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ECOSSYSTEMS

Look at the trees: synopsis of *Terminalia s.s.* in the Brazilian Amazon with conservation and distribution implications

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Abstract: *Terminalia* L. has a pantropical distribution, almost exclusively constituting tropical Combretaceae. In this work, a comprehensive synopsis of all the native species of *Terminalia s.s.* in the Brazilian Amazon is presented, including diagnostic characters, identification key, illustrations, geographic distribution maps, diversity and richness patterns with a new occurrence in Brazil, and a table with conservation status and number of records/ protected areas and their protected areas for all species. This information seeks to support the identification of these tree species, in addition to actions to conserve trees in the Brazilian Amazon.

Key words: Amazon, diversity, Myrtales, new occurrences, spatial analysis.

INTRODUCTION

The Amazon is the most diverse rainforest in the world, standing out for its large number of species (Cardoso et al. 2017, Antonelli et al. 2018). Such biological diversity results from a complex interaction between abiotic (e.g., hydrological and topographic alterations) and biotic factors, such as species adaptations and intra and interspecific interactions (Fine et al. 2004, Eva & Huber 2005, Hoorn et al. 2010, Antonelli et al. 2018).

Tree species in the Amazon are one of the groups that are most affected by deforestation, with an estimated 58% reduction in species richness by 2050 (Gomes et al. 2019). In this scenario, small- or large-scale studies that collect data about distribution patterns, richness, and ecological aspects of tree species and mitigation of deforestation are essential to establish actions that reduce the loss of plant diversity. Furthermore, such studies help to define areas of interest for taxa conservation, such as those developed by Cardoso et al. (2017) and Gomes et al. (2019) who presented the general list of species, as well as the richness and area of tree occurrence for the entire Amazon region, respectively.

Among the tree groups in the Amazon region, *Terminalia* L. is highlighted with 12 species recorded in different phytophysiognomies (Ribeiro et al. 2020). The genus, included in the Terminaliinae (DC.) Exell & Stace subtribe, is formed by about 290 species with pantropical distribution, almost exclusively constituting the tropical Combretaceae (Stace 1965, 2010, POWO 2021). It is represented by trees with simple and alternate leaves, usually clustered at the apex of the branches, bisexual or unisexual flowers, apetals and fruits betulids, actinomorphic or zygomorphic. The group presents high vegetative and reproductive morphological diversity, making it difficult to recognize the taxa (Stace 2010, Ribeiro et al. 2018).

In Brazil, the genus comprises 22 species, of which seven are endemic, belonging to nine

sections (Stace 2010). *Terminalia* representatives occur in different phytogeographic domains of the country, however, the largest diversity of *Terminalia*, including native and exotic species, was recorded in the Amazon, corresponding to 55% of the species (12 spp.), followed by the Atlantic Forest (11 spp.) and Neotropical savanna (Cerrado) (8 spp.) (Ribeiro et al. 2020).

Regarding taxonomic treatments of the group, the study by Stace (2010), which includes *Terminalia* representatives from the Neotropical region, is still the most recent and comprehensive. However, despite the descriptions, not all species were illustrated, and further updates are needed regarding new occurrences and aspects of distribution, richness and conservation of taxa in Brazil, which have not yet been contemplated for this group.

For Brazil, important taxonomic studies were developed involving representatives of *Terminalia s.s.* from Central-West, Northeast, Southeast and South Brazilian geopolitical regions include those by Marquete & Valente (1996), Marquete et al. (2003), Linsigen et al. (2009), Soares-Neto et al. (2014), Ribeiro et al. (2017, 2018, 2020), and Sousa et al. (2018).

To this date, only two Combretaceae species inventories were carried out in the Brazilian Amazon. The first one, undertaken in the Adolfo Ducke Forest Reserve in the State of Amazonas, listed only eight representatives of *Buchenavia* Eichler and *Combretum* Loefl. (Marquete & Valente 2005). Recently, one species of *Combretum* (*Combretum laxum* Jacq.) was recorded in the Serra dos Carajás, State of Pará (Praia 2017).

The representatives of *Terminalia s.s.* are recognized for their great timber potential, which may be related to the reduction of their natural populations in extraction areas in the Brazilian Amazon (Stace 2010, Mayoral et al. 2017).

Studies about the conservation status of *Terminalia* taxa are still punctual and include few species, especially those developed by Borges et al. (2012) who evaluated four species (*Terminalia acuminata* (Allemão) Eichler, *T. argentea* Mart. & Zucc., *T. mameluco* Pickel and *T. triflora* (Griseb.) Lillo), Loiola et al. (2013), including only *T. acuminata*, and the National Center for Plant Conservation (CNC Flora 2021) and IUCN Red List of Threatened Species (IUCN 2021) list five and eight species, respectively.

From a phylogenetic perspective, Maurin et al. (2017) proposed including *Buchenavia* in *Terminalia*. Therefore, we have chosen to analyze only *Terminalia s.s.* The delimitation of *Terminalia s.l.* is still inconclusive and have being studied by molecular approach to establish a stable taxonomic concept for the taxon, based on consistent and comprehensive morphological and phylogenetic data.

Due to the lack of recent work for this group in the Amazon region and in attempts to fill some gaps about the taxonomy and distribution of species in Brazil, which were previously pointed out by Marquete et al. (2003) and Ribeiro et al. (2018), the synopsis presented here is intended to provide information about *Terminalia s.s.* taxa of the Brazilian Amazon with: 1) diagnostic characters, identification key and illustrations of all taxa; 2) characterization of patterns of geographic distribution, diversity and richness of *Terminalia* species, including new occurrence records; 3) conservation status assessment according to "B1" criteria of IUCN red list (IUCN 2017) and definition of species registered in Protected Areas (PA) and their respective PA.

MATERIALS AND METHODS

Brazilian Amazon

The Amazon Domain has about six million km^2 comprising various ecosystems, including

rainforest, savanna (Amazonian savannas) and flooded fields (Carvalho & Mustin 2017, Gomes et al. 2019). This extensive region encompasses the following countries: Brazil, Bolivia, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, and Venezuela (Gomes et al. 2019).

Within the geographic boundaries of Brazil, the Amazon is a phytogeographic domain present in the North Brazilian geopolitical region and in some states in the Central-West and Northeast regions (Figure 1a), including a region known as the "Arc of Deforestation", which is an area that has the highest deforestation rates within the legal Brazilian Amazon (Steege et al. 2003, Herrera et al. 2019, IBGE 2021).

According to Cardoso et al. (2017), the Amazon region has about 7.000 spp. of trees (48% of the total plant biodiversity of the

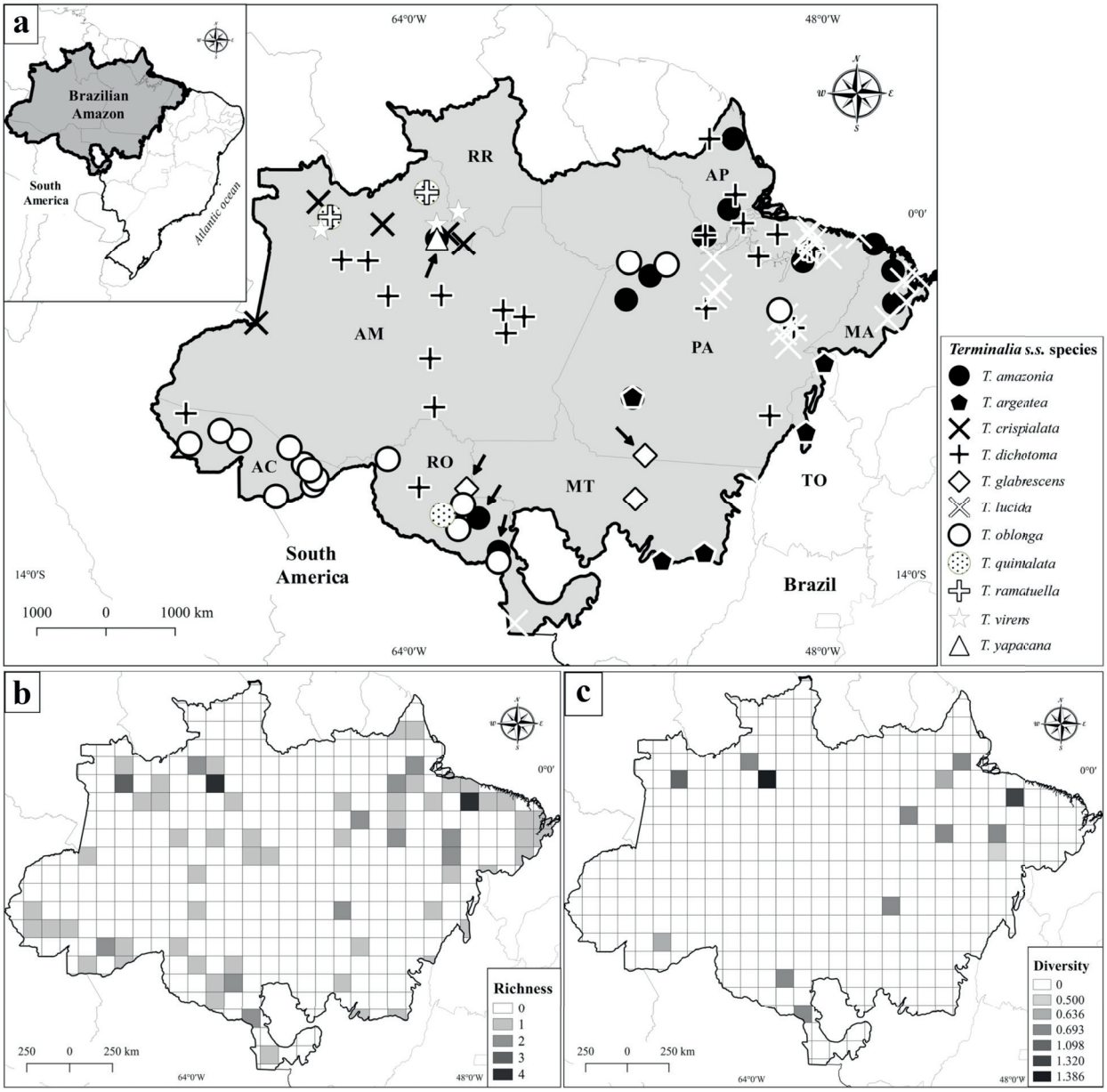

Figure 1. a,b,c. *Terminalia s.s.* taxa in the Brazilian Amazon. —a. Distribution pattern. —b. Species richness. —c. Diversity using the Shannon índex. Grids in 1° × 1° grids. Arrows indicate new occurrences.

Amazon region). Brazil stands out for having almost 5.000 spp., equivalent to 68% of the tree species occurring in the Amazon domain. Therefore, the considerations presented here regarding the distribution, conservation, diversity and richness aspects of *Terminalia* taxa and vegetation types follow the limits of the Amazonian phytogeographic domain in Brazil (including states in the Central-West, North and Northeast regions) using shapefiles (.shp) obtained from the Ministry of the Environment (MMA 2021) and National Institute for Space Research (INPE 2021) websites.

Morphological analysis

The taxonomic synopsis presented in this study was based on the morphological analysis of herborized specimens and field collections. Exsiccates from the following herbaria were examined: BM, BR, CEN, CTBS, ESA, GH, GOET, F, FI, FLAS, HUEFS, IAN, INPA, K, LE, LTR, M, MA, MAR, MG, MO, MYF, NY, OXF, P, PEUFR, R, RB, RON, S, SPF, TCD, U, UB, UC, UNIP, US, VEN and W (acronyms according to Thiers 2021). The standardization of vegetative and reproductive structural terminology was based on Stace (1965), Hickey (1973) and Radford et al. (1974). Species determination was based mainly on Stace (2010) and data from the Brazilian Flora 2020 project (Ribeiro et al. 2020). Furthermore, notes of geographic distributions and habitat data were based on field collections and information from the literature and exsiccate labels.

All original citations and types were analyzed by the authors and are indicated by the barcode or herbarium accession number and exclamation point. The protologues and types were examined through the Global Plants on JSTOR (2021) and the Biodiversity Heritage Library (2021) websites.

For each species, this synopsis includes the characteristics of taxa essential for recognition, illustrations (some published here for the first time), a brief characterization of distribution, ecology, conservation comments and some selected specimens.

Morphological diagnostic characteristics not yet highlighted in previous works were evidenced here as inflorescence patterns in *Terminalia ramatuella* Alwan & Stace and *T. yapacana* Maguire and details about the flowers of *T. dichotoma* G. Mey. and *T. lucida* Hoffmanns. ex Mart. & Zucc. that aid in the recognition and distinction of these taxa. Additional comments that help to distinguish the taxa which have not yet been extensively studied, such as *T. crispialata* (Ducke) Alwan & Stace, *T. ramatuella* Alwan & Stace, *T. virens* (Spruce ex Eichler) Alwan & Stace and *T. yapacana* Maguire, are explored in this study.

Species occurrence data and spatial analyses

Initially, we compiled the occurrence data for all *Terminalia* species recorded in the Brazilian Amazon based on the synopsis proposed here and other literature and database sites, such as Flora Neotropica Monograph (Stace 2010), speciesLink system of the Reference Center on Environmental Information – CRIA (CRIA 2021), the Reflora Virtual Herbarium (REFLORA 2021) and the Global Biodiversity Information Facility - GBIF (GBIF 2021). The initial data set contained 1300 records, which was reduced to 872 records for the 11 species studied after being checked and validating taxonomic identification.

Whenever possible, records without coordinates were georeferenced using the "GeoLoc" tool available on CRIA (http://splink.cria.org.br/geoloc?criaLANG=pt) or Google Earth (https://www.google.com/earth/). Duplicate occurrences for a municipality and taxon or records prior to 1945 were disregarded for spatial analyses, the latter due to possible inaccuracies

and lack of information, resulting in about 100 records.

All records verified and confirmed for *Terminalia* species in the Brazilian Amazon were plotted on a map divided into 782 grid squares of 1×1° representing our Operating Geographic Units (OGU). For each grid square, the species richness (as the total number of species) and diversity (using the Shannon index, which considers the contribution of each species per grid square) were calculated using DIVA-GIS 7.5 program (Hijmans et al. 2001). All the maps presented here were generated through the Quantum GIS 3.8 software (QGIS 2021).

Conservation aspects

The preliminary conservation status of the *Terminalia* taxa registered for the Brazilian Amazon were defined according to criteria "B1" proposed by the IUCN red list, Version 13 (IUCN 2017), considering the EOO (Extent of occurrence) and AOO (Area of occupancy), which were both implemented in GeoCAT (Bachman et al. 2011). In addition, a table with the number of Protected Areas (PA) is provided, and the names of Protected Areas (PA) (Municipal, State or Federal levels) for each species are mentioned (Table I).

RESULTS

Taxonomic and morphological aspects of *Terminalia s.s.*

In the Brazilian Amazon, 11 native species of *Terminalia* s.s. were registered: *Terminalia amazonia* (J.F.Gmel.) Exell, *T. argentea*, *T. crispialata*, *T. dichotoma*, *T. glabrescens* Mart., *T. lucida*, *T. oblonga* (Ruiz & Pav.) Steud., *T. quintalata* Maguire, *T. ramatuella*, *T. virens* and *T. yapacana*. The exotic species, *T. catappa* L. was not included in this study.

According to Stace (2010), the genus representatives in the Neotropical region are positioned in 12 sections. Of these, nine include taxa registered for Brazil and the Amazon species were recorded in six sections (*Chuncoa* (Pav. ex Juss.) C.B. Clarke, *Diptera* (Eichler) Engl. & Diels, *Pachyphylla* Maguire & Exell, *Ramatuellea* (Kunth) Alwan & Stace, *Rhombocarpae* Engl. & Diels and Oblongae Engl. & Diels) (Table I).

The sections *Pachyphylla* and *Ramatuellea* stand out for having representatives that only occur in the Amazon domain (Brazil and extra-Brazil). In addition, the taxa of these sections have less occurrence records than the other *Terminalia* taxa registered in Brazil.

Geographic distribution, richness and diversity patterns

Terminalia s.s. is widely distributed in the Brazilian Amazon (Figure 1a) and has the following distribution limits: to the north, *T. amazonia* in the municipality of Oiapoque, AP; to the south, *T. oblonga* in the municipality of Cabixi, RO; to the east, *T. lucida* in the municipality of Alcântara, MA; and to the west, *T. dichotoma* in the municipality of Rodrigues Alves, AC.

Regarding collections efforts', *T. dichotoma*, *T. lucida* and *T. amazonia* stood out for presenting the largest number of records for the Amazon, with 23, 20 and 17 occurrences in different municipalities, respectively, while *T. yapacana* (one) and *T. ramatuella* (two) have the lowest number of occurrences.

Terminalia yapacana presents its first register in the Brazilian territory in Amazonas state, and until now, the taxon only had been known in the Venezuelan Amazon. In Amazonas state, the species is associated with the rainforest near river courses (Figure 1a). In addition to *T. yapacana*, three other new occurrences of *Terminalia* were identified for the Brazilian Amazon (Table I), one for *T. amazonia* in the state of Rondônia and two for *T. glabrescens* in the states of Pará and Rondônia (Figure 1a).

Table I. Distribution and conservation data of *Terminalia s.s.* occurring in the Brazilian Amazon. Abbreviations of Brazilian states: AC – Acre, AL – Alagoas, AM – Amazonas, AP – Amapá, BA – Bahia, CE – Ceará, GO – Goiás, MA – Maranhão, MG – Minas Gerais, MT - Mato Grosso, MS - Mato Grosso do Sul, PA – Pará, PI – Piauí, PR – Paraná, RJ – Rio de Janeiro, RO – Rondônia, RR – Roraima, SP – São Paulo, TO – Tocantins. Red List Category: CR - Critically endangered, EN – Endangered, VU – Vulnerable, LC - Least concern. *indicates new occurrences. Abbreviations for Conservation units: APA - Environmental Protection Area, FLONA - National Forest, REBIO - Biological Reserve, RESEX - Extractive Reserve.

Sections	Species	Distribution in the Brazilian states	Protected Areas (including indigenous lands)	Conservation status		
				IUCN 2019	This study (only B1 criteria)	
					AOO	EOO
Chuncoa (Pav. ex Juss.) C.B. Clarke	*T. amazonia*	AC, AM, AP, MA, PA, PE, PI, RO*	Grove Rodrigues Alves (PA), FLONA of Tapajós (PA), Alto Turiaçu Indigenous Land (MA)	LC	EN	LC
	T. glabrescens	AL, BA, CE, ES, GO, MA, MG, MS, MT, PA*, PI, PR, RJ, RO*, SP, TO	RESEX Guariba-Roosevelt (RO)	VU	EN	LC
Diptera (Eichler) Engl. & Diels	*T. argentea*	BA, CE, ES, GO, MG, MS, MT, PA, PR, SP, TO	Grove Rodrigues Alves (PA), REBIO Nascentes da Serra do Cachimbo (PA)	LC	EN	LC
Pachyphylla Maguire & Exell	*T. quintalata*	AM, RO	-	-	EN	LC
	T. yapacana	AM*	-	-	CR	CR
Ramatuellea (Kunth) Alwan & Stace	*T. crispialata*	AM, RO	-	-	EN	LC
	T. ramatuella	AM	-	-	CR	CR
	T. virens	AM, RR	-	-	EN	VU
Rhombocarpae Engl. & Diels	*T. dichotoma*	AC, AM, AP, BA, MA, PA, RO, RR	RDS Mamirauá (AM), RDS Rio Madeira (AM), APA of Marajó Archipelago (PA)	-	EN	LC
	T. lucida	BA, GO, MA, MT, PA, PI, TO	APA of Marajó Archipelago (PA)	-	EN	LC
Oblongae Engl. & Diels	T. oblonga	AC, AM, BA, PA, PE, RO	APA Raimundo Irineu Serra (AC), RESEX of Alto Juruá (AC), RESEX of Cazumbá-Iracema (AC), RESEX Chico Mendes (AC), Kaxinawá Indigenous Land of Carapanã Beach (AC)	LC	EN	LC

Three richness centers were identified in the region, the first and second in the state of Amazonas with four species each and a third in the state of Pará with three taxa (Figure 1b). *Terminalia s.s.* diversity in the Amazon (Figure 1c) seems to be associated with three main areas in state of Amazonas with a diversity index of 1.38 and 1.32, respectively, and the third in the state

of Pará with an index of 1.09. The grid squares with highest diversity are located in the north of the Amazon region. However, we highlight a second center of diversity in the south, in the state of Rondônia, with lower values, index of 0.62.

Conservation

Of the eleven species of *Terminalia* confirmed and analyzed here, six (55%) (*T. amazonia*, *T. argentea*, *T. dichotoma*, *T. glabrescens*, *T. lucida* and *T. oblonga*) were recorded in protected areas (PA) in the Amazon. Of the taxa occurring in PA, *T. oblonga* presented the largest number of records (4) in different units (Table I).

The species with the highest EOO was *T. amazonia* (2,511,901,232 km^2) and the smallest were *T. ramatuella* and *T. yapacana* (0,000 km^2), whose species were represented by few collections. *T. dichotoma* stands out with the largest AOO area (92,000 km^2), while *T. yapacana* presented the smallest (4,000 km^2). More detailed information can be found in species comments and in Table I.

Taxonomic treatment

1. *Terminalia* L., Syst. Nat. 12. (2): 674. 1767. TYPE: *Terminalia catappa* L.

Shrubs to trees, branches glabrous. Leaves alternate, spirally arranged, usually clustered at the end of the branches. Glands 2 or absent in the petiole. Inflorescences in subcapitate, capitate or elongated spikes, axillary or terminal. Flowers unisexual or bisexual. Calyx (4–)5-lobed, developed lobes, reflexed or not. Corolla absent. Stamens (8–)10, inserted in two whorls; anthers versatile. Nectariferous disk, usually developed, ringlike, margin free. Fruit betulid, dried, actinomorphic or zygomorphic, 2–5-alate.

Key to the Brazilian Amazon species of *Terminalia s.s.*

1a. Leaves with sparse to dense-sericeous, dense cinereous-sericeous, or dense-puberulous indument in the abaxial surface.

2a. Leaves without domatia; subcapitate or capitates spikes ..... *T. glabrescens* Mart.

2b. Leaves with domatia; elongated spikes.

3a. Leaves chartaceous to subcoriaceous, acuminate apex; eucamptodromous-brochidodromous venation; zygomorphic fruit ..... *T. argentea* Mart. & Zucc.

3b. Leaves always coriaceous, rounded to retuse apex; brochidodromous venation; actinomorphic fruit.

4a. Leaves with 5–7 pairs of secondaries veins; fruits with an indumentum dense cinereous-sericeous, wings with entire margins .... *T. ramatuella* Alwan & Stace

4b. Leaves 8–14 pairs of secondaries veins; fruits glabrous, wings with crispate margins ..... *T. crispialata* (Ducke) Alwan & Stace

1b. Leaves with abaxial surface glabrous.

5a. Subcapitate spikes; fruit wings with sinuate margins .... *T. virens* (Spruce ex Eichler) Alwan & Stace

5b. Elongated spikes; fruit wings with flat margins.

6a. Chartaceous to subcoriaceous leaves.

7a. Leaves with 3–5 pairs of secondaries veins; style glabrous; fruits 4–7 × 10–17 mm, 4-winged, unequal wings ..... *T. amazonia* (J.F.Gmel.) Exell

7b. Leaves with 5–8(–10) pairs of secondaries veins; style villous to dense-villous; fruits 24–36 × 27–50 mm, 2-winged, equal wings.

8a. Leaves with cuneate base; style villous in the proximal half; fruit with spongy wings .... *T. dichotoma* G. Mey.

8b. Leaves with attenuate base; style dense-villous from the proximal half to the apex; fruit

with coriaceous wings ..... *T. oblonga* (Ruiz & Pav.) Steud.

6b. Strongly coriaceous leaves.

9a. Leaves with acute to short-acuminate apex; style dense-villous, except glabrous only at apex; fruits 12–23 × 16–32 mm, 2-winged, zygomorphic ..... *T. lucida* Hoffmanns. ex Mart. & Zucc.

9b. Leaves with rounded to retuse apex; style glabrous or sparse-pubescent at the base; fruits 3–11 × 2–10 mm, (4-)5-winged, actinomorphic.

10a. Leaves narrow-obovate to oblanceolate, 3–5.7 × 1.4–3.1 cm; fruit with rounded wings .... *T. yapacana* Maguire

10b. Leaves obovate to oblong-obovate, 8–14.1 × 5.8–7.6 cm; fruit with narrow-elliptic wings ..... *T. quintalata* Maguire

1. *Terminalia amazonia* (J.F.Gmel.) Exell, Fl. Suriname 3(1): 173. 1935. TYPE: Peru. Sylvis fluvio Amazonio contermis, Chunco du Maragnon, 1786 (fl.), *Pavon & Dombey s.n.* (holotype, P-00681414!) (Figure 2a-c).

Terminalia amazonia is very closely related to *T. glabrescens* in morphological aspects of

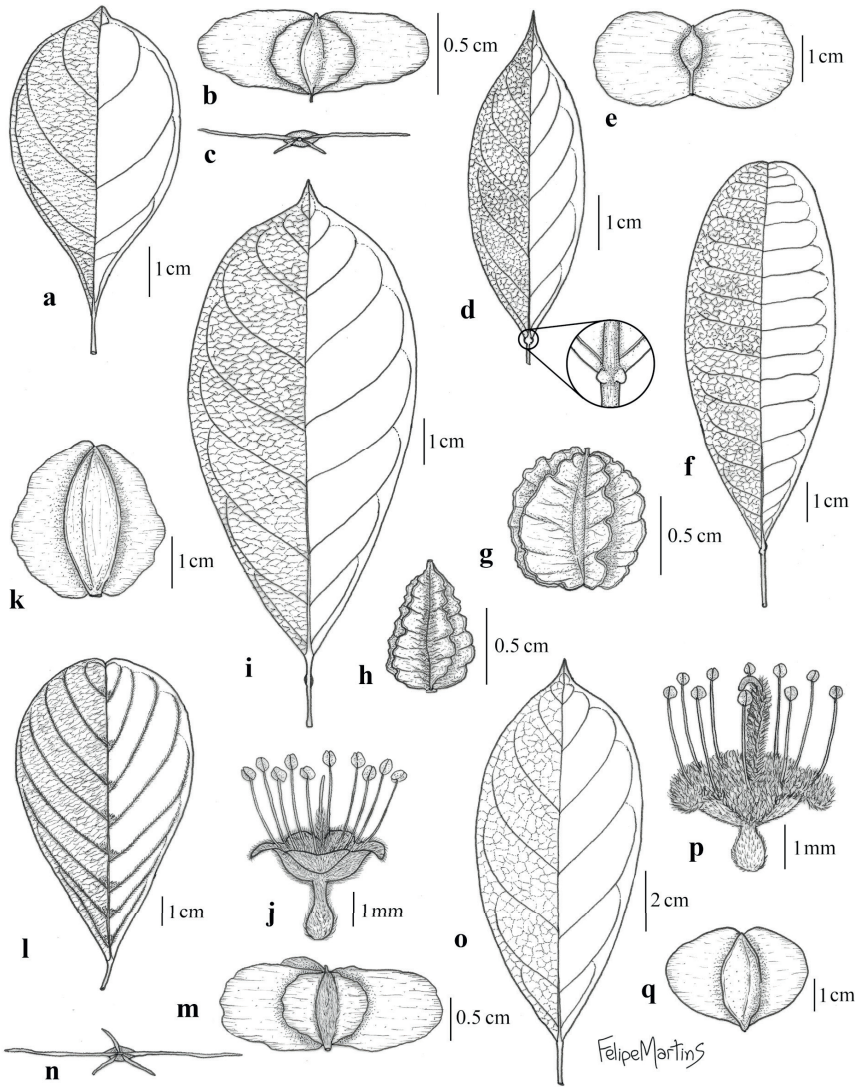

Figure 2. a,b,c. *Terminalia amazonia* —a. Leaf. —b. Fruit. c. Apical view of the fruit. d,e. *T. argentea* —d. Leaf with detail of petiolar glands. —e. Fruit (front view). f,g,h. *T. crispialata* —f. Leaf. g,h. Fruit. i,j,k. *T. dichotoma* —i. Leaf. j. Flower. k. Fruit. l,m,n. *T. glabrescens* —l. Leaf. m. Fruit (front view). n. Fruit (apical view). o,p,q. *T. lucida* —o. Leaf. p. Flower. q. Fruit (front view). a,c. *LR Marinho & BGS Ribeiro 726* (IAN); d,e. *JM Pires & GA Black 6437* (IAN); f,h. *Huber et al. 10806* (INPA, K, MIRR, NY, US); i,j. *DF Austin et al. 7414* (INPA, RB); k. *NT da Silva 4814* (MG, NY, UEC); l, n. *PV Oliveira et al. 11-286* (RB); o. *PC da S. Rosário et al. 158* (MG, NY); q. *IC Antônio PSCF 912* (IAN, MG, UFPA).

its leaves, and pattern of its inflorescence and fruits. However, *Terminalia amazonia* can be differentiated by its leaves glabrous on the abaxial face (*vs.* leaves dense-sericeous with ferrugineous trichomes), 3–5 pairs of secondary veins (*vs.* 6–8 pairs of secondary vein pairs), and fruits 4-winged (*vs.* fruits 5-winged).

Selected examined material. BRAZIL. **Acre:** Sena Madureira, trail to rio Iaco from km 7 road Sena Madureira to Rio Branco, 68º 39' 24" W, 9º 3' 57" S, 1 Oct.1968 (fr), *G.T. Prance 7717* (F, INPA, K, MG, U, US). **Maranhão:** Itapecuru Mirim, Fazenda São Benedito, 29 Nov.1975 (fl), *D.P. Lima 13401* (PEUFR). **Pará:** Almeirim, Jari, estrada entre Planalto A e Tinguelim, km 16, 3 Feb. 1970 (fr), *N.T. Silva 3412* (IAN); Belém, Bosque Municipal Rodrigues Alves, mata de terra firme, 28 Dec. 1946 (fl), *A. Ducke 2042* (IAN, MO, NY, R, RB).

Habitat, distribution and conservation status: *Terminalia amazonia* is distributed from Mexico to Bolivia (Stace, 2010). In Brazil, the species occurs in the North (Acre, Amapá, Amazonas, Pará and Rondônia) and Northeast (Maranhão, Pernambuco and Piauí) regions (Ribeiro et al. 2020). *T. amazonia* is found in areas of Ombrophyllous and Terra-Firme forests in the Brazilian Amazon. A new occurrence is reported here for the state of Rondônia (Figure 1a). Regarding conservation aspects, the species is designated as least concern (LC) due to its EOO of 2,511,901,232 km^2 and endangered (EN) due to its AOO of 68,000 km^2 (Table I). *T. amazonia* has been recorded in protected areas in the Amazon and indigenous lands, including the National Forest of Tapajós and Alto Turiaçu Indigenous Land of the Ka'apor Indigenous People (Table I).

Vernacular names: Chapada (Maranhão), cuiarana (Pará), miringiba de mata (Pará), mirindiba roxa (Rondônia), periquiteira (Pará), tanimbuca (Amapá), tanimbuca folha média (Pará), tukury'y (Maranhão), tukur-y-wa-´y (Maranhão).

Notes: *Terminalia amazonia*, both in the original work and in the revision by Stace (2010), did not present any material in herbaria related to the type collection. Based on information from the protologue, the collection of *Pavon & Dombey* in 1786 deposited at the P herbarium is referred to as the type-collection herein. Unlike *Terminalia glabrescens*, *T. amazonia* has more records in the Amazon region, while *T. glabrescens* is more frequent in the Northeast and Southeast regions of Brazil, in Savanna (Cerrado), Stepic Savanna (Caatinga) and Ombrophyllous Forest (Atlantic Rainforest).

2. *Terminalia argentea* Mart. & Zucc. Flora 7(1; Beil. 4): 130. 1824; Nov. Gen. Sp. Pl. 1: 43. 1824. TYPE: Brazil. Bahia: In montosis ad villa do Rio Contos, 1817-1820, *Martius 1714* (holotype, M0146731!; isotypes, M0146732!, M0146733!) (Figure 2d-e).

Terminalia argentea is distinguished by its narrow-elliptic, elliptic to ovate leaves with acuminate apex, dense-sericeous indument on adaxial surface when young, eucamptodromous-brochidodromous venation; short capitate spikes and zygomorphic 2-winged fruit with rounded wings.

Selected examined material: BRAZIL. **Mato Grosso:** Garapu, Serra do Roncador, vicinity of Garapu, 2 Oct.1964 (fr), *G.T. Prance et al. 59230* (K, LTR, M, NY, S, UB, US). **Pará:** Belém, Bosque Municipal Rodrigues Alves, 28 May 1947 (fl, fr), *J.M. Pires & G.A. Black 1622* (IAN); Novo Progresso, Serra do Cachimbo, 17 Dec. 1956 (fr), *J.M. Pires & G.A. Black 6437* (BM, IAN, LTR, NY, UB). **Tocantins:** Presidente Kennedy, 2 Feb. 1980 (fr), *T.C. Plowman et al. 8301* (INPA, LTR, MG, MO, NY, US).

Habitat, distribution and conservation status: *Terminalia argentea* is exclusive to South America, occurring in Brazil, Bolivia, Paraguay and Peru (Stace, 2010). In Brazil, it is one of the most widely distributed taxa in the country, occurring in all regions of the Brazilian territory

(Central-West, North, Northeast, Southeast and South) (Ribeiro et al. 2020). In the Amazon region (Figure 1a), the species was registered in the states of Mato Grosso (Central-West), Pará and Tocantins (North). It is often found in Brazilian territory in areas of Savanna, Gallery Forest and Ombrophyllous Forest within the Amazon phytogeographic domain. As for conservation, *T. argentea* is hereby designated as least concern (LC) due to its EOO of 614,719,310 km^2 and endangered (EN) due to its AOO of 24,000 km^2 (Table I). The taxon was registered in Protected Areas in the Amazon, especially in the Nascentes da Serra do Cachimbo Biological Reserve, which guarantees the preservation of the vegetation in the Arc deforestation region (Table I).

Vernacular names: Capitão do campo (Mato Grosso), pau de bicho (Mato Grosso), tanimbuca amarela (Pará).

3. *Terminalia crispialata* (Ducke) Alwan & Stace, Ann. Missouri Bot. Gard. 76: 1126. 1989. TYPE: BRAZIL. Amazonas: Caatinga ad Igarape Jurupary, baixo Rio Uaupés, 2 Nov. 1932, *A. Ducke 25024* (holotype, RB [barcode] 537404!; isotypes, K-000640640!, US-00117645!) (Figure 2f-h).

Terminalia crispialata is characterized by its leaves with dense-puberulous indument only on the abaxial surface of leaves, 4(-5)-winged fruits, wings with crispate margins.

Selected examined material: BRAZIL. **Amazonas:** Santa Isabel do Rio Negro, na beira do Lago Dodona, 20 Sep. 2000 (fr), *J.A.C. Silva 913* (INPA, MG). **Roraima:** Caracaraí, 16 Apr. 1974 (fr), *J.M. Pires et al. 13992* (IAN, LTR).

Habitat, distribution and conservation status: *Terminalia crispialata* occurs in Brazil, Colombia and Venezuela (Stace, 2010). In Brazil, the taxon was registered only in the states of Amazonas and Roraima, both in the Northern region (Ribeiro et al. 2020). *T. crispialata* occurs in environments of Amazonian Campinarana, inundated forest known as *igapó* and Amazonian Savanna. This species is designated as least concern (LC) due to its EOO of 196,098,824 km^2 and endangered (EN) due to its AOO of 28,000 km^2 (Table I). The species has not yet been registered in protected areas in the Amazon (Table I).

Vernacular names: None registered.

4. *Terminalia dichotoma* G. Mey. Prim. Fl. Esseq. 177-178. 1818 ≡ *Terminalia latifolia* var. *dichotoma* (G. Mey.) DC., Prodr. (1828: 12). TYPE: Guyana. Essequibo: In silvis insulae Arowabish Essequibo, *G. Meyer 113* (holotype, GOET-000941!) (Figure 2i-k).

Terminalia dichotoma has a close affinity to *T. lucida* due to leaf shape and fruit consistency. However, *T. dichotoma* is distinguished from *T. lucida* by longer leaves 9–22 × 4–10 cm (*vs.* 5–7.5 × 1.6–3.4 cm) and chartaceous to subcoriaceous (*vs.* leaves coriaceous); style villous in the proximal half (*vs.* dense-villous, except glabrous only at apex) and fruit 28–36 × 27–29 mm (*vs.* 12–23 × 16–32 mm), with spongy wings (*vs.* coriaceous wings).

Selected examined material: BRAZIL. **Acre:** Rio Juruá, 1 km upstream from Colônia Rodriguez Alvez, Oct. 1986, (fr), *Campbell et al. 10983* (INPA, LTR, MG, NY). **Amapá:** Rio Oiapoque, river banks between Oiapoque and Santo Antonio, 26 July 1960, (fl), *H.S. Irwin et al. 47154* (IAN, K, LTR, MG, NY, R). **Amazonas:** Alvarães, Estação Ecológica de Mamirauá, 23 Nov. 1999, (fr), *M.A.D de Souza et al. 763* (IAN, INPA, RB). **Pará:** Jacundá, Jatobal, area to be flooded by Tucuruí dam, margin of rio Tocantins, 20 Oct. 1977 (fl), *A.S.L. Silva et al. 77* (K, MG, US). São Domingos do Capim, comunidade Independência, 6 Sep.1999, (fr), *A.G. Nave & A. Novello 6* (ESA, UNIP).

Habitat, distribution and conservation status: *Terminalia dichotoma* occurs in different South American countries (Brazil, Ecuador, Guyana, French Guyana, Peru, Suriname, Trinidad and Venezuela). In Brazil, the taxon presents

records in the North and Northeast regions (Ribeiro et al. 2020). In the Brazilian Amazon, *T. dichotoma* was found in inundated forest known as *várzea* and Ombrophyllous Forest vegetations. As for conservation status, the species was designated as least concern (LC) due to its EOO of 2,445,804,330 km^2 and endangered (EN) due to its AOO of 92,000 km^2 (Table I). It has been registered in protected areas such as the Mamirauá Sustainable Development Reserve (Table I).

Vernacular names: Cinzeiro (Pará), cuiarana (Pará), tanibouca (Pará), tanimbouca (Amapá, Amazonas), tanimbuca (Pará).

5. *Terminalia glabrescens* Mart. Flora 20, Beibl. 2: 124. 1837 ≡ *Myrobalanus glabrescens* (Mart.) Kuntze, Revis. Gen. Pl. 1: 237. 1891. TYPE: Brazil. Rio de Janeiro: Serra da Broca, prov. Sebastianopolis, July-Aug. 1833, *Luschnath s.n.* (holotype, BR697541!; isotypes, LE not seen, M not seen, P not seen) (Figure 2l-n).

Terminalia glabrescens is distinguished by its leaves sericeous with ferrugineous trichomes, 6–8 pairs of secondary vein pairs, and fruits 5-alate. For full comparison see *T. amazonia*.

Selected examined material: BRAZIL. **Mato Grosso:** Itaúba, resgate de flora da UHE Colíder, 3 Sep. 2015 (fr), *P.V. Oliveira et al. equipe 11-286* (RB). **Pará:** Itaituba, estrada Santarém-Cuiabá, BR 163, km 794, Serra do Cachimbo, 26 Apr.1983 (fr), *I.L. Amaral 958* (K, INPA, UB, US).

Habitat, distribution and conservation status: *Terminalia glabrescens* occurs in southwestern South America in Brazil, Bolivia and Paraguay (Stace 2010). In Brazil, the species is registered in all regions (Central-West, North, Northeast, Southeast and South). In the Amazon, *T. glabrescens* was recorded in Ombrophyllous Forest and Amazonian Savanna environments, as well as in ecotone (transition) areas between these vegetations, specifically in Mato Grosso state. The states of Pará and Rondônia are reported here with two new occurrences for the taxon. Occurrences of *T. glabrescens* in the Amazon, including the new records, appear to represent the septentrional boundary of taxon distribution. The species has been defined here as least concern (LC) due to its EOO of 67,959,874 km^2 and endangered (EN) due to its AOO of 12,000 km^2 (Table I). *T. glabrescens* was only recorded in the Guariba-Roosevelt Extractive Reserve (Table I).

Vernacular names: Cuiarana (PA).

6. *Terminalia lucida* Hoffmanns. ex Mart. & Zucc. Flora 7(1, Beil.): 130. 1824; Nov. Gen. Sp. Pl. 1: 43. 1824 ≡ *Myrobalanus lucida* (Hoffmanns ex Mart. & Zucc.) Kuntze, Revis. Gen. Pl. 1: 237. 1891. TYPE: Brazil. Pará: Siber, 1812, *J.C. von Hoffmannsegg s.n.* (lectotype, designated by Stace [2010: 181] BR-0000006975067!; isolectotype, BM-000838189!) (Figure 2o-q).

Terminalia lucida can be recognized and distinguished from *T. dichotoma* by its coriaceous leaves, style villous, except glabrous only at apex and fruit with 12–23 × 16–32 mm, coriaceous wings.

Selected examined material: BRAZIL. **Maranhão:** Palmeirândia, 16 Aug. 2011 (fl), *M. Ribeiro PM21* (IAN, MAR). **Pará:** Altamira, Acampamento de Aero-Sul a 1 km de Porto Alegre, 24 Oct. 1986 (fr), *S.A. da M. Souza et al. 464* (MG, MO, SPF).

Habitat, distribution and conservation status: According to Stace (2010), *Terminalia lucida* occurs in Africa (Guinea, Guinea Bissau and Sierra Leone) and South America (Brazil, Colombia, French Guiana, Guyana and Suriname), is characterized by a disjunct distribution. In Brazil, the taxon is registered for the Central-West (Goiás, Mato Grosso), Northeast (Bahia, Maranhão, Piauí) and North (Pará, Tocantins) regions (Ribeiro et al. 2020). In the Amazon, *T. lucida* has been found in areas of *Várzea*

and in sandy environments, such as Coastal Forest. The species has been defined here as least concern (LC) due to its EOO of 1,071,85,167 km^2 and endangered (EN) due to its AOO of 80,000 km^2 (Table I). In protected areas in the Amazon, it occurs only in the Marajó Archipelago Environmental Protection Area (APA).

Vernacular names: Cararambeira (Pará), cinzeiro (Pará), cororombeira (Pará), cuia-rana or cuiarana (Pará), tanibouca (MA).

7. *Terminalia oblonga* (Ruiz & Pav.) Steud., Nomencl. Bot., ed. 2, 2: 668. 1841 ≡ *Gimbernatia oblonga* Ruiz & Pav., Syst. Veg. Fl. Peruv. Chil. 275. 1798 ≡ *Chuncoa oblonga* (Ruiz & Pav.) Pers., Syn. Pl. 1: 486. 1805 ≡ *Myrobalanus oblonga* (Ruiz & Pav.) Kuntze, Revis. Gen. Pl. 1: 237. 1891. TYPE: Peru. Huanuco: Pozuzo nemoribus, 1780-1788, *R. Pavón & Dombey s.n.* (holotype MA-AJB04-D-1568!; isotypes: F not seen, FI not seen, MA-00813647!, MA-00813648!, OXF-00059256!) (Figure 3a-b).

Terminalia oblonga is distinguished from the other species by elliptic-oblong, oblong to obovate-oblong leaves, acute to short-acuminate apex, attenuate base, elongated inflorescence, style dense-villous from the proximal half to the apex and fruits 2-winged with wings rounded or subtriangular, coriaceous.

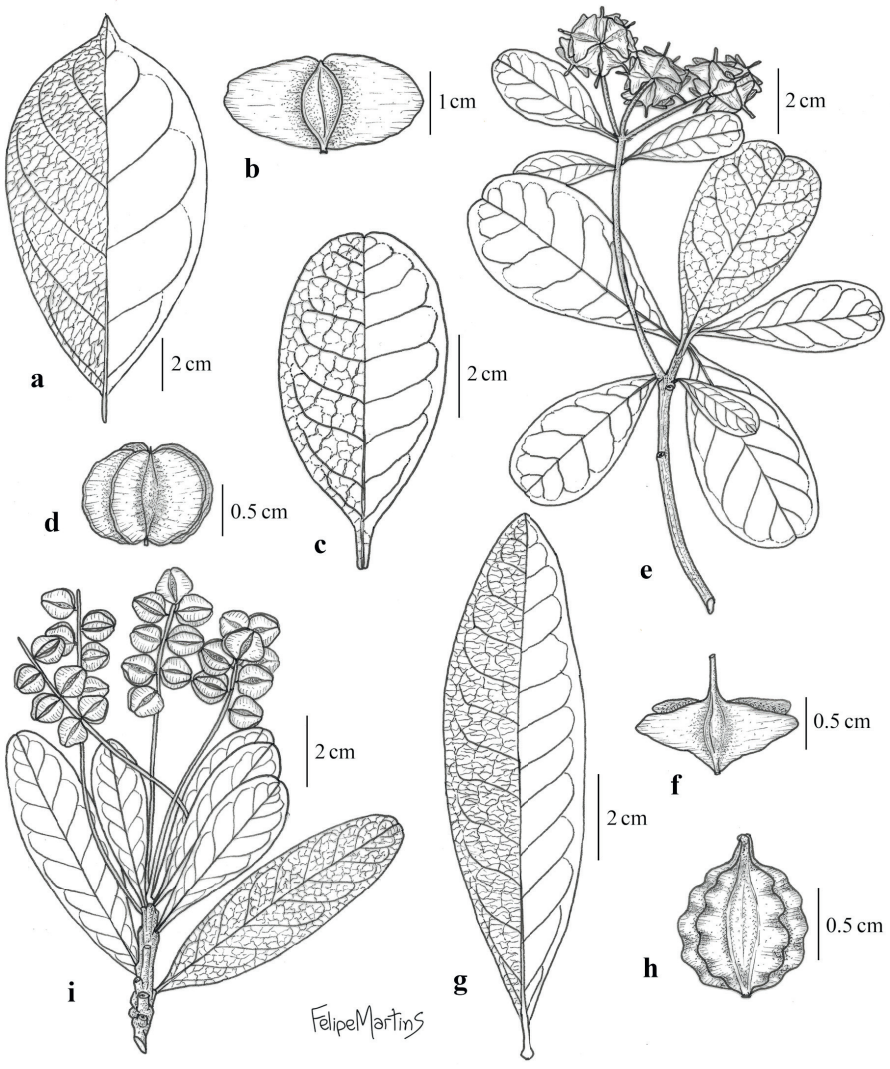

Figure 3. a,b. ***Terminalia oblonga*** **—a. Leaf. —b. Fruit (front view). c,d. *T. quintalata* —c. Leaf. —d. Fruit (front view). e,f. *Terminalia ramatuella* —e. Branch with infructescence. —f. Fruit (front view). g,h. *T. virens* —g. Leaf. —h. Fruit (front view). i. *T. yapacana* —i. Branch with leaves and infrutescence. a,b. *CS Figueiredo 829* (MO, NY); c,d. *GT Prance 28874* (INPA, NY, RB); e,f. *HC de Lima et al. 3194* (NY, RB); g,h. *JA Silva 374* (INPA, K, NY, SP, US); i. *B Maguire 30480* (K, RB).**

Selected examined material: BRAZIL. **Acre:** Sena Madureira, Reserva Extrativista Cazumbá-Iracema, 3 May 2017 (fr), *H. Medeiros et al. 2149* (RB). **Amazonas:** Benjamin Constant, Esperança, ad ostium fluminis Javary, 26 Jan.1942 (fl), *A. Ducke 880* (IAN, MO, US). **Rondônia:** Porto Velho, margem esquerda do rio Madeira, 22. June 2010 (fr), *G. Pereira-Silva 15428* (CEN, HUEFS, INPA, NY, RB, RON).

Habitat, distribution and conservation status: *Terminalia oblonga* is distributed in Central and South America (Stace, 2010). In Brazil, the taxon was registered in the North (Acre, Amazonas, Pará and Rondônia) and Northeast (Bahia and Pernambuco) regions of the country. In the Amazon, *T. oblonga* occurs in *Igapó*, Terra Firme Forest, Ombrophyllous Forest and Amazonian vegetation. The species has been designated as least concern (LC) due to its EOO of 1,533,416,561 km^2 and endangered (EN) due to its AOO of 64,000 km^2 (Table I). The taxon occurs in protected areas and indigenous lands in the Amazon, among which includes the Raimundo Irineu Serra APA.

Vernacular names: Andiroba-rana (Pará), imbiridiba amarelo (Acre).

8. *Terminalia quintalata* Maguire Bull. Torrey Bot. Club 75: 649. 1948. TYPE: Guyana. Essequibo: Potaro River Gorge, below Amatuk Portage, 19 May 1944, *Maguire & Fanshawe 23551* (holotype, NY-00245980!; isotypes: BM not seen, BR-0000006975142!, F-0054651!, FDG not seen, G not seen, K-000640650!, GH-00068632!, MO-313448!, P-01901247!, RB-00537371!, RB-00537415!, U-0001200!, UC-00793860!, US-00117618!, VEN-0029118!) (Figure 3c-d).

Terminalia quintalata seems to be similar to *T. yapacana*, however, differs due to the larger leaves 8–14.1 × 5.8–7.6 cm, obovate or oblong-obovate (*vs.* leaves 3–5.7 × 1.4–3.1 cm, narrow-obovate to oblanceolate), elongated inflorescence 7–16 cm (*vs.* 5–7.5 cm), (4-) 5-winged fruits, with narrow-elliptic wings.

Selected examined material: BRAZIL. **Amazonas:** Barcelos, 3 km ao sul da parte central da Serra Aracá e 8 km a leste do rio Jauari, 29 Feb. 1984 (fr), *W.A. Rodrigues et al. 10489* (K, INPA, NY, US). **Rondônia:** São Miguel do Guaporé, July 1975 (fl), *B.G.S. Ribeiro 1099* (IAN, MG).

Habitat, distribution and conservation status: *Terminalia quintalata* is distributed in Brazil, Guyana and Venezuela, generally found along the course of the Amazon rivers (Stace, 2010). In Brazil, it only occurs in the Amazon, with records in the states of Amazonas and Rondônia (Ribeiro et al. 2020). The species was recorded in Ombrophyllous Forest and Amazonian Savanna. *T. quintalata* was designated here as least concern (LC) due to its EOO of 306,888,235 km^2 and as endangered (EN) due to its AOO of 12,000 km^2 (Table I). Based on the records, it was not possible to verify this taxon in protected areas in the Amazon.

Vernacular names: None registered.

9. *Terminalia ramatuella* Alwan & Stace Ann. Missouri Bot. Gard. 76: 1126. 1989. TYPE: Venezuela. Amazonas: Rio Atapabo, 1799-1804, *A.J.A. Bonpland s.n.* (holotype, P-00679492!; isotypes, P-00789746!, F-0044100F!) (Figure 3e-f).

Terminalia ramatuella is a well-defined species, distinct from similarly distributed species of the genus, such as *T. crispialata*, *T. quintalata* and *T. virens*. It is characterized by its narrow-obovate or elliptic, 5–7 pairs of secondaries veins and dense cinereous-sericeous indument on the abaxial surface of leaves and fruits. In addition, capitate spikes and fruits 4-5 winged, wings narrow-rhombic, entire.

Selected examined material: BRAZIL. **Amazonas:** São Gabriel da Cachoeira, Comunidade de Camarão do Rio Içana, 21 July

2012 (fl), *F. Bonadeu 667* (CTBS, HUEFS, INPA); Beira do Rio Cubate, 19 Nov. 1945 (fr), *R.L. Fróes 21421* (F, IAN, K, NY, US).

Habitat, distribution and conservation status: *Terminalia ramatuella* has limited occurrence in Brazil, Colombia and Venezuela (Stace, 2010). It is a taxon with few records in Brazilian collections. For the Brazilian Amazon, the species only occurs in the state of Amazonas in Ombrophyllous and *Várzea* Forests vegetation, usually associated with rivers. *T. ramatuella* was designated as critically endangered (CR) due to its EOO of 0,000 km^2 and critically endangered (CR) due to its AOO of 8,000 km^2 (Table I). Based on the records, it was not possible to verify this taxon in protected areas in the Amazon.

Vernacular names: None registered.

Notes: A common misspelling (*Terminalia ramatuellea* instead of *T. ramatuella*) of the taxon name has been observed in some studies. In the original work, the taxon is called *T. ramatuella*, as in this study.

10. *Terminalia virens* (Spruce ex Eichler) Alwan & Stace, Ann. Missouri Bot. Gard. 76(4): 1126. 1989. TYPE: Venezuela. Amazonas: Rio Guaima, above its confluence with Rio Casiquiare, Nov. 1854, *R. Spruce 3758* (lectotype, designated by Stace [2010: 246] W-0000257!; isolectotypes, A, GH, B destroyed neg. in US not seen, BM not seen, BR [barcode] 5639618 not seen, C not seen, CGE not seen, F not seen, G not seen, GOET not seen, K-000640638!, K-000640639!, LE not seen, OXF-00059257!, P-01901334!, P-01901335!, RB [barcode] 17671!, TCD-0000706!, W-0333711!) (Figure 3g-h).

Terminalia virens is distinguished from *T. ramatuella* by its elliptic-oblong to obovate-oblong leaves (*vs.* narrow-obovate or elliptic) and subcapitate inflorescences (*vs.* elongated inflorescences). In addition, *T. virens* may be similar to *T. crispialata*, differing by elliptic, rare rounded, fruits, wings with entire or sinuate margins, while *T. crispialata* has ovate fruits, wings with crispate margins.

Selected examined material: BRAZIL. **Amazonas:** Barcelos, Rio Aracá, 28 July 1985 (fr), *J.A. Silva 374* (INPA, K, LTR, MG, NY); São Gabriel da Cachoeira, Rio Cubaté, afluente do Içana, 02 Nov. 1987 (fl), *C. Farney et al. 1874* (FLAS, INPA, MG, NY, RB). **Roraima:** Caracaraí, rio Xeriuni, Apr.1974 (fl), *J.M. Pires et al. 14025* (IAN, INPA, LTR, MG, RB).

Habitat, distribution and conservation status. *Terminalia virens* is restricted to northwestern South America, specifically to Brazil, Colombia and Venezuela (Stace, 2010). In Brazil, it occurs only in the North region (Amazonas and Roraima). It is present in Ombrophyllous and *Várzea* Forests vegetation, associated with the river courses of the region, such as Rio Negro and its tributaries, similar to *T. ramatuellea*. From a conservation perspective, *T. virens* was designated as vulnerable (VU) due to its EOO of 12,708,813 km^2 and endangered (EN) due to its AOO of 12,000 km^2 (Table I). Based on the records, it was not possible to verify this taxon in protected areas in the Amazon.

Vernacular names: None registered.

11. *Terminalia yapacana* Maguire Mem. New York Bot. Gard. 8: 132. 1953. TYPE: Venezuela. Amazonas: Yapacana Savanna III, Cerro Yapacana, Alto Rio Orinoco, 125 m, 1 Jan. 1951, (fr), *Maguire et al. 30590* (holotype, NY-00245985!; isotypes: BM not seen, IAN [barcode] 72731!, RB-00537416!, US-00117627!, VEN [barcode] 31340!) (Figure 3i).

Terminalia yapacana is related to *T. quintalata*, and is characterized and distinguished by its 3–5.7 × 1.4–3.1 cm, narrow-obovate to oblanceolate leaves (*vs.* 8–14.1 × 5.8–7.6 cm, obovate to oblong-obovate leaves) and fruits with rounded wings (*vs.* fruits with narrow-elliptic wings).

Selected examined material: BRAZIL. **Amazonas:** Barcelos, Rio Aracá, igapó, 18 Aug. 2014 (fl), *C.E. Zartman 9587* (INPA).

Additional examined material: VENEZUELA. **Amazonas:** Atabapo, E of Caño Perro de Agua confluence, 30 Nov. 1978 (fr), *O. Huber & S. Tillett 2788* (INPA, LTR, MYF).

Habitat, distribution and conservation status: *Terminalia yapacana*, until now, was restricted to Venezuela (Stace, 2010). However, through the present study, the species' distribution expanded to Brazil, including a new registry in Amazonas state. The confirmation of *T. yapacana* was possible after observing a set of diagnostic characters, such as smaller and narrow-obovate to oblong-oblanceolate leaves and relatively shorter inflorescences, when compared to *T. quintalata* (related species). *T. yapacana* is present in *Igapó*, Amazonian forest vegetation, and is associated with the river course of the region. Regarding conservation, the taxon was designated as critically endangered (CR) due to its EOO of 0,000 km^2 and critically endangered (CR) due to its AOO of 4,000 km^2 (Table I). The species was not registered in protected areas in the Brazilian Amazon.

Vernacular names: None registered.

DISCUSSION

Terminalia s.s. is considered a complex group from a morphological point of view, as well as presents wide plasticity of its morphological features (Marquete et al. 2003, Ribeiro et al. 2018).

According to Ribeiro et al. (2018), the concept of *Terminalia* taxa is commonly based on morphological aspects of inflorescences and fruits. Further detailing of vegetative and reproductive structures allows us to differentiate taxa related through unused characters, such as leaf and style indument, thus facilitating the process of recognizing group taxa, either in the field or based on sterile or fertile specimens.

The taxa of *Terminalia s.s.* registered in the Brazilian Amazon have different global distribution patterns, whether or not they are restricted to South America. Some taxa are widely distributed in South America, such as *T. amazonia*, *T. argentea*, *T. dichotoma*, *T. glabrescens* and *T. lucida*, while others are more restricted to the Amazon region, i.e., *T. quintalata*, *T. ramatuella*, *T. yapacana* and *T. virens* (Stace 2010).

Furthermore, the diversity of vegetation formations in which *Terminalia* species were recorded indicate that they have high ecological versatility, as they are present both in humid environments such as the Ombrophyllous Forest, as well as drier areas such as the Amazonian Savanna. In the Amazon, we highlight the savanna regions with significant area reduction, mainly due to deforestation (Carvalho & Mustin 2017, Gomes et al. 2019).

The distribution patterns of taxa (Figure 1a) reflected the concentration of records in some regions of the Amazon and the absence of occurrences in others, which are mainly associated with easier or more difficult access. According to Borges et al. (2012), the existence of underexploited areas hinders studies about distribution and conservation assessment for these taxa in the Amazon.

The richness and diversity areas were concentrated in three centers in the northern portion of the Amazon region, in Dense Ombrophyllous Forest and Amazonian Campinarana Forest vegetation. Therefore, these centers are associated with vegetations that exclusively (*Pachyphylla* and *Ramatuellea* sections) or largely (*Chuncoa*, *Oblongae and Rhombocarpae* sections) represent the occurrence records of the taxa of these sections of *Terminalia s.s.*

In addition, these richness centers of *Terminalia s.s.* in the Amazon are concentrated

in the northern portion of the region, coinciding with the areas of refuge provided by the "refuge theory" proposed by Haffer (1969). As proposed by this theory, some species occurring in the Amazon remained more restricted to refuge areas, e.g., *T. crispialata*, *T. quintalata*, *T. ramatuella*, *T. virens* and *T. yapacana*; while others, such as *T. amazonia*, *T. glabrescens* and *T. oblonga* also occurred in refuges in the Atlantic Forest domain (Andrade-Lima 1966, Haffer & Prance 2002, Ribeiro et al. 2018).

The patterns of richness and diversity of *Terminalia s.s.* in the Amazon reinforce the need for field expeditions in different areas, especially in the central region, which would provide more records and new species citations for this area, in addition to the four new occurrences reported here. According to Versieux et al. (2017), the increased number of collections in underexploited areas may reveal new occurrences for widely distributed taxa, especially for the more restricted ones. In addition to taxonomic listings, such as those by Steege et al. (2016) and Cardoso et al. (2017), studies such as the one presented here may provide information for recognizing and understanding distribution patterns and areas of greater richness and diversity for Amazonian tree taxa in particular.

Protected areas (PA) (municipal, state or federal levels) in which taxa have been registered, in addition to indigenous lands, represent important regions for the preservation of natural populations of *Terminalia* in the Brazilian Amazon.

Among the studied taxa, *T. oblonga* presented the largest number of records, being found in four different PA. The presence in PA indicates a lower threat of species disappearance, especially for those considered endangered (Hoffmann et al. 2018, Herrera et al. 2019).

Terminalia crispialata, *T. quintalata*, *T. ramatuellea*, *T. virens* and *T. yapacana* were not recorded in PA in the Amazon. In addition, they had lower EOO and AOO. Steege et al. (2015) produced estimates for population sizes, deforestation projections and conservation status for more than 15,000 Amazonian trees, indicating reductions in populations by 2050 projections for *T. yapacana,* as well as *T. amazonia*, *T. argentea*, *T. crispialata*, *T. dichotoma*, *T. glabrescens*, *T. lucida* and *T. oblonga*. These authors also categorized *T. argentea* and *T. glabrescens* as vulnerable (VU), according to IUCN criteria.

Furthermore, Barber et al. (2014) and Steege et al. (2015) highlight those protected areas and existing indigenous territories in the Amazon help protect viable populations, especially more endangered species, highlighting the importance of avoiding deforestation in these areas, as well as of improving their governance.

Unfortunately, recent data about deforestation in protected areas and indigenous land does not allow us to conclude that populations of Amazonian tree species, including *Terminalia s.s.*, will not suffer significant reductions or even disappear in the region (Freitas et al. 2018, Gomes et al. 2019).

Listings of tree species from the Amazon emphasize the need to identify the taxa from the region. However, these studies should conduct taxonomic treatments, such as the one presented here, including information about habitat, diagnostic characters and patterns of distribution and richness to aid the conservation actions of Amazonian inventoried tree taxa.

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