

Pentaphylacaceae in focus: two new species of *Ternstroemia* Mutis ex L.f from the Brazilian Atlantic Rainforest

Jaqueline A. Vieira^{1,6} | João Victor L. Monzoli¹ | Lisandra A. Teixeira² | Valner Matheus M. Jordão³ | Mario Tomasiello Filho⁴ | Daniela Sampaio⁵

¹ Programa de Pós-Graduação em Biociências. Instituto de Biociências, Letras e Ciências Exatas (IBILCE), Universidade Estadual Paulista "Júlio de Mesquita Filho". Departamento de Ciências Biológicas. Rua Cristovão Colombo, 2265, São José do Rio Preto, 15054-000, São Paulo, Brazil

² Programa de Pós-Graduação em Biodiversidades. Instituto de Biociências, Letras e Ciências Exatas (IBILCE), Universidade Estadual Paulista "Júlio de Mesquita Filho", Departamento de Ciências Biológicas, Rua Cristovão Colombo, 2265, São José do Rio Preto, 15054-000, São Paulo, Brazil.

³ Programa de Pós-Graduação em Botânica, Escola Nacional de Botânica Tropical (ENBT), Instituto de Pesquisa Jardim Botânico do Rio de Janeiro (JBRJ), Rua Pacheco Leão, 915, Rio de Janeiro, 22460-030, Rio de Janeiro, Brazil.

⁴ Departamento de Ciências Florestais, Escola Superior de Agricultura "Luiz de Queiroz" (Esalq), Universidade de São Paulo. Av. Pádua Dias, 235, Piracicaba, 13418-900, São Paulo, Brazil.

⁵ Instituto de Biociências, Letras e Ciências Exatas (IBILCE), Universidade Estadual Paulista "Júlio de Mesquita Filho". Departamento de Ciências Biológicas. Rua Cristovão Colombo, 2265, São José do Rio Preto, 15054-000, São Paulo, Brazil.

⁶ Correspondence: jav_botany@outlook.com.br

ABSTRACT

Pentaphylacaceae (Ericales) comprises 14 genera and ca. 520 species distributed worldwide in the tropics and subtropics. In Brazil, the family is represented by two genera, *Freziera* (two species) and *Ternstroemia* (25 species, including two new species described here). Here, we propose two new species of *Ternstroemia* from the Brazilian Atlantic Forest: *T. ombrophicola* J.A.Vieira & D.Sampaio *sp. nov.*, from Wenceslau Guimarães, state of Bahia, and *T. serratifolia* J.A.Vieira & D.Sampaio *sp. nov.*, from Caratinga, state of Minas Gerais, both rare, each with only one population known. Morphological descriptions are presented, as well as comments on habitat, distribution, conservation, phenology and taxonomic affinity. Images *in vivo*, line drawings, and distribution maps are also provided. An identification key to the extra-Amazonian Brazilian species of *Ternstroemia* is also provided.

1 | INTRODUCTION

Pentaphylacaceae Engl. (Ericales) is a pantropical family of angiosperms (POWO 2024) represented by 14 genera (Tsou *et al.* 2016) and ca. 520 species (POWO 2024). In Brazil, the family is represented by two genera, *Freziera* Willd., with only two species (Zorzanelli 2019; Vieira and

Vieira *et al.* – Two new species of *Ternstroemia*

Sampaio 2024;2020a), and *Ternstroemia* Mutis ex L.f., which harbors 25 species including those described here (Grande-Allende 2021; Vieira *et al.* 2021b).

Furthermore, in Brazil, a taxonomic revision of Pentaphylacaceae was conducted by Vieira (2020), which reflected in the "Flora do Brasil 2020" treatment of the family (Vieira and Sampaio 2020a). A taxonomic revision of *Ternstroemia* from Brazil was also conducted by Grande-Allende (2019), and since then several new species were described to Brasil (Grande-Allende 2021; Vieira *et al.* 2021b). *Ternstroemia* is also being treated in the "Phylogenomic and Taxonomic revision of *Ternstroemia* from the Neotropical Region" project (FAPESP 2022/05573-8), by the first author, and this article provides the first results of this project.

Ternstroemia, the most diverse genus of the family, comprises about 160 species distributed worldwide throughout the tropics and subtropics, 110 of them in the Neotropical region (POWO 2024). Brazil has the greatest species diversity of *Ternstroemia*, followed by Venezuela (23 spp.) and Colombia (18 spp., Fonseca-Cortés & Grande-Allende 2024).

In this study we describe two new species of *Ternstroemia* from vegetation formations in the South American Atlantic Forest domain, a rainforest marked by a typically hot climate with well-demarcated rainy summers and dry winters, with approximately 1000 mm of precipitation per year (Fonseca *et al.* 2003; Oliveira *et al.* 2006). Here, we provide a taxonomic treatment with etymology and observations in the distribution and ecology, phenology, conservations status, taxonomic comments, field images, and line drawings. We also present an identification key and a table (Table 1) with the extra-amazonian Brazilian species of *Ternstroemia*.

TABLE 1. Comparison between reproductive characters of extra-Amazonian *Ternstroemia* species and their respective domains of occurrence.

Species	Locule number	Seeds per locule	Stigma	Connective	Domain
<i>T. alnifolia</i> Wawra	3	(1)2	Peltate	Apiculate	Brazilian Atlantic Forest
<i>T. bahiensis</i> J.A.Vieira & D.Sampaio	2–4 with false septa	1–6	Punctate	Aristate	Caatinga
<i>T. brasiliensis</i> Cambess.	(2)3–5	2	Punctate	Apiculate to caudate	Brazilian Atlantic Forest and Caatinga
<i>T. carnosa</i> Cambess.	(2)3(4)	2	2-lobate	Mucronate	Cerrado, Caatinga and Brazilian Atlantic Forest
<i>T. cuneifolia</i> Gardner	3	2	2-3-lobate	Mucronate	Brazilian Atlantic Forest
<i>T. ombrophicola</i> J.A.Vieira & D.Sampaio	2	2	Punctate	Apiculate	Brazilian Atlantic Forest
<i>T. rupestris</i> J.A.Vieira & D.Sampaio	4	1	Capitate	Caudate	Brazilian Atlantic Forest
<i>T. serratifolia</i> J.A.Vieira & D.Sampaio	2	2	Capitate	Apiculate	Brazilian Atlantic Forest

2 | MATERIAL AND METHODS

All Neotropical nomenclatural types of *Ternstroemia* were examined to warrant the description of the taxa presented here as new. We analyzed in this process ca. 3000 specimens, representing 110 species, from national and international herbaria. The nomenclatural types and general collections of the following herbaria were studied, either via high resolution images or physical loans: A, AA, ALCB, B, BHCB, BM, BR, CAP, CAS, CEN, CEPEC, E, ESA, F, FLOR, G, GH, HAL,

Vieira *et al.* – Two new species of *Ternstroemia*

HAMAB, HRCB, HUEFS, INPA, K, M, MA, MBM, MBML, MEX, MFS, MG, MO, MPU, NY, P, R, RB, RON, S, SP, SPF, SPSF, U, UB, UEC, UPCB, US, VEN, VIES, W, WIS (all acronyms following Thiers 2024).

Morphological analysis for species descriptions and line drawings were carried out using a stereo microscope; descriptions were made following the botanical glossary of Harris and Harris (2001) and Kobuski (1942). Diagnostic characters given relevance in this work on Pentaphragmaceae include inflorescence position and architecture, size and shape of bracts, bracteoles, sepals and petals, stigma shape, number of locules in the ovary and ovules per locule and fruit dehiscence, as well as vegetative characters as habit, length and shape of the petioles and leaves.

For the description of the venation patterns, secondary and tertiary, samples of entire leaves of the two new species were digitally x-rayed in a Faxitron LX-60 cabinet X-ray system coupled with a computer with the software Faxitron DX version 1.0. The images were captured by using an X-ray exposure time 18 seconds at a voltage of 29 kV, according to Moraes *et al.* (2021) and Lima *et al.* (2021). The venation descriptions were conducted based on Ellis *et al.* (2009).

The distribution data was elaborated using QGIS version 3.16.8 (<http://www.qgis.org>). Preliminary conservation assessment was prepared using the IUCN (2024).

3 | TAXONOMY

Ternstroemia ombrophicola J.A.Vieira & D.Sampaio, *sp. nov.*

Ternstroemia ombrophicola resembles *T. brasiliensis* Cambess. (*sensu* Vieira *et al.* 2021a) due to its 2-locular ovary and 2 ovules per locule, although this 2-locular ovary sometimes occurs in *T. brasiliensis*; both species also have punctate stigmas. *Ternstroemia ombrophicola* differs from *T. brasiliensis* by the presence of membranous to chartaceous leaf lamina (*vs.* coriaceous in *T. brasiliensis*), the undulate leaf margin (*vs.* entire or with the distal portion serrate), black punctuations absent in the abaxial surface of the leaf lamina (*vs.* present), the inflorescence congested and arranged in a brachyblast (*vs.* arranged along the branches, not arranged in a brachyblast).

Typus—BRAZIL: Bahia, Wenceslau Guimarães, trilha atrás da sede em direção a cachoeira, 13°35'56" S, 39°43'09" W, elev.: 662 m, 25.XI.2013, fl., L.Y.S. Aona *et al.* 3412 (holotype: HURB 7630!; isotypes: HUEFS 212627!, RB 607644!).

Shrubs or trees, up to 4 m tall. Leaves evenly distributed along the branches, or clustered at the apex of the branches, alternate to pseudo-verticillate; petioles 0.3–0.6 long and 0.1 cm wide, thin; leaf blade 3.5–7.3 long and 1.1–2.8 cm wide, membranaceous to chartaceous, oblanceolate, base acute, decurrent, margin slightly undulate, apex acute to acuminate, venations pinate, weak conspicuous, inconspicuous in chartaceous leaves, slightly conspicuous in membranaceous leaves on abaxial face, midrib flat adaxially, prominent abaxially and with different color between adaxial and abaxial faces, dark green adaxial, light green abaxial, venations weak inconspicuous, midrib flat adaxially, prominent abaxially, secondaries weak brochidodromous, irregular, uniform,

Vieira *et al.* – Two new species of *Ternstroemia*

intersecondaries weak, tertiaries alternate percurrent, irregular, sinuous, obtuse, inconsistent; black punctuations absent on abaxial face. Bract 1, ca. 0.1 cm long, ovate, apex obtuse, margin glandular-denticulate; pedicels thin, 0.4–0.6 long and 0.05 cm wide. Flowers 0.4–0.9 cm long, congested, grouped in brachyblasts with 2-many flowers; bracteoles 2, 0.1–0.4 long and 0.1–0.35 cm wide, subequal to unequal, coriaceous, ovate, the apex rounded to obtuse, the margin entire to sparsely glandular at the base; sepals 5, vinaceous outside and white inside, ovate, margins scarious and entire, 2 outer sepals 0.3–0.35 cm long, apices obtuse, 3 inner sepals, 0.4–0.6 long and 0.3–0.4 cm wide, ovate, apex rounded, margins scarious, entire; petals 5, yellow, 0.3–0.6 long and 0.1–0.25 wide, membranaceous, connate up to the middle, apex acute; stamens 22–32, 2-whorled, filaments 0.05–0.1 cm long, anthers 0.1–0.16 cm long, connectives 0.04–0.15 cm long, apiculate; ovary 0.15–0.17 cm long, pyriform, 2-locular, 2 ovules per locule; style 0.18–0.36 cm long, not divided, stigma punctate, glandular. Fruits not seen.

Additional material examined (paratypes)—BRAZIL: Bahia, Wenceslau Guimarães, Estação Ecológica, Trilha atrás do alojamento, passando a captação, 13°36'00"S, 39°43'06"W, elev.: 702 m, 16.XII.2012, fl., *W. Milliken et al.* 5092 (HUEFS, HURB, SJRP, UEC).

Etymology—The epithet *ombrophicola* refers to the occurrence of the species in the ombrophilous forest, one of the vegetation types found in the Atlantic Forest domain.

Distribution and ecology—*Ternstroemia ombrophicola* occurs in the ombrophilous forest of the Atlantic Forest region of the state of Bahia, on hillsides under advanced ecological succession (Fig. 1). The physiognomy of the area is composed of vegetation typical of Wet Tropical Forest, Ombrophilous Forest. The Wenceslau Guimarães State Ecological Station is located in the Rio Recôncavo Sul hydrographic basin, Rio das Almas hydrographic sub-basin, and is an important fragment of dense Ombrophilous Forest of montane formation (Velooso *et al.* 1991; INEMA 2018; Evangelista *et al.* 2019). The conservation unit is known for its species richness and endemism, as well as harboring threatened species (INEMA 2018). The topography of the ecological station is mountainous, characterized by a granitic composition containing quartz and feldspar. The soil consists of red-yellow latosols. The region has a humid-subhumid climate, with annual temperatures between 22° and 25.5°C and high rainfall ranging from 800 to 1500 mm per year, which sustains the hygrophilous forest vegetation (Convênio SEAGRI/DDF/BA–FUNATURA 1997). A peculiarity of the area is the presence of several Amazonian species, such as *Ecclinusa ramiflora* Mart., *Micropholis guyanensis* (A. DC.) Pierre, *Aspidosperma oblongum* A.DC., *Parkia pendula* (Willd.) Benth. ex Walp. and *Cordia nodosa* Lam. (SEAGRI/DDF/BA–FUNATURA 1997).

Phenology—Flowers from November to December.

Neodiversity

Vieira *et al.* – Two new species of *Ternstroemia*

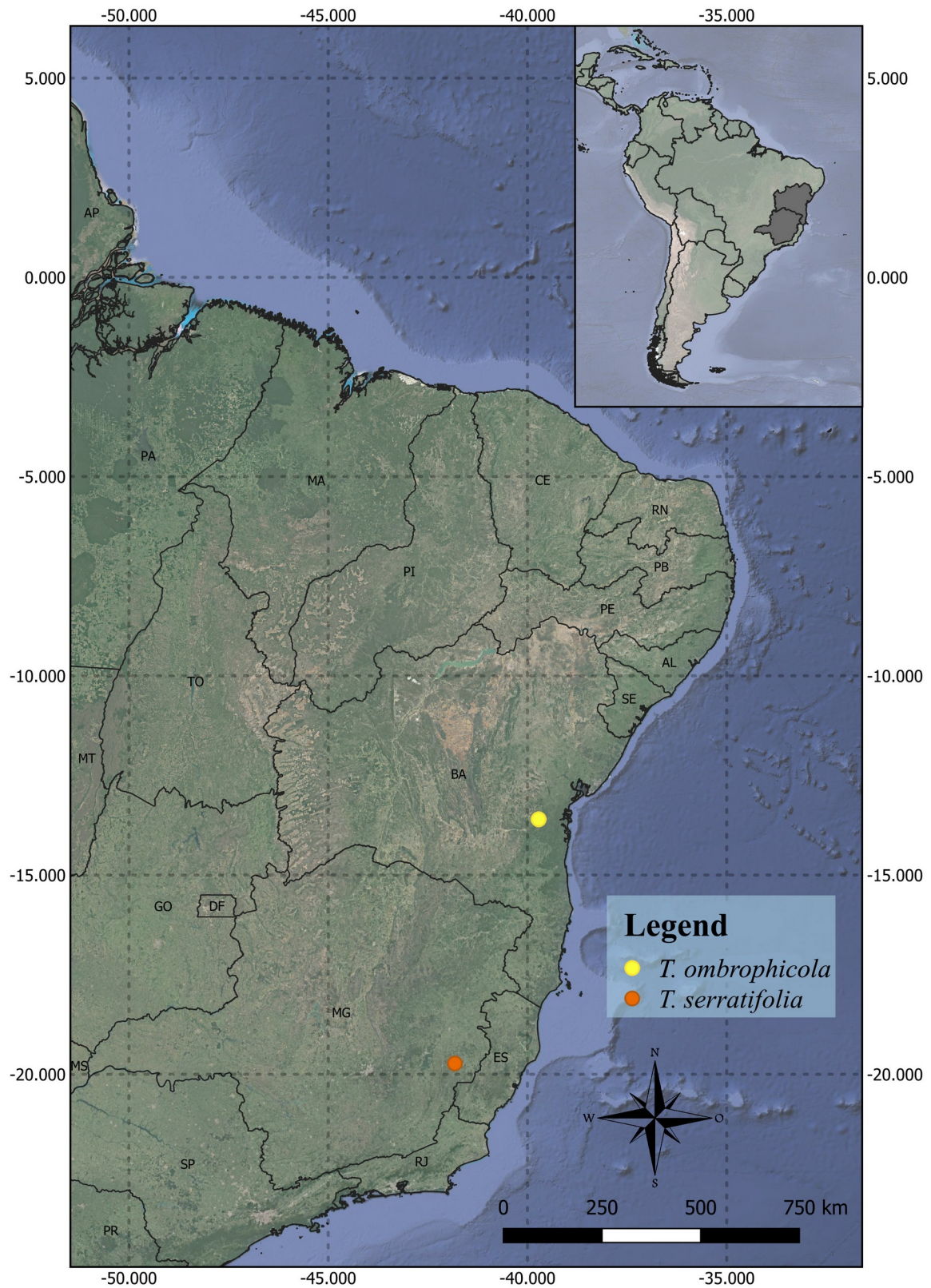


Figure 1. Occurrence map of *Ternstroemia ombrophicola* and *T. serratifolia*.

Conservation status—*Ternstroemia ombrophicola* was assessed as deficient data (DD). *Ternstroemia ombrophicola* is restricted to Wenceslau Guimarães State Ecological Station (ESEC Wenceslau Guimarães), a conservation unit in Bahia state. However, the area is threatened by deforestation, fire, and fragmentation.

Taxonomic comments—*Ternstroemia ombrophicola* is characterized by its membranaceous or chartaceous leaf lamina, secondaries veins weak brochidodromous, irregular, uniform, intersecondaries weak, tertiaries alternate percurrent, irregular, sinuous, obtuse, inconsistent (Fig. 2), leaves without black punctuations on the abaxial face, flowers congested, grouped in brachyblasts, ovary 2-locular, and locules with two ovules (Fig. 3A-G). The sepals are vinaceous outside and white inside, and the petals are yellow (Fig. 4A-D).

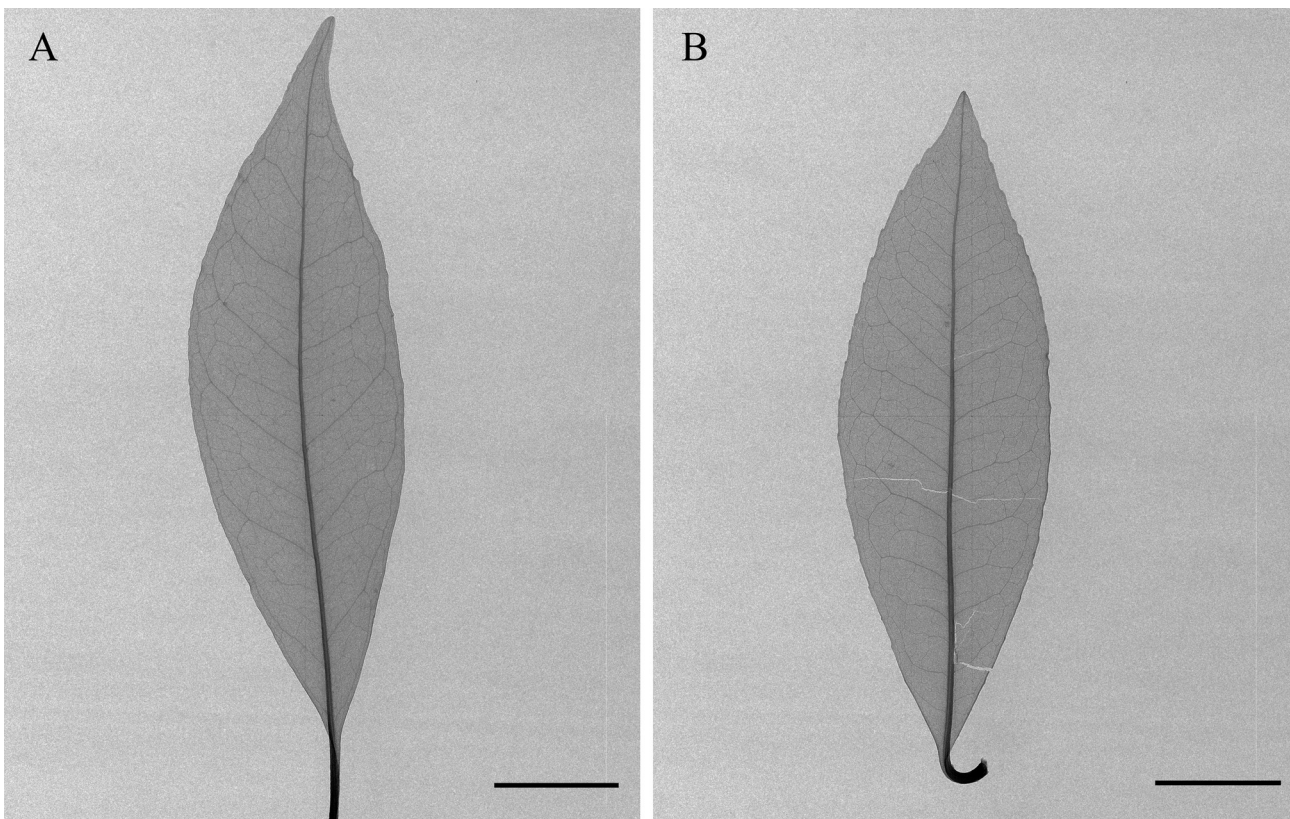


Figure 2. A. X-ray images of the leaf venation of *Ternstroemia ombrophicola* (from L. Y. Aona 3412). B. X-ray images of the leaf venations of *Ternstroemia serratifolia* (from P.M. Andrade 204).

Ternstroemia serratifolia* J.Vieira & D.Samp., *sp. nov.

Ternstroemia serratifolia resembles *T. rupestris* J.A.Vieira & D.Sampaio by its inflorescence reduced into a single flower, not congested, and arranged in a brachyblast and capitate stigma and seeds 4 per fruit. *Ternstroemia serratifolia* differs from *T. rupestris* by the elliptic leaves (vs. oblong to oblong-elliptic leaves in *T. rupestris*), chartaceous to coriaceous leaf blade (vs. coriaceous), with serrate margins (vs. dentate to serrulate), black punctuations absent on the abaxial face (vs. present), ovary 2-locular (vs. 4-locular), fruit 1–1.1 long and 0.7 cm wide (vs. 3.5 × 1–2.5 cm), seeds 2 per locule (vs. 1 per locule), ca. 0.4 long and 0.2 cm wide (vs. 1 × 0.5 cm).

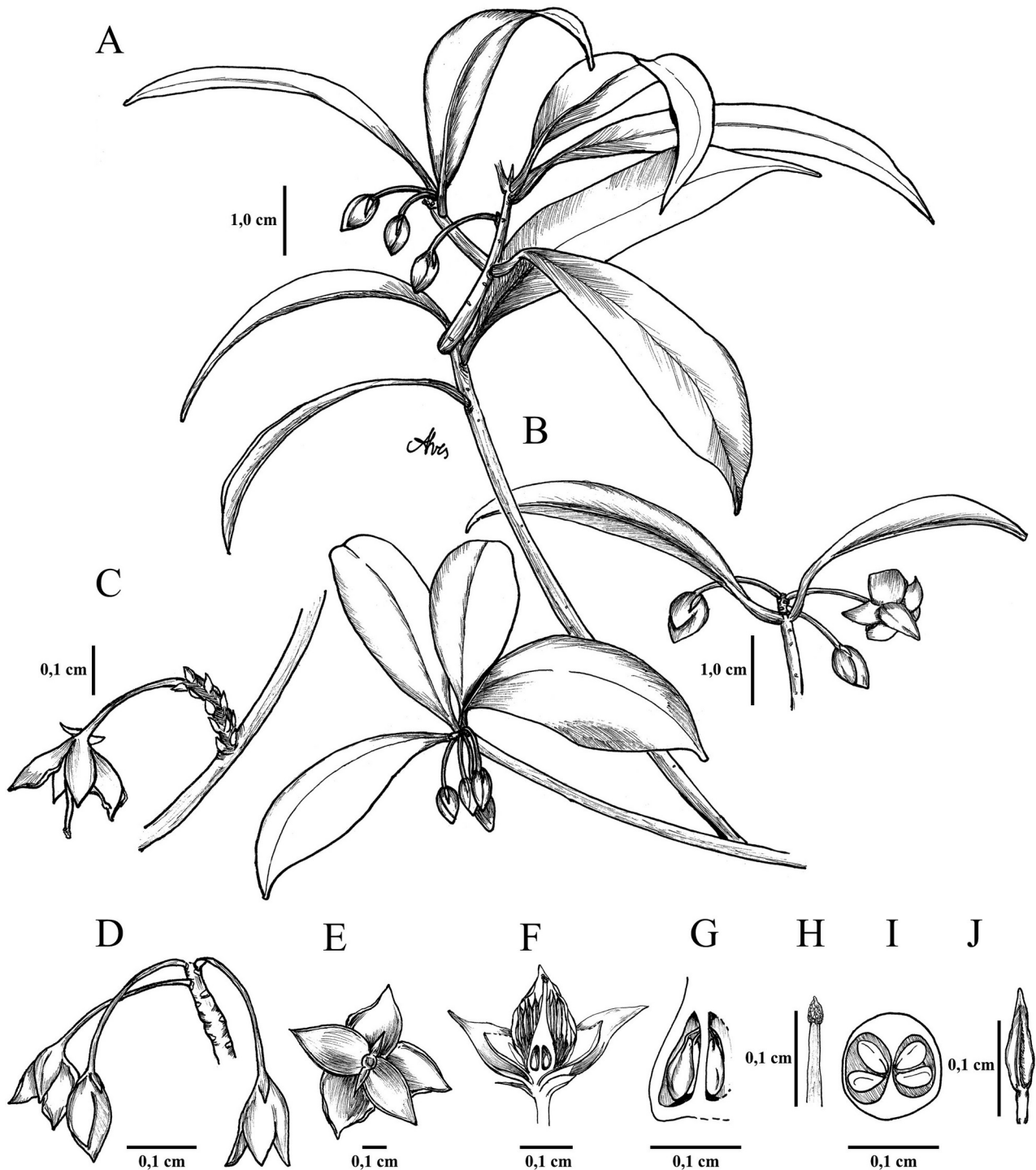


Figure 3. *Ternstroemia ombrophicola* (RB6007644): A. Branch with flowers. B. Inflorescence in brachyblasts at the apex of the branch. C. Inflorescence in brachyblasts, bracts present. D. Inflorescence in brachyblasts, bracts caducous. E. Bracteoles, outer sepals, and inner sepals. F. Flower in longitudinal cut. G. Ovary in longitudinal cut. H. Style and stigma. I. Ovary in transversal cut. J. Stamen. Drawn by J.A. Vieira, edited by: Valner Matheus Milanezi Jordão.

Neodiversity

Vieira *et al.* – Two new species of *Ternstroemia*



Figure 4. *Ternstroemia ombrophicola*: A to C. Branch with buds. D. Branch with buds and flowers upside down. Photographs: João Victor Longhi Monzoli.

Vieira *et al.* – Two new species of *Ternstroemia*

Typus—BRAZIL: Minas Gerais, Estação Biológica de Caratinga, 23 February 1984, fl. and fr., *P.M. Andrade & M.A. Lopes 204* (holotype: RB 005287020!; isotype: US 00919639!)

Tree 4–10 m tall. Leaves evenly distributed along the branches, or clustered at the apex of the branches, alternate to pseudovercillate; petioles 0.3–0.7 long and 0.1 cm wide, thin; leaf blade 3.5–6.5 long and 1.1–2.3 wide, dark green adaxial, light green abaxial, chartaceous to coriaceous, elliptic, base acute, decurrent, margin serrate, apex acute to acuminate, venations pinate, weak conspicuous, midrib flat adaxially, prominent abaxially, secondaries weak brochidodromous, irregular, smoothly increasing toward base, intersecondaries weak, tertiaries alternate percurrent, irregular, convex, obtuse, inconsistent; black punctuations absent on abaxial face. Bract not seen. Flowers ca. 0.5 cm long, reduced into a single flower, axillary in a caducous bract; pedicels thin, 0.9–1.1 long and 0.1 cm wide; bracteoles 2, 0.1–0.4 long and 0.1–0.35 wide, subequal to unequal, coriaceous, ovate, apex rounded to obtuse, margin entire to sparsely glandular basally, sepals 5, 2 outer sepals 0.3–0.4 cm long, ovate, apices obtuse, margin glandular-denticulate, entire, 3 inner sepals 0.4–0.6 long and 0.3–0.4 cm wide, ovate, apices rounded, margin scarious, entire; petals 5, 0.3–0.6 long and 0.1–0.3 cm wide, acute, membranous, basally connate up to middle, apices acute; number of stamens unknown, filaments 0.05–0.1 cm long, anthers 0.1–0.16 cm long, connectives 0.04–0.15 cm long, aristate; ovary 0.15–0.17 cm long, pyriform, 2-locular, 2 ovules per locule; style ca. 0.2 cm long, not divided, stigma capitate. Fruits 1–1.1 long and 0.7 cm wide, long-ovate, smooth in sicco, 2-locular, dehiscent into irregular valves or indehiscent. Seeds 4, ca. 0.4–0.6 long and 0.2–0.4 cm wide, 2 per locule.

Additional material examined (paratypes)—BRAZIL: Minas Gerais, Caratinga, Fazenda Montes Claros, Trilha J nas proximidades do ponto 26, 19°50'S, 41°50'W, 02.III.1993, fr., *G.A.R.de Melo 77* (VIC); Estação Biológica de Caratinga – Matão, 25.IV.1984, *M.A.Lopes & D.M.Andrade 355* (NY); RPPN Feliciano Miguel Abdala, trilha J subindo a partir do ponto 30, 19.73224S, 41.82836W, 08.X.2022, *J.A.Vieira et al. 788* (SJRP); RPPN Feliciano Miguel Abdala, trilha J subindo, no ponto 35, 19.73232S, 41.82866W, 08.X.2022, *J.A.Vieira et al. 789* (SJRP); RPPN Feliciano Miguel Abdala, trilha J subindo, no ponto 36, 19.73232S, 41.82866W, 08.X.2022, *J.A.Vieira et al. 790* (SJRP); RPPN Feliciano Miguel Abdala, trilha J subindo, no ponto 36, 19.73232S, 41.82866W, 08.X.2022, *J.A.Vieira et al. 792* (SJRP).

Etymology—The epithet *serratifolia* refers to the serrate margin of the leaf lamina in this species.

Distribution and ecology—*Ternstroemia serratifolia* is known from only one known population, in Caratinga, Minas Gerais (Fig. 1). The species occurs in the RPPN–Feliciano Miguel Abdala, previously known as Montes Claros Farm and Ecological Station of Caratinga, is located in Caratinga, Minas Gerais. The RPPM-FMA was created by IBAMA (Brazilian Institute of Environment and Renewable Natural Resources) by joining the Biological Station of Caratinga and Montes Claros Farm (Torres and Cosenza 2018). This protected area is on the left bank of Manhuaçu river of the Rio Doce hydrographic basin, with Montes Claros farm accounting for 72% of the area. The area is considered of paramount biological importance due to the high endemism of plant species (Fonseca *et al.* 2003). The physiognomy of the area is composed of vegetation typical of Semideciduous Seasonal Forest. The area has a mountainous relief with an altitude of 318–628 m (Fonseca *et al.* 2003), the soil is

Vieira *et al.* – Two new species of *Ternstroemia*

deep, nutrient poor, consisting of red-yellow alic (LA) oxisols originating from granite and gneiss, with constant leaching causing nutrient scarcity (Veado 2002; Costa e Silva *et al.* 1996).

Phenology—Fruits in February and October.

Conservation status—*Ternstroemia serratifolia* was assessed as deficient data (DD). *Ternstroemia serratifolia* is restricted to one protected area in Minas Gerais, the Feliciano Miguel Abdala Natural Heritage Private Reserve (Reserva Particular do Patrimônio Natural Feliciano Miguel Abdala – RPPN–FMA). This area is threatened by deforestation, fire, and fragmentation.

Taxonomic comments—*Ternstroemia serratifolia* are trees, measuring 4–10 m in height, and is characterized by its suberous trunk, and chartaceous to coriaceous leaf lamina with serrate margin (Fig. 5A–H), the secondaries venation are smoothly increasing toward base, 30° from primary near to the base, 45° near to the apex (Fig. 2), leaves without black punctuations on the abaxial face, a 2-locular ovary, with two ovules per locule (Fig. 6A–F). The the Fig. 5H shows four seeds, two mature and two immature, immature seeds were not considered in the measurements. Old flowers were available on only one sample of *Ternstroemia serratifolia* and it was therefore impossible to observe the number of stamens.

Ternstroemia serratifolia also resembles *T. brasiliensis* by its geographical distribution, inflorescence reduced into a single flower, not arranged in a brachyblast, otherwise, *T. serratifolia* differs from *T. brasiliensis* by the elliptic leaves (vs. obovate to oblanceolate leaves in *T. brasiliensis*), chartaceous to coriaceous leaf blade (vs. coriaceous), with serrate margins (vs. entire or with the distal portion serrate), black punctuations absent (vs. present), ovary 2-locular (vs. (2)3–5-locular), fruit 1–1.1 × 0.7 cm (vs. 1–3.5 × 2–2.5 cm), seeds 4 (vs. 6–10), ca. 0.4 × 0.2 cm (vs. 1–2 × 1–2 cm).

Ternstroemia serratifolia differs from the other non-amazonian species of *Ternstroemia* (*T. alnifolia*, *T. bahiensis*, *T. brasiliensis*, *T. carnosa*, *T. cuneifolia* and *T. ombrophicola*) by its 2-locular ovary (vs. 3-locular in *T. alnifolia*, 2–3-locular with many false septa in *T. bahiensis*, 3-locular in *T. cuneifolia*, 4-locular in *T. rupestris*). Although *Ternstroemia carnosa* can also present a 2-locular ovary with 2 seeds per locule, this number of locules is rare and a 3-locular ovary is more common. Furthermore, *Ternstroemia serratifolia* differs from *T. carnosa* by its capitate stigma (vs. 2-lobate stigma in *T. carnosa*), apiculate connectives (vs. mucronate connectives) and fruits dehiscent into irregular valves or indehiscent (vs. dehiscent by a circumcised line at the base of fruit). *Ternstroemia serratifolia* differs from *T. ombrophicola* by its chartaceous to coriaceous leaves, never membranaceous (vs. membranaceous to chartaceous in *T. ombrophicola*), serrate margin (vs. slightly undulate margin), inflorescence reduced to one flower not grouped in brachyblasts (vs. flowers grouped in brachyblasts) and capitate stigma (vs. punctate stigma).

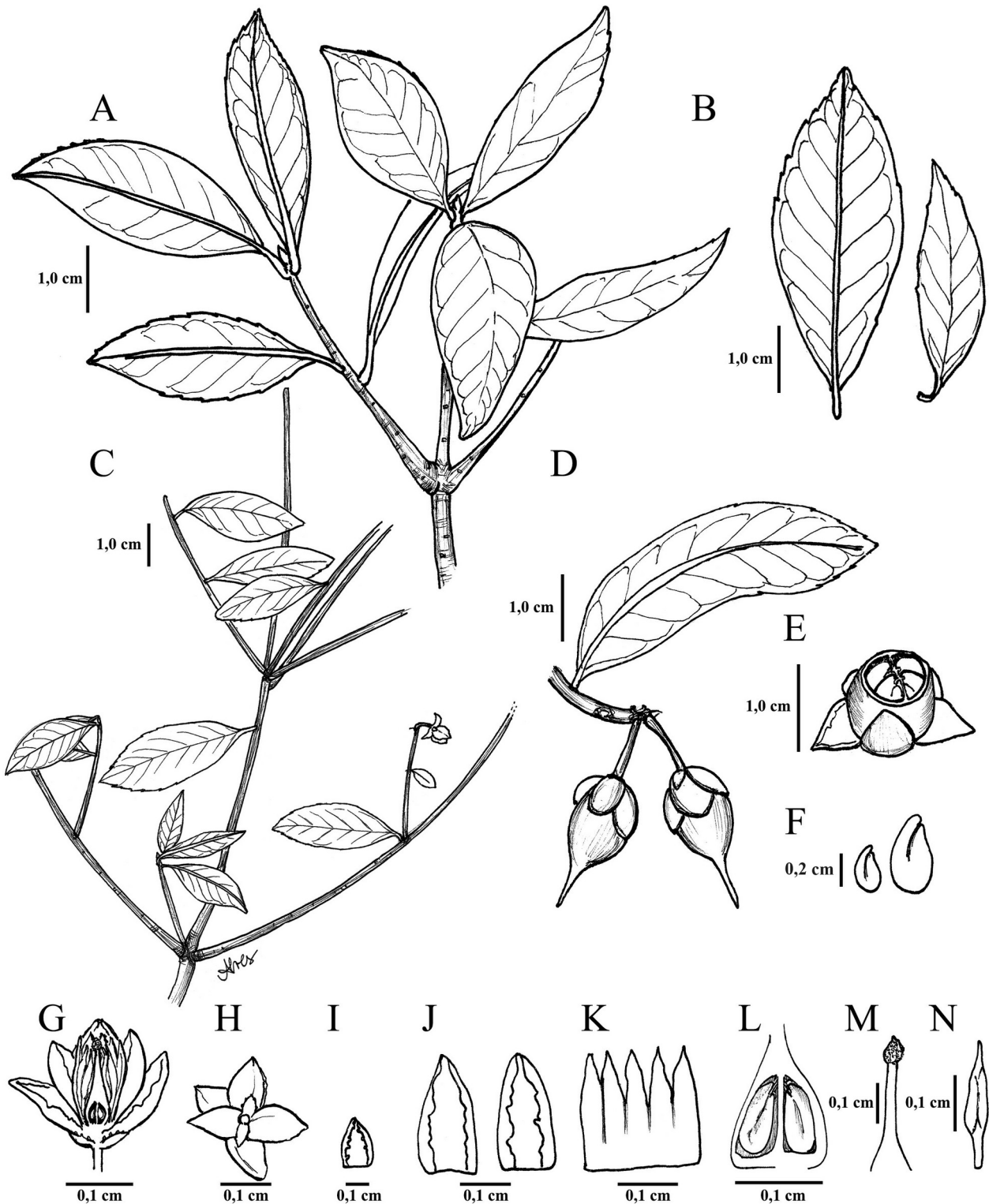


Figure 5. *Ternstroemia serratifolia* (RB467798): A. Branch. B. Leaves. C. Branch with inflorescence. D. Branch with fruits. E. Fruit in transversal cut. F. Seeds. G. Flower in longitudinal cut. H. Bracteoles, outer sepals, inner sepals. I. Bracteole. J. Outer sepals. K. Petals. L. Ovary in transversal cut. M. Style with stigma. N. Stamen. Drawn by J. A. Vieira, edited by Valner Matheus Milanezi Jordão

Neodiversity

Vieira *et al.* – Two new species of *Ternstroemia*

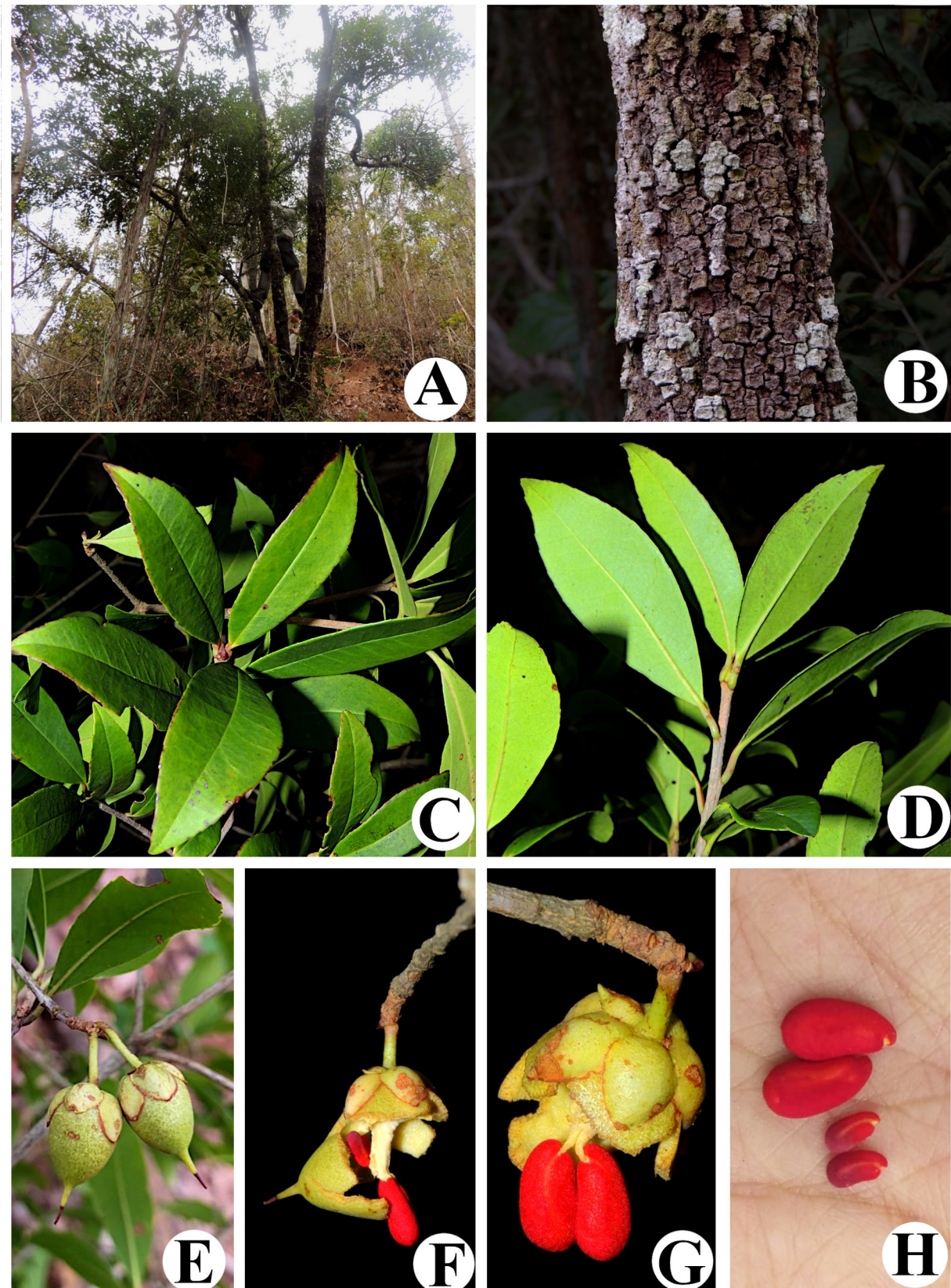


Figure 6. *Ternstroemia serratifolia*: A. Habit – tree. B. Trunk with suberous bark. C to D. Branch with leaves. E. Fruits. F. Dehiscence into irregular valves. G. Fruits after dehiscence exposing the seeds. H. Seeds. Photographs: A to D, F and G. João Victor Longhi Monzoli. Photographs: E and H. Jaqueline Alves Vieira.

Identification key to extra-amazonian Brazilian species of *Ternstroemia*

1. Inflorescence congest arranged in brachyblasts..... *T. ombrophicola*
1'. Inflorescence reduced into a single flower, not arranged in brachyblasts 2
2. Stigma peltate or 2–3 lobed 3
2'. Stigma punctate or capitate 5
3. Stigma peltate; connective apiculate*T. alnifolia*
3'. Stigma 2–3 lobed; connective mucronate4
4. Fruits dehiscent by circumcised line at the base *T. carnosa*
4'. Fruits indehiscent or dehiscent into irregular valves*T. cuneifolia*
5. Stigma capitate 6
5'. Stigma punctate..... 7
6. Connective caudate, fruit with 4 locules, 1 seed per locule *T. rupestris*
6'. Connective apiculate, fruit with 2 locules, 2 seeds per locule *T. serratifolia*
7. Connective apiculate to caudate, fruits with 2 seeds per locule *T. brasiliensis*
7'. Connective aristate, fruits with 1 – 6 seeds per locule or 2 per false septa..... *T. bahiensis*

4 | CONCLUSIONS

Since 2018, when studies to date in Pentaphylacaceae from Brazil were summarized in the “Flora do Brasil 2020” project, continuous nomenclatural, taxonomic and descriptive updates in *Ternstroemia* have resulted from monographic studies of the family underway as part of the first author’s PhD studies; *Ternstroemia* was also treated in Grande-Allende (2019; 2021; 2022). This article forms part of the Ph.D. thesis “Filogenia e Revisão Taxonômica de *Ternstroemia* para a região Neotropical” (Phylogeny and Taxonomic revision of *Ternstroemia* from the Neotropical region) and the ongoing “Flora e Funga do Brasil” project. The new species based on recent collections indicate a general lack of data on the Brazilian Flora that persists, even in widely studied domains such as Atlantic Forest. These knowledge gaps are particularly acute in small families that are often understudied and seen to have limited economic potential. This work highlights the need for more studies on Pentaphylacaceae and its constituent genera in the Neotropics.

5 | ACKNOWLEDGEMENTS

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