



## Original Paper

# Flora of Ceará, Brazil: Clusiaceae

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### Abstract

The floristic-taxonomic survey of Clusiaceae is presented as part of the project “Flora of Ceará: knowing to conserve”. The study was based on the analysis of specimens deposited in national and international herbaria and observations of natural populations during field expeditions carried out from February, 2019 to March, 2020. The family is represented in Ceará by eight species distributed in four genera: *Clusia*, *Garcinia*, *Symphonia* and *Tovomita*. *Clusia* was the most representative with five species: *C. ibiapabensis*, *C. melchiorii*, *C. nemorosa*, *C. nogueirae* and *C. panapanari*. The other genera are represented by one species each: *Garcinia gardneriana*, *Symphonia globulifera* and *Tovomita mangle*. The species preferentially occur in humid environments such as Dense Ombrophilous Forest and near watercourses. *Clusia ibiapabensis* and *C. nogueirae* are endemic to Ceará, and *C. melchiorii* and *S. globulifera* are new records for the state. Only *Clusia nemorosa* and *C. panapanari* were recorded in conservation units. Identification keys, descriptions, taxonomic relationships, illustrations, and comments on the geographical distribution and phenology of the species are presented.

**Key words:** *Clusia*, diversity, Malpighiales, northeastern Brazil, taxonomy.

### Resumo

É apresentado o levantamento florístico-taxonômico de Clusiaceae como parte do projeto “Flora do Ceará: conhecer para conservar”. O estudo se baseou na análise de espécimes depositados em herbários nacionais e internacionais e observações de populações naturais durante as expedições de campo realizadas no período de fevereiro/2019 a março/2020. A família está representada no Ceará por oito espécies distribuídas em quatro gêneros: *Clusia*, *Garcinia*, *Symphonia* e *Tovomita*. *Clusia* foi o mais representativo com cinco espécies: *C. ibiapabensis*, *C. melchiorii*, *C. nemorosa*, *C. nogueirae* e *C. panapanari*, seguido pelos demais gêneros representados por uma espécie cada: *Garcinia gardneriana*, *Symphonia globulifera* e *Tovomita mangle*. As espécies ocorrem preferencialmente em ambientes úmidos como Floresta Ombrófila Densa e próximo à corpos d’água. *Clusia ibiapabensis* e *C. nogueirae* são endêmicas do Ceará e *C. melchiorii* e *S. globulifera* são novos registros para o estado. Apenas *Clusia nemorosa* e *C. panapanari* foram registradas em Unidades de Conservação. Chave de identificação, descrições morfológicas, relações taxonômicas, ilustrações, além de comentários sobre a distribuição geográfica e fenologia das espécies são apresentadas.

**Palavras-chave:** *Clusia*, diversidade, Malpighiales, nordeste do Brasil, taxonomia.

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## Introduction

Clusiaceae, included in the order Malpighiales, comprises 15 genera and about 800 species with tropical distribution, and is more diversified in the Neotropical region (Stevens 2001 onwards; Marinho *et al.* 2019). Its species can be found in a wide variety of environments, from wetter regions of tropical forests to xeromorphic environments (Gustafsson 2009, 2010; Marinho *et al.* 2020a).

The family is characterized as mainly trees, shrubs or hemiepiphytes, glabrous, evergreen, with secretory ducts; leaves simple, opposite, entire, secondary veins generally parallel and often united to an intramarginal vein; flowers solitary or in terminal or axillary inflorescence; flowers bisexual or unisexual, actinomorphic; sepals two to five (-numerous), free or united; petals four to eight, free; stamens four or more, free or fused in synandrium or staminal tube; nectariferous disc can be present or absent, staminodes can be present or absent in pistillate and staminate flowers, with or without resin secretion; ovary superior, 2-multilocular, with one to numerous ovules per locule, placentation usually axillary, rare parietal or basal; free or united styles, usually permanent on the fruit; fruit berry or fleshy capsule, with one to numerous seeds which are arillate or not (Stevens 2001 onwards, 2007; Bittrich 2003).

In Brazil, Clusiaceae is represented by 11 genera and about 149 species, of which 51 are endemic. It occurs in all Brazilian states and phytogeographic domains, except the Pampas, though has higher incidence in the Amazon Forest (Marinho *et al.* 2020b). Among the floristic surveys focused on Clusiaceae in Brazil, it is possible to highlight the studies of Cabral *et al.* (2017) in the Viruá National Park, in Roraima; Ribeiro & Bittrich (1999) in the Flora of Reserva Ducke, in Amazonas; Oliveira *et al.* (2015) and Alencar & Marinho (2017) in the state of Pará; Araújo (2010) in Paraíba; Mariz (1974, 1989) in Pernambuco; Alkimim *et al.* (2011) in Distrito Federal; Alencar *et al.* (2023) in Espírito Santo; Bittrich (2003) in São Paulo; Cometti & Pirani (2004) in Grão-Mogol in Minas Gerais; and Marinho *et al.* (2016) of the *Tovomita* Aublet (1775: 956) species of the Brazilian Atlantic Forest.

In Ceará, Clusiaceae is mentioned only in regional floristic surveys, such as Loiola *et al.* (2015) in Chapada do Araripe, in the southern portion of the state; Loiola *et al.* (2020) in the

catalog of angiosperm diversity in Ceará; Silveira *et al.* (2020a) in a field and herbarium survey of the phanerogamic flora of the Ubajara National Park, and Silveira *et al.* (2020b) in the flora of Serra de Baturité. In addition, two new species of *Clusia* Linnaeus (1753: 510) were recently described based on specimens from the Ibiapaba plateau, *C. ibiapabensis* A.C. Alencar & A.S. Farias-Castro (2020: 262) and *C. nogueirae* A.C. Alencar & A.S. Farias-Castro (2020: 260). As part of the project “Flora do Ceará: knowing to conserve”, this study aimed to carry out a taxonomic treatment of Clusiaceae, with updates of identifications and geographic distribution of the species, using taxonomic descriptions, identification keys, illustrations and maps, as well as taxonomic and phenological comments, thus contributing to the knowledge of the group and the diversity of the flora of Ceará.

## Material and Methods

The study was based on the analysis of specimens of Clusiaceae from the ALCB, ASE, EAC, HCDAL, HDELTA, HUEFS, HURB, HUVA, IPA, MO, NY, R, UEC and UFP herbaria collections (acronyms according to Thiers, continuously updated), and also from HST (not indexed, Recife, Pernambuco). Fresh material was collected during field expeditions carried out between February, 2019 and March, 2020. Author names follow Flora e Funga do Brasil 2020 (continuously updated) Project. Morphological terminology was based on Radford *et al.* (1974) and Harris & Harris (2001). Data on habits, habitat, phenology and popular names were obtained from exsiccate labels. When the samples collected in Ceará were insufficient for the description or illustration of the species, additional materials from other states were used.

The vegetation classification was performed according to Figueiredo (1997) and the Technical Manual of Brazilian Vegetation (IBGE 2012): Vegetation Complex of the Coastal Zone (comprises the Pioneer Psammophilous Vegetation, Forest behind the Dunes and Lowland Semi-deciduous Forest = Mata de Tabuleiro), Semi-deciduous Seasonal Forest (Mata Seca), Dense Ombrophilous Forest (Mata Úmida), Savanna (Cerrado), Forested Savanna (Cerradão), Steppic Savanna (Caatinga/Carrasco) and Vegetation under Fluvial and/or Lacustrine Influence (Mata Ciliar). Distribution maps were delimited by squares of 0.5° longitude x 0.5° latitude as per Rebouças *et al.* (2020).

## Results and Discussion

A total of eight species of Clusiaceae were recorded for Ceará state, which belong to the following four genera: *Clusia* (*C. ibiapabensis*, *C. melchiorii* Gleason (1931: 403), *C. nemorosa* G. Meyer (1818: 203), *C. nogueirae* and *C. panapanari* (Aublet, 1775: 900) Choisy, 1824: 559). *Garcinia gardneriana* (Planchon & Triana, 1860: 321) Zappi (1993: 410), *Symphonia globulifera* Linnaeus f. (1781: 302), and *Tovomita mangle* G. Mariz, 1974: 367). *Clusia melchiorii* and *Symphonia globulifera* are new records for Ceará, and *C. ibiapabensis* and *C. nogueirae* have so far only been recorded in the state of Ceará. *Clusia nemorosa* and *C. panapanari* are the species with the widest distribution in Ceará and both occur in the Ubajara National Park. There are few records of Clusiaceae species in conservation units, which demonstrates the need for studies that focus on the conservation status of the Clusiaceae family in the state of Ceará.

In Ceará, the representatives of Clusiaceae occur, preferentially, in humid environments (Dense Ombrophilous Forest), and are generally registered in the mountains of Guaramiranga, Baturité and

Maranguape. However, there were records in dry environments such as Savanna (Cerrado), Steppic Savanna (Carrasco) and in the Vegetation Complex of the Coastal Zone in the Lowland Semi-deciduous Forest = (Mata de Tabuleiro).

### Taxonomic treatment

**Clusiaceae** Lindl. Intr. Nat. Syst. Bot. (ed. 2) 74. 1836, *nom. cons.*

Trees, shrubs or hemiepiphytes, dioecious or monoecious, with secretory ducts; leaves opposite, entire, glabrous; stipules and glands absent; secondary veins usually numerous and parallel to each other, usually joining in an intramarginal vein; inflorescences terminal or axillary, rarely a solitary flower, bracts and bracteoles present or absent; flowers uni- or bisexual, actinomorphic; sepals 2 or 4(–6), free or connate; petals 4–8, free; stamens 4–numerous, free or fused in a synandrium of staminal tube, pistillate flowers usually with staminodes, staminate flowers usually with pistillode, resin present or absent, nectary disc present or absent, ovary superous, 2–5(–numerous)-locular, styles free or connate, stigma usually sessile; fruits berries or fleshy capsules; seeds arillate or exarillate.

### Identification key for Clusiaceae species in Ceará

1. Bisexual flowers; stamens fused in a staminal tube.....7. *Symphonia globulifera*
- 1'. Unisexual flowers; stamens fused in a synandrium or free.
  2. Axillary inflorescences; berries fruits; exarillate seeds.....6. *Garcinia gardneriana*
  - 2'. Terminal inflorescences; fleshy capsules fruits; arillate seeds.
    3. Leaves membranaceous, secondary veins  $\leq 9$  pairs; floral buds enclosed by the outer pairs of the sepals .....8. *Tovomita mangle*
    - 3'. Leaves subcoriaceous to coriaceous, secondary veins numerous; floral buds not enclosed by the sepals.
      4. Diameter of flowers  $\leq 1$  cm, arranged in panicles; capsules 4-carpellate ..... 2. *Clusia melchiorii*
      - 4'. Diameter of flowers  $\geq 1.4$  cm, solitary or arranged in cymes; capsules  $> 5$ -carpellate.
        5. Staminate flowers with lateral anthers, connective exceeding the thecae, resiniferous staminodes surrounded by stamens .....3. *Clusia nemorosa*
        - 5'. Staminate flowers with apical anthers, connective not exceeding the thecae, staminodes absent.
          6. Staminate flowers with ca. 200 stamens fused in a synandrium ..... 4. *Clusia nogueirae*
          - 6'. Staminate flowers with  $\leq 35$  free and clavate stamens.
            7. Subcoriaceous leaves, intramarginal vein inconspicuous; staminate flowers with 10 stamens; pistillode absent.....5. *Clusia panapanari*
            - 7'. Coriaceous leaves; intramarginal vein conspicuous; staminate flowers with  $\geq 11$  stamens; pistillode present ..... 1. *Clusia ibiapabensis*

**1. *Clusia ibiapabensis*** A.C. Alencar & A.S. Farias-Castro, Phytotaxa 460(4): 262. 2020.

Figs. 1; 2a-b; 3a-e

Trees. Branches woody, not crenate, not escrobiculate, not striate. Petioles 0.5–1.2 cm long, colleters absent. Leaf blade 4–8.1 × 3.1–5.7 cm, obovate, base decurrent, apex rounded, coriaceous, not scaly, secretory ducts visible as dark lines mainly on the adaxial surface; midvein conspicuous for 3–4/6 of leaf blade on both surfaces, not crenate; secondary veins 0.2–0.5 cm distant from each other, prominent on both surfaces, forming a 45°–55° angle with the midvein; intramarginal vein distant from the margin ca. 0.1 cm, crenate. Bracts 2, 0.2–0.25 × 0.4 cm, deltoid, crenate, plane, margins membranaceous. Inflorescence terminal cyme; peduncles 0.8–1 cm long, cylindrical, not crenate; pedicels ca. 0.8 cm long. Flowers 3–11, ca. 2.5 cm diam., pendulous, unisexual; sepals 4–6, rounded, plane, subcoriaceous, margin membranaceous, inner sepals ca. 0.5 × 0.8 cm, outer sepals ca. 0.2 × 0.3 cm; petals 5, ca. 1.1 × 1 cm, slightly spatulate, plane, membranaceous. Staminate flowers with 11–35 stamens, congested, free, forming a broad ring around the pistillode; pistillode ca. 0.2 cm, erect, smooth; anthers apical, thecae diverging,

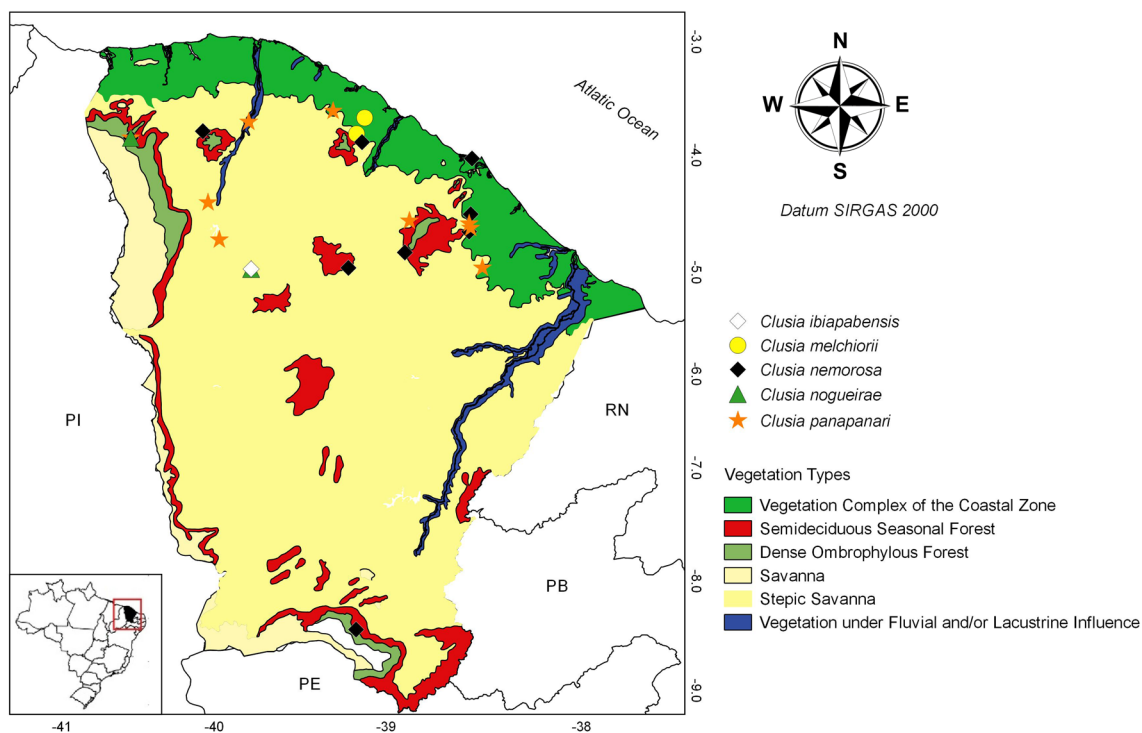
connective not exceeding the thecae, staminodes absent, resin absent, rudimentary stigma papillose. Pistillate flowers with ovary ca. 0.55 × 0.45 cm, 5-carpellate, oblong; stigmas ca. 1.5 × 1 cm, deltoid, papillose; staminodes 5, ca. 0.2 × 0.1 cm, clavate, resiniferous. Capsules 2.4–2.8 × 1.5 cm, 5-valvar, elliptic; sepals, petals and staminodes caducous, stigmas persistent. Seeds with aril present.

**Specimens examined:** Ipueiras, Buriti, 4.I.2014, fl., *A.S.F. Castro* 2787 (EAC); 31.I.2012, fl., *A.S.F. Castro* 2621 (EAC); 31.I.2012, fl., *A.S.F. Castro* 2617 (EAC).

The recently described *C. ibiapabensis* was compared to *C. panapanari* due to the free and clavate stamens. *Clusia ibiapabensis* has 11–35 stamens (vs. 10 stamens in *C. panapanari*) and pink to red petals with a white margin (vs. white or white with a pink/reddish center). *Clusia ibiapabensis* differs from *C. nogueirae* especially because of the absence of resin on the stamens (vs. resin present in *C. nogueirae*).

*Clusia ibiapabensis* is an endemic species from the state of Ceará, recorded only in Steppic Savanna (Carrasco) (Fig. 1).

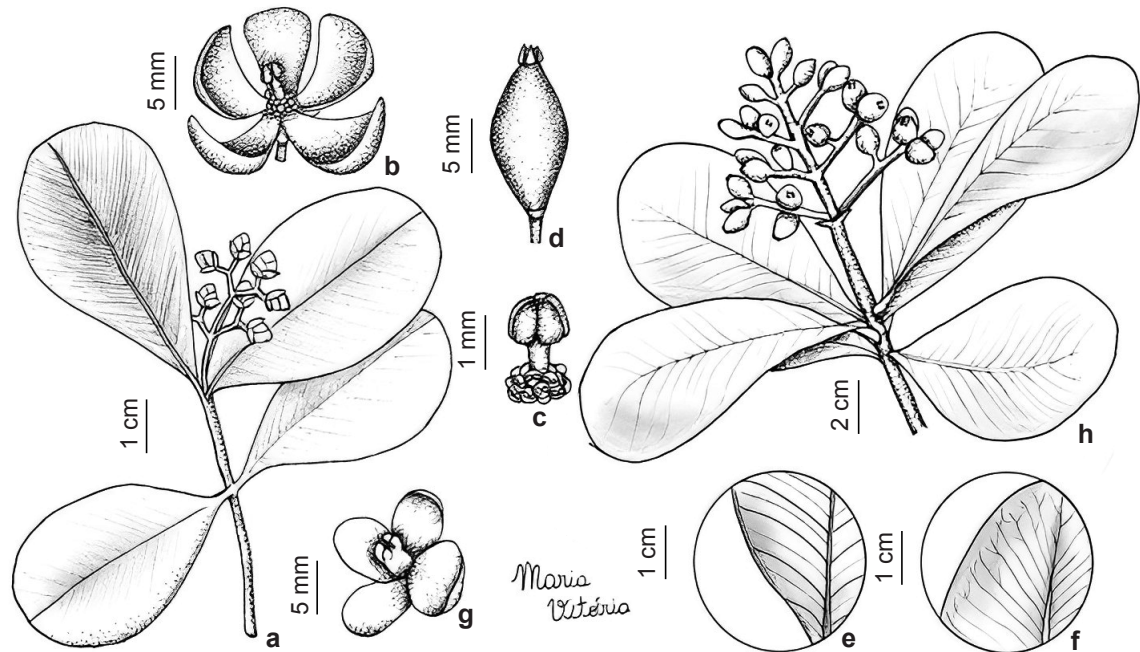
The species was collected with flowers and fruits in January.



**Figure 1** – Geographic distribution of *Clusia* species in Ceará, Brazil.



**Figure 2** – a-b. *Clusia ibiapabensis* – a. staminate inflorescence; b. staminate flowers. c-d. *C. melchiorii* – c. staminate inflorescence; d. fruits. e-h. *C. nemorosa* – e. leaves; f. floral buds; g-h. pistillate flower. i-j. *C. nogueirae* – staminate flower. k-n. *C. panapanari* – k. leaves; l. pistillate inflorescence; m. pistillate flower; n. fruits; o. *Symphonia globulifera* – floral buds and flowers. p. *Tovomita mangle* – staminate inflorescence. Photos: a-b, i-j. *L. Jales*; c-d, o-p. *L. Marinho*; e, k-m. *V. Rebouças*; f, h. *V. Sampaio*; g. *D. Zappi*.



**Figure 3** – a-e. *Clusia ibiapabensis* – a. branch with floral buds; b. staminate flower; c. pistillode detail; d. side view of fruit; e. detail of the vein of the leaf adaxial surface. f-h. *Clusia melchiorii* – f. branch with floral buds (panicle); g. pistillate flower; h. detail of the vein on the leaf adaxial surface. (a-e. Castro 2787; f-h. Loiola et al. 2477).

**2. *Clusia melchiorii*** Gleason, Bull. Torrey Bot. Club 58: 403. 1931. Figs. 1; 2c-d; 3f-h

Trees. Branches woody, not crenate, not escrobiculate, striate *in sicco*. Petioles 0.4–1 cm long, colleters absent. Leaf blade 7.5–16 × 3.4–10 cm, obovate to large obovate, base decurrent, apex rounded, coriaceous, scaly, secretory ducts conspicuous on both surfaces, discolor *in sicco*; midvein conspicuous on both surfaces, not crenate; secondary veins 0.2–0.4 cm distant from each other, prominent on both surfaces, forming a 35°–40° angle with the midvein; intramarginal vein conspicuous, distant from margin ca. 0.1 cm, crenate. Bracts 2, ca. 0.4 × 0.4 cm, deltoid, crenate, plane, margins membranaceous. Inflorescence terminal panicle; peduncles 1.6–2 cm long, cylindrical, not crenate; pedicels ca. 0.5 cm long. Flowers ca. 40, 0.5–1 cm diam., erect, unisexual; sepals 4, rounded, concave, subcoriaceous, glabrous, margin membranaceous, inner sepals ca. 0.3 × 0.5 cm, outer sepals ca. 0.25 × 0.4 cm; petals 4, ca. 0.4 × 0.6 cm, rounded, concave, subcoriaceous, glabrous, margin membranaceous. Staminate flowers with ca. 16 stamens, free, filiform; apical anthers, broad connective, thecae diverging, staminodes and pistillode absent, resin

absent. Pistillate flowers with ovary ca. 0.1 × 0.15 cm, 4-carpellate, obovate, stigmas ca. 0.8 cm long, terminal, ovoid, smooth; staminodes absent. Capsules 0.5–1 × 0.2–0.6 cm, 5-valvular, elliptic, glabrous; sepals, petals and stigmas persistent. Seeds with aril present.

**Selected specimens:** Itapajé, Maciço de Uruburetama, topo da Serra dos Coquinhos, 18.V.2012, fl., E.B. Souza & D.A. Lima 2611 (EAC, HUVA). Maranguape, trilha da Pirapora, 27.IX.2014, fr., M.I.B. Loiola et al. 2477 (EAC); mangue da serra, 13.XII.1997, fr., A.S.F. Castro (EAC 25133); serra, 10.IV.1992, fr., L.P. Félix (EAC 19063); topo da serra, 28.VI.1981, fr., P. Martins & E. Nunes (EAC 10562); sítio Monte Alegre, 14.VI.1946, fr., P. Bezerra (EAC 804).

*Clusia melchiorii* differs from the other *Clusia* species recorded in the territory of Ceará mainly for its tiny flowers (0.5–1 cm diam. vs. ≥ 1.4–3 cm diam. in the other species) and inflorescences in panicles (vs. solitary flowers or cymes).

*Clusia melchiorii* is endemic to Brazil, with records for the northeastern (Bahia and Pernambuco) and southeastern (Espírito Santo) regions (Marinho et al. 2020b). *Clusia melchiorii* is recorded here for the first time in Ceará, in areas of Dense Ombrophilous Forest (Fig. 1).

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

**3. *Clusia nemorosa*** G. Mey., Prim. Fl. Esseq. 203. 1818.

Figs. 1; 2e-h; 4a-d

Trees or shrubs. Branches woody, crenate, escrobiculate, not striate. Petiole 1–5 cm long, colleters present, intrapetiolar. Leaf blade 3.2–17 × 3.5–9.5 cm, obovate to oblanceolate, base cuneate, apex rounded to obtuse, coriaceous, not scaly, secretory ducts inconspicuous; midvein conspicuous for 4/5 of leaf blade, prominent on both surfaces, not crenate; secondary veins 0.3–0.4 cm distant from each other, prominent on the abaxial surface, forming a 35°–40° angle with the midvein; intramarginal vein conspicuous, distant from the margin ca. 0.1 cm, crenate. Bracts 2, ca. 0.2 × 0.4 cm, deltoid, not crenate, plane, margin membranaceous. Inflorescence terminal cyme; peduncles 1.2–1.6 cm long, cylindrical, not crenate; pedicels 1–1.7 cm long. Flowers 1–3, ca. 3 cm diam., erect or pendulous, unisexual; sepals 4–6, rounded, plane, subcoriaceous, margin membranaceous, inner sepals ca. 1.2 × 1.4 cm, outer sepals 0.8–1 × 1–1.2 cm; petals 5, ca. 2 × 1.4 cm, rounded, plane, membranaceous, glabrous. Staminate flowers with ∞ stamens free, filiform, anthers lateral, connective exceeding the thecae, yellow, thecae diverging, resiniferous staminodes present, surrounded by stamens, pistillode absent. Pistillate flowers with ovary ca. 0.7 × 0.5 cm, 5–8-carpellate, oblong; stigmas ca. 0.2 × 0.25 cm, rounded, papillae absent; staminodes ∞, ca. 0.2 × 0.15 cm, forming a resin ring around the ovary. Capsules 3–5.3 × 2.5–4 cm, 8–9-valvular, orbicular to oblong; sepals, petals, staminodes and stigmas persistent. Seeds with aril present.

**Specimens examined:** Aratuba, sítio Jacarandá, 1.III.2009, fr., *A.S.F. Castro 2145* (EAC). Baturité, 9.XI.2016, fl., *M.L. Guedes et al. 25259* (ALCB). Crato, Belmonte, 27.VI.2009, fl., *R.L. Roque & L.K.P. Dutra* (HCDAL 4768); 12.VIII.2011, fr., *A.H. Oliveira* (HCDAL 6671); 29.IX.2011, fl. and fr., *A.H. Oliveira* (HCDAL 6933); estrada Velha das Guaribas, 29.XI.1966, fr., *J.S. Sobrinho 368* (HST, IPA); Floresta Nacional do Araripe, sítio Luanda, 2.VIII.2014, fl., *J.E.G. Santos* (HCDAL 10782, UEC 193083); Trilha Corujas, 14.VI.2011, fl., *A.C.A. Moraes-Mendonça 260* (HCDAL). Fortaleza, 10.IX.1978, *V. Andrade* (UFP 5361). Graça, Cachoeira do Belizário, 29.IX.2017, fr., *E.B. Souza et al. 4801* (EAC, HUVA). Guaramiranga, Pico Alto, 9.III.1989, fl., *M.A. Figueiredo* (EAC 15733); 6.IV.2004, fr., *E. Silveira* (EAC 33827); 20.VII.2004, fr., *E. Silveira*

(EAC 34294); 30.IX.2004, fl., *E. Silveira* (EAC 34459); margem da estrada, 30.IV.2017, fl., *J.C.M.S.M. Sobczak 606* (EAC); serra de Baturité, capoeira, 13.II.1966, *Andrade-Lima 66-4435* (IPA); 22.I.1974, fr., *B. Maguire 65508* (NYBG); 13.VIII.1976, fl., *A. Fernandes* (EAC 2839); sítio Arvoredo, 3.X.2002, fl. and fr., *F.S. Araújo 1602* (EAC); 13.III.2003, fl., *A. Silveira 967 & R.F. Oliveira* (EAC); 22.VIII.2003, *V. Gomes 648* (EAC); sítio Cana Brava, 30.IV.1994, fl. and fr., *M.R.L. Oliveira* (EAC 20927); sítio Lagoa, 13.II.2003, fl., *A.P. Silveira 815* (EAC); 22.VIII.2003, fl., *V. Gomes 620* (EAC); 3.XII.2003, fr., *V. Gomes 1156* (EAC); sítio Sinimbu, 11.II.2003, fr., *A.P. Silveira 740* (EAC). Pacatuba, serra Pacatuba, 22.I.1974, fr., *B. Maguire 65505* (NYBG). Pacoti, Botija, 5.X.1990, fl., *E. Nunes* (EAC 16931); serra de Baturité, Pico Alto, 12.VIII.2011, fl., *F.S. Gomes 995 et al.* (ALCB, EAC); sítio Arvoredo, 14.X.1990, fr., *M.A. Figueiredo* (EAC 17057). Ubajara, Reserva Florestal, PARNA, 4.VIII.1999, fl., *F.S. Cavalcanti 543* (EAC); Sítio Murimbeca, 26.VIII.2012, fr., *M.I.B. Loiola et al. 1950* (EAC). Viçosa do Ceará, serra das flores, 13.XII.1985, fr., *A. Fernandes* (EAC 13995); 8.VIII.2005, fl., *L.W. Lima-Verde et al. 3403-04* (EAC).

*Clusia nemorosa* is easily characterized by its cymes that are composed of 1–3 flowers and mainly due to it presenting staminate flowers with filiform stamens, connective exceeding the thecae, plus central resiniferous staminodes surrounded by the stamens.

*Clusia nemorosa* was found throughout many phytophysiognomies and countries of South America, with records in Brazil, Guyana, French Guiana, Suriname and Venezuela (Tropicos 2020). In Brazil, it has records in all regions, except for the South (Nascimento Jr. & Alencar 2020). In Ceará, *C. nemorosa* was recorded at altitudes varying between 475–935 m, in Dense Ombrophilous Forest, Savanna, Steppic Savanna (Carrasco), Forested Savanna, transition areas of Steppic Savanna and Savanna and Semi-deciduous Seasonal Forest (Fig. 1). The species was collected in Ubajara National Park.

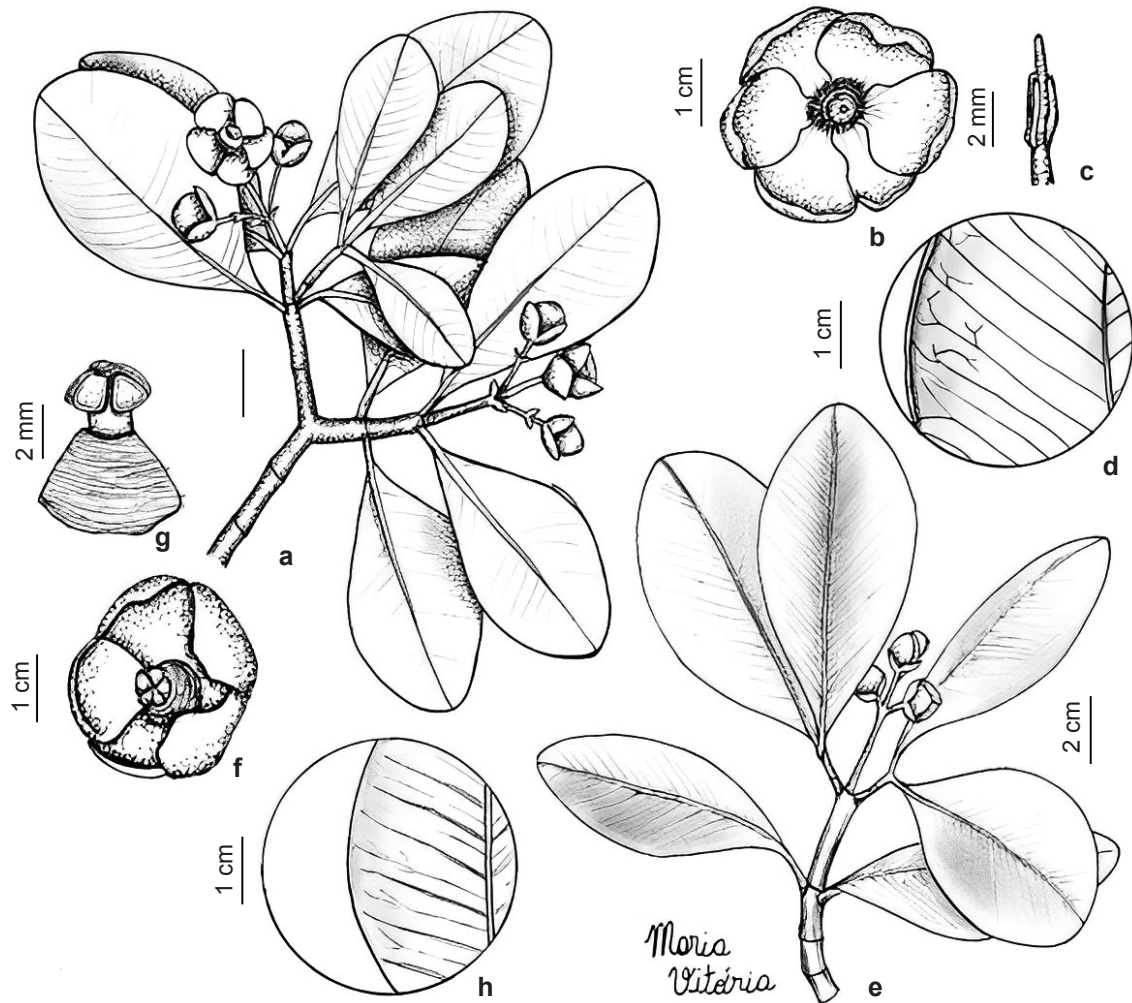
The species was collected with flowers in February, March, June, August, September, and October and with fruits in January, February, March, April, July, August, September, October, November, and December.

The vernacular name of the species is "orelha-de-burro".

**4. *Clusia nogueirae*** A.C. Alencar & A.S. Farias-Castro, Phytotaxa, 460(4): 260. 2020.

Figs. 1; 2i-j; 4e-h

Trees. Branches woody, not crenate, not escrobiculate, not striate. Petiole 0.5–1.5 cm long,



**Figure 4** – a-d. *Clusia nemorosa* – a. branch with cymes; b. staminate flower; c. stamen with lateral anther and connective exceeding the thecae; d. detail of the vein of the leaf abaxial surface. e-h. *Clusia nogueirae* – e. branch with floral buds; f. staminate flower; g. pistillode detail; h. detail of the vein of the leaf adaxial surface. (a-d. *Loiola et al.* 1950; e-h. *Castro* 2786).

colleters absent. Leaf blade 6–11.4 × 4–7.6 cm, obovate to large obovate, base decurrent, apex rounded, coriaceous, not scaly, secretory ducts slightly visible on both surfaces, yellowish *in sicco*; midvein conspicuous for 4–5/6 of leaf blade, prominent on both surfaces, not crenate; secondary veins 0.3–0.5 cm distant from each other, prominent on the adaxial surface, slightly prominent on the abaxial surface, forming a 55°–60° angle with the midvein; intramarginal vein conspicuous, distant from the margin ca. 0.2 cm, crenate. Bracts 4, with ca. 0.6 × 0.28 cm, rounded, not crenate, concave, margin membranaceous. Inflorescence terminal cyme; peduncles ca. 1.2

cm long, cylindrical, not crenate; pedicels ca. 0.5 cm long. Flowers 2, ca. 2.7 cm diam., pendulous, unisexual; sepals 5, rounded, plane, subcoriaceous, margin membranaceous, inner sepals ca. 1 × 1.1 cm, outer sepals ca. 0.8 × 0.8 cm; petals 5, ca. 1.2 × 1.1 cm, slightly spatulate, plane, membranaceous. Staminate flowers with a conical, crateriform, circular synandrium, ca. 0.7 × 0.5 cm, ca. 300 stamens, congested, free, anthers apical, thecae diverging, covered by resin, staminodes absent, pistillode ca. 0.3 cm long, well developed, smooth. Pistillate flowers with ovary ca. 0.6 × 0.5 cm, 5-carpellate, oblong; stigmas ca. 0.3 × 0.25 cm, terminal, triangular, papillose; staminodes 9–11, ca.



0.5 × 0.2 cm, resiniferous. Capsules 2–3.3 × 1.2–2.9 cm, 5-valvar, oblong, elliptic or asymmetrical; sepals, petals and staminodes caducous, stigmas persistent. Seeds with aril present.

**Selected specimens:** Ipueiras, Buriti, 4.I.2014, fr., *A.S.F. Castro 2785* (EAC, UEC); 4.I.2014, fl. and fr., *A.S.F. Castro 2786* (EAC, UEC). Viçosa do Ceará, Tanque, 10.I.2012, fr., *A.S.F. Castro 2595* (EAC, UEC).

*Clusia nogueirae* has as peculiar characteristics since the staminate flower forms a conical, crateriform, circular synandrium, numerous compacted stamens, tiny and resin-covered around a well-developed pistillode. It can be confused with *C. ibiapabensis* due to the general appearance of the branches, which are not crenate and not escrobiculate, but it differs by the number of stamens (ca. 200 stamens fused in a synandrium vs. ≤ 35 free and clavate stamens in *C. ibiapabensis*).

*Clusia nogueirae* is an endemic species to Ceará, and was recorded in Dense Ombrophilous Forest and Steppic Savanna (Carrasco) (Fig. 1).

The species was collected with flowers and fruits in January.

**5. *Clusia panapanari*** (Aubl.) Choisy, Prodr. 1: 559. 1824. Figs. 1; 2k-n; 5a-c

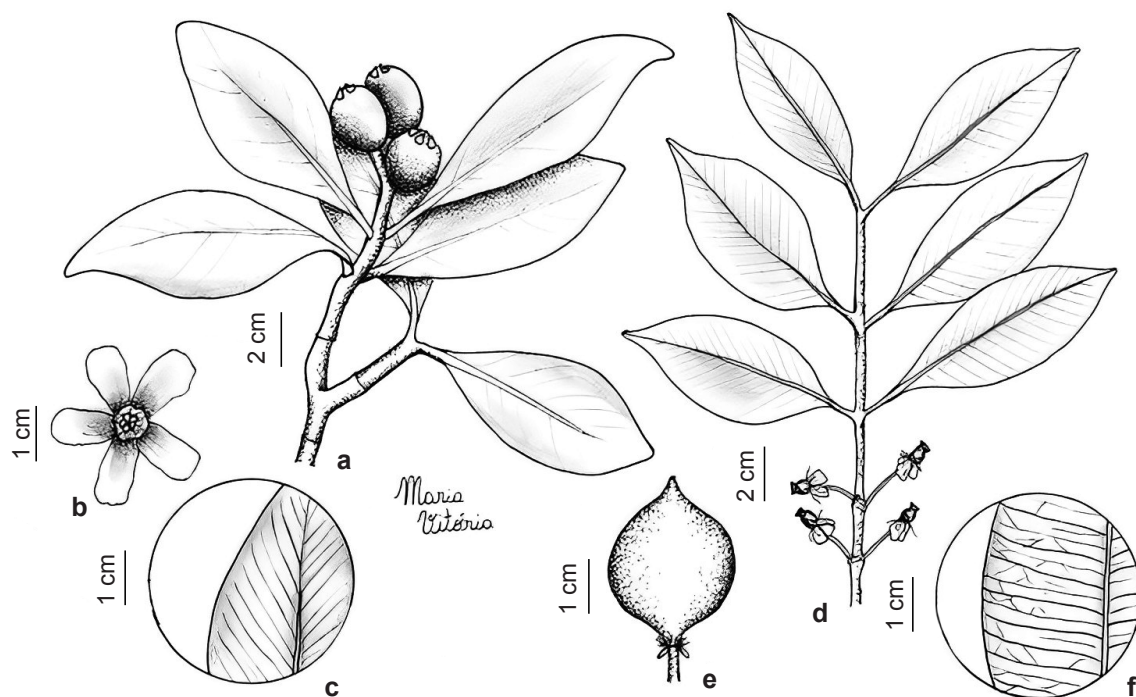
Trees or shrubs. Branches woody, not crenate, escrobiculate, not striate. Petiole 0.2–1 cm long, colleters present, intrapetiolar. Leaf blade 1–7.9 × 0.6–4 cm, obovate to oblanceolate, base attenuate, margin slightly sinuous at the apex varying to the base, apex rounded to obtuse, subcoriaceous, not scaly, secretory ducts conspicuous; midvein conspicuous for 5/6 of leaf blade, prominent on both surfaces, crenate on abaxial surface; secondary veins 0.2–0.3 cm distant from each other, slightly prominent on both surfaces, forming a 45°–55° angle with the midvein; intramarginal vein inconspicuous, distant from the margin ca. 0.1 cm, crenate. Bracts 2, with 1–3.8 × 1.2–1.5 cm, rounded, crenate, plane, margin membranaceous. Inflorescence terminal cyme, pendulous; peduncles 0.4–0.5 cm long, cylindrical, crenate; pedicels 0.2–0.4 cm long. Flowers 3–10, with 1.4–1.9 cm diam., unisexual; sepals 5, rounded, plane, subcoriaceous, margin membranaceous, inner sepals ca. 0.7 × 0.9 cm, outer sepals ca. 0.4 × 0.6 cm; petals 5, ca. 1.4 × 1 cm, oblong, plane, membranaceous. Staminate flowers with 10 stamens, free, clavate, anthers apical, thecae diverging, broad connective,

staminodes and pistillode absents. Pistillate flowers with ovary ca. 0.6 × 0.2 cm, 5-carpellate, oblong; stigmas ca. 0.1 × 0.2 cm, terminal, triangular, papillose; staminodes 10, ca. 0.5 × 0.6 cm, clavate, resiniferous. Capsules 1.3–2.9 × 0.6–1.6 cm, 5-valvar, piriform to elliptic; sepals, petals and staminodes caducous, stigmas persistent. Seeds with aril present.

**Specimens examined:** Baturité, 04°53'33''S, 39°46'66''W, 9.XI.2016, fr., *M.L. Guedes et al. 25265* (ALCB). Guaramiranga, Pico Alto, 6.IV.2004, fl., *E. Silveira* (EAC 33822); 20.VII.2004, fl., *E. Silveira* (EAC 34296); 26.VIII.2005, fl., *E. Silveira* (EAC 39436); 25.VIII.2006, fr., *E. Silveira* (EAC 39585); 1.VIII.2007, fr., *E. Silveira* (EAC 40605); 18.IV.2008, *L.W. Lima-Verde 3475* (EAC); 28.III.2015, fl., *M.I.B. Loiola et al. 2542* (EAC). Ipueiras, Buriti, 21.VII.1975, fr., *S. Jordy Filho* (UEC 67754); 21.VII.1979, *S. Jordy Filho 59* (IPA). Mulungu, Sítio Jardim, 14.II.2003, fr., *A.P. Silveira & R.F. Oliveira 858* (EAC); 3.XII.2003, fr., *V. Gomes 1144* (EAC). Pacoti, serra de Baturité, Serrinha, 4.VI.1983, fl., *P. Bezerra* (EAC 12048); 12.VIII.2011, fl., *F.S. Gomes et al. 985* (EAC). São Benedito, 27.V.1981, fl., *A. Fernandes* (EAC 10395); 04°04'86''S, 40°86'50''W, 16.XI.2011, fl., *A.S.F. Castro 2576* (EAC). São Gonçalo do Amarante, Área da Companhia Siderúrgica do Pecém-CSP, 6.IV.2008, fl., *M.F. Moro 377* (EAC); 11.IV.2010, fr., *R.G. Ferreira 113* (EAC). Ubajara, Cachoeira do Boi Morto, 21.IV.1977, fl., *A. Fernandes* (EAC 3140); 22.III.1980, fr., *A. Fernandes* (EAC 8286); PARNA Ubajara, 24.IX.1998, *A. Fernandes* (EAC 27784); 25.IX.1998, *A. Fernandes* (EAC 27766); serra da Ibiapaba, 28.I.1968, fl., *Andrade-Lima 66-5188* (IPA); 3.XI.1978, fr., *A. Fernandes* (EAC 5100). Viçosa do Ceará, Serra das Flores, 13.XII.1985, fr., *A. Fernandes* (EAC 13994).

*Clusia panapanari* differs from the other species of *Clusia* found in Ceará mainly by its subcoriaceous leaves with an inconspicuous intramarginal vein, and abundant secretory ducts. In Ceará, the species resembles *C. ibiapabensis* and the differentiation between them can be seen in the comments on this species.

*Clusia panapanari* occurs in Brazil, Guyana, French Guiana, Suriname and Venezuela (Tropicos 2020). In Brazil, it occurs in the northern (Amazonas, Amapá, Pará and Roraima) and northeastern (Bahia, Ceará, Maranhão and Piauí) regions (Nascimento Jr. & Alencar 2020). In Ceará, *C. panapanari* was recorded in Lowland Semi-deciduous Forest, Dense Ombrophilous Forest, Savanna and Steppic Savanna (Carrasco) (Fig. 1). The species was recorded in Ubajara National Park.



**Figure 5** – a-c. *Clusia panapanari* – a. branch with fruits; b. staminate flower; c. detail of the vein of the leaf adaxial surface. d-f. *Garcinia gardneriana* – d. branch with axillary flowers; e. side view of fruit; f. detail of the vein on the leaf adaxial surface. (a-c. *Ferreira 113*; d-f. *Silveira* (EAC 41636).

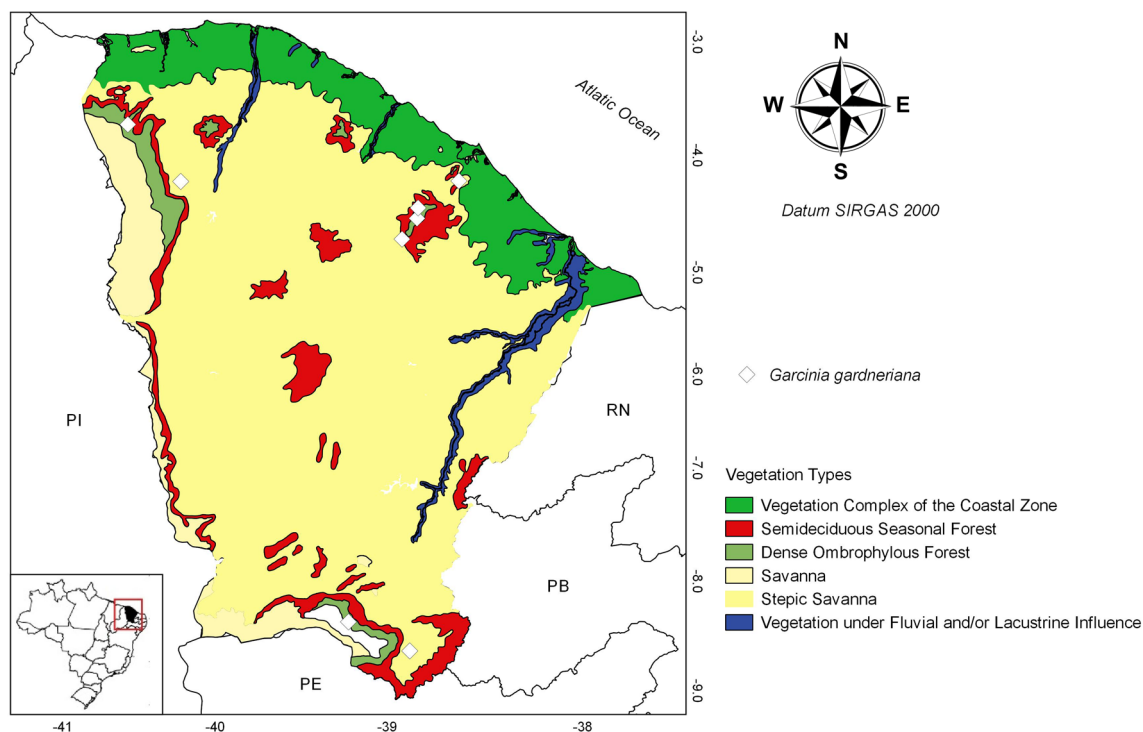
The species was collected with flowers in March, April, May, July, August, and November and fruits in February, March, April, July, August, September, November, and December.

**6. *Garcinia gardneriana*** (Planch. & Triana) Zappi, *Kew Bull.* 48(2): 410. 1993. Figs. 5d-f; 6

Trees or shrubs. Branches woody, not carenate, escrobiculate, with longitudinal depressions, not striate. Petiole 0.4–1.7 cm long, transversally striate. Leaf blade 3.3–17 × 1.2–6.7 cm, oblong to elliptic, rarely widely elliptic, base attenuate, margin slightly sinuous, apex attenuate, subcoriaceous, not scaly, secretory ducts conspicuous; midvein conspicuous for 5/6 of leaf blade, prominent on both surfaces, not carenate; secondary veins 0.1–0.2 cm distant from each other, prominent on both surfaces, forming a 65°–75° angle with the midvein, reticulated near the margin blade; inter-secondary veins parallel to the secondary ones; tertiary veins prominent on abaxial surface, reticulodromous; intramarginal vein conspicuous, distant from the margin ca. 1 cm, crenate. Inflorescences in axillary fascicles; pedicels 0.1–0.25 cm long;

floral buds globose. Flowers 5–15, with ca. 1 cm diam., unisexual; sepals 2, with ca. 0.2 cm diam., rounded, subcoriaceous, margin membranaceous, greenish-white; petals 4, with 0.4–0.6 × 0.2–0.35 cm, oblong-ovate, subcoriaceous, strongly reflex after anthesis, white. Staminate flowers 10–15, stamens 12–20 erect, free, arranged in 2 series; filaments flattened, hyalines; anthers apical, thecae diverging, staminodes and pistillode absents; nectariferous disc not seen. Pistillate flowers 5–10 per fascicle, ovary ca. 3.5 × 3 mm, ovate, 2-carpellate; stigma ca. 2 × 3 mm, staminodes and disc not seen. Berries 2.3–5.1 × 2.5–3.7 cm, globose, smooth, rostrate, glabrous, pedicels 1–1.6 cm long; sepals and petals caducous, stigmas persistent. Seeds with aril absent.

**Selected specimens:** Aratuba, 30.VIII.1980, fl. ♂, *M.A. Figueiredo* (ASE 17083, EAC 8925). Brejo Santo, Chapada do Araripe, 3.I.2015, fr., *A.S.F. Castro 2848* (EAC). Crato, sítio Caianas, 6.IX.2007, *K.V. Linhares* (EAC 45851); sítio Guaribas, 18.XI.1998, fr., *E.B. Souza* (EAC 28275). Guaramiranga, 21.I.1994, fr., *A.S.F. Castro 5* (EAC); 27.I.2006, fr., *E. Silveira* (EAC 38678); 9.X.2007, fl. ♀, *E. Silveira* (EAC 41636, HUEFS 138570); Mata do Adauto Bezerra,



**Figure 6** – Geographic distribution of *Garcinia gardneriana* in Ceará, Brazil.

17.XII.1988, fr., *A. Fernandes* (EAC 15755); Serra de Baturité, Morro das Pedrinhas, 17.IV.1994, fr., *M.A. Figueiredo* 552 (EAC); Sítio Arvoredo, 2.XI.2003, *V. Gomes* 1014 (EAC); Sítio Cana Brava, 12.III.1994, fr., *M.R.L. Oliveira* (EAC 20928); Sítio Sinimbu, 22.VIII.2003, *V. Gomes* 692 (EAC). Pacatuba, Serra da Aratã, 3.I.1996, fr., *L.W. Lima-Verde* (EAC 31442); subida pelo mosteiro, 26.XII.1999, fr., *A.S.F. Castro* 775 (EAC). Pacoti, 17.VIII.2014, fr., *D. Poczwadowski* 135 (EAC); Munguba, 4.XI.2017, fr., *J.C.M.S.M. Sobczak* 733 (EAC); Remanso, 25.XI.1981, fr., *M.A. Figueiredo* (EAC 10940). Pacujá, 19.XII.2007, *A.A. Leopoldino* 20 (HUEFS). Viçosa do Ceará, Chapada da Ibiapaba, 21.VIII.1987, fr., *A. Fernandes & Matos* (EAC 15091).

*Garcinia gardneriana* is easily recognized among the species of Ceará by the inflorescences in axillary fascicles.

*Garcinia gardneriana* occurs in Brazil and, according to Mouzinho *et al.* (2022, 2023), the species is restricted to the Atlantic Forest. In Ceará, the species was recorded in Dense Ombrophilous Forest and Steppic Savana (Carrasco) (Fig. 6).

The species was collected with flowers in October and fruits in January, March, April, August, November, and December.

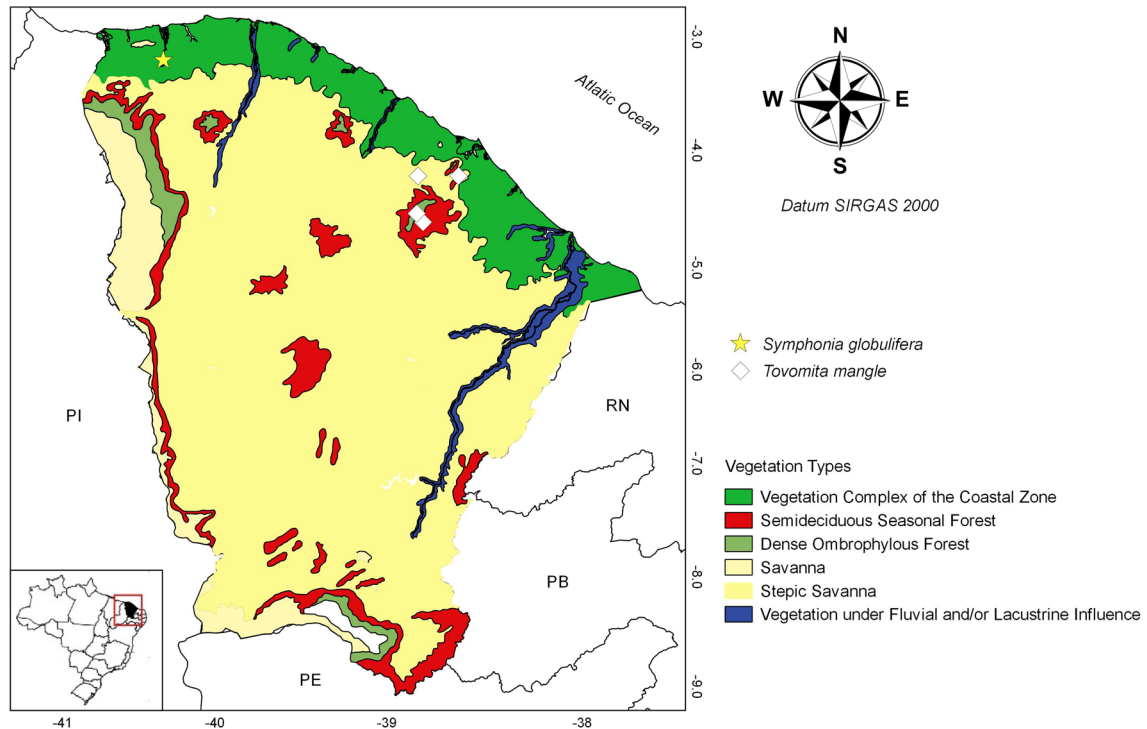
*Garcinia gardneriana* is known as Bacupari. The species has edible fruits that are consumed as

juices or fresh, in addition to being a food source for capuchin monkeys and agouti (Guimarães *et al.* 2004).

### 7. *Symphonia globulifera* L.f., Suppl. Pl. 302. 1781[1782].

Figs. 2o; 7; 8a-c

Trees. Branches woody, not crenate, escrobiculate, with longitudinal depressions, not striate. Petiole 0.5–0.8 cm long, smooth. Leaf blade 3.5–8.5 × 0.9–2.2 cm, elliptic, base decurrent, margin slightly revolute, apex acuminate, chartaceous, not scaly, secretory ducts inconspicuous, grayish-green; midvein conspicuous for 5/6 of leaf blade, prominent on abaxial surface, impressed on adaxial surface, not crenate; secondary veins 0.1–0.2 cm distant from each other, united close to the margin blade, forming a 75°–80° angle with the midvein; tertiary veins parallel and similar to secondary ones, prominent on both surfaces; intramarginal vein inconspicuous. Inflorescence terminal, umbelliform; peduncle absent; pedicels 1.7–2.1 cm long. Flowers 3–12, with 0.4–1.9 cm diam., bisexual; sepals 5, with 0.25–0.45 × 0.4–0.6 cm, deltoid, vinaceous, membranaceous; petals 5, with 1–1.5 × 1–1.2 cm, widely ovate, red, fleshy, forming a chamber over the reproductive whorls,



**Figure 7** – Geographic distribution of *Symphonia globulifera* and *Tovomita mangle* in Ceará, Brazil.

contorts; stamens 5, with 1–1.5 cm long, fused forming a staminal tube surrounding the style, 1/4 distal free, anthers with glandular connective, thecae diverging; filaments 1.2–1.5 cm long; ovary 0.2–0.3 cm, oblong, 5-carpellate, styles 5, with 0.5–1 cm long, connate, stigmas 5, free. Berry ca. 2.9 × 1.8 cm, orbicular; styles and stigmas persistent. Seeds with aril absent.

**Specimen examined:** Granja, Serra da Ubatuba, 10.IX.2005, fl., *A.S.F. Castro 1623* (EAC).

**Additional specimen examined:** BRAZIL. SERGIPE: Pirambu, REBIO de Santa Isabel, próximo à cachoeira do Roncador, 19.XI.2012, fl., *E.S. Ferreira 161* & *E.V.S. Oliveira* (ASE).

*Symphonia globulifera* differs from the other species occurring in the territory of Ceará by the bisexual flowers, with red petals forming a chamber over the reproductive whorls, and stamens fused forming a staminal tube surrounding the style.

*Symphonia globulifera* occurs in Argentina, Belize, Bolivia, Brazil, Caribbean, Colombia, Costa Rica, Ecuador, Guyana, French Guiana, Guatemala, Honduras, Madagascar, Mexico, Panama, Peru, Suriname and Venezuela (Tropicos 2020). In Brazilian territory, it has records for all regions of the country, with the exception of the

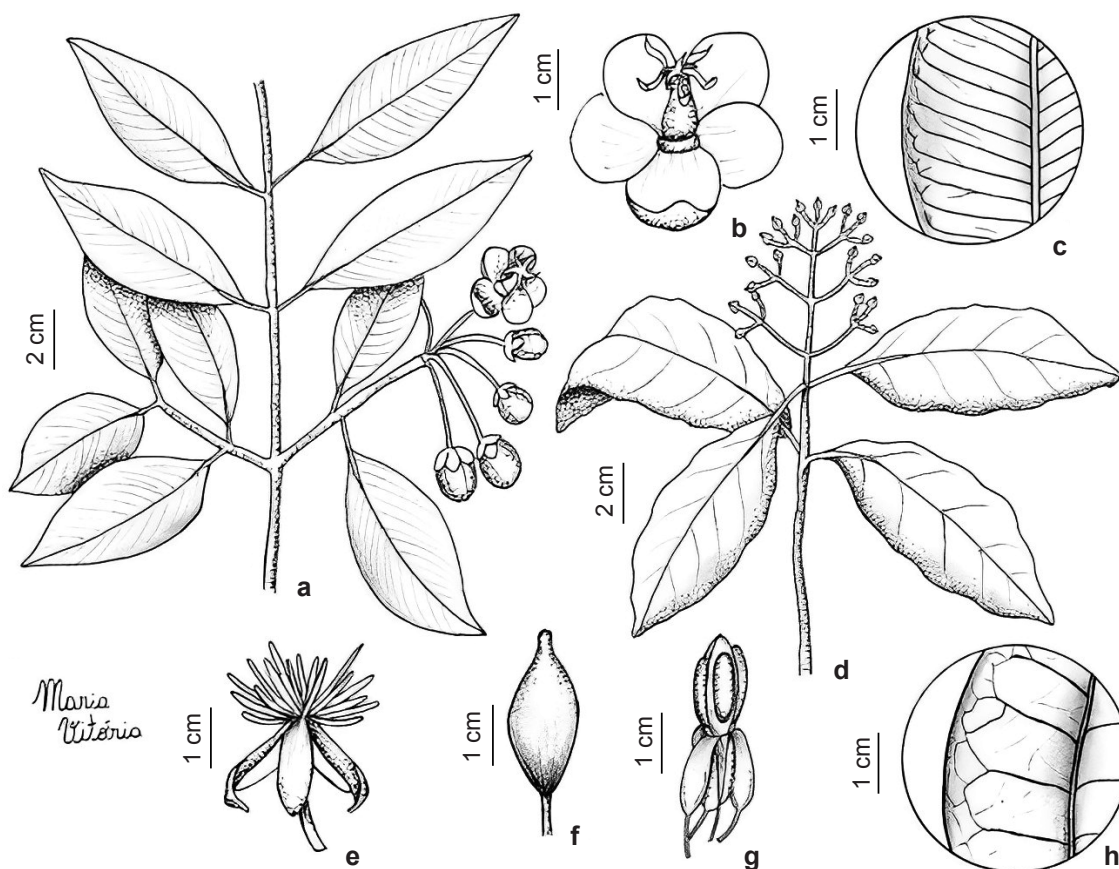
South (Muniz 2020). In Ceará, the species was recorded in vegetation with fluvial-lacustrine influence in only one municipality (Fig. 7).

The species was collected with flowers in September.

**8. *Tovomita mangle*** G. Mariz, Bull. Torrey Bot. Club 101(6): 367, 369-371, f. 3-5. 1974.

Figs. 2p; 7; 8d-h

Treelets. Branches woody, not carenate, not escrobiculate, not striate. Petiole 1–2 cm long, smooth. Leaf blade 4.5–19 × 1.5–8.2 cm, elliptic to widely elliptic, base decurrent, margin sinuous, apex agude to acuminate, membranaceous, not scaly, secretory ducts inconspicuous; midvein conspicuous for the entire leaf blade, prominent on abaxial surface, impressed on adaxial surface, carenate; secondary veins 9–10 pairs, 0.5–2.5 cm distant from each other, prominent on abaxial surface; intramarginal vein absent. Inflorescence terminal dichasium, single or compound for 3–15 flowers; peduncle absent; pedicels 0.5–0.15 cm long; floral buds 0.6–0.11 cm long, oblong, apex mucronulate, completely covered by the sepals. Flowers ca. 1.3 × 1.2 cm diam.; sepals 2, with 0.6–0.8 × 0.3–0.6 cm, oblong, fleshy; petals 4, with



**Figure 8** – a-c. *Symphonia globulifera* – a. branch with inflorescence; b. monoecious flower; c. detail on the vein in leaf adaxial surface. d-h. *Tovomita mangle* – d. branch with floral buds; e. staminate flower; f. floral bud; g. open fruit; h. detail of the vein on the leaf adaxial surface. (a-c. Castro 1623; d-h. Félix 5442).

0.8–1 × 0.25–0.5 cm, elliptic, subcoriaceous, apex mucronulate, reflex. Staminate flowers with 30–40 stamens, free, anthers apical, thecae diverging, pistillode present, conical. Pistillate flower with ovary ca. 0.1 × 0.4 cm, oblong, 4-carpellate; stigma 4, partially connate, staminodes 25–28, ca. 0.5 cm. Capsules 1.8–2 × 0.8–1.3 cm, 4-valvar, elliptic to pyriform; petals caducous, sepals, staminodes and stigmas persistent. Seeds with aril present.

**Specimens examined:** Baturité, interior da mata, 9.X.1992, fl., L.P. Félix 5442 (EAC); Sítio Santa Clara, 28.IX.1939, fl., J. Eugênio (EAC 5369). Guaramiranga, 19.III.2008, fr., Edilberto & Otilia (EAC 42683). Pacatuba, Serra da Aratanha, 25.III.2000, fr., E.B. Souza *et al.* 435 (EAC, HUVA). Pacoti, Serra de Baturité, Sítio Arvoredo, 23.VI.1990, fl. and fr., M.A. Figueiredo & A.F. Fernandes (EAC 27625).

*Tovomita mangle* can be distinguished from other species of Clusiaceae from Ceará by the few secondary veins (9–10 pairs) and small floral buds

(0.6–0.11 cm long) totally covered by the sepals. The capsule fruit is similar to those of *Clusia* but has only one seed per locule.

*Tovomita mangle* is an endemic species of the Brazilian Atlantic Forest, often found in forest plains and Lowland Semi-deciduous Forest, and is generally associated with watercourses (Marinho *et al.* 2016). In Ceará, *T. mangle* was recorded only in highland environments in Dense Ombrophilous Forest (Fig. 7).

The species was collected with floral buds in September and October, and fruits in March.

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### Data availability statement

In accordance with Open Science communication practices, the authors inform that all data are available within the manuscript.

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