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Original Paper

Flora of the Reserva Ducke, Amazonas, Brazil: Simaroubaceae

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Abstract

The present study aims to improve the knowledge of Simaroubaceae in the Reserva Ducke, Manaus, Amazonas. It is based on morphological analysis of herbaria collections and field expeditions. The family is represented in that area by six species belonging to four genera: *Homalolepis* (1 sp.), *Picrolemma* (1 sp.), *Simaba* (3 spp., including a new one described herein), and *Simarouba* (1 sp.). Identification keys, morphological descriptions, illustrations, and taxonomic comments are provided for each species.

Key words: Amazon, floristic inventories, *Homalolepis*, new species, *Picrolemma*, *Simaba*, *Simarouba*.

Resumo

O presente estudo visa aprimorar o conhecimento da família Simaroubaceae na Reserva Ducke, Manaus, Amazonas. O estudo baseia-se na análise morfológica de coleções de herbários e expedições de campo. A família é representada nessa área por seis espécies pertencentes a quatro gêneros: *Homalolepis* (1 sp.), *Picrolemma* (1 sp.), *Simaba* (3 spp., incluindo uma nova aqui descrita) e *Simarouba* (1 sp.). São apresentados chaves de identificação, descrições morfológicas, ilustrações e comentários taxonômicos para cada espécie.

Palavras-chave: Amazônia, inventários florísticos, *Homalolepis*, espécie nova, *Picrolemma*, *Simaba*, *Simarouba*.

Introduction

Simaroubaceae is a small monophyletic family in the order Sapindales with 23 genera and around 117 species according to Clayton (2011) and Devecchi *et al.* (2018b). The family has a primarily pantropical distribution but also includes subtropical and temperate elements. Most of its species diversity is found in the New World, especially in Brazil where 36 species of the seven genera occur, distributed throughout most of the territory across the phytogeographical domains of the Amazon, Caatinga, Cerrado and Atlantic Forest (Devecchi *et al.* 2020). The three most diverse genera in number of species that occur in Brazil are *Homalolepis*, with 25 spp. found primarily in the extra-Amazonian parts of the country, *Simaba* with 5 spp. mostly restricted to the Amazon basin, and *Simarouba* with one widespread species and another distributed in Central Brazil.

Material and Methods

Study area

The Ducke Forest Reserve is located in the central part of the Amazon, near to the city of Manaus, Amazonas state (03º05'S, 60º00'W) (Fig. 1). It belongs to the National Institute for Amazon Research - INPA, and covers an area of 100 km^2 of primary Amazonian forest with vegetation formed by upland forest - known as Terra firme forest (Hopkins 2005).

The climate of the region is classified as Afi (Koppen), with medium temperature of 26 ºC, ranges from 19 ºC of minimum and 39 ºC maximum. Annual rainfall ranges from 1,900 to 2,300 mm, and

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rainy season in December to May and dry season from June to November (Ferreira *et al.* 2012).

Morphological analysis

The present study was based on the analysis of botanical material obtained by the authors during field trips in the Ducke Reserve in 1996, 1997, 2013 and 2014, and on exsiccatae from the following herbaria: HRB, INPA, MBM, MG, MO, NY, R, RB, SPF and SP - acronyms acording Thiers (continuosly updated). The morphological descriptions were based on the analysis of exsiccatae, with floral parts rehydrated when necessary, complemented with observations of natural populations. The samples were analyzed with the aid of a stereomicroscope with 10–60 × magnification (SZ-STLA, Olympus) and the measurements were taken with a digital pachymeter, 300 mm, with fully expanded structures. The descriptions of the family and genera was based in the literature and cover all taxa. The morphological terminology follows the proposal by Harris & Harris (2001) and Radford *et al.* (1976).

Results and Discussion

Simaroubaceae

Trees, shrubs or subshrubs; leaves alternate, spirally arranged, pinnately compound, seldom unifoliolate or simple, venation pinnate, brochidodromous; laminar glands present or lacking; stipules absent. Bitter principles (triterpenoid quassinoids) present throughout vegetative and reproductive organs. Inflorescence terminal or axillary, thyrses, thyrsoids, panicles or less frequently racemes, cymes, pseudo-umbellate, catkin-like or flowers solitary or clustered in leaf

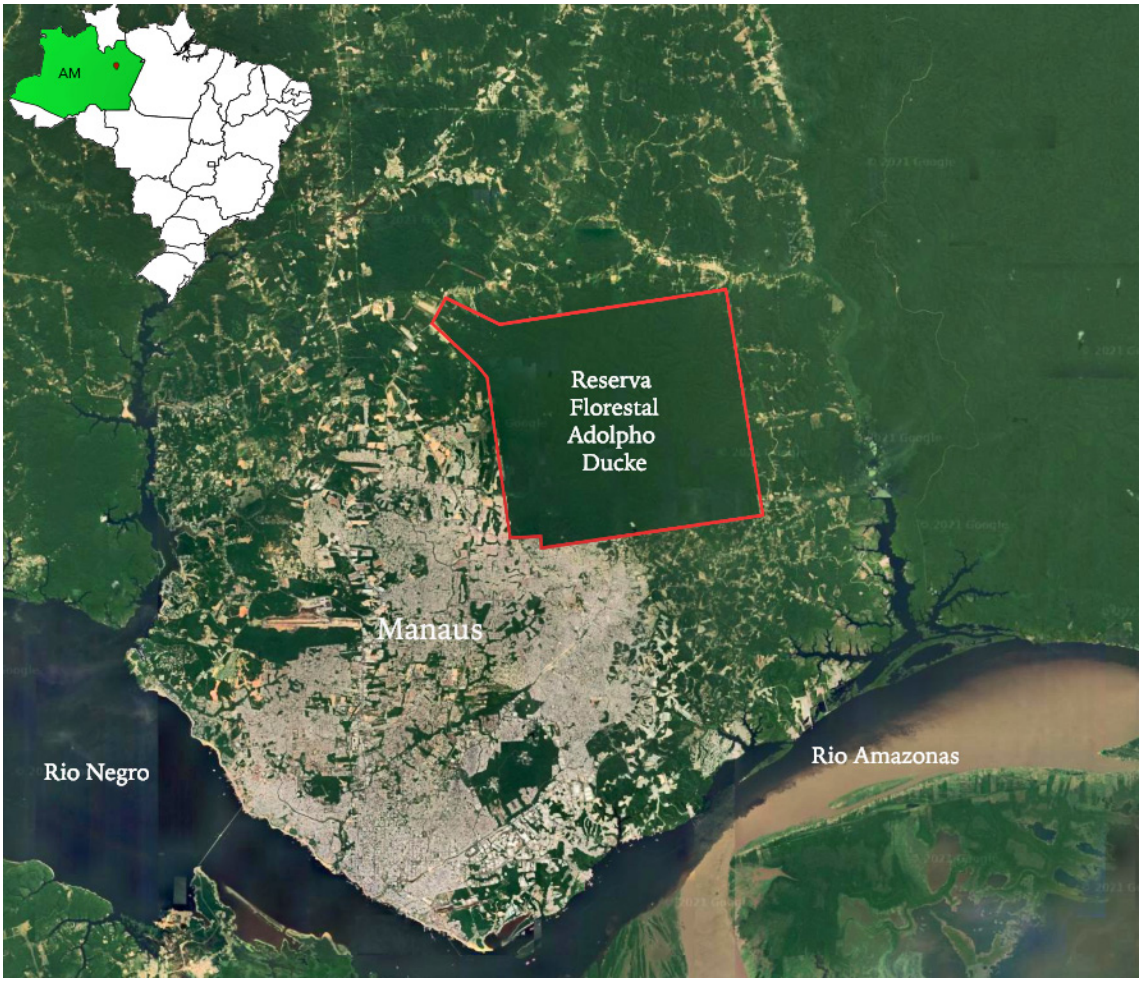

Figure 1 – Location of Reserva Florestal Adolpho Ducke, Manaus, Amazonas (adapted from: Google earth 2021).

axils. Flowers actinomorphic, bisexual or unisexual (in monoecious, dioecious or polygamous plants), when unisexual bearing or not staminodes or pistillodes; pedicel occasionally jointed; sepals 4–5(–6), connate at base, with considerable variation in the size of the tube and lobes; petals 4–5(–8), free, glabrous or sparsely to densely hairy; stamens 4–10(–18), free, often bearing a basal, adaxial appendage which is sparsely to densely hairy; anthers dorsifixed or basifixed, rimose; staminodes frequently present in female flowers; gynoecium composed of (1–)2–5(–6) carpels, distinct or connate basally and along the style, stigma punctiform, capitate, lobed or with spreading stigmatic branches, ovule 1 per locule, placentation axial; pistillode frequently present in male flowers. Fruits with 1–5(–6) one-seeded, drupaceous or samaroid fruitlets.

Within the limits of the Reserva Ducke six species were recorded, belonging to four genera: *Homalolepis* Turcz. (1 sp.), *Picrolemma* Hook. f. (1 sp.), *Simaba* Aubl. (3 spp., including a new one) and *Simarouba* Aubl. (1 sp.).

Key to distinguish the taxa of Simaroubaceae from Reserva Ducke

1. Leaflets alternate, seldom some subopposite; large tree ..... 4.1. *Simarouba amara*
1'. Leaflets opposite, seldom some subopposite; medium-sized trees, treelets or shrubs.
    2. Hollow stem (myrmecophyte); flowers unisexual (dioecious plants); stamens 4–5, with filaments lacking appendages ..... 2.1. *Picrolemma sprucei*
    2'. Stem solid, not fistulose; flowers bisexual (hermaphroditic plants) or occasionally with some unisexual flowers (polygamic plants); stamens 10, filaments with a basal, pubescent appendage.
        3. Leaflets with laminar glands present only on adaxial surface; anthers with connective smooth; stigma with short divergent branches; fruits laterally flattened or lenticular ..... 3. *Simaba*
        3'. Leaflets with laminar glands often present on both surfaces; anthers with connective papillate; stigma punctiform to slightly lobed; fruits globose, ovoid or obovoid .... 1.1. *Homalolepis cedron*

1. *Homalolepis* Turcz.

Trees, shrubs or subshrubs usually with a well-developed underground system, stem non-hollow. Leaves alternate, imparipinnate, rarely paripinnate, petiole usually swollen at base; leaflets opposite or occasionally subopposite, petiolulate, blades variable in shape and size, with a nectariferous gland usually conspicuous at the leaflet apex, laminar glands scattered usually on both surfaces or less frequent only at one surface; margin entire, discolorous, glabrous or covered by trichomes. Inflorescence terminal, subterminal or axillary, thyrsoids or thyrses, branches puberulent to tomentose, bracts usually modified as globose glands. Flowers bisexual, occasionally unisexual (polygamous plants), (4–)5(–6)-merous; calyx gamosepalous with free distal lobes; petals free, contorted or slightly imbricate in bud, cream, greenish or yellowish, densely covered by long trichomes on both surfaces; stamens (8–)10(–12), filament with an adaxial appendage, flattened dorsiventrally, partially free to fully connate to the filament; anthers dorsifixed, white to cream, yellow to orange, connective papillate; gynophore nectariferous, long and stout, terete or subterete, smooth or slightly costate, pubescent, sericeous, tomentose, velutinous or villous; carpels (4–)5(–6), free from each other but coherent at ovary level and united up to the region of transition to the style up to the stigma; style terete, tapering towards the apex, usually bristly near the base; stigma punctiform or slightly lobed; ovule 1 per carpel. Fruit composed of 1–2(–6) drupaceous fruitlets, globose, obovoid, yellow to ferrugineous, orange, brown to vinaceous, glabrous or pubescent.

Species of this genus were previously treated as *Simaba*. As a recent phylogenetic analysis showed that *Simaba* is not monophyletic, a narrower circumscription of that genus was proposed, while *Homalolepis* was reinstated and a taxonomic revision was provided (Devecchi *et al.* 2018a, b). As currently circumscribed, *Homalolepis* comprises 28 native species and is restricted to tropical South America; only one species is widely distributed, reaching Central America: *H. cedron*. Most species occur in the Cerrado and Atlantic Forest biomes, with a few species also present or endemic to the Amazon region (Devecchi *et al.* 2018a, 2020).

1.1. *Homalolepis cedron* (Planch.) Devecchi & Pirani, Phytotaxa 366(1): 67. 2018.
Simaba cedron Planch., London J. Bot. 5: 566. 1846.
Quassia cedron D. Dietr., Syn. Pl. 2:1416. 1846.
Fig. 2a-d

Treelets 1.5–8 m tall; stem slender, usually unbranched, bark thin and longitudinal fissured, young stem puberulent and glabrous at maturity. Leaves imparipinnate, less frequent paripinnate, usually clustered near the apex; petiole 19–33 cm long, base swollen; rachis 30–62 cm long, puberulent or pubescent; petiolule 3.4–5 mm long, swollen and wrinkled; leaflets 9–21, opposite, less frequent subopposite, the terminal and distal lateral leaflets 19–24 × 4.8–7.5, the terminal obovate to widely obovate, the distal lateral leaflets oblong-obovate to narrowly oblong or narrowly elliptic, apex short to long-acuminate, base attenuate in the terminal leaflet and oblique to oblique-attenuate in the lateral ones, coriaceous to subcoriaceous, margin revolute or not, glabrous except along the midvein on both surfaces, discolorous, adaxial surface dark green and shiny, abaxial surface pale green and dull; the midvein and secondary veins prominent on abaxial surfaces, inconspicuous on adaxial surface; a conspicuous, rigid and dark gland present at the leaflet apex. Thyrse terminal, main axis 140 cm long, the lateral branches gradually shorter toward the apex; bracts 1.6–3.4 × 1.2–2.7 mm, spathulate, puberulent, tip swollen, glandular. Flowers: pedicel 2.5–6 mm long, pubescent; sepals green-ferrugineous, connate at base, lobes ca. 0.6 mm long, shorter than the tube, pubescent; petals 25–31 × 2.9–3.5 mm, narrowly oblong, apex acute to rounded, cream to greenish, pubescent on both surfaces; stamens 10, filaments terete, 17–25 mm long, with an adaxial appendage 17–21 mm long, ca. 2/3 fused to the filament, villous, forming a pseudotube by the intertwining of the trichomes; anthers dorsifixed 1.3–1.8 mm long, white to pinkish; gynophore 4–5 mm long, pubescent; ovary 1.9–2.5 mm long, pubescent; style 15–17 mm long, bristly near the base; stigma punctiform. Fruits usually with a single fruitlet, 5.6–8 × 3.6–4.5 cm, obovoid, densely pubescent, immature green to ferrugineous and brown to ferrugineous at maturity.
Material examined: 23.X.1997, fl., *J.R. Pirani 3849* (SPF); 7.XI.1995, fl., *C.A. Sothers et al. 667* (INPA, SPF); 16.XII.2013, *M.F. Devecchi 262* (SPF); 18.XII.2013, *M.F. Devecchi 267* (SPF).
Additional specimens examined: BRAZIL. RONDÔNIA: Costa Marques, Parque Estadual Serra dos Reis, 10.XI.1996, fr., *L.C.B. Lobato et al. 1248* (MG). PARÁ: Magalhães Barata, Sítio Vila Nova, 16.XII.2002, fr., *J. Oliveira et al. 551 B* (MG).

The palm like habit of this species, characterized by a slender, unbranched stem bearing very long, spreading leaves clustered near the apex, as well as its terminal, large and broad inflorescences allow its easy recognition and distinction from other species in the Reserva Ducke. The leaves can reach up to 1.6 m long and the fruits up to 8 × 5.5 cm, which are records of largest leaves and fruits known for the genus. In the Reserve, *H. cedron* has been collected with flowers in October and November. The species shows the broadest geographic distribution of the genus, occurring from southeastern Brazil to the Amazonian region and extending to Central America, reaching Costa Rica and El Salvador. It belongs to *H.* sect. *Grandiflorae* (Engl.) Devecchi & Pirani; only two other species of this section are represented in the Amazon region [*H. cavalcantei* (W.W. Thomas) Devecchi & Pirani and *H. pohliana* (Boas) Devecchi & Pirani], but they have not been found at the Reserva Ducke.

2. *Picrolemma* Hook. f.

Shrubs or small treelets, stem hollow (myrmecophyte). Leaves alternate, imparipinnate, petioles usually swollen at base; leaflets opposite or less frequent alternate, petiolulate, margin entire to slightly undulate, without a nectariferous gland at the leaflet apex, laminar glands present only on abaxial surface; venation brochidodromous; lamina discolorous, glabrous. Inflorescence terminal, thyrsoid, branches glabrous, bracts usually swollen and modified as glands. Flowers unisexual (in dioecious plants), (4–)5-merous; calyx gamosepalous with the distal lobes free; petals free, imbricate in bud, orange, glabrous; stamens 5, opposite the petals, in the female flowers reduced to staminodes alternating with the petals; filaments terete, without appendages; anthers dorsifixed; gynophore long and stout, slightly lobed, glabrous; carpels (4–)5, free, style terete, stigma globose, in male flowers carpels reduced to small pistillodes. Fruit with 1–2 drupaceous fruitlets, ellipsoid and slightly elongated, not-carenate, yellow to reddish, glabrous.

Picrolemma comprises only two South American species, restricted to the Amazon region. *Picrolemma huberi* is found in forest areas of Peru, Ecuador and Colombia, while *P. sprucei* occurs in forest areas of Brazil, Ecuador, French Guiana,

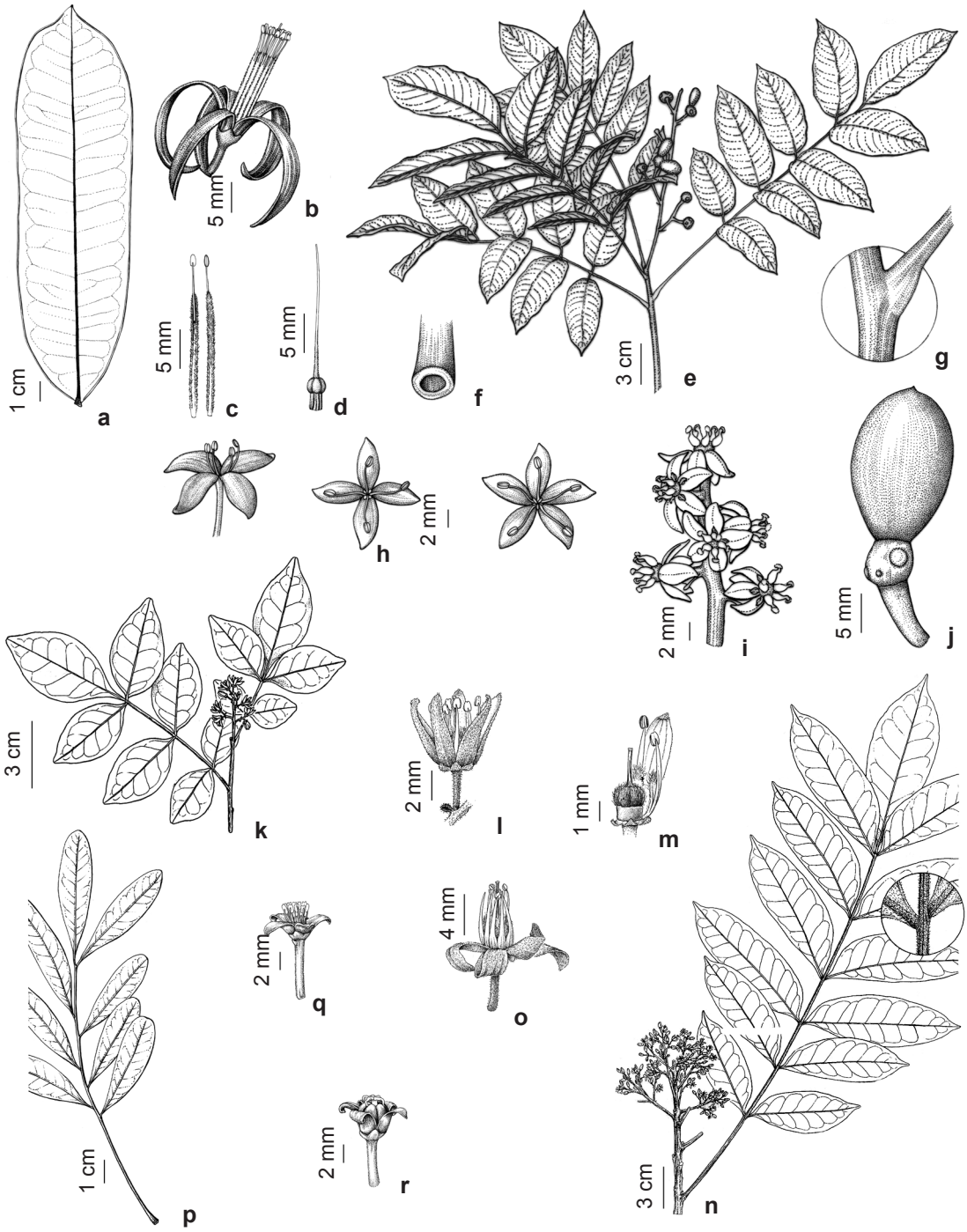

Figure 2 – a-d. *Homalolepis cedron* – a. leaflet, abaxial surface; b. flower at anthesis; c. stamens in dorsal and ventral view; d. gynoecium on top of a gynophore. e-j. *Picrolemma sprucei* – e. shoot with imparipinnate leaves and a terminal inflorescence with fruitlets in development; f. hollow stem; g. detail of a swollen petiole; h. male flower in lateral view and frontal view, with four and five petals and stamens; i. inflorescence with female flowers at anthesis; j. fruitlet. k-m. *Simaba guianensis* – k. shoot with imparipinnate leaves and a short terminal inflorescence; l. flower; m. flower with four petals removed showing the gynophore and ovary. n-o. *Simaba polyphylla* – n. shoot with imparipinnate leaf and inflorescence; o. flower at anthesis. p-r. *Simarouba amara* – p. imparipinnate leaf; q. male flower; r. female flower. Modified from: a-d. Devecchi *et al.* (2018b); k-o. Thomas (1985); p-r. Devecchi & Pirani (2016).

Guyana, Peru and Venezuela. Species of this genus have a peculiar hollow stem which is inhabited by ants that protect the plant against herbivores.

2.1. *Picrolemma sprucei* Hook. f., Gen. Pl. 1: 312. 1862.
Picrolemma pseudocoffea Ducke, Arch. Jard. Bot. Rio de Janeiro 4:196. 1925. Fig. 2e-j

Shrubs to small treelets 0.5–1.5 m tall.; stem hollow, bark thin, smooth and longitudinal fissured, branches glabrous. Leaves attached along the terminal portion of the branches, imparipinnate; petiole 9.3–12.4 cm long, base broadly swollen; rachis 16–25 cm long, shortly winged, glabrous; petiolules 5–7 mm long, not-swollen, smooth, glabrous; leaflets 9–19, opposite, the terminal and lateral ones 11–16 × 4.5–6.3 cm, the terminal elliptic, the lateral ones oblong-elliptic or ovate, base rounded or cuneate to slightly attenuate, apex long-acuminate, membranaceous to chartaceous; midvein prominent on abaxial surface, slightly sulcate on adaxial surface, secondary veins prominulous on both surfaces; apex of leaflets lacking a gland, laminar glands on abaxial surface; margin entire, slightly undulate; glabrous on both surfaces; discolorous, dark green and shiny on adaxial surface and pale green and dull on abaxial surface. Inflorescence thyrsoid, the main axis 10–26 cm long, the distal lateral branches gradually shorter toward the apex, glabrous; bracts 2–6(–11) × 0.8–1.4 mm, oblanceolate to narrowly oblong, glabrous, non-glandular. Flowers: pedicel papillate 1.8–4 mm long, glabrous; calyx 4(–5)-lobate, glabrous, lobes larger than the tube; petals 3.6–4.8 × 1.6–2 mm, oblong-obovate to oblong-elliptic, apex rounded, yellow to orange, glabrous on both surfaces; stamens 4(–5), filaments 2.5–3.1 mm long, without appendages, anthers dorsifixed, ca. 1 mm long, the female flowers with 2–4 staminodes, ca. 1 mm long; gynophore 0.4–0.9 mm long, fleshy, glabrous; carpels free from each other, 0.5–0.9 mm long, glabrous, rudimentary in the male flowers; style ca. 1 mm long, glabrous; stigma subglobose. Fruit with 1–2 drupaceous fruitlets 1.5–1.9 × 1.3–1.6 cm, ellipsoid, slightly elongate, yellow to orange.

Material examined: 14.VIII.1957, fl., *W.A. Rodrigues 518* (INPA); 12.VIII.1958, fr., *D.F. Coelho 6713* (INPA); 7.XI.1958, fl., *W.A. Rodrigues 1295* (INPA); 21.VIII.1959, fl., *W. Rodrigues & D.F. Coelho 1255* (INPA); 3.VII.1993, fl., *J.E.L.S. Ribeiro et al. 988* (INPA, SPF); 5.X.1995, fl., *M.A.S. Costa & P.A.C.L. Assunção 377* (INPA, SPF); 19.XII.1994, fl., *J.R. Nascimento et al. 694* (INPA, SPF); 18.XII.1997, fr., *M.A.D. Souza & P.A.C.L. Assunção 502* (INPA, SPF); 27.IX.1995, fl., *C.A. Sothers et al. 580* (INPA, SPF).

Picrolemma sprucei is the only species of the genus that occurs in Brazil. It can be distinguished from *P. huberi* Ducke by the petals orange and smaller, 3.6–4.8 mm long (*vs.* white and larger, 5–7 mm). *Picrolemma sprucei* was collected with flowers from July to December and with fruits in December, in the Reserva Ducke, where it is found in slope forests and capoeira on sandy to clayey soil.

3. *Simaba* Aubl.

Trees or shrubs, stem non-hollow. Leaves alternate, imparipinnate or paripinnate, rarely unifoliolate, petiolate; leaflets opposite to subopposite, petiolulate, margin entire, usually with an inconspicuous nectariferous gland present in the leaflet apex, laminar glands scattered only on adaxial surface; lamina discolorous, covered by trichomes or glabrous. Inflorescence terminal or axillary, depauperate thyrsoids to botryoids, branches glabrous to pubescent; bracts usually dilated, glandular. Flowers bisexual, occasionally unisexual (hermaphroditic or polygamous plants), (4–)5(–6)-merous; calyx gamosepalous with free distal lobes; petals free, imbricate in bud, white, greenish to yellowish, covered by short trichomes on both surfaces; stamens (8–)10(–12), filaments terete, tapering toward the apex, provided at the base with an adaxial appendage, dorsiventrally flattened, partially free to complete fused to the filament; anthers dorsifixed, white to cream, yellow to orange, connective smooth; gynophore short, terete, subterete to conical, usually thicker than the ovary, smooth or slightly costate, glabrous or sparsely to densely pubescent; carpels (4–)5, free from each other but coherent at ovary level and united up to the region of transition to the style up to the stigma, dorsally bulged, glabrous or pubescent or tomentose, ocasionally reduced to a pistillode; style terete; stigmas short divergent. Fruit with 1–5 drupaceous fruitlets, usually lenticular, often carenate or obovoid and strongly laterally flattened, yellow, red, orange, vinaceous to dark-red, glabrous to densely pubescent.

In its current circumscription, *Simaba s.s.* comprises about ten Amazonian species, with only two disjunct occurrences, one in the Atlantic forest in southern Bahia, northeast of Brazil, and the other in the forests of the Caribbean coast of Panama (Devecchi 2017). Phylogenetically it is

closely related to the genera *Homalolepis* and *Simarouba*, but morphologically distinct by its leaves and flowers, which are much smaller than in the two other genera. Additionally, the petals in *Simaba* have a striated surface, bearing short trichomes with ornate surface, and the fruitlets can be strongly flattened laterally or lenticular. In addition to stamens, the flowers present vestigial staminodes, which is a unique feature among the related genera (Devecchi *et al.* 2018a).

Key to species of *Simaba* from Reserva Ducke

1. Shrubs or treelets; leaflets glabrous on both surfaces; laminar glands along the whole margin or only from the base to the half portion of the blade; gynophore glabrous ..... 3.1. *Simaba guianensis*
1'. Trees; leaflets glabrous except along the midvein on the adaxial surface; laminar glands near the margin, from the base to the half portion of the leaflet; gynophore puberulent to pubescent..... 2
   2. Leaflets (7–)11–17(–29); staminal appendages 2.3–2.6 mm long, apex acuminate; fruitlets glabrous to puberulent, pale green to yellowish ..... 3.2. *Simaba polyphylla*
   2'. Leaflets 5–7; staminal appendages 0.9–1.8 mm long, apex bilobed; fruitlets densely pubescent to velutinous, red.....3.3. *Simaba pubicarpa*

3.1. *Simaba guianensis* Aubl., Hist. Pl. Guiane 1: 400. 1775. Fig. 2k-m

Shrubs to small treelets 0.5–3(–11) m tall.; stem cylindrical, bark thin, longitudinal fissured, branches puberulent and glabrous at maturity. Leaves imparipinnate, attached along the terminal portion of the branches; petiole (0.6–)1.1–4.1(–7.7) cm long, glabrescent to puberulent, base slightly swollen; rachis 1.7–7.8(–9.5) cm long, glabrescent to puberulent; petiolule sessile or up to 2.4 mm long, slightly swollen and smooth, glabrescent to puberulent; leaflets (1–)3–9, opposite, less frequently subopposite, the terminal and the distal lateral ones 3.2–11.6(–18) × 1.8–3.9(–5.2) cm, the terminal and the distal lateral ones elliptic to elliptic-obovate or narrowly elliptic, base short attenuate to attenuate in the terminal leaflet and oblique-attenuate in the lateral ones, apex acuminate or acute, membranaceous, chartaceous to subcoriaceous; midvein prominent on abaxial surface, secondary veins prominulous to immerse in the mesophyll; an inconspicuous gland present at the leaflet apex; laminar glands scattered near the margin from the base to near the apex; margin non-revolute to slightly revolute, glabrous on both surfaces, discolorous, adaxial surface dark green and shiny, abaxial surface pale green and dull. Inflorescence terminal or axillary, depauperate thyrsoid to botryoid, branches puberulent, the main axis 1.4–3.7 cm long, the lateral branches 0.4–1.4(–4,5) cm long, gradually shorter toward the apex, puberulent; bracts 0.4–1.6 × 0.2–0.6 mm, spathulate to obovate, puberulent, usually with an apex glandular. Flowers: pedicel 1.5–4.2 mm long, puberulent; calyx 5-lobed, puberulent, lobes twice larger than the tube; petals 3–5.9 × 1.1–2.7 mm, oblong, ovate to oblong-ovate, apex acute to obtuse, cream to greenish, puberulent on both surfaces; stamens (8–)10, filaments flattened near the base, 3.1–5.1 mm long, bearing an adaxial appendage 1.6–2.5 mm long, the basal half adnate to the filament and the distal half free, glabrescent to puberulent near the base and tomentose toward the apex, apex acuminate; anthers dorsifixed, 0.5–0.9 mm long, white to cream; gynophore 0.4–1.1 mm tall., glabrous; ovary 0.5–1.3 mm long, pubescent; style 1.3–3.2 mm long, glabrous to bristly near the base; stigma with short and divergent lobes. Fruit usually with a single fruitlet, 1.1–1.7 × 0.8–1.3 cm, lenticular, carenate, glabrous to sparsely puberulent, orange to red.

Material examined: 27.VI.1997, fl., *C.A. Sothers et al. 1038* (INPA, SPF).

Additional specimens examined: BRAZIL. AMAZONAS: Vazadouro do Morcego, Rio Madeira, 31.VIII.1923, *Kuhlmann 312* (RB). Nova Prainha, 23.VII.1976, *Mota & Monteiro* (HRB). Humaitá, perto do acampamento a 150 km de Humaitá, 27.IX.1979, *Vieira et al. 199* (INPA, RB).

The problematic *S. guianensis* complex has been the subject of interest of several botanists, since Engler's monograph (Engler 1874). Here we roughly follow the latest review of this species complex, provided by Thomas (1985), including a broad morphological variability, particularly in habit, leaf features and ecological ranges. Further studies are necessary to achieve a better understanding of the limits of this species and its putative infraspecific taxa. As here circumscribed,

Simaba guianensis is endemic to the Amazon region, found in Brazil (Amazonas, Amapá, Bahia, Maranhão, Pará, Piauí), Colombia, Ecuador, French Guiana, Guyana, Peru and Suriname. It occurs mainly in the understory and forest edges. So far there is only one record from the Reserva Ducke. The species is easily distinguished from the other species that occur in the Reserve by the habit of shrubs to small treelets. It differs from *S. polyphylla* by the reduced number of leaflets (1–)3–9 *vs*. (7–)11–29(–35), and from *S. pubicarpa* by the glabrous fruitlets (vs. densely pubescent to villous).

3.2. *Simaba polyphylla* (Cavalcante) W.W. Thomas, Acta Amazon. 15(1-2):76. 1985.
Simaba guianensis subsp. *polyphylla* Cavalcante, Publicações avulsas do Museu Goeldi 37: 40. 1983. Fig. 2n-o

Trees 10–25 m tall.; stem cylindrical, bark thin, longitudinal fissured, branches puberulent, ferrugineous, and glabrous at maturity. Leaves attached along the terminal portion of the branches, imparipinnate; petiole 4–9(–15) cm long, puberulent, base swollen; rachis 11–28(–37) cm long, puberulent; petiolule sessile or smaller than 1 mm long, non-swollen, smooth, glabrous; leaflets (7–)11–17(–29), opposite, less frequently subopposite, the terminal and the distal lateral ones 6–10 × 2–3.4 cm, the terminal oblanceolate or obovate, the distal lateral ones oblong-elliptic, narrowly elliptic or obovate, base attenuate in the terminal leaflet, oblique-attenuate in the lateral ones, apex cuspidate to caudate, chartaceous; midvein prominent on abaxial surface, slightly sulcate on adaxial surface, secondary veins immerse on the mesophyll on both surfaces; an inconspicuous gland present at the leaflet apex; laminar glands scattered along the margin, from the base to the half lamina, margin not revolute, glabrous, except along the midvein on the adaxial surface, discolorous, adaxial surface dark green and shiny, abaxial surface pale green and dull. Inflorescence terminal, depauperate thyrsoid to botryoid, main axis 2.5–6.5 cm long, the lateral branches 3(–5) cm long, gradually shorter toward the apex, puberulent; bracts 1.6–2.8 × 1.4–1.9 mm, oblong to spathulate, puberulent, usually with an apex glandular. Flowers: pedicel 2.6–3.4 mm long, puberulent; calyx 5-lobed, puberulent, the lobes twice larger than the tube; petals 5.8–6.5 × 2–2.5 mm, oblanceolate, apex rounded, white to greenish, puberulent on both surfaces; stamens 10, filament slightly flattened near the base, 4.2–4.8 mm long, bearing a adaxial appendage 2.3–2.6 mm long, the basal half adnate to the filament, the distal half free, villous, apex acuminate; anthers dorsifixed 0.6–0.8 mm long, white to yellow; gynophore 1.1–1.4 mm long, puberulent to pubescent; ovary 0.7–1.2 mm long, pubescent to velutinous; style 2.6–3.5 mm long, bristly near the base; stigma with short and divergent lobes. Fruit usually with one fruitlet per flower, 1.2–1.5 × 1–1.2 cm, ellipsoid to obovoid, glabrous to puberulent, pale green to yellowish.
Material examined: 15.IX.1995, fl., *M.A.D. Souza et al. 102* (INPA, MBM, SPF); 15.IX.1995, fl., *M.A.S. Costa 359* (R, SP, SPF); 21.IX.1995, fl., *M.A.S. Costa 370* (INPA, SPF); 3.X.1995, fr., *M.A.S. Costa et al. 376* (INPA, SPF); 21.IX.1995, fl., *J.E.L.S. Ribeiro & P.A.C.L. Assunção 1924* (INPA, SPF); 8.XI.1985, fr., *W.W. Thomas & D. Ackerley 4817* (NY, SPF); 8.XI.1985, fr., *W.W. Thomas & D. Ackerley 4818* (NY, SPF); 16.XII.2013, *M.F. Devecchi 264* (NY, SPF); 17.XII.2013, *M.F. Devecchi 266* (NY, SPF).

Simaba polyphylla is a tree species found on slope and plateau forests on sandy to clayey soil, in northern Brazil (Amazonas, Pará, Rondônia, Roraima), Ecuador, French Guiana and Peru. Its flowers exude a strong and sweet fragrance. It is easily distinguished from the other *Simaba* species that occur in the Ducke Reserve area. It differs from *S. guianensis* in the number and size of leaflets, from 7–29 (*vs.* 3–9). It differs from *S. pubicarpa* in the glabrous to puberulent fruitlets (*vs.* densely pubescent to velutinous) and by the staminal appendages with the basal half adnate to the filament, the distal half free; apex acuminate (*vs.* fully adnate to the filament except for a short apical portion, with bilobed apex). In the Reserve area, *S. polyphylla* was collected with flowers in September and with fruits in October and November.

3.3. *Simaba pubicarpa* Devecchi, W.W. Thomas & Francesch., sp. nov.
Simaba pubicarpa differs from the all its congeners by the densely pubescent to velutinous fruitlets (*vs.* glabrous to sparsely pubescent).
Type: BRAZIL. AMAZONAS: Reserva Florestal Ducke, rodovia Manaus-Itacoatiara, km 26, estrada alojamento-torre de observação, km 0.35, 02°53'S, 59°58'W, 23.VI.1996, *P.A.C.L. Assunção & C.L. Silva 359* (holotype SPF!, isotype INPA!). Fig. 3

Trees 12–18 m tall; stem cylindrical, bark thin, dark, longitudinal fissured, branches puberulent, and glabrous at maturity. Leaves attached along the terminal portion of the branches, imparipinnate; petiole 2.7–4.6 cm long, puberulent, base slightly swollen; rachis 1.8–3.9 cm long,

puberulent; petiolule 0.9–1.4 mm long, non-swollen, smooth, puberulent; leaflets 5–7, opposite, less frequent subopposite, the terminal and the distal lateral ones 5.4–8.8 × 2.4–3.9 cm, the terminal and the distal lateral ones elliptic to elliptic-obovate, base attenuate in the terminal leaflet and lateral ones, apex acute to acuminate or shortly cuspidate, chartaceous to subcoriaceous, venation brochidodromous; midvein prominent on abaxial surface, prominulous on adaxial surface, secondary veins immerse on mesophyll on both surfaces; an inconspicuous gland present at the leaflet apex; laminar glands scattered along the margin, from the base to the middle of the lamina; margin not revolute, glabrous, except along the midvein on adaxial surface, discolorous, adaxial surface dark green and shiny, abaxial surface pale green and dull. Inflorescence terminal or axillary, depauperate thyrsoid to botryoid, main axis up to 10.3–15.9 cm long, the lateral branches 4.4–8.1 cm long, gradually shorter toward the apex, densely puberulent; bracts 2.1–2.5 × 0.7–1.2 mm, lanceolate to spathulate, densely pubescent, non- glandular. Flowers: pedicel 2.5–3.6 mm long, puberulent; calyx 5-lobed, puberulent, the lobes three times larger than the tube; petals 5.9–6.3 × 1.9–2.2 mm, narrowly obovate to lanceolate, apex acute, greenish to yellowish, puberulent on both surfaces; stamens 10, filament slightly flattened near the base, 2.6–3.2 mm long, bearing an adaxial appendage 0.9–1.8 mm long, three quarter adnate to the filament, the distal one quarter free, pilose apex bilobed; anthers dorsifixed, 0.4–0.6 mm long, cream to yellowish; gynophore 0.6–0.9 mm long, puberulent; ovary 0.7–0.9 mm long, pubescent; style 1.2–1.6 mm long, bristly near the base; stigma with short and divergent lobes. Fruit with 1–4 fruitlets per flower, 1.2–2 ×0.9–1.3 cm, obovoid, slightly flattened laterally, densely pubescent to velutinous, red.

Additional specimens examined: (paratypes): BRAZIL. ACRE: RBO-AC, EMBRAPA, UEPAE, 25.VII.1991, *R.S. Saraiva & I.F. Rego 1327* (NY). Tarauacá, Seringal Universo, 08°25.39'S, 71°18.89'W, 21.IX.1994, *D.C. Daly et al. 8303* (INPA, MO); upper Rio Jarupary, 13.VII.1933, *B.A. Krukoff 5226* (SP). AMAZONAS: Manaus, estrada da Cachoeira Alta do Tarumã, 6.VII.1961, *W.A. Rodrigues & L.F. Coelho 2151* (INPA, SPF); atrás do Roncador, 1.VII.1933, *A. Ducke RB25330* (RB, SPF); Reserva Florestal Ducke, rodovia Manaus-Itacotiara, km 26, 02°53'S, 59°58'W, 30.VIII.1996, *P.A.C.L. Assunção et al. 404* (INPA, SPF); Acará, próximo ao acampamento, 21.VIII.1996, *M.A.S. Costa & P.A.C.L. Assunção 554* (INPA, SPF); 30.VIII.1996, *P.A.C.L. Assunção et al. 403* (INPA, SPF); na trilha para a torre de observação, depois do igarapé Barro Branco,16.XII.2013, *M.F. Devecchi 263* (SPF); trilha L-O4, km 0.5, 02°57'13''S, 59°57'38''W, 10.VIII.2001, *E.C. Pereira 25* (INPA); estrada alojamento-torre de observação, km 0.65, 23.VII.1996, *P.A.C.L. Assunção & C.L. Silva 357* (INPA, SPF). Presidente Figueiredo, canteiro de obras da hidrelétrica de Balbina, a 8 km a montante da barragem, área a ser inundada, 01°2'S, 59°60W, 8.III.1985, *C.A.C. Ferreira et al. 6652* (NY). RONDÔNIA: estrada Belmonte, 11.IX.1975, *M.R. Cordeiro 754* (NY).

Simaba pubicarpa is a tree species that occurs preferentially in terra firme forest with clayey soil in the Brazilian states of Acre, Amazonas and Rondônia. The new species was collected with flowers in June and July and with immature fruits in August to September. It is the only species of the genus that has fruits covered by a pubescent to velutinous indument (*vs.* glabrous to glabrescent). This taxon was previously reported as a putative new species in the Identification Guide for the plants of the Reserva Ducke (Costa & Pirani 1999).

4. *Simarouba* Aubl.

Large to small trees, stem non-hollow. Leaves alternate, imparipinnate or paripinnate, petiole usually swollen at the base; leaflets alternate or occasionally subopposite, petiolulate, margin entire, with an inconspicuous nectariferous gland at leaflet apex, laminar gland scattered on both surfaces; lamina discolorous, covered by trichomes or glabrous. Inflorescence terminal, thyrsoid, branches glabrous, bracts usually non-glandular. Flowers unisexual (in dioecious plants), (4–)5-merous; calyx gamosepalous with free distal lobes; petals free, imbricate or contorted in bud, white, greenish, glabrous or sparsely covered by trichome; stamens 10, with short appendages at the adaxial base of the filament, glabrous to pubescent; anthers dorsifixed; staminodes absent or reduced in the female flowers; gynophore stout, short, fleshy, terete to slightly lobed, glabrous to pubescent; carpels (4–)5, uniovulate, partially free from each other, fused along the style, vestigial in the male flowers; stigma with spreading stigmatic branches. Fruit with 1–2 drupaceous fruitlets, ovoid to ellipsoid, orange, reddish to black, glabrous; seed 1 per fruitlet.

Simarouba is composed of six species. Three species, *S. berteroana* Krug & Urb. *ex* Urb., *S. laevis* Griseb. and *S. tulae* Urb. are endemic to the Caribbean islands and *S. glauca* DC. is restrict to continental Central America (Cronquist

1944). *Simarouba amara* Aubl. and *S. versicolor* A.St.-Hil. are the two species that occur in Brazil, the former broadly distributed in tropical South America, the latter mostly restrict to the Cerrado Domain. Franceschinelli *et al.* (1998) provide a key for distinguishing *Simarouba* species in which it is possible to separate *S. amara* from *S. versicolor* based mainly on the size of flowers and anthers.

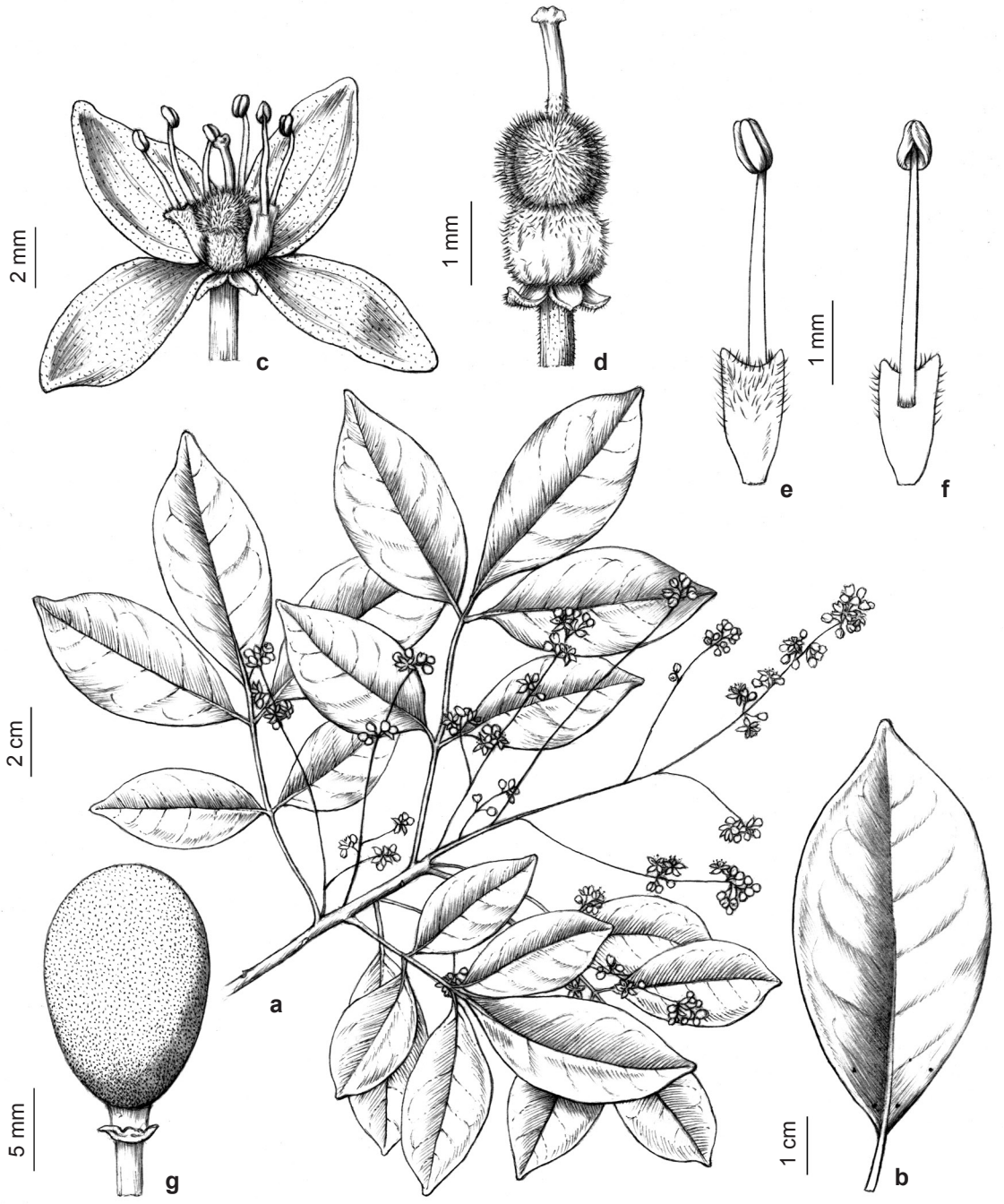

Figure 3 – a-g. *Simaba pubicarpa* – a. branch with terminal and axillary inflorescences; b. leaflet with brochidodromous venation and the laminar glands distributed near the base; c. flower with a petal and four stamens removed showing the gynoecium; d. gynoecium on top of the gynophore and style; e. stamens with anther, filament and filament appendage, abaxial view; f. same as e. adaxial view; g. fruitlet. (a-f. *Assunção & Silva 359*; g. *Assunção et al. 404*).

4.1. *Simarouba amara* Aubl., Hist. Pl. Guiane 2: 859. 1775.
Quassia Simarouba L. f., Suppl. Pl., 2343. 1781.
Simarouba opaca (Engl.) Radlk. *ex* Engl., Nat. Pflanzenfam 19A: 374. 1931.
Zwingera amara (Aubl.) Willd., Sp. Pl. 2: 569. 1799. Fig. 2p-r

Trees, 10–25 m tall., stem cylindrical, bark peeling in longitudinal plates, branches glabrous. Leaves attached along the terminal portion of the branches, paripinnate or imparipinnate; petiole 7–12 cm long, base slightly swollen; rachis 15–29 cm long, glabrous; petiolule 2.5–4.7 mm long, not swollen, glabrous; leaflets 8–17, alternate to subopposite, the terminal and the distal lateral 6–8.4 × 1.9–3.2 cm, the terminal and the lateral ones oblong-obovate or oblong-elliptic, base attenuate to cuneate, apex rounded or retuse, subcoriaceous; venation brochidodromous; midvein prominent on abaxial surface, slightly sulcate on adaxial surface, secondary veins immerse on the mesophyll on both surfaces; an inconspicuous gland present at the apes; laminar gland present near the base or near the apex, near the margin; margin non-revolute, glabrous, except along the midvein on adaxial surface, discolorous, adaxial surface dark green and shiny, abaxial surface pale green and dull. Inflorescence terminal, thyrsoid, main axis 10–23 cm long; the lateral branches gradually shorter toward the apex, glabrous; bracts 6–14 × 1.2–2.2 mm, oblanceolate to narrowly oblong, glabrous, non-glandular. Flowers: pedicel 0.8–4 mm long, puberulent; calyx 5-lobed, puberulent, the lobes twice larger than the tube; petals cream to greenish, 3.8–4.2 × 1.6–2.1 mm, oblong-elliptic, glabrous; stamens 10, filaments 2.8–3.1 mm long, bearing an adaxial appendage 0.9–1.1 mm long, partially adnate to the filament, villous; anthers dorsifixed 0.6–0.8 mm long, white to greenish; staminodes in female flowers 0.7–0.9 mm long, spathulate, pubescent; gynophore 0.5–0.9 mm long glabrous; ovary 1.7–1.9 mm long, glabrous, rudimentary in male flowers; style ca. 0.3–0.5 mm long, glabrous; stigma with long and divergent branches. Fruit with 1–2(–5) fruitlets, 1.5–1.9 × 1.2–1.4 cm, ellipsoid, reddish to dark, glabrous.
Material examined: 3.VII.1969, fl., *J.A. Souza 323* (INPA, SPF); 20.VII.1995, fl., *M.A.S. Costa et al. 326* (INPA, SPF); 8.XII.1994, fl., *J.R. Nascimento 679* (INPA, SPF); 8.VII.1994, fl., *M.J.G. Hopkins et al. 1453* (INPA, SPF); 13.I.1968, fr., *A. Vieira Neto* (*INPA 20862*) (INPA, SPF).

Simarouba amara is a tree species that can reach more than 30 m tall. It is widely distributed in northern and western South America (Bolivia, Ecuador, French Guiana, Guyana, Colombia Peru and Suriname) mainly in tropical parts of Brazil and in the Central America (Belize, Costa Rica, El Salvador, Guatemala, Panama, Trinidad and Tobago) reaching Mexico in North America. It is commonly found in forest areas, but also occasionally found in areas of cerrado, restinga and capoeiras. In the Reserva Ducke it was collected mainly in areas with sandy-loam soil. In the Reserve area individuals in flower were collected in July and December and with fruits in January.

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