

Original Paper

Two new species of *Pachira* (Bombacoideae, Malvaceae) and typification of *Pachira patinoi*

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Abstract

We aimed to describe two new species endemic to Brazil - one from sandy habitats in northeastern Brazil (*Pachira inaequalivalvis*), mainly characterized by fruits with unequal valves, and the other from Amazonian rainforest (*P. deflexifolia*, having the downward-oriented leaflets) - and provide complete morphological descriptions, illustrations, comments, conservation status, and distribution maps. We also designate a lectotype and an epitype for *Pachira patinoi*.

Key words: Brazilian biomes, new name, nomenclature, *Pachira* sensu lato clade, taxonomy.

Resumo

Objetivou-se realizar a descrição de duas novas espécies endêmicas do Brasil: uma do nordeste Brasileiro (*P. inaequalivalvis*), caracterizada principalmente pelos frutos com valvas desiguais, e outra da Amazônia Brasileira (*P. deflexifolia*, que possui os folíolos orientados para baixo); e são fornecidas descrições morfológicas completas, ilustrações, comentários, status de conservação e mapas de distribuição geográfica. Também designamos um lectótipo e um epítipo para *Pachira patinoi*.

Palavras-chave: biomas brasileiros, novo nome, nomenclatura, clado *Pachira* sensu lato, taxonomia.

Introduction

Several nomenclatural novelties were published recently for the genus *Pachira* Aubl., including lectotypifications, designations of epitypes, descriptions of new species and combinations (Andino & Fernández-Alonso 2018; Carvalho-Sobrinho & Dorr 2020; Carvalho-Sobrinho *et al.* 2021; Yoshikawa *et al.* 2022).

The first comprehensive treatment of *Pachira* was included in a revision of the genus *Bombax* s.l. by Robyns (1963). In this work, he recognized seven segregate genera, of which five were neotropical in distribution: *Bombacopsis* Pittier, *Eriotheca* Schott & Endl., *Pachira*, *Pseudobombax* Dugand, and *Rhodognaphalopsis* A. Robyns. Subsequent authors consistently treat *Pseudobombax* as a distinct genus. Nearly all species assigned by Robyns to *Bombacopsis*,

Pachira, and *Rhodognaphalopsis* were combined into *Pochota* Ram. Goyena by Steyermark & Stevens (1988), and later placed in *Pachira* (e.g., Alverson 1994; Fernández-Alonso 1998a,b, 2003). *Pochota* now comprises a single species, phylogenetically distant from *Pachira* (Alverson & Duarte 2015; Carvalho-Sobrinho *et al.* 2016), and whether *Eriotheca* should be merged into *Pachira* is under study (see below).

Thus, the genus *Pachira* now includes about 50 species (Tropicos.org 2022; Andino & Fernández-Alonso 2018; Carvalho-Sobrinho & Dorr 2020; Carvalho-Sobrinho *et al.* 2021; Yoshikawa *et al.* 2022), nearly half of which occur in Brazil: 18 species in Amazonian rainforest and 6 in Atlantic Rainforest (*Mata Atlântica*) and dry shrub-thorn forest (*caatinga*) (Flora & Funga do Brasil 2022).

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Morphologically, *Pachira* comprises unarmed trees with palmately compound leaves (1–11 leaflets) with brochidodromous veins, entire margins, flowers 8–40 cm in length with petals fused near their base, numerous stamens (100–1,000) grouped in phalanges, and striate seeds (Robyns 1963; Duarte *et al.* 2011; Carvalho-Sobrinho *et al.* 2016).

In phylogenetic studies, species of *Pachira* emerged in two different clades (Carvalho-Sobrinho *et al.* 2016): an Amazonian Clade, with species found in Amazonian Rainforest (*campina*, *campinarana*, *igapó*, and *terra firme* vegetation types) and an Extra-Amazonian Clade, which includes species from Brazil's Atlantic rainforest, *caatinga*, and *cerrado* (savannah, grassland, and shrubland) biomes. This second clade emerged within a clade formed by species of *Eriotheca* (Duarte *et al.* 2011), highlighting the need of further morphological and phylogenetical investigations.

Against this background, while revising the Amazonian *Pachira* Clade we found one new species from Amazonian Rainforest (in Amazonas state) and another from sandy coastal regions (*dunas*) from the states of Alagoas, Bahia, Ceará, and Rio Grande do Norte, all within the Atlantic Rainforest region.

Finally, we designate a lectotype and an epitype for *Pachira patinoi* (Dugand & A. Robyns) Fern.Alonso.

Material and Methods

This study involved bibliographic search of BHL (<<https://www.biodiversitylibrary.org>>), Biblioteca Nacional Digital do Brasil (<<http://memoria.bn.br/>>), JSTOR (<<https://plants.jstor.org>>) and consultation of herbaria BHCB, COAH, COL, EAC, F, HUAM, HUEFS, HUMC, IBGE, INPA, MBM, MG, NY, OUPR, P, PAMG, Q, QAP, QCA, QCNE, R, RB, SP, SPF, UB, UFAC, UFG, UFMT, UFMS, UFRN, and US (acronyms according to Thiers, continuously updated).

We obtained morphological data by measurements with stereomicroscopes and calipers. The maps of geographical distribution were made using Qgis 3.20 software (Qgis Development Team 2022) and label data from herbarium specimens. The illustration was made drawing the type specimen with Indian ink.

We assigned conservation status following the IUCN (2022) criteria, using the GeoCat tools (Bachman *et al.* 2011) to calculate the extent of occurrence (EEO) and area of occupancy (AOO).

Results and Discussion

We found two new species of *Pachira* from Brazil: *P. deflexifolia* from state of Amazonas and *P. inaequalivalvis* from the northeastern region. These two new species are described below, and we designate a lectotype and a new epitype for *Pachira patinoi* (Figs 1-7).

Key to the new species of *Pachira* and related congeners

1. Species found in Amazonian rainforest of Amazonas (state of Brazil and department of Venezuela), Roraima (Brazil) and Colombia; small trees up to 4 m tall; fruits obovoid, 3–6.6 × 1.7–5 cm 2
- 1'. Species found in Atlantic Rainforest (*Mata Atlântica*) or *caatinga* species from Northeastern region of Brazil; trees 4.5–25 m tall; fruits fusiform, 7.5–9 × 6.5 cm 5
 2. Leaflets strongly coriaceous 3
 - 2'. Leaflets chartaceous to slightly-coriaceous 4
 3. Leaflets with abaxial surface lepidote, scales not seen with naked eye; petals with arachnoid indumentum on the inner surface; seeds obovoid *Pachira coriacea*
 - 3'. Leaflets with abaxial surface lepidote, scales seen with naked eye; petals with velutinous on the inner surface; seeds slightly-deltoid to oblongoid *Pachira sordida*
 4. Leaflets elliptical, margins non revolute; petals whitish; staminal tubes 1.5–2.2 cm long *Pachira gracilis*
 - 4'. Leaflets linear to oblong, margins revolute; petals greenish to brownish; staminal tubes 3.2–4.4 cm long 1. *Pachira deflexifolia*
 5. Leaflets papyraceous to chartaceous; staminal tubes not constricted or constricted at the base; fruits with valves equal 6
 - 5'. Leaflets membranaceous; staminal tubes constricted towards the apex; fruits with valves unequal 2. *Pachira inaequalivalvis*

6. Leaflets obovate, both surfaces glabrous; staminal tubes pubescent, apex and base glabrous; seeds ovoid; habitat in sand-dune habitats (*dunas*) *Pachira cearensis*
- 6'. Leaflets slightly-oblongate to linear, glabrous on the adaxial surface, lepidote on the abaxial surface; staminal tubes entirely sparse pubescent; seeds globose; habitat in forest *Pachira endecaphylla*

1. *Pachira deflexifolia* Yoshikawa & M.C. Duarte sp. nov.

Type: BRAZIL. AMAZONAS: Nova Prainha, RADAM/BRASIL SB_20_ZB_Pto. 19, Cerrado, terreno arenoso, lf. fl., 8.VIII.1976, *C.D.A. Mota & O.P. Monteiro 401* (holotype: INPA61007!).

Figs. 1-2; 7

This new species is distinguished from its congeners by its coriaceous, deflexed, linear to oblong leaflets, with revolute margins and mucronulate apices; by its subtubular calyces with apiculate apices; and by its small, obovate fruits with ferruginous indument.

Treelets, rarely trees 0.5–4 m tall, buttresses absent, trunks usually brownish. Branches 0.5–0.6 cm diam., lenticels absent. Stipules 0.2–0.4 × 0.2–0.3 cm, deltoid to rhomboid, deciduous. Petiole 3–5.2 × 0.1–0.2 cm, base not thickened, with a pair of linear nectaries. Petiolules absent or 0.2–0.3 cm long, not canaliculate. Leaves 5–7-foliolate, perennial. Leaflets 5.5–10.1 × 1.7–3 cm, oriented downwards, linear to slightly-elliptical, coriaceous, concolor to slightly discolor, dull, glabrous in both surfaces, their bases rounded to obtuse, margins entire, revolute, apices rounded to obtuse-mucronulate, primary veins impressed on the adaxial surface, thickened and prominent on the abaxial surface, nectaries in the apical half, secondary veins not prominent in both surfaces. Flowers 11–17 cm long, borne apically or subapically, solitary or in 2-flowered cymes; peduncles 2–4 × 0.2–0.3 cm, cylindrical, not constricted in the middle portion; bracts deciduous; floral buds 0.4–6.3 × 0.3–0.8 cm, linear to oblongoid; receptacles 0.1 cm long., with 5 elliptical nectaries; calyces 1.1–1.5 × 0.7–0.9 cm, campanulate to subtubular, chartaceous, apex truncate to 5-apiculate, ciliate, externally smooth, pubescent with brownish stellate trichomes; petals 7.5–17.6 × 0.6–0.7 cm, linear, not fleshy, floral tubes at base of petals 1.3–2.2 cm long, whitish, or greenish to brownish, pubescent on both surfaces; staminal tubes 3.2–4.4 × 0.5–0.6 cm, cylindrical, not constricted, whitish, pubescent with pale stellate trichomes, phalanges 0.5 cm long; filaments 6–11.6 cm long, ca. 100–200 in number, whitish at the base, reddish at the apex, glabrous; anthers 0.1–0.2 cm long; styles 13–15

cm long; stigmas shortly-5-lobed; ovaries 0.3–0.4 × 0.4–0.5 cm, placentation axial. Fruits 2.4–3 × 1.8–2 cm, obovoid, valves woody and ca. 0.5 cm thick, kapok abundant, brownish. Seeds 0.5 × 0.45 cm, ovoid, 1-striate, the striae light brown, with dark-verrucous ornamentation.

Specimens examined: Lábrea, 8.VII.1976, *C.D.A. Mota* (INPA60584). Apuí, Prainha Nova, 10.VIII.1976, *C.D.A. Mota & O.P. Monteiro* (INPA61339); 23.VII.1976, *C.D.A. Mota et al.* (INPA60713); 15.VII.1976, *J. Ramos et al.* (INPA62164); 27.VI.1979, *C.E. Calderón 2702* (COL, INPA, US).

Pachira deflexifolia can be easily distinguished from other species of *Pachira* by its oblong to linear, downward-oriented leaflets with margins strongly revolute and veins not prominent on both surfaces (Figs. 1a-e; 2). This species is morphologically similar to *Pachira gracilis* (A. Robyns) W.S. Alverson in its height (–4 m) and peduncle length (–4 cm). However, they can be differentiated by the shape, margins, and veins of the leaflets (oblong to linear, revolute, and primary vein impressed in the adaxial surface, lighter in color than the blade on both surfaces vs. elliptical to slightly-elliptical, non-revolute, and primary vein prominent on both surfaces and of the same color as the blade); by the petal color (greenish to brownish vs. whitish), and by staminal tube length (3.2–4.4 cm vs. 1.5–2.2 cm).

Pachira deflexifolia occurs only in the State of Amazonas, Brazil (Fig. 7), in *campina*, *terra firme* and *igapó* vegetation types.

The species flowers in February, and in June to September. Fruits in August and September.

This species is characterized by its downward-oriented, *i.e.*, deflexed, leaflets.

Pachira deflexifolia is classified as Endangered (EN): B1: a, b (i, iv) because of its small Extent of Occurrence (1,290 km²), and only two localities of occurrence: Lábrea and Prainha Nova municipalities.

2. *Pachira inaequalivalvis* Yoshikawa & M.C. Duarte sp. nov.

Type: BRAZIL. RIO GRANDE DO NORTE: Natal, Parque da Cidade Dom Nivaldo Monte, Restinga. 05°50'57''S, 35°13'46''W, alt. 68 m, 30.IV.2016,

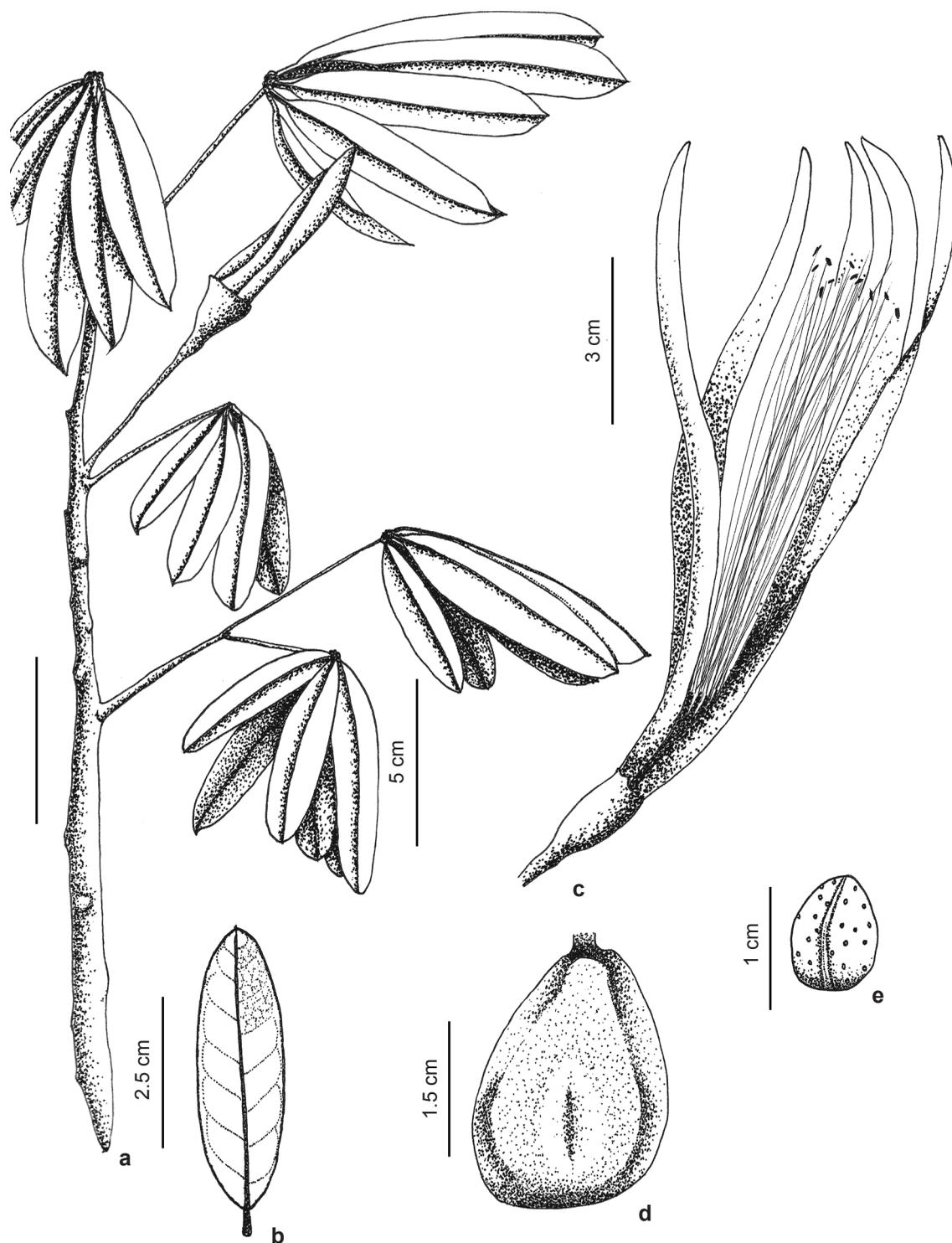


Figure 1 – a-e. Morphological characteristics of *Pachira deflexifolia* – a. branch; b. abaxial surface of leaflet; c. flower; d. fruit; e. seed. (a-c. *Mota INPA 60504*; d-e. *Mota INPA 61339*). Illustration: Vania N. Yoshikawa.



Figure 2 – Paratype of *Pachira deflexifolia*.

A.A. Roque 1791 (holotype: UFRN021000! [2 sheets: 1/2: branches and leaves, 2/2: flowers and fruit valve]). Figs. 3-; 5g-i; 7

This species is easily recognized by its membranaceous and oblanceolate leaflets

with rounded-mucronulate apices, fusiform fruits with unequal valves, and the greyish and subglobose to piriform seeds that are 4-striate at the apex and 10-striate at the base (with light brown striae).

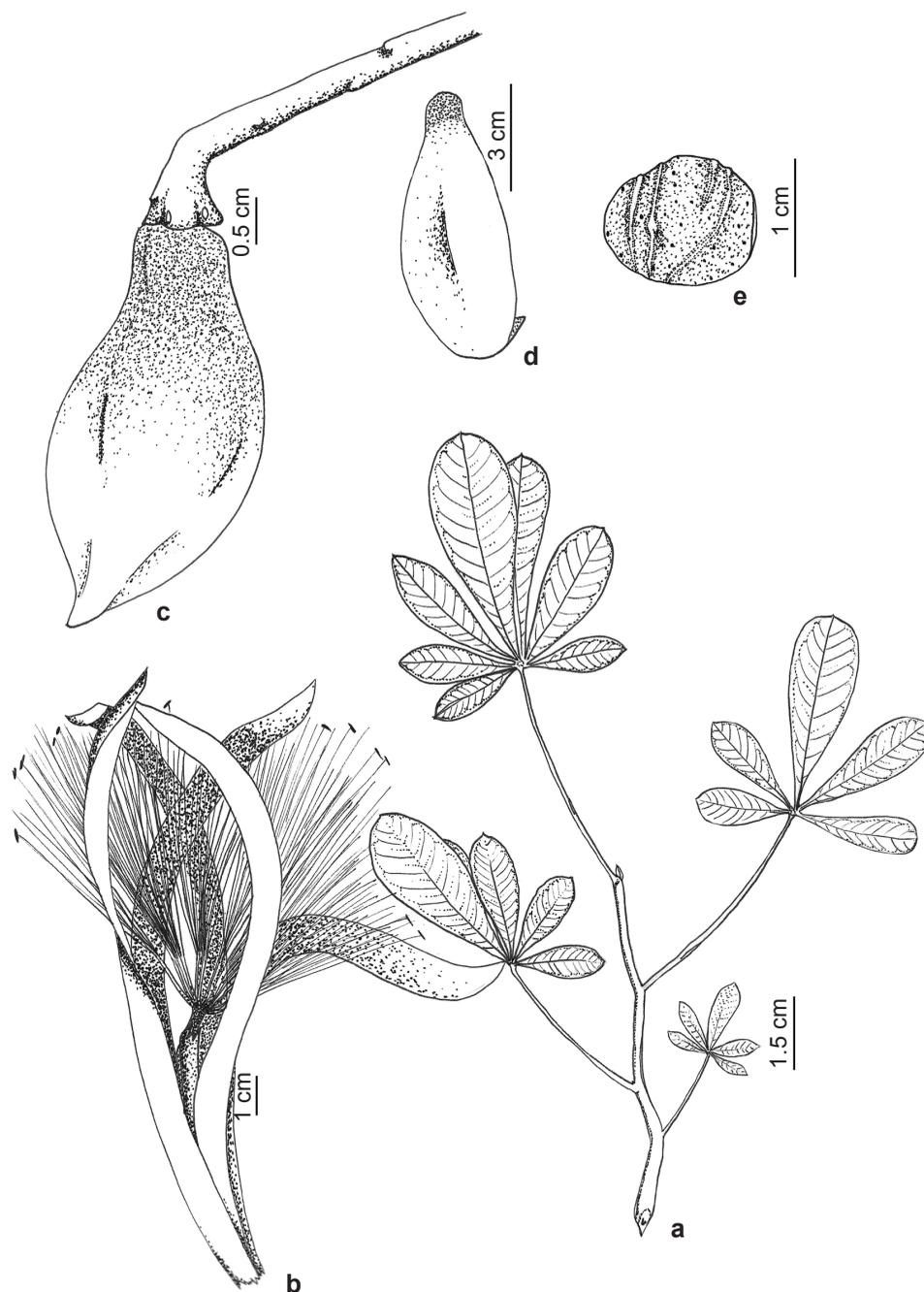


Figure 3 – a-e. Morphological characteristics of *Pachira inaequalivalvis* – a. branch; b. flower; c. fruit; d. fruit valve; e. seed. (a-b. *A.A. Roque 1791*; c-e. *Castro 2393*). Illustration: Vania N. Yoshikawa.

Trees 4.5–10 m tall, buttresses absent, trunk greenish. Branches 0.3–0.4 cm diam., young portions glaucous, lenticels elliptical to globose, whitish to orange. Stipules 0.1–0.2 × 0.1–0.2 cm, deltoid, deciduous. Petioles 3–10 × 0.1–0.2 cm, bases not thickened, with a pair of linear nectaries, glabrous. Petiolules absent, not canaliculate. Leaves 5–9-foliolate, deciduous. Leaflets 3.5–12 × 1.6–4.5 cm, erect, obovate to oblanceolate, membranaceous, discolored, both surfaces sublustrous, glabrous, base acute, margins entire to slightly sinuate, non-revolute, apices rounded-mucronulate to obtuse-mucronulate, primary veins impressed in the adaxial surfaces, thickened and prominent on the abaxial surfaces, nectaries present on the apical third or two thirds of the abaxial primary veins, secondary veins 8–12 pairs per side, impressed in the adaxial surfaces, prominent on the abaxial surface with same color as the blade. Flowers 12–15 cm long, borne subapically, solitary; peduncles not seen; bracts not seen; floral buds not seen;

receptacles with 5 elliptical nectaries; calyces not seen; petals 13.5–15.5 × 0.6–0.7 cm, linear, non-fleshy, floral tube 4 cm long, cream-colored, with pubescent indumentum (dorsally of 5-radiate stellate trichomes, ventrally of 3-radiate stellate trichomes); staminal tubes 5.5–6 × 0.4–0.6 cm, cylindrical, constricted apically, orange, with light-brown indumentum of stellate trichomes (but glabrous for 1 cm at apex), with 15 phalanges each 1.3–1.5 cm long; filaments 115 in number, 6.5 cm long, entirely orange, glabrous; anthers 0.3 cm long, oblong; styles 14–16 cm long.; stigmas shortly-5-lobed; ovaries 0.3–0.5 × 0.3 cm, placentation axial. Fruits 7.5–9 × 6.5 cm, fusiform, greenish when young, light-brown when dry, valves 0.6 cm thick and unequal, woody, kapok abundant, brown, and shiny. Seeds 17 per fruit, 0.8 × 0.7 × 0.7 cm, pyriform to subglobose, glabrous, gray, 3–4-striate at apex, 10-striate at base, contrasting light-brown striae, with brown verrucous ornamentation.

Specimens examined: ALAGOAS: Murici, Estação Ecológica de Murici, Fazenda Santa Fé, 14.XI.2010,



Figure 4 – Holotype of *Pachira inaequalivalvis*.

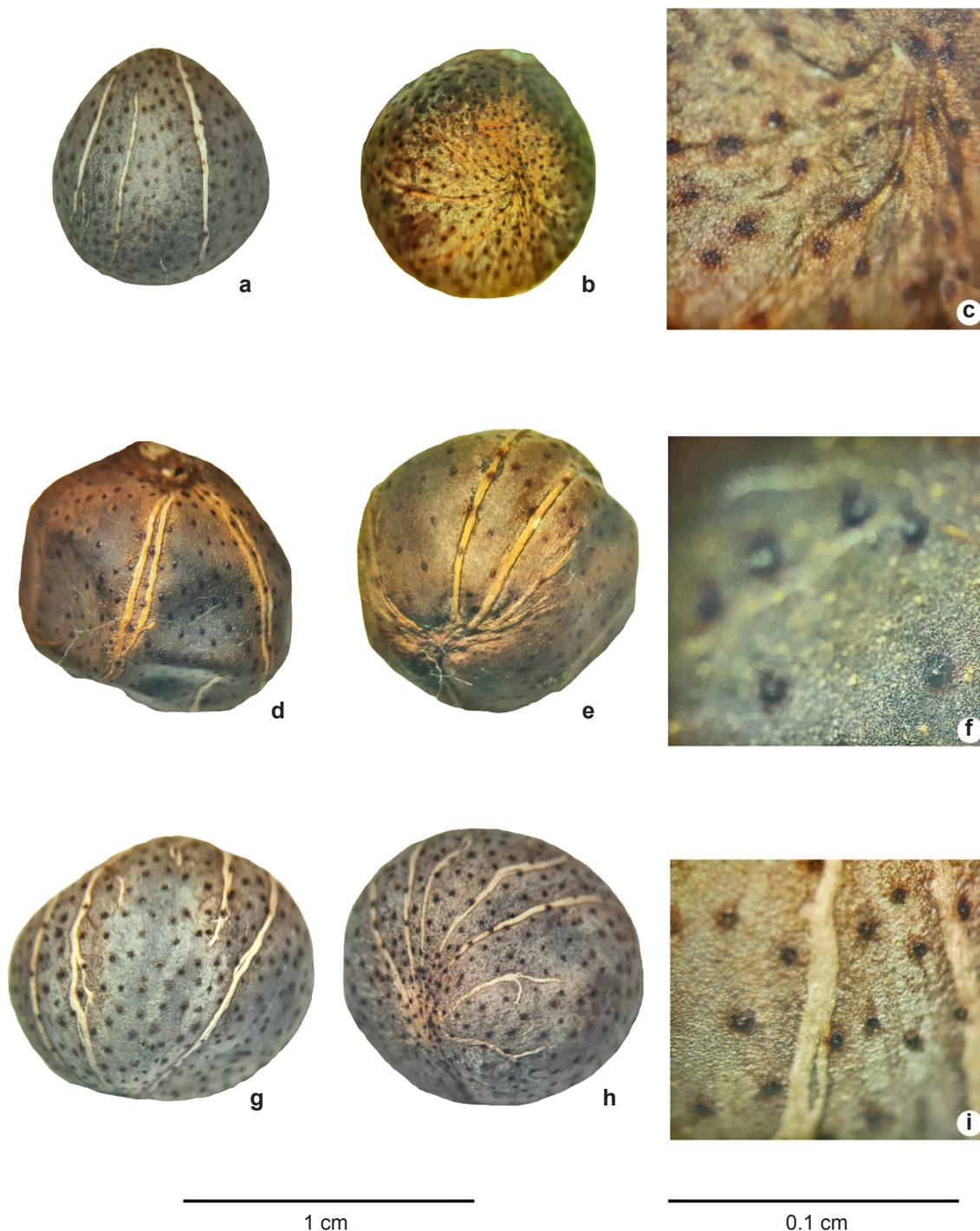


Figure 5 – a-i. Seed morphology of *Pachira cearensis*, *Pachira endecaphylla* and *Pachira inaequalivalvis* – a-c. seed of *P. cearensis* – a. dorsal view; b. ventral view; c. detail of verrucous ornamentation; d-f. seed of *P. endecaphylla* – d. dorsal view; e. ventral view; f. detail of verrucous ornamentation; g-i. *P. inaequalivalvis*; g. dorsal view; h. ventral view; i. detail of verrucous ornamentation. (a-c. *E.O. Moura 306*; d-f. *Macedo 39*; g-i. *A.A. Roque 1791*).

Chagas-Mota 9456 (MAC). Teotônio Vilela, Reserva Madeiras, 25.VII.2009, R.P. Lyra-Lemos *et al.* 12239 (MAC). Traipu, Mata das Amescas, 22.II.2009, R.P. Lyra-Lemos *et al.* 11914 (MAC). BAHIA: Rui Barbosa, Serra do Orobó, Bom Jardim, 27.VII.2004, L.P. Queiroz *et al.* 9291 (HUEFS). CEARÁ: São Gonçalo do Amarante, Pecém, Estação Ecológica, 29.VIII.2010, A.S.F. Castro 2393 (EAC). RIO GRANDE DO NORTE: Baía Formosa, Mata Estrela, 9.III.2012, W.M.B. São-Matheus *et al.* 95 (UFRN). Natal, Parque da Cidade Dom Nivaldo Monte, 28.XII.2015, A.A. Roque 1710 (RB, UFRN); 30.IV.2016, A.A. Roque 1791 (UFRN).

This new species can be confused with *Pachira endecaphylla* (Vell.) Carv.-Sobr. and *Pachira cearensis* (Ducke) Carv.-Sobr. & Dorr by the obovate to oblanceolate leaflets, lack of petiolules, verrucose seeds, and presence in the Atlantic Rainforest in northeastern Brazil (Fig. 7). *Pachira inaequalivalvis* differs from *P. endecaphylla* by habitat (*dunas vs. forest*), by leaflet texture and indumentum (membranaceous and glabrous *vs. papyraceous and sparsely lepidote on the abaxial surface*), petal width (0.6 cm *vs. 1 cm*), staminal tubes constricted at the apex (*vs. cylindrical*), capsule length (–9 cm *vs. 11–15 cm*), and by the seeds (subglobose to pyriform, with abundant verrucous ornamentation *vs. globose, with scarce verrucous ornamentation*) (Figs. 5g, h, i and 5d, e, f, respectively). *Pachira inaequalivalvis* differs from *P. cearensis* by the color of its lenticels (whitish to orange *vs. blackish*), staminal tube morphology (constricted at the apex *vs. constricted in the basal portion*), seed shape (pyriform or subglobose *vs. obovoid*), and seed surfaces (10-striate in the base, with contrasting light-brown striae, *vs. 7-striate with striae the same color as the seed*) (Fig. 5g-i and a, b, c, respectively).

Pachira inaequalivalvis is endemic to northeastern Brazil, occurring in the states of Alagoas, Bahia, Ceará and Rio Grande do Norte (Fig. 7), in sandy soils (frequently associated with sandy dunes).

The species flowers in March and April. Fruits in March, August, and December.

This species is distinct because of its fruit shape and unequal fruit valves.

Pachira inaequalivalvis can be considered as Vulnerable (VU): B1: a, b (i, iv), by its Area of Occupancy (AOO) of 1,768 km² (less than 2,000 km²) and seven locations (fortunately, many of its populations occur in protected areas,

such as Estação Ecológica Santa Fé (state of Alagoas) and Parque da Cidade Nivaldo Monte (state of Rio Grande do Norte).

3. *Pachira patinoi* (Dugand & A. Robyns) Fern.Alonso, Revista Acad. Colomb. Ci. Exact. 22(82): 7-12. 1998b. *Bombacopsis patinoi* Dugand & A. Robyns, Mutisia 31: 1. 1968. Type: COLOMBIA, NARIÑO. Carrizal, márgen derecha del Río Guisa, Carretera entre Ricaurte y Altaquer alt 500 meters, 17.X.1965, V.M. Patiño 269 (US), lectotype, first-step designated by Fernández-Alonso (1998b), second-step here designated: US257920 ([barcode 00101956!], 2 sheets: 1/2: leaves, 2/2: fruit; isolectotypes US2579519 [barcode 00101957!], F1757475 [barcode F0075438F!], NY [barcode 00133526!], P [barcode 02285307!], B [barcode B 10 0244024!], MO1961541 [barcode MO-309118!], BR [barcode 696 002!], NY [barcode 00133515!]). Epitype here designated: *A. Gentry et al.* 34917 (COL 251514!). Fig. 6

When Dugand & Robyns (1968) described *Bombacopsis patinoi* in honor of Dr. Victor Manuel Patiño, they cited *Patiño 269* at US herbarium as the holotype. However, there are two specimens from this collection (US257920 and US2579519). Here, we take the second step of lectotypification (Turland *et al.* 2018; ICN, Art. 9.17) and designate specimen US257920 [barcode 00101956] as the lectotype, rather than US2579519 [barcode 00101957] because the former specimen has fully developed leaflets and the latter has immature leaflets and it contains the fruits.

The designation of an epitype also is necessary (ICN, Art. 9.9) because the protologue lacks information about the flowers, which Fernández-Alonso (1998b) described subsequently, and because the flowers (mainly the calyx and staminal tube shape) are essential to identify *Pachira patinoi*. Therefore, we choose the specimen *A. Gentry et al.* 34917 (COL 251514) as the epitype (Fig. 6) because it occurs in the same region where the type was collected (Nariño, Colombia) and agrees with the protologue.

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Figure 6 – Epitype of *Pachira patinoi*.

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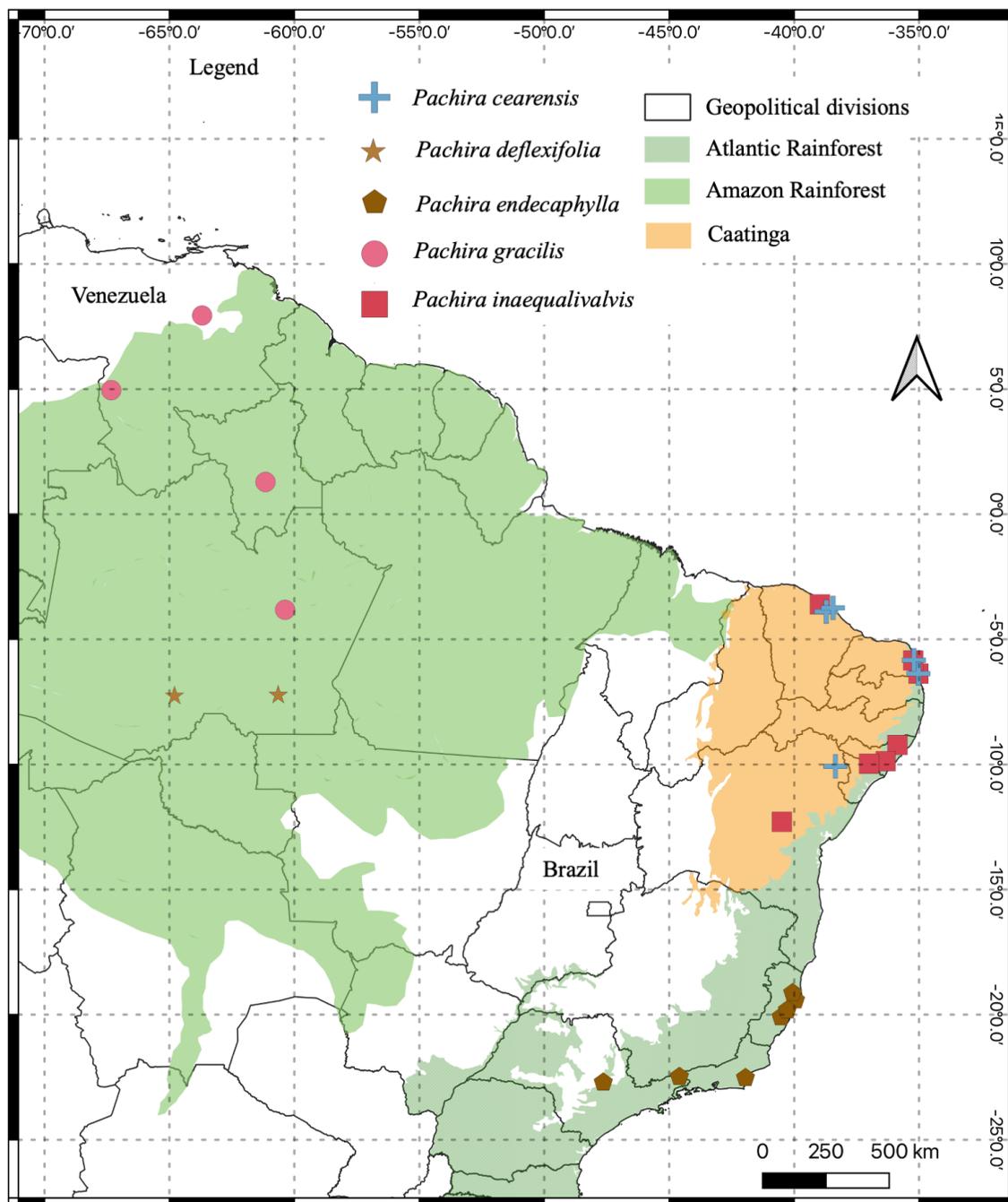


Figure 7 – Distribution map of *Pachira deflexifolia*, *Pachira inaequalivalvis*, and related species.

Data availability statement

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

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