. 1. Claredon Press, Oxford. 516p.

IBGE - Instituto Brasileiro de Geografia e Estatística (2012) Manual técnico da vegetação brasileira. 2a ed. Available at <ftp://geoftp.ibge.gov.br/documentos/recursos_naturais/ manuais_tecnicos/ manual_tecnico_vegetacao_brasileira.pdf>. Access on 18 July 2021.

Jacquin NJ (1763) Nicolai Josephi Jacquin Selectarum stirpium Americanarum historia. Ex officina Krausiana, Vindobonae. 301p.

Johnston MC (1971) Revision of Colubrina (Rhamnaceae). Brittonia 23: 2-53.

Johnston MC & Soares MAF (1972) Ramnáceas. *In*: Reitz PR (ed.) Flora Ilustrada Catarinense. Herbário Barbosa Rodrigues, Itajaí. 50p

Jussieu AL (1789) Rhamni. *Genera Plantarum secundum ordines naturales disposita*. Herissant et Barrois, Paris. Pp. 376-383.

Kellermann J & Udovicic F (2008). Large indels obscure phylogeny in analysis of chloroplast DNA (trnL-F) sequence data: Pomaderreae (Rhamnaceae) revisited. Telopea 12: 1-22.

Lima RB (2000) A família Rhamnaceae no Brasil: diversidade e taxonomia. Tese de Doutorado. Universidade de São Paulo, São Paulo. 292p.

Lima RB (2006a) Flora de Grão-Mogol, Minas Gerais: Rhamnaceae. Boletim de Botânica da Universidade de São Paulo 24: 35-37.

Lima RB (2006b) Flora da Reserva de Ducke, Amazonas, Brasil: Rhamnaceae. Rodriguésia 57: 247-249.

Lima RB (2011) Flora da Serra do Cipó, Minas Gerais: Rhamnaceae. Boletim de Botânica da Universidade de São Paulo 29: 47-56.

Lima RB & Giulietti AM (2006) Diversidade da família Rhamnaceae Juss. no semi-árido brasileiro. *In*: Giulietti AM, Conceição A & Queiroz LP (eds.) Instituto do Milênio do Semi-Árido: diversidade e caracterização das fanerógamas do semi-árido brasileiro. Vol. 1. Ed. Associação Plantas do Nordeste, Recife. Pp. 365-436.

Lima RB & Giulietti AM (2005) Rhamnaceae. *In*: Wanderley MGL, Shepherd GJ, Melhem TS, Martins SE, Kirizawa M & Giulietti AM (eds.) Flora fanerogâmica do estado de São Paulo. Instituto de Botânica, São Paulo. Vol. 4, pp. 331-342.

Lima RB (2009) Rhamnaceae. *In*: Alves M, Araújo MF, Maciel JR & Martins S (eds.) Flora de Mirandiba. Associação Plantas do Nordeste, Recife. Pp. 317-319.

Lima RB (in memoriam), Barbosa MRV & Giulietti AM (2020) *Rhamnaceae. In* Flora do Brasil 2020 (continuously updated) Jardim botânico do Rio de Janeiro. Available at <http://reflora.jbrj.gov.br/reflora/floradobrasil/FB20649>. Access on 20 February 2021.

Loiola MIB, Araújo FS, Lima-Verde LW, Souza SSG, Matias LQ, Menezes MOT, Soares Neto RL, Silva MAP, Souza MMA, Mendonça AM, Macêdo MS, Oliveira SF, Sousa RS, Balcázar AL, Crepaldi CG, Campos LZO, Nascimento LGS, Cavalcanti MCBT, Oliveira RD, Silva TC & Albuquerque UP (2015) Flora da Chapada do Araripe. *In*: Albuquerque UP & Meiado MV (eds.) Sociobiodiversidade na Chapada do Araripe. Vol. 1. NUPEEA, Recife. Pp. 103-148.

Loiola MIB, Ribeiro RTM, Sampaio VS & Souza EB (2020) Diversidade de angiospermas do Ceará. Edições HUVA, Sobral. 257p. Available at <http://www.uvanet.br/edicoes_uva/gera_xml.php?arquivo=diversidade_angiospermas_ceara_2020_2112>. Access on 16 October 2021.

Lorenzi H (2020) Árvores brasileiras: manual de identificação e cultivo de plantas arbóreas nativas do Brasil. Vol. 1. Instituto Plantarum, Nova Odessa, 384p.

Lorenzi H & Matos FJA (2002) Plantas medicinais no Brasil: nativas e exóticas cultivadas. Vol. 1. Instituto Plantarum, Nova Odessa. 512p.

Martius CFP (1826) Nova genera et species plantarum: quas in itinere per Brasiliam MDCCCXVII-MDCCCXX jussu et auspiciis Maximiliani Josephi I., Bavariae regis augustissimi instituto. V. 3. Impesis Auctoris, Munich. 148p.

Medan D & Schirarend C (2004) Rhamnaceae. *In*: Kubitzki K (ed.) Families and genera of vascular plants. Vol. 6. Springer, Berlin. Pp. 320-338.

Miquel FAG (1849) Manipulus Stirpium Blanchetianarum in Brasilia collectarum. Linnaea 22: 793-807.

Montagna T & Reis MS (2011) Grupos de uso e as espécies prioritárias: *Colubrina glandulosa*. *In*: Coradin L, Siminski A & Reis A (eds.) Espécies nativas da flora brasileira de valor econômico atual ou potencial: plantas para o futuro: Região Sul. Ministério do Meio Ambiente, Brasília. Pp. 448-452.

Pereira M, Silva FC, Cardôso H & Rocha LF (2012) Levantamento florístico de espécies nativas e exóticas na Universidade Federal de Campina Grande, Campus de Cajazeiras, Paraíba, Brasil. Enciclopédia Biosfera 8: 1828-1835.

Perkins JR (1911) Rhamnaceae peruv., boliv., aequat. Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 45: 463-466.

QGIS Development Team (2022) QGIS (QGIS 2.18.28 - Las palmas) Geographic information

system installation guide. Open Source Geospatial Foundation Project. Available at <https://github.com/qgis/QGIS>. Access on 20 February 2022.

Reissek S (1861) Rhamneae. *In*: Martius CFP & Urban I (eds). *Flora brasiliensis*. Fleischer, Leipzig. Vol. 11, pars 1. pp. 81-116.

Richardson JE, Fay M, Cronk QCB, Bowman D & Chase MW (2000a) A phylogenetic analysis of Rhamnaceae using rbcL and trnL-F plastid DNA sequences. American Journal of Botany 87: 1309-1324.

Richardson JE, Fay MF, Cronk QCB & Chase MW (2000b) A revision of the tribal classification of Rhamnaceae. Kew Bulletin 55: 311-340.

Rocha AM, Luz ARM, Correia CC & Abreu MC (2016) Levantamento florístico de espécies arbóreas em uma área de caatinga no semiárido piauiense. Ed. Realize, Campina Grande. Available at <https://www.editorarealize.com.br/artigo/visualizar/23942>. Access on 22 October 2021.

Santos JP (2006) Riqueza e distribuição de espécies úteis no semi-árido do Nordeste do Brasil. Dissertação de Mestrado. Universidade Federal Rural de Pernambuco, Recife. 69p.

Silva SR, Medeiros MB, Gomes BM, Seixas ENC & Silva MAP (2012) Angiosperms from the Araripe National Forest, Ceará, Brazil. Check List 8: 744-751.

Silveira AP, Menezes BS, Loiola MIB, Lima-Verde LW, Zanina DN, Carvalho ECD, Souza BC, Costa RC, Mantovani W, Menezes MOT, Flores LMA, Nogueira FCB, Matias LQ, Barbosa LS, Gomes FM, Cordeiro LS, Sampaio VS, Batista MEP, Soares Neto RL, Silva MAP, Campos NB, Oliveira AA & Araújo FS (2020a) Flora and annual distribution of flowers and fruits in the Ubajara National Park, Ceará, Brazil. Floresta e Ambiente 27: 1-19.

Silveira AP, Loiola MIB, Gomes VS, Lima-Verde LW, Oliveira TS, Silva EF, Otutumi AT, Ribeiro K, Xavier FAS, Bruno MMA, Souza SSG & Araújo FS (2020b) Flora of Batiruté, Ceará: a west island in the Brazilian semiarid. Flora e Ambiente 27: 1-22.

Souza VC & Lorenzi H (2019) Botânica sistemática: guia ilustrado para identificação das famílias de fanerogámas nativas e exóticas no Brasil, baseado em APG IV. 4. Instituto Plantarum, Nova Odessa. 768p.

Stevens PF (2001 onwards) Angiosperm Phylogeny Website. Version 14, July 2017 [and more or less continuously updated since]. Available at <http://www.mobot.org/MOBOT/research/APweb/>. Access on 16 October 2021.

Takhtajan A (1969) Flowering plants, origin and dispersal. Smithsonian Institution Press, Washington. 310p.

Thiers B (continuously updated) Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. Available at <http://sweetgum.nybg.org/science/ih/>. Access on 19 February 2021.

Ucella Filho JGM, Silva AB, Almeida DB, Carnaval AA & Azevedo TKB (2017) Levantamento florístico da arborização da Universidade Federal do Rio Grande do Norte, Campus Macaíba. Available at <https://www.researchgate.net/publication/326539361_LEVANTAMENTO_FLORISTICO_DA_ARBORIZACAO_DA_UNIVERSIDADE_FEDERAL_DO_RIO_GRANDE_DO_NORTE_CAMPUS_MACAIBA/link/5eee3f69458515814a6f1502/download>. Access on 22 October 2021. DOI: 10.31692/2526-7701.IICOINTERPDVAGRO.2017.00096

Urban I (1910) Symbolae Antillanae, seu Fundamenta florae Indiae Occidentalis. V.4. Parisiis, Fratres Borntraeger; Paul Klincksieck, Berolini. 771p.

Area Editor: Dr. Marcelo Trovó
Received in December 23, 2021. Accepted in July 28, 2022.