



Celtis atlantica (Cannabaceae): A new endangered tree species from southwest of Brazil

Henrique Borges Zamengo^{1*} , Fabio Mostacato Bastos² , Débora Chamorro^{3,4} ,
André Luiz Gaglioti^{5,6}  & Leandro Cardoso Pederneiras¹ 

Received: July 3, 2023

Accepted: November 2, 2023

ABSTRACT

During the Neotropical review of *Celtis*, a new species (*Celtis atlantica*) endemic and endangered to southeastern Brazil was discovered. A morphological description, a distribution map, conservation status, taxonomic notes, illustrations, and an identification key of the *Celtis* from the Southern Cone and Brazil are provided.

Keywords: Atlantic rainforest, *Brachyteles hypoxanthus*, Cannabaceae, *Celtis*, Cerrado, endocarp, *Mertensia*, Neotropics, taxonomy, and Urticalean.

Introduction

Celtis L. is a monophyletic genus belonging to Cannabaceae. The genus has 64 species distributed in worldwide (Fu *et al.* 2022). In Brazil, *Celtis* is represented by 13 species, distributed in all phytogeographical regions of the country (Zamengo *et al.* 2023a). *Celtis* can be recognized mostly by: shrubs to trees, monoecious, armed or unarmed; leaves estipulate, alternate, trinervate, domatia present or

not; inflorescences solitary or in pairs, unisexual flowers; dialysepal calyx, sepals 5, corolla absent; stamens 5 and opposite to the sepals; ovary bicarpellate, uniovulate, stigma entire or bifurcate; fruits small drupes with petrous endocarp (Berg & Dahlberg 2001; Chamorro *et al.* 2021; Leme *et al.* 2020; 2021; Zamengo *et al.* 2020; 2021).

Since the beginning of the 21st century, the number of Neotropical species of *Celtis* has been questioned (Berg & Dahlberg 2001; Torres & Luca 2005; Henrickson 2010; Pederneiras *et al.* 2011; Oakley & Prado 2013; Ayala 2015;

Citação não encontrada na lista de referências, por gentileza, verificar.

¹ Instituto de Pesquisa do Jardim Botânico do Rio de Janeiro, DIPEQ, 22460-030, Rio de Janeiro, Rio de Janeiro, Brazil.

² Instituto Estadual do Ambiente – Inea, 20081-312, Rio de Janeiro, RJ, Brazil.

³ Cátedra de Botánica, Facultad de Ciencias Agrarias, UNR, Campo Experimental Villarino, C.C. N° 14, S2125ZAA, Zavalla, Santa Fe, Argentina.

⁴ IICAR (Instituto de Investigaciones en Ciencias Agrarias de Rosario), CONICET (Consejo Nacional de Investigaciones Científicas y Técnicas), Facultad de Ciencias Agrarias, UNR, Campo Experimental Villarino, C.C. N° 14, S2125ZAA, Zavalla, Santa Fe Argentina.

⁵ Universidade Estadual do Centro-Oeste, Plant Genetics and Molecular Biology Lab., 85015-430, Paraná, Guarapuava, Santa Cruz, Brazil.

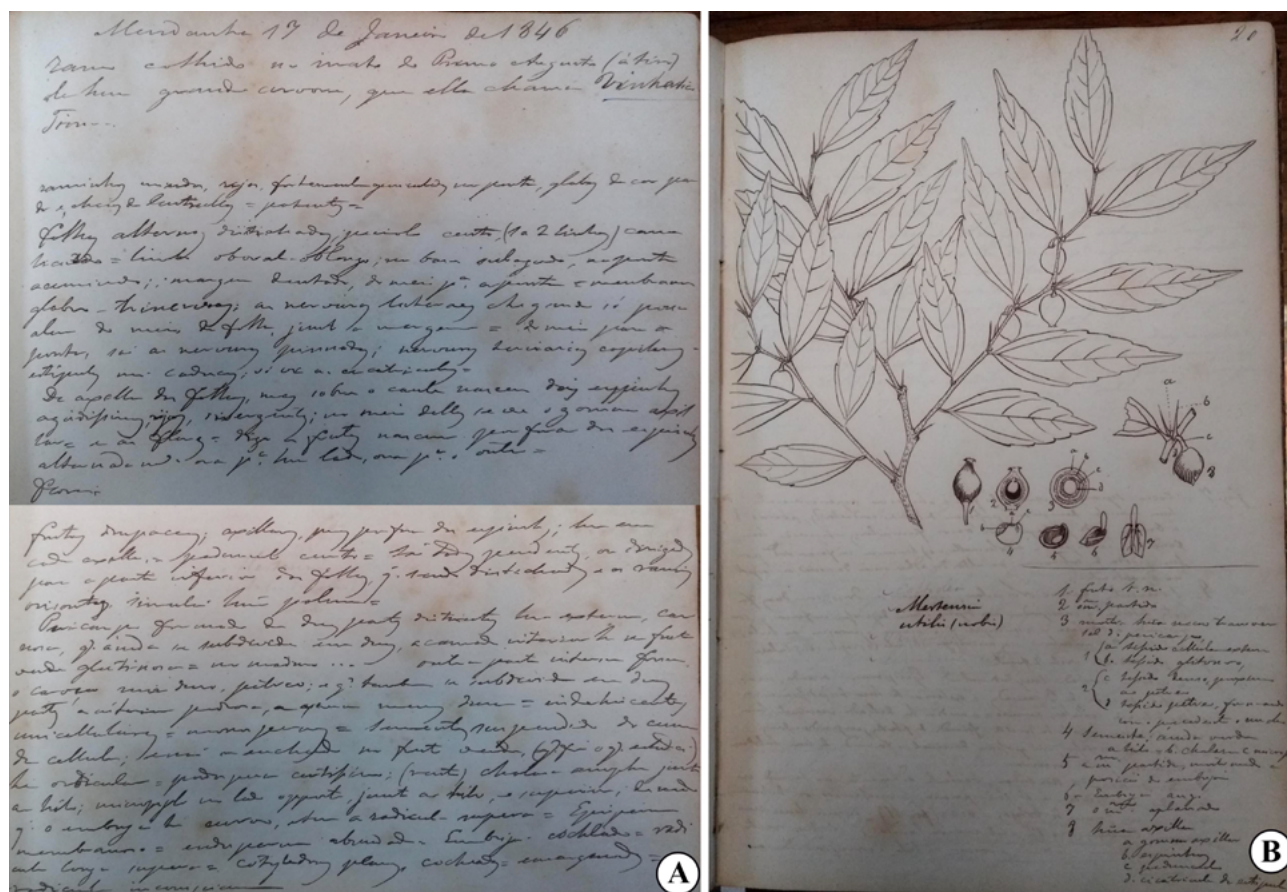
⁶ Instituto de Pesquisas Ambientais, Herbarium SP, 04301-902, São Paulo, São Paulo, Brazil.

*Corresponding author: zamengo.botanic@gmail.com

Asmus *et al.* 2018; Chamorro *et al.* 2021; Chamorro 2022; Zamengo *et al.* 2020; 2023a; b). From this scenario, Zamengo (*in prep*) proposed to revise the Neotropical names of *Celtis*.

Among the names that are being revised, *Celtis orthacanthos* Planchon (described for the state of Bahia), *Celtis utilis* (Cisneiros) Caminhoá ($\equiv$ *Mertensia utilis* Cisneiros) and *Ziziphus allemaovii* Glaziov (both described for the state of Rio de Janeiro) stand out. Regarding protologues and types, Planchon (1848) cites the Salzmann s.n. collection from the Hookerianum herbarium (currently in K, under

barcode numbers 000512940!, and 000964265!); Cisneiros (1846) provides a description (Fig. 1A) and an illustration of the species (Fig. 1B) without designating any material (type or not) or herbarium of deposit; Caminhoá (1881) mentions the phytotherapeutic uses of *C. utilis* (Fig. 1C), without designating any material (type or not) or herbarium of deposit; and Glaziov (1905) provides a diagnosis (“Grand arbre”) for *Z. allemaovii* (Fig. 1D) and mentions that the specimen Glaziov 18991a collected is deposited in herbaria B, K, and P (only P’s specimen was located by the curators).



Limoeiro (impropriamente), Celtis utilis J. Caminhoá (Mertensia utilis Freire Allemão), do Rio de Janeiro, é medicinal, excitante e anti-diarrheico, etc. (C)

3. Z. Allemaovii n. sp. in herb. Berol., Kew., Paris., etc. — Serra do Jericino, près Campo Grande, Rio-Jan., n° 18991. Grand arbre, fl. verdâtres. Juin-juillet. R. (D)

Figure 1. Protologues of *Mertensia utilis* Cisneiros, *Celtis utilis* (Cisneiros) Caminhoá, and *Ziziphus allemaovii* Glaziov. **A.** Protologue of *Mertensia utilis*. **B.** Illustration of *Mertensia utilis*. **C.** Protologue of *Celtis utilis*. **D.** Protologue of *Ziziphus allemaovii*.

Of these four names, only *C. orthacanthos* is considered a legitimate name, as it is in accordance with the ICBN rules (Turland *et al.* 2018). With regard to *M. utilis* Cisneiros, Zamengo *et al.* (2023b) classified it as *nomen nudum*, which is incorrect, as this “name” was never, in fact, published (Art. 12.1., Turland *et al.* 2018). Cisneiros restricted the name to the National Library of Rio de Janeiro, without wide distribution and, does not meet the of Article 29.1. (Turland *et al.* 2018). This type of “name” is known as a designation, as it does not have nomenclatural status (Art. 6.3., Turland *et al.* 2018). Furthermore, *C. utilis* must be considered a *nomen nudum* since Caminhoá (1881) did not include a description, diagnosis or any material reference, which does not satisfy Articles 38.1. and 38.3. (Turland *et al.* 2018). Finally, *Z. allemaovii* is considered a name not validly published, since the article of Glaziou (1905) is considered suppressed (“*opera utique oppressa*”, Art. 34.1., Turland *et al.* 2018) (Mansano & Pederneiras 2016).

In the latest review of *Celtis* subg. *Mertensia* Planch., Berg and Dahlberg (2001) grouped *C. utilis* ($\equiv M. utilis$) and *Z. allemaovii* in the section “*Nomina nuda and/or nomina in schedula*” and considered these names to be synonyms of *C. orthacanthos*. After noting that *M. utilis* cannot be recognized as a name, that *C. utilis* is a *nomen nudum* and that Glaziou’s species (Glaziou 18991a) is a species of *Celtis* and not of *Ziziphus* Miller, we propose *Celtis atlantica* sp. nov. as a new species belonging to *Celtis* subg. *Mertensia*.

Materials and methods

The specimens were analyzed in person or using high-resolution images from the herbaria BHCB, CVRD, ESA, HUENF, IAC, K, NY, P, PMSP, RB, SP, SPF, SPSF, UEC, and US (acronyms according to Thiers 2023).

To standardize the terminology referring to the habit and the types of spines we followed Chamorro *et al.* (2021), the stem surfaces are according to Beentje (2016), for the types of domatia we adopted O’Dowd and Wilson (1989), for the patterns of indumentum and leaf-forms we followed Radford *et al.* (1974) and for colors, leaf apex, leaf base, leaf margins, leaf surfaces, leaf textures, inflorescence type, stigma divisions, fruit, and pyrene shapes we adopted Beentje (2016), pyrene ornamentations are according to Chamorro *et al.* (2021). For the extractions and cleaning of the pyrenes, the methodologies of Zamengo *et al.* (2020) were adopted.

To avoid repetitions during the taxonomic description, all colors of the structures were observed *in natura* or *in sicco*, and all trichomes mentioned in the description are *ivory*. The abbreviations (fl.) and (fr.) were used in the “Additional specimens examined (Paratypes)” list to cite the phenological status of the analyzed specimens. Specimens that do not have this abbreviation were collected in a vegetative state. The map was made with the program QGIS 3.22.1.

Results

Taxonomic treatment

***Celtis atlantica* Zamengo sp. nov.** TYPE: BRAZIL. RIO DE JANEIRO: Rio de Janeiro, Alto da Boa Vista, Estrada Dona Castorina, Trilha em direção às cachoeiras da Gruta e dos Primatas, à direita do primeiro córrego de água, 22°57’55.2”S 43°14’57.8”W, 16.V.2023, fr., H.B.Z. Souza 230 (holotype: RB herbarium number 850940, barcode number 01490789; isotypes: IAC, K, MBM, MO, NY, P, PMSP, R, SP, SPF, US). Figs. 2, 3, 4, 5, 6, 7.

Popular names: caboco, guajissara, limoeiro, limoeiro-silvestre, and juá preto.

Diagnosis: Among the *Celtis* species, *C. atlantica* is similar to *Celtis tala* Gillies ex Planch. because they are the only armed species to present an arboreal habit, despite this similarity, *C. atlantica* differs by presenting: limb 6–12.5 × 2–5 cm *vs* 1.7–3.5 × 0.8–1.5 cm, apex acuminate to caudate *vs* acute to attenuate, base attenuate to cuneate *vs* obtuse, domatias inconspicuous *vs* conspicuous; pistillate flowers with style conspicuous *vs* style absent, stigmatic lobes bifid *vs* bilobed; pyrene monoapiculate *vs* without apiculum, respectively.

Description: **Trees** 6–30 m tall, scaly wood, secondary and tertiary branches fawn or vinaceous, sinuous, entire, glabrous to subglabrous; **branches** armed, spines 1–13 mm length, in pairs or solitary, straight, vinaceous, glabrous to subglabrous, trichomes scarce both at the base and on the entire surface of the spines. **Petiole** 1–5 mm length, glabrous to subglabrous, limb elliptic, 6–12.5 × 2–5 cm, membranaceous, apex acuminate or caudate, base symmetric, attenuate or cuneate, margins with teeth, crenate-serrate or serrate, teeth congested or lax emerging from the lower third to the upper third, from the middle portion to the upper third, and/or restricted to the upper third, surfaces concolorous (both emerald or olive *in natura* or both buff, cinnamon, coppery, olive or stramineous *in sicco*), adaxial surface shiny, glabrous to subglabrous, trichomes concentrated on the veins and scarce on the laminar surface, adaxial surface smooth to the touch *in sicco*, abaxial surface glabrous to subglabrous, trichomes concentrated on the veins and scarce on the laminar surface, abaxial surface smooth to the touch *in sicco*, veins salient, chestnut or stramineous contrasting in relation to the abaxial surface, domatias in pockets, inconspicuous, glabrous to subglabrous, trichomes ciliate or arranged over the entire surface of the domatia. **Inflorescence** in cymes dichotomous or in glomerule, peduncle 2–3 mm length, subglabrous, not bracteolate. **Staminate flowers** with pedicels 1–1.5 mm length, subglabrous, bracteolate, abaxial surface of the sepals glabrous to subglabrous, margins



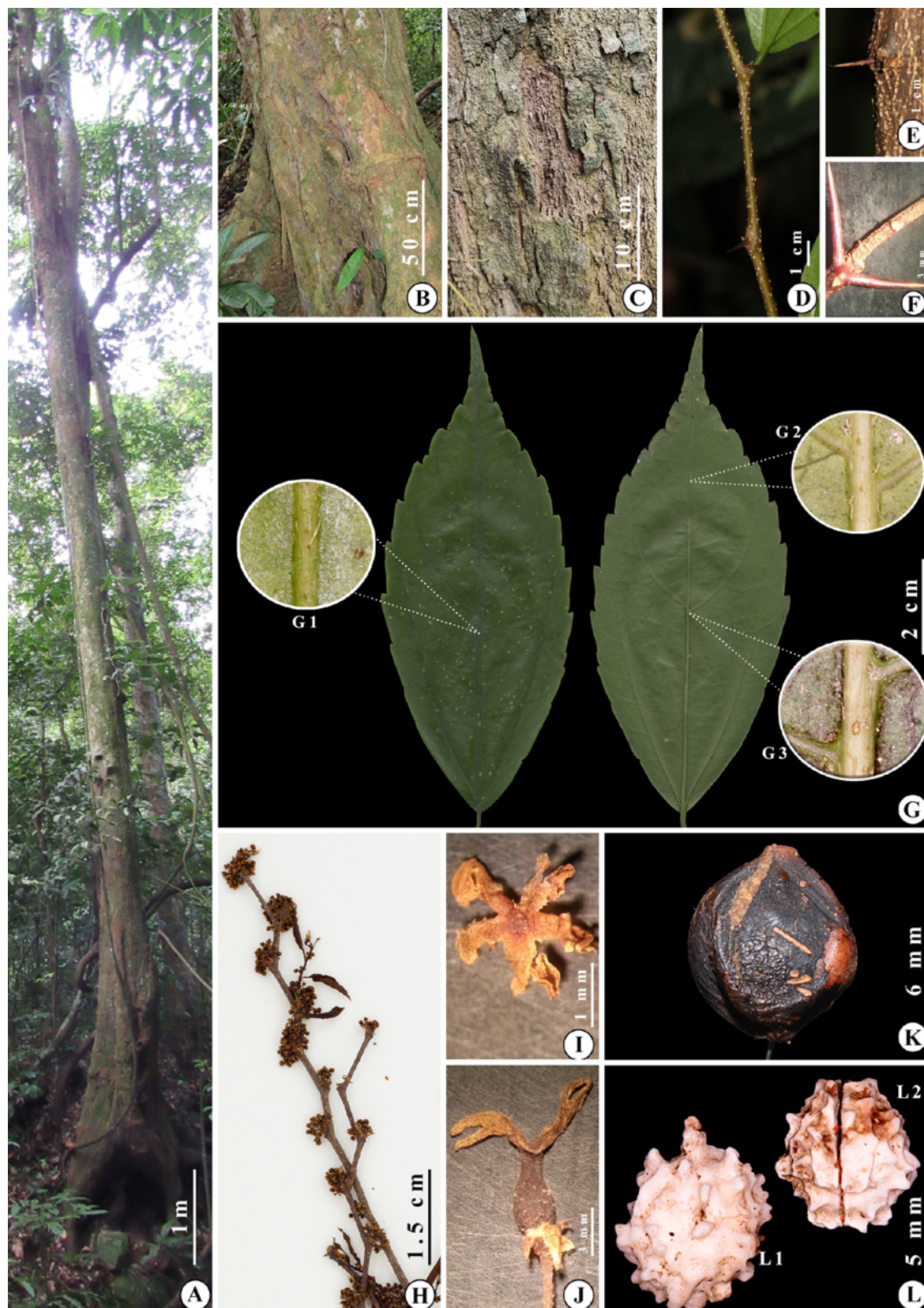


Figure 2. Main characteristics of *Celtis atlantica* Zamengo. **A.** Habit. **B-C.** Bark. **D.** Branch with lenticels. **E.** Detail of the lenticels. **F.** Spines. **G.** Limb. **G1.** Adaxial surface trichomes. **G2.** Abaxial surface trichomes. **G3.** Domatias. **H.** Cyme. **I.** Staminate flower. **J.** Pistillate flower. **K.** Drupe. **L.** Pyrenes. **L1.** Pyrene verrucose. **L2.** Pyrene verrucose evidencing the suture.

entire. **Pistillate flowers** with pedicels 2–3.5 mm length, subglabrous, **ovary** 1.5–3 × 0.75–1.5 mm, glabrous to subglabrous, trichomes scarce both at the base and on the ovary surface, ovary surface smooth to the touch *in sicco*, **style** conspicuous (0.6–1 mm length), **stigma** **branches** supported by the style, 3–4 mm length, **stigma lobes** bifid (incisions 1–1.5 mm deep). **Pedicels of the drupe** with 3–3.5 mm length, glabrous to subglabrous, mature drupes lemon or primrose *in natura*, ovate, 10–13 × 5–11 mm, **epicarp** glabrous to subglabrous, trichomes scarce both at the base and on the epicarp surface, epicarp surface smooth to the touch *in sicco*, deciduous sepals at the base, **mesocarp** non-viscous, membranaceous, not ornamented, **pyrene** ivory, ovate, 5.5–10 × 5.5–7, apiculate, monoapiculate, apiculum aciculate, 0.5–1 mm length, apex rounded, apiculum scar absent, pyrene surface verrucose, randomly distributed warts.

Distribution and habitat: *Celtis atlantica* is endemic to Brazil occurring in the Cerrado and Atlantic Forest biomes (Fig. 3A). The type specimen was collected in Parque Nacional da Tijuca (Rio de Janeiro, Fig. 3B). Unlike most of *Celtis* Neotropical species, *C. atlantica* occurs within the forests (with little incidence of light), most occasionally the species is associated with humid environments (waterfalls and water streams, Fig. 3C). Two of the three specimens collected in the Cerrado do not have information about the phytophysognomies in which *C. atlantica* was collected, only the sample Barreto *et al.* 393 (ESA) mentions that *C. atlantica* was collected in semi-deciduous mesophyll forest. For the states of Minas Gerais, Rio de Janeiro (Fig. 3B) and São Paulo the species was collected in areas of rainforest (at sea level), for the state of Espírito Santo, the species was collected in areas of up to 200 m altitude recognized as “Mata de Tabuleiro”.

The areas of occurrence of *C. atlantica* may be associated with its dispersers, since the label of specimen *J. Gomes* 118 (BHCB047661) mentions Mamaliocoria dispersal by *Brachyteles hypoxanthus* (Kuhl, 1820, Fig. 3D-E). This same species of monkey was observed eating the fruits of *C. atlantica* by Dr. Karen Strier during her doctoral project at the Caratinga Biological Station (between June 1983 and July 1984).

Additional specimens examined (Paratypes):

BRAZIL. Espírito Santo: Linhares, estrada de Linhares a Regência, -39.7555 S, -78.41769 W, 15 January 2014, (fr.), *D.A. Folli* 7165 (CVRD!, RB!). **Minas Gerais:** Caratinga, Estação Biológica de Caratinga, mata do Jaó, 20 November 2012, (fr.), *F.R. Couto* 159 (BHCB!); idem 19°50' S, 41°50' W, 23 April 1994, *J. Gomes* 118 (BHCB!); idem 1 April 1984, (fr.), *K.B. Strier* 613 (BHCB!, NY!); idem 19°40' S, 41°50' W, 25 March 1984, (fr.), *K.B. Strier* 836 (NY!). **Rio de Janeiro:** Cachoeiras de Macacu, Estação Ecológica Estadual do Paraíso, acima da represa CEDAE, 9 June 1992, *B.C. Kurtz et al.* s.n. (RB barcode 00439269!). Campos dos Goytacazes, Mata do

Mergulhão, 21°46'42" S, 41°15'27" W, 10 June 2003, *M.T. Nascimento & G.R. Rabelo* 34 (HUENFI!), Maciço do Itaóca, 21°47'50" S, 41°26'53" W, 3 August 2012, *T.P. Souza* 1221 (HUENFI!). Guapimirim, Estação Ecológica Estadual de Paraíso, parcela 2B, área 02B, 22°26'0" S, 42°50'0" W, 26 September 1991, (fl.), *C.M. Vieira et al.* 118 (RB!); parcela 7A, área 07A, 22°26'0" S, 42°50'0" W, 24 October 1991, (fl.), *C.M. Vieira et al.* 142 (RB!). Magé, Paraíso, Centro de primatologia (CPRJ), Serra dos Porcos, 12 November 1984, *H.C. de Lima et al.* 2399 (RB!). Rio de Janeiro, matas do Sumaré, 3 September 1927, (fl.), *Pessoal do Horto Florestal* s.n. (K barcode 000964290!, NY barcode 00476067!, P barcode 06781657!, RB barcode 00439263!); Tijuca, mata do pai Ricardo, perto da sede do horto florestal, 3 September 1927, (fr.), *Paulim* 1566 (RB!). São Francisco de Itabapoana, fazenda Santo Antônio, 21°17'49" S, 41°5'25" W, 17 June 2009, *K.M.P.A. Archanjo & M.T. Nascimento* 337 (HUENFI!); fazenda Imburi, 21°19'32" S, 41°6'0" W, 9 August 2008, *K.M.P.A. Archanjo & M.T. Nascimento* 1129 (HUENFI!); 21°19'32" S, 41°6'0" W, 9 August 2008, *K.M.P.A. Archanjo & M.T. Nascimento* 1821 (HUENFI!); fazenda Palmeiras, 21°19'18" S, 41°7'11" W, 13 October 2008, *K.M.P.A. Archanjo & M.T. Nascimento* 2047 (HUENFI!). São Pedro da Aldeia, Assentamento Ademir Moreira, -22.718569 S, -42.119600, 27 March 2021, *H.B.Z. Souza & F.M. Bastos* 147 (PMSP!, RB!). Serra do Gericinó, 15 June 1982, fr., *A. Glaziou* 18991a (P!). Volta Redonda, floresta da Cicuta vale do Paraíba do Sul, 22°33'2" S, 44°5'0" W, 26 September 2001, (fl.), *G.R. de Souza et al.* 60 (RB!). **São Paulo:** Americana, Carioba, Mata Boa Esperança, 21 May 1943, *M. Kuhlmann* 852 (IAC!, SP!). Amparo, Monte Alegre, mata da fazenda Santa Isabel, 28 August 1943, (fr.), *M. Kuhlmann* 991 (IAC!, SP!). Anhembi, mata da fazenda Barreiro Rico, 5 October 1956, (fl., fr.), *M. Kuhlmann* 3956 (IAC!, SP!). Campinas, mata da Fazenda Santana do Atalaia, fragmento M4, 22°48' S, 46°53' W, 10 June 2000, *K. Santos & R. Balinello* 1955 (UEC!); mata da Fazenda Santa Helena, fragmento P1, 22°54' S, 46°54' W, 16 June 2000, *K. Santos & R. Balinello* 2274 (UEC!); 27 July 2006, *L.T. Vieira & L.P. Sims* 335 (UEC!); mata Ribeirão Cachoeira, August 2008, *L.P. Sims & J. Melis* 1406 (UEC!); mata Santa Genebra, 1984–1985, *J.Y. Tamashiro et al.* 110, 250, 1053 (UEC!). Charqueada, Mata da Glória, 14 May 1993, *K.D. Barreto et al.* 393 (ESA!). Limeira, Fazenda Morro Azul, 5 October 1956, (fr.), *M. Kuhlmann* 2879 (SP!). São Paulo, Jardim Botânico de São Paulo, September 1942, (fl.), *O. Handro* s.n. (IAC herbarium number 54003!, NY barcode 00777749!, P barcode 06781154!, SP herbarium number 35604!, SPF herbarium number 148257!). Without locality, September 1942, (fl.), *D.G.S. Camargo* 608 (SPSF!). **Unknown location:** October 1822, (fl.), *L. Riedel* (NY barcode 02429058!, US barcode 1328438!); “*prope mandioca*”, October 1922, (fl.), *L. Riedel* (US barcode 01328438!); October 1923, (fl.), *L. Riedel* (NY barcode 02429055!, NY barcode 02429058!); 3 September 1927, (fl.), s.c (RB barcode 004392!, RB barcode 00439263!).

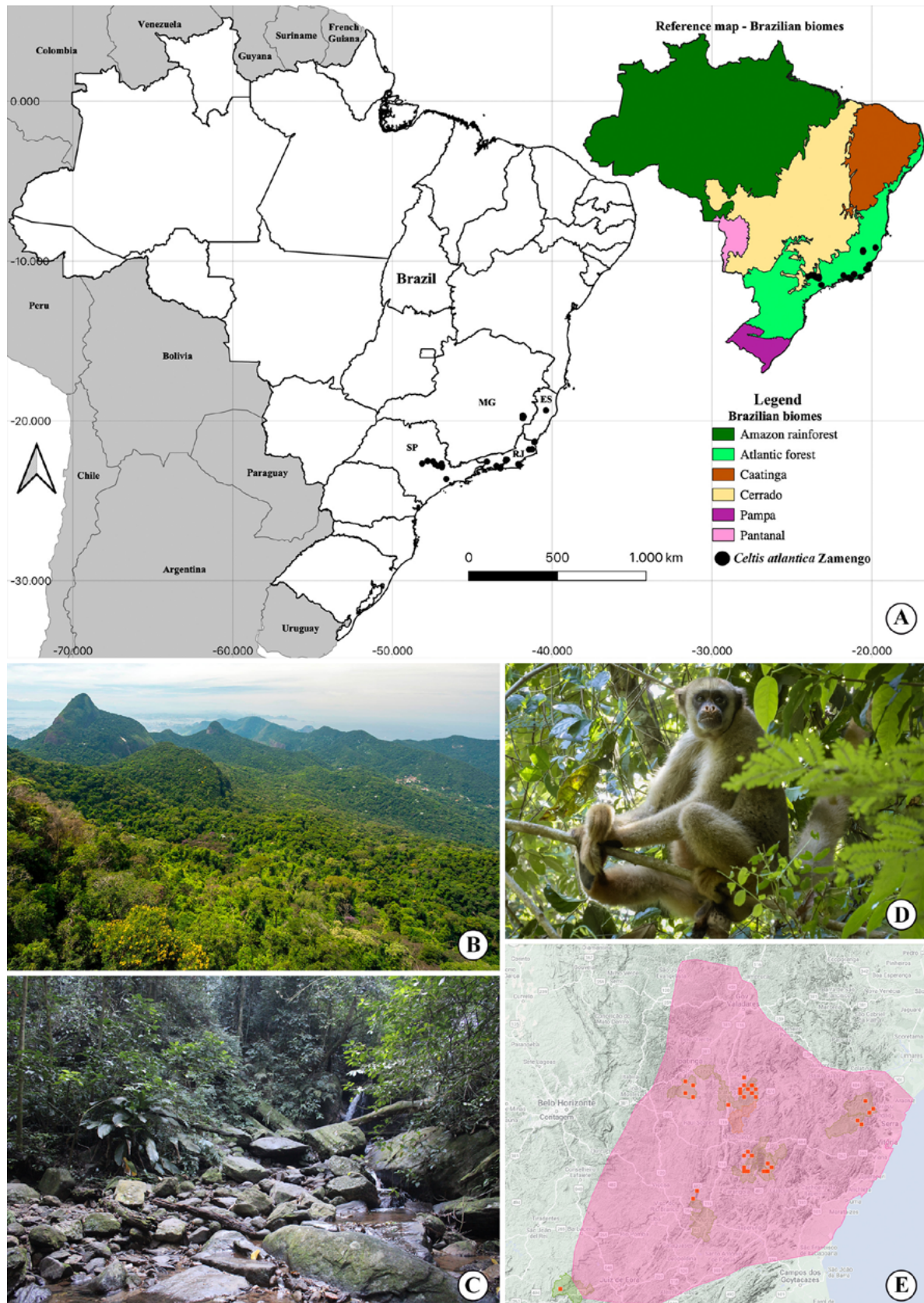


Figure 3. Distribution map of *Celtis atlantica* Zamengo and *Brachyteles hypoxanthus* Kuhl. **A.** Distribution map of *Celtis atlantica* Zamengo. **B.** Parque Nacional da Tijuca. **C.** Habitat of *Celtis atlantica* Zamengo. **D.** *Brachyteles hypoxanthus* Kuhl, photo by Henrique Junior. **E.** Distribution map of *Brachyteles hypoxanthus*, states of Espírito Santo, Minas Gerais and Rio de Janeiro.

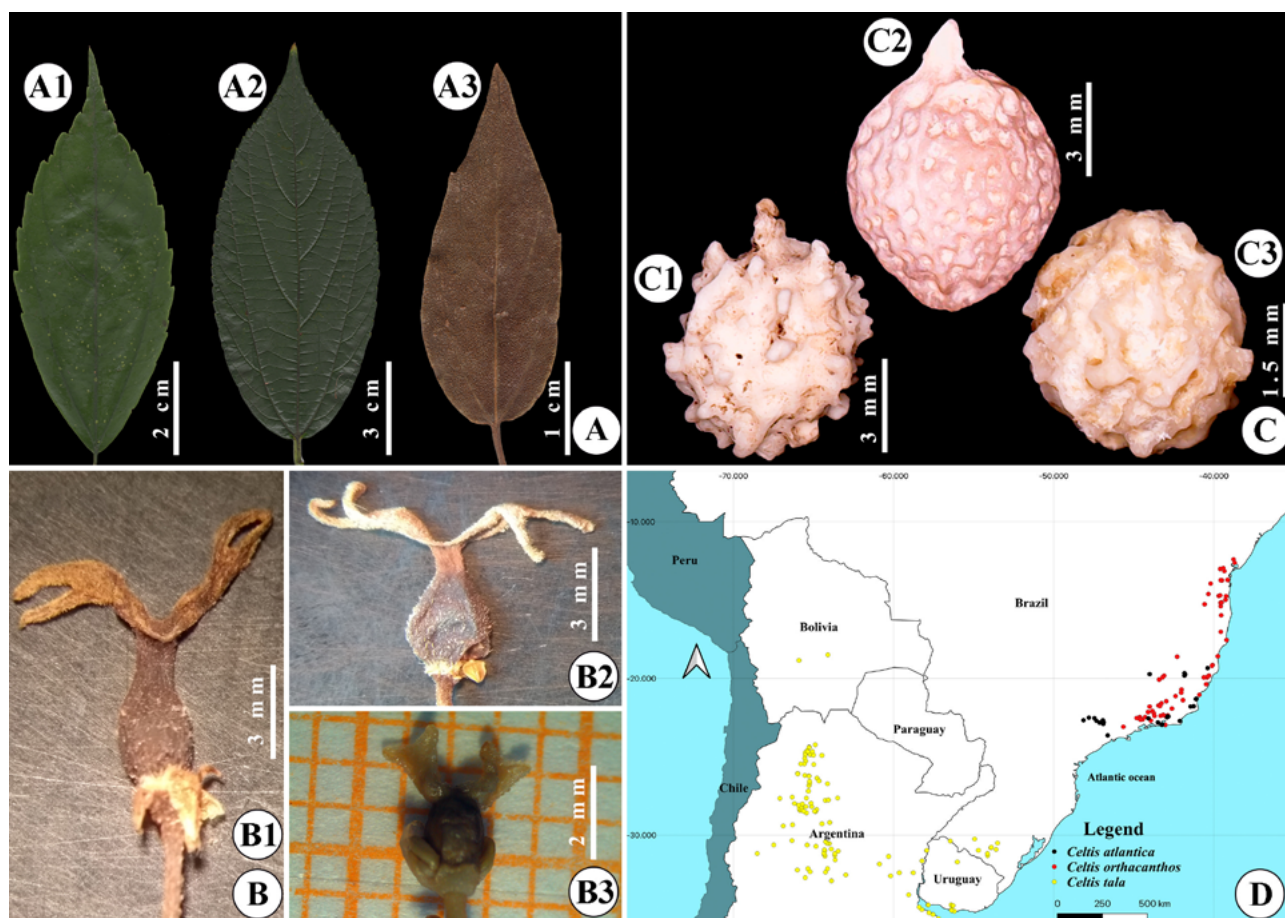


Figure 4. Main differences between *Celtis atlantica* Zamengo, *Celtis orthacanthos* Planch., and *Celtis tala* Gillies ex Planch. **A.** Leaves. **A1.** *Celtis atlantica*. **A2.** *Celtis orthacanthos*. **A3.** *Celtis tala*. **B.** Pistillate flowers. **B1.** *Celtis atlantica*. **B2.** *Celtis orthacanthos*. **B3.** *Celtis tala*. **C.** Pyrenes. **C1.** *Celtis atlantica*. **C2.** *Celtis orthacanthos*. **C3.** *Celtis tala*. **D.** Distribution map of *Celtis atlantica*, *Celtis orthacanthos* and *Celtis tala*.

Conservation status: *Celtis atlantica* is known from 39 specimens and 19 localities from southeastern Brazil (Fig. 3A). Using GeoCAT (Bachman *et al.* 2011) and a 2 km² grid, it has an estimated extent of occurrence (EOO) of 209,878.228 km² and minimal area of occupancy (AOO) of 116 km².

The main biome present in this region is the Atlantic Forest which, continues to be fragmented with the implementation of agricultural, farming, and cities. Due to deforestation, *C. atlantica* presents a fragmented distribution (Fig. 3A), occurring in isolated areas which are subject to different threats. For example, in remnants of Rio de Janeiro state (Parque Nacional da Tijuca) the species is threatened by the invasion of *Artocarpus heterophyllus* Lamarck, which was introduced in Brazil more than 200 years ago (Sartorelli *et al.* 2018).

Of the 39 specimens, 29 have a locality designation. Of these 29 specimens, 13 were collected in protected areas (Conservation Units) belonging to the states of Minas Gerais (Caratinga Ecological Station) and Rio de Janeiro (Floresta da Cicuta Area of Relevant Ecological Interest,

Paraíso State Ecological Station, Tijuca National Park and Serra do Mendanha Municipal Natural Park).

As for the other 16 specimens, these were collected in Cerrado fragments located in the interior of the state of São Paulo, that are surrounded by agricultural, farming and/or urban areas. New expeditions are needed to learn more about the Cerrado's phytophysiognomies, as the labels of the specimens from these localities do not contain any information about the biome's phytophysiognomies. Based on this scenario, we recommend that *C. atlantica* be assessed as endangered (B1ab(i, ii, iii, iv)+2ab(i, ii, iii, iv)), based on the IUCN (2022).

Etymology: The epithet “atlantica” was attributed in allusion to the main biome where the species occurs.

Phenology: The species has flowering records for the months of September and October, while the fruit was collected in January, March, April, June, August, September, October and November.



Figure 5. Holotype of *Celtis atlantica* Zamengo.

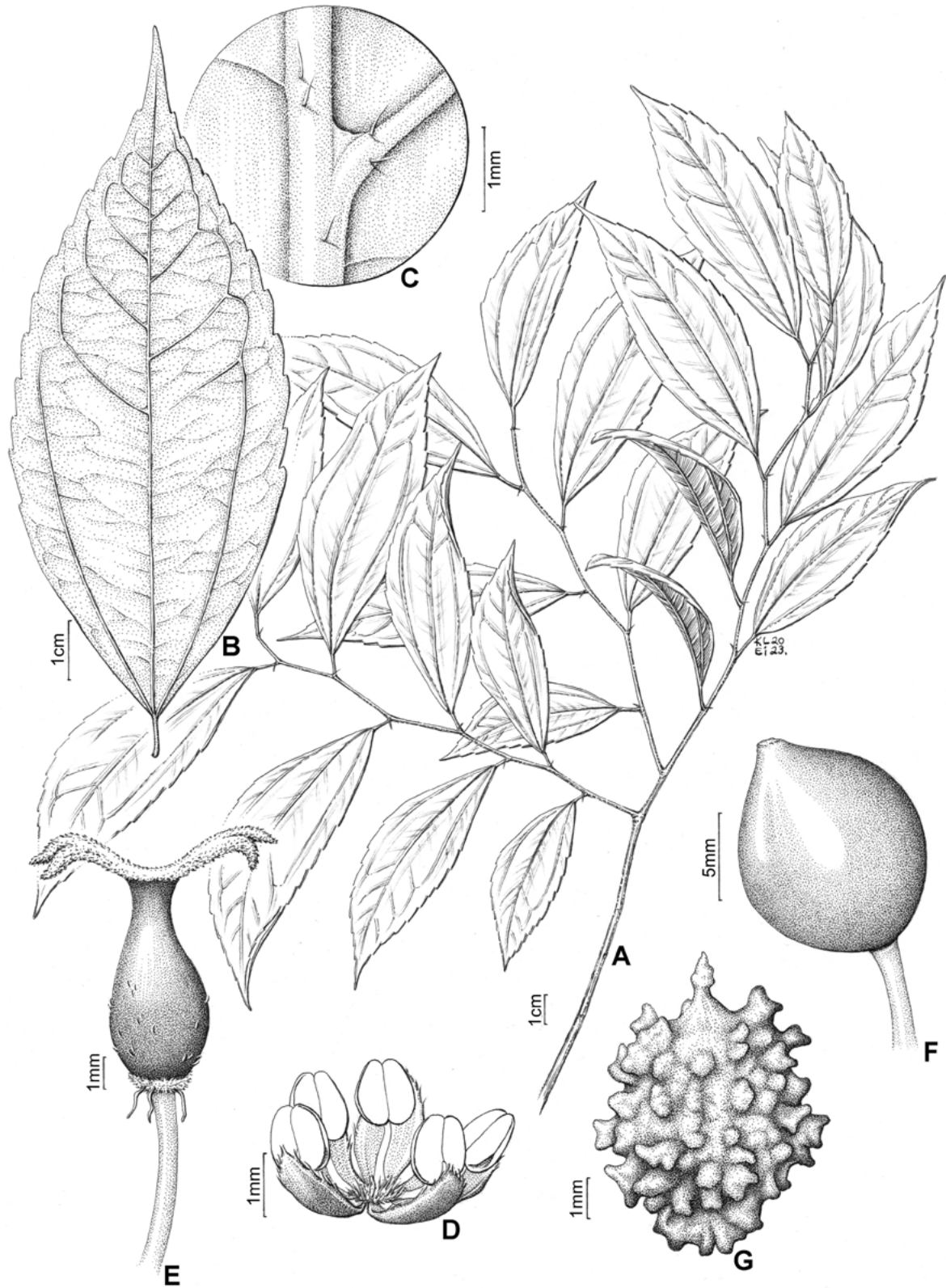


Figure 6. Illustration of *Celtis atlantica* Zamengo. **A.** Branch. **B.** Leaf. **C.** Domatia. **D.** Staminate flower. **E.** Pistillate flower. **F.** Drupe. **G.** Pyrene. Illustrator: Klei Rodrigo Sousa.

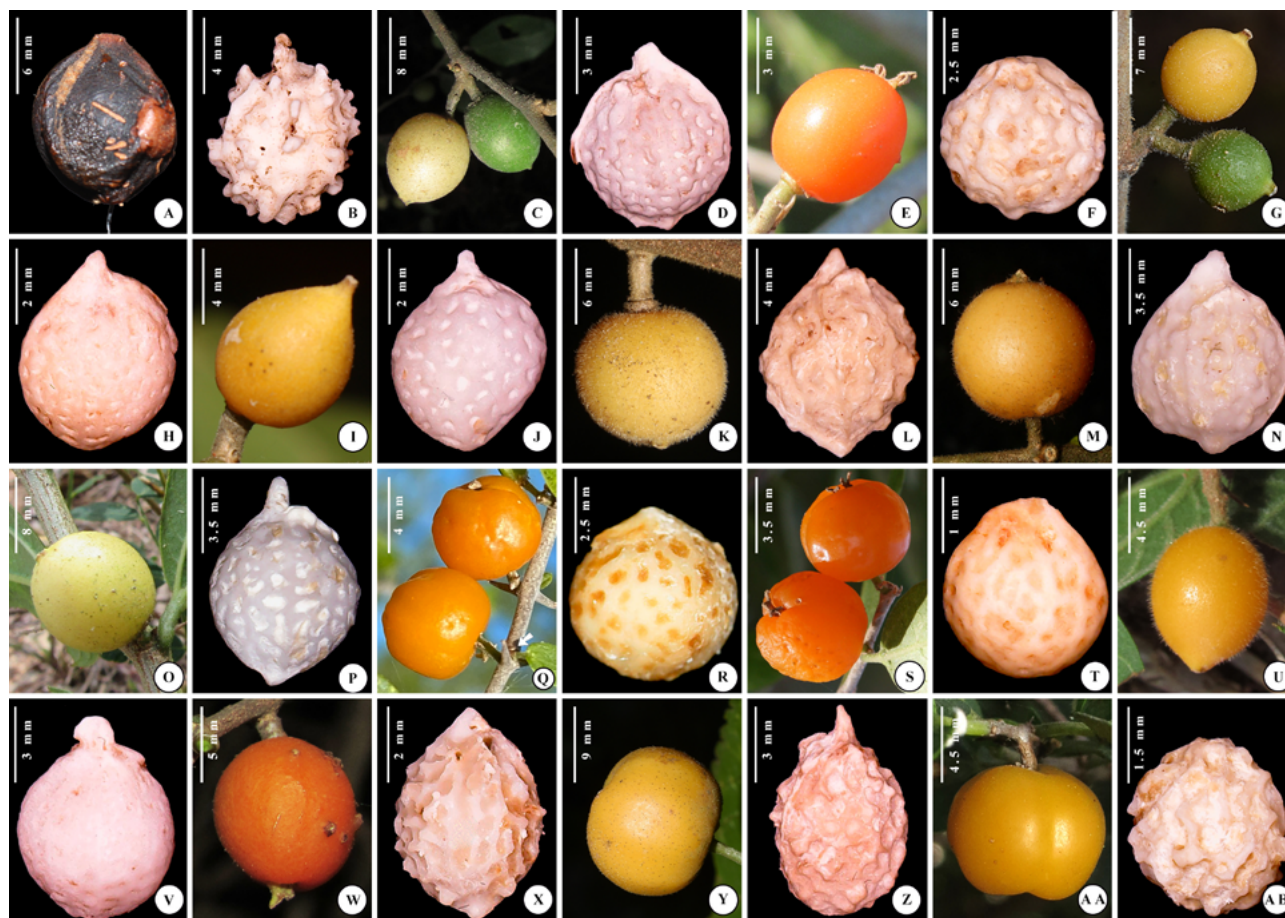


Figure 7. Drupes and pyrenes of *Celtis* species currently accepted for Brazil and the Southern Cone. **A-B.** *Celtis atlantica*. **C-D.** *Celtis brasiliensis*. **E-F.** *Celtis chichape*. **G-H.** *Celtis clauseniana*. **I-J.** *Celtis flavovenarum*. **K-L.** *Celtis fluminensis*. **M-N.** *Celtis lancifolia*. **O-P.** *Celtis orthacanthos*. **Q-R.** *Celtis pallida* var. *discolor*, white arrow indicating the foliated brachyblast. **S-T.** *Celtis pallida* var. *pallida*. **U-V.** *Celtis serratissima*. **W-X.** *Celtis spinosa*. **Y-Z.** *Celtis spinosissima*. **AA-AB.** *Celtis tala*.

Taxonomic notes: Analyzing herbarium specimens, we observed that *C. atlantica* is frequently confused with *C. orthacanthos* (due to the misinterpretation of Berg & Dahlberg 2001) and with *C. tala*. To distinguish these species, we suggest that some characteristics be compared (habit, leaves (length × width, apex and base, Fig. 4A), pistillate flowers (ovary indumentum, style length, degree of incision of stigmatic lobes, Fig. 4B), mature drupe (size), pyrene (size, form, presence of apiculus, presence of apiculus scar and ornamentations, Fig. 4C), and areas of distributions (Fig. 4D, Table 1).

Below we provide the new identification key, contemplating the new species and all the others currently recognized (Chamorro *et al.* 2021; Zamengo *et al.* 2023a). We did not include *Celtis iguanaea* (Jacquin) Sargent since we believe that this species does not occur in these regions (see Zamengo *et al.* 2020; Chamorro *et al.* 2021). Based on the results obtained by Fu *et al.* (2022), we also excluded *Celtis schippii* Standley. For the characteristics related to fruits and endocarps, see Fig. 7.

Table 1. Main morphological differences between *C. atlantica*, *C. orthacanthos* and *C. tala*.

Characteristic	<i>C. atlantica</i>	<i>C. orthacanthos</i>	<i>C. tala</i>
Habit	Tree not climbing	Climbing shrub	Tree not climbing
Leaf (size cm)	6-12.5 × 2-5	4-12.5 × 1.5-5.5	1.7-5 × 0.8-2.5
Leaf (apex)	Acuminate to caudate	Acuminate	Acute to attenuate
Leaf (base)	Attenuate to cuneate	Obtuse, rounded to sub-cordate	Obtuse
Perfect flower (indumentum ovary)	Glabrous to subglabrous	Subglabrous to pilose	Glabrous to subglabrous
Pistilate flower (length of style)	0.6-1 mm	0.6-1 mm	Null
Pistilate flower (stigmatic lobes)	Bifid (1-1.5 mm deep)	Bifid (3-4 mm deep)	Bilobate (0.1-0.5 mm deep)
Drupe (size mm)	10-13 × 5-6.5	11.5-13 × 9.5-10.5	4-7 × 3-5
Pyrene (size mm)	5.5-10 × 5.5-7	7-9 × 5-6	3.5-4 × 3-4
Pyrene (form)	Ovate	Ovate	Globose
Pyrene (apiculum)	Present	Present	Absent
Pyrene (apiculum scar)	Absent	Present	Absent
Pyrene (ornamentation)	Verrucose	Alveolate-crateriform	Verrucose
Distribution areas	Southeast Brazil	Southeast and Northeast Brazil	Southern Bolivia and Brazil, eastern, central and western Argentina, and throughout Uruguay

Key to the species of Celtis from Brazil and Southern Cone

1. Trees 2
2. Limb 6–12.5 × 2–5 cm, apex acuminate to caudate, base attenuate to cuneate, domatias inconspicuous; style conspicuous, stigmatic lobes bifid; pyrene monoapiculate *C. atlantica*
- 2'. Limb 1.7–3.5 × 0.8–1.5 cm, apex acute to attenuated, base obtuse, domatias conspicuous; style absent, stigmatic lobes bilobed; pyrene without apiculum *C. tala*
1. Shrubs 3
3. Foliated brachyblasts present; pyrenes cream 4
4. Limb discolorous, abaxial surface pubescent to velutinous *C. pallida* var. *discolor*
- 4'. Limb concolorous, abaxial surface glabrous to pilose *C. pallida* var. *pallida*
- 3'. Foliate brachyblasts absent; pyrenes ivory 5
5. Adaxial lamina surface scabrous *in sicco* 6
6. Abaxial lamina surface scabrous *in sicco* *C. flavovenarum*
- 6'. Abaxial lamina surface lanate *in sicco* 7
7. Branches, spines, flowers and drupes with trichomes chestnut *in sicco* *C. fluminensis*
- 7'. Branches, spines, flowers and drupes with trichomes ivory or lemon *in sicco* 8
8. Mature drupe orange *in natura*, pyrene surface alveolate to smooth *C. serratissima*
- 8'. Mature drupes lemon, primrose or saffron *in natura*, pyrenes surfaces alveolate-crateriform, alveolate-crateriform-verrucose or verrucose 9
9. Drupe surface lanate *in sicco*; pyrene bi-apiculate, apicular scar present, pyrene surface verrucose *C. lancifolia*
- 9'. Drupe surface scabrous or smooth *in sicco*; pyrene mono-apiculate, apicular scar absent, pyrene surface alveolate-crateriform or alveolate-crateriform-verrucose 10
10. Adaxial lamina surface subglabrous; ovary 2–3 × 2–3 mm; mature drupe primrose *in natura*, 10.3–10.6 × 8.5–9.3 mm, epicarp glabrous to subglabrous, mesocarp viscous, pyrene 6.5–7 × 5.5–5.7 mm, pyrene surface alveolate-crateriform-verrucose *C. brasiliensis*



- 10'. Adaxial lamina surface pilose to pubescent; ovary 1–2 × 0.5–1 mm; mature drupe lemon and/or saffron *in natura*, 6.5–8.5 × 3–6.5 mm, epicarp pilose to pubescent, mesocarp not viscous, pyrene 4.5–5 × 3.5–4.5 mm, pyrene surface alveolate-crateriform *C. clauseniana*
- 5'. Adaxial lamina surface smooth 11
11. Style inconspicuous; pyrene without apiculum *C. chichape*
- 11'. Style conspicuous; pyrene apiculate 12
12. Mature drupe orange *C. spinosa*
- 12'. Mature drupes primrose 13
13. Branches secondary and tertiary not sulcate; adaxial surface shiny; peduncle 5–11 mm length, arranged flowers in dichotomous cymes; mesocarp not ornamented, pyrene surface alveolate-crateriform *C. orthacanthos*
- 13'. Branches secondary and tertiary sulcate; adaxial surface opaque; peduncle 1–1.5 mm length, arranged flowers in glomerular cymes; mesocarp ornamented, pyrene surface verrucose *C. spinosissima*

Discussion

Celtis atlantica is a new species described for the *Celtis* subg. *Mertensia* (Planchon 1848). In Brazil, among the species with spines, *C. atlantica* and *C. tala* are unique to present an arboreal habit. Despite this similarity, the species have distinct distributions, *C. atlantica* is restricted to southeastern Brazil and *C. tala* is restricted to southern South America (Fig. 4D).

For Glaziov (1905) the specimen *Glaziov 18991a* (here identified as *C. atlantica*) should be recognized as a species of the genus *Ziziphus*. This proposal should be ignored, as this specimen has the same morphological characteristics as the specimens identified here as *C. atlantica*. In addition to the morphological characteristics, the results of Zamengo *et al.* (2020) also refute Glaziov's (1905) proposal. In this phylogeny, Zamengo *et al.* (2020) compared a specimen (*M. Kuhlmann 3956*) which has the same characteristics as the *Glaziov 18991a* specimen with 18 other specimens of *Celtis*, and they all proved to be monophyletic.

Based on the results of Zamengo *et al.* (2020) associated to the morphological, nomenclatural and taxonomic results here presented, we conclude that *C. atlantica* and *C. orthacanthos* (sense Planchon 1848) are distinct species. Finally, we would like to point out that Berg and Dahlberg's (2001) characterization of *C. orthacanthos* is mistaken, as all the specimens (Appendix 1) used to characterize this species refer to *C. atlantica*.

Acknowledgments

The authors HBZ, LCP, and ALG thank the Jardim Botânico do Rio de Janeiro, Instituto de Pesquisas Ambientais, and Universidade Estadual do Centro-Oeste, Brazil. The authors thank the reviewers and the editor in charge, whose contributions substantially improved this work. HBZ thanks CAPES (88887.721972/2022-00) for the

Grant awarded. HBZ thanks all the curators of the herbaria visited physically and virtually. HBZ is grateful for the nomenclatural clarifications provided by Dr. Jefferson Prado (IBT). HBZ also thanks his colleagues Diego Ferreira da Silva for your help in the field collection. HBZ thanks Dr. Karen Strier for the information related to the monkeys of Caratinga (Minas Gerais, Brazil). HBZ thanks the staff of the National Library of Rio de Janeiro for their help in locating the articles by Caminhoá and Cisneiros. The author FMB thanks the Instituto Estadual do Ambiente (Inea/RJ) for the institutional support. The author LCP thanks Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ, E-26/202.277/2019, E-26/202.278/2019).

References

- Asmus J, Chamorro D, Moggi VY, Oakley LJ, Prado DE. 2018. Identidad Taxonómica de Los "Talas": Análisis morfológico de *Celtis tala* y *Celtis pallida* (Celtidaceae). Boletín de la Sociedad Argentina de Botánica 53: 653–664. doi: 10.31055/1851.2372.v53.n4.22117.
- Ayala MM. 2015. Cannabaceae. In: Flora del Valle de Tehuacán-Cuicatlán. México, Instituto de Biología, Universidad Nacional Autónoma de México, UNAM, Fasc. 129. p. 1–21.
- Bachman S, Moat J, Hill AW, de la Torre J, Scott B. 2011. Supporting Red List threat assessments with GeoCAT: Geospatial conservation assessment tool. ZooKeys 150: 117–126.
- Beentje H. 2016. The Kew Plant Glossary an illustrated dictionary of plant terms. 2nd. edn. Richmond, Royal Botanical Garden, Kew.
- Berg CC, Dahlberg SV. 2001. A revision of *Celtis* subg. *Mertensia* (Ulmaceae). Brittonia 53: 66–81. doi: 10.1007/BF02805398.
- Caminhoá JM. 1881. Botânica geral e médica. Vol. V, fascículos XI e XII. Rio de Janeiro, Typographia Nacional.
- Chamorro DC, Zamengo HB, Moggi VY *et al.* 2021. Morfología comparada de diez taxones del género *Celtis* (Cannabaceae) del Cono Sur Sudamericano. Darwiniana 9: 217–244. doi: 10.14522/darwiniana.2021.91.936.
- Chamorro DC. 2022. Estudio filogenético y biogeográfico del género *Celtis* (Cannabaceae) para el cono sur Sudamericano. PhD Thesis, Universidad Nacional de Rosario, Rosario.
- Cisneiros FFA. 1846. Estudos botânicos 1834–1866, Vol. VI. p. 20–23.
- Fu XG, Liu SY, Velzen R *et al.* 2022. Phylogenomic analysis of the hemp family (Cannabaceae) reveals deep cyto-nuclear discordance and



Referência não encontrada no texto.

- provides new insights into generic relationships. *Journal of Systematics and Evolution* 61: 806-826. doi: 10.1111/jse.12920.
- Glaziov AFM. 1905. Mémoires 3 Plantae Brasiliae centralis a Glaziov lectae. *Bulletin de la Société Botanique de France* 52: 1-662.
- Henrickson J. 2010. Comments on a revision of *Celtis* subgenus *Mertensia* (Celtidaceae) and the recognition of *Celtis pallida*. *Journal of the Botanical Institute of Texas* 4: 287-293.
- IUCN. 2022. IUCN Red List Categories and Criteria. The IUCN Red List of Threatened Species. Version 2022-2. <https://www.iucnredlist.org>. 25 Sep. 2023.
- Leme FM, Schöenberger J, Staedler YM, Teixeira SP. 2020. Comparative floral development reveals novel aspects of structure and diversity of flowers in Cannabaceae. *Botanical Journal of the Linnean Society* 193: 64-83. doi: 10.1093/botlinnean/boaa004.
- Mansano VF, Pederneiras LC. 2016. Proposal to add Glaziov's "Plantae Brasiliae centralis a Glaziov lectae" to the list of suppressed works in Appendix VI. *Taxon* 65: 1181-1182. DOI: 10.12705/655.28.
- O'Dowd DJ, Wilson MF. 1989. Leaf domatia and mites on Australasian plants: ecological and evolutionary implications. *Biological Journal of the Linnean Society* 37: 191-236. doi: 10.1111/j.1095-8312.1989.tb01901.x.
- Oakley LJ, Prado DE. 2013. Consideraciones sobre la identidad y delimitación de *Celtis chichape* (Wedd.) Miq. (Celtidaceae). *Rojasiana* 12: 117-124.
- Pederneiras LC, Costa AF, Araújo DSD, Carauta JPP. 2011. Ulmaceae, Cannabaceae e Urticaceae das restingas do estado do Rio de Janeiro. *Rodriguésia* 62: 299-313. doi: 10.1590/2175-7860201162207.
- Planchon JE. 1848. Sur les Ulmacées (Ulmacées et Celtidées de quelques auteurs) considérées comme tribu de la famille des Urticées. In: Brongniart MMAD, Decaise J (eds.). *Annales des Sciences Naturelles*. Paris, Victor Mason. p. 244-341.
- QGIS Development Team. 2022. QGIS Geographic Information System. <http://qgis.osgeo.org>. 10 Jun. 2022.
- Radford AE, Dickison WC, Massey JR, Bell CR. 1974. *Vascular plant systematics*. New York, Harper & Row Publishers.
- Sartorelli PAR, Benedito ALD, Campos Filho EM, Sampaio AB, Gouvêa APML. 2018. Guia de plantas não desejáveis na restauração florestal. São Paulo, Agroicone.
- Thiers B. 2023. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/>. 1 Aug. 2023.
- Torres RB, Luca AQ. 2005. Ulmaceae. In: Wanderley MGL, Shepherd G, Giulietti AM, Melhem TS (eds.). *Flora Fanerogâmica do Estado de São Paulo*. São Paulo, RiMa. p. 361-370.
- Turland NJ, Wiersema JH, Barrie FR *et al.* 2018. International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Shenzhen, Glashütten, Koeltz Botanical Books.
- Zamengo HB, Gaglioti AL, Chamorro D *et al.* 2020. Nomenclatural novelties in *Celtis* (Cannabaceae) and a preliminary phylogeny of the genus with emphasis on the South American species. *Brazilian Journal of Botany* 43: 947-960. doi: 10.1007/s40415-020-00656-x.
- Zamengo HB, Machado AFP, Silva MFO. 2023a. *Celtis*. Flora e Funga do Brasil, Rio de Janeiro. <https://floradobrasil.jbrj.gov.br/FB608655>.
- DIA MÊS ANO.**
- Zamengo HB, Chamorro D, Gaglioti AL, Oakley L, Pederneiras LC. 2023b. Nomenclatural notes on Brazilian *Celtis* (Cannabaceae). *Phytotaxa* 579: 209-218. doi: 10.11646/phytotaxa.579.3.6.
- Zamengo HB. *in prep.* Taxonomia e filogenia de *Celtis* L. (Cannabaceae) com foco nas linhagens neotropicais. PhD Thesis, Escola Nacional de Botânica Tropical, Rio de Janeiro.

Por gentileza,
informar a data de
acesso.



Appendix

Appendix 1. Materials of *Celtis atlantica* Zamengo erroneously cited as *Celtis orthacanthos* Planchon by Berg & Dahlberg (2001). **Minas Gerais:** Caratinga, Estação Biológica de Caratinga, 1 April 1984, (fr.), *K.B. Strier* 613 (BHCB, NY); idem 19°40' S, 41°50' W, 25 March 1984,

(fr.), *K.B. Strier* 836 (NY!). **Rio de Janeiro:** Rio de Janeiro, matas do Sumaré, 3 September 1927, (fl.), *Pessoal do Horto Florestal s.n.* (K barcode 000964290!, NY barcode 00476067!, P barcode 06781657!, RB barcode 00439263!). Serra do Gericinó, 15 June 1982, fr., *A. Glaziou* 18991a (P!). **Unknown locality:** “prope mandioca” October 1923, (fl.), *L. Riedel* (NY barcode 02429055!, NY barcode 02429058!).

