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Original Paper

Flora of *Anacardium* (Anacardiaceae) in the state of Pará, Brazil

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Abstract

This study presents a taxonomic treatment of *Anacardium* for the state of Pará (Brazil), based on the analysis of specimens from herbaria (CEN, ESA, IAN, INPA, MBM, MFS, MG, RB, UB, and UEC), material collected in the field, and images of specimens from virtual databases. Species identifications were confirmed by consultation of protologues and types or images of types. A morphoanatomical analysis of the leaves of *Anacardium* was conducted to support taxonomic characterizations. Descriptions, plates, a distribution map, and an identification key for the species of *Anacardium* occurring in Pará (*A. amapaense*, *A. giganteum*, *A. humile*, *A. microsepalum*, *A. occidentale*, and *A. spruceanum*) are provided.

Key words: Amazon, Anacardioideae, cashew, morphology, Neotropics.

Resumo

Este estudo apresenta o tratamento taxonômico de *Anacardium* para o estado do Pará (Brasil), baseado na análise de espécimes provenientes de herbários (CEN, ESA, IAN, INPA, MBM, MFS, MG, RB, UB e UEC), materiais coletados em campo e imagens de espécimes disponíveis em bancos de dados virtuais. As identificações das espécies foram confirmadas por consulta aos protólogos e tipos ou imagens dos tipos. A análise morfoanatômica das folhas de *Anacardium* foi realizada a fim de dar suporte às caracterizações taxonômicas. São apresentadas descrições, pranchas, um mapa de distribuição e uma chave de identificação para as espécies de *Anacardium* ocorrentes no Pará (*A. amapaense*, *A. giganteum*, *A. humile*, *A. microsepalum*, *A. occidentale* e *A. spruceanum*).

Palavras-chave: Amazônia, Anacardioideae, caju, morfologia, Neotrópicos.

Introduction

Anacardiaceae is one of the nine families of the order Sapindales (APG IV 2016) and is divided into the subfamilies Anacardioideae and Spondioideae (Pell *et al*. 2004; Mitchell *et al*. 2006; Wannan 2006; Pell *et al*. 2011). The family has a mainly tropical and subtropical distribution and comprises about 80 genera and 800 species (Mitchell & Mori 1987; Mitchell 1992; Pell *et al*. 2011). In Brazil, Anacardiaceae is represented by 15 genera and 64 species (19 endemic), with higher concentrations of species in the Atlantic Forest (32 species) and the Amazon (26 species) (Silva-Luz *et al.* 2020).

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Anacardium L. is one of the best-known genera of Anacardiaceae (Mitchell & Mori 1987; Barros & Crisóstomo 1995; Garcia 2009). According to the most recent taxonomic revision of the genus, it comprises 11 species (Mitchell & Mori 1987), nine of which occur in Brazil (Mitchell & Mori 1987; Mitchell 1992; Silva-Luz *et al.* 2020). *Anacardium* has a neotropical distribution with a primary center of diversity in the Amazon (Mitchell & Mori 1987).

Species of *Anacardium* have a subshrub or arboreal habit, simple and alternate leaves, thyrsopaniculate inflorescences, staminate or bisexual flowers (andromonoic plants), and drupaceous fruits with woody pericarp (generally fleshy hypocarp) (Ducke 1939; Mitchell & Mori 1987; Mitchell 1992; Pirani 2003; Silva-Luz 2011). *Anacardium occidentale* L., the best known and most widely distributed species of the genus, possesses an edible hypocarp and seed, medicinal properties, and timber and ornamental potential (Barros & Crisóstomo 1995; Falcão *et al*. 2005; Sarubbo *et al*. 2007; Silva *et al*. 2007; Garcia 2009; Chaves *et al*. 2010; Gama *et al*. 2013; Reis *et al*. 2014).

Although *Anacardium* is a well-studied genus, the identification of some species remains complex. In the Amazon region, the flowering specimens are rare cycles of some of its species are not frequent, beingand it is difficult to identify sterile individuals, in some cases, due to overlapping morphological characters. The state of Pará, therefore, is an important study area since it encompasses most of the species of *Anacardium* found in the Amazon (Pereira *et al.* 2014). Thus, in order to improve the knowledge of the genus, we provide a taxonomic treatment of the species of *Anacardium* that occur in the state of Pará, Brazil.

Material and Methods

Anatomical analysis

Anatomical study was based on the analysis of dried leaves obtained from herbarium vouchers. For purposes of comparison, we also analyzed the Amazonian species *Anacardium parvifolium* Ducke, which does not occur in the state of Pará. Leaf blades were extracted from the fourth and fifth nodes of three specimens of each species (Tab. 1). The leaf fragments were rehydrated in boiling distilled water and treated with 2% potassium hydroxide (KOH) until they submerged (Smith & Smith 1942). These samples were then isolated, dehydrated in an ethyl series up to 70% (Johansen 1940), embedded in methacrylate (Leica Historesina, Germany) (Meira & Martins 2003), and sectioned with a rotary microtome (Leica RM2245, Germany). The sections (transverse, 5–6 µm thick) were stained with toluidine blue at pH 4.0 (O'Brien & McCully 1981) for structural characterization.

Table 1 – Voucher information of *Anacardium* species used for morphoanatomical analysis.

Species	Collection
Anacardium amapaense J.D.Mitch.	*R.L. Fróes 34625* (MG)
	L.C.B. Lobato et al. 2568 (MG)
	A.S.L. Silva et al. 1622 (MG)
Anacardium giganteum W.Hancock *ex* Engl.	*J.M. Pires & N.T. Silva 11073* (IAN)
	G.T. Prance et al. 30275 (MG)
	N.T. Silva 5206 (MG)
Anacardium microsepalum Loes.	*P. Cavalcante 1125* (MG)
	A. Ducke 1196 (MG)
	E. Ule 5965 (MG)
Anacardium occidentale L.	*C.A. Cid Ferreira 9459* (MG)
	E. Oliveira 5360 (IAN)
	A.S. de S. Pereira 21 (MFS)
Anacardium parvifolium Ducke	*J.R. Nascimento & E.C. Pereira 514* (MG)
	W.A. Rodrigues 5977 (INPA)
	A. Vicentini et al. 958 (MG)
Anacardium spruceanum Benth. *ex* Engl.	*I.L. Amaral et al. 1322* (MG)
	A.S. de S. Pereira et al. 131 (UEC)
	N.T. Silva 5137 (MG)

Photomicrographs were obtained using a digital camera (Zeiss AxioCam ICc5, Germany) coupled to a microscope (Zeiss Axio Scope.A1, Germany). Other portions of the samples were also critical-point dried, sputter coated with a thin layer of gold (Robards 1978), and electromicrographed using a scanning electron microscope (Zeiss Sigma VP, Germany).

Taxonomic treatment

Taxonomic study was based on the analysis of collections of the herbaria CEN, ESA, IAN, INPA, MBM, MFS, MG, RB, UB, and UEC [acronyms according to Thiers (continuously updated)], specimens collected by us, and images of herbarium vouchers from the databases INCT - Virtual Herbarium of Flora and Fungi (speciesLink 2020) and Reflora - Virtual Herbarium (Reflora 2020). Collected material was incorporated into the herbaria MFS and UEC. Species identifications were confirmed through the analysis of protologues and types or images of types available at the JSTOR Global Plants website (Ithaka 2020).

Structures were analyzed and described under a stereomicroscope and measured using a digital caliper and graph paper. Information on leaf color is based on dried material. The terminology used follows Radford *et al*. (1974), Mitchell & Mori (1987), Mitchell (1992) (especially for the orifices located in the axils of secondary veins on the abaxial surface), Pirani (2003), and Lacchia *et al*. (2016). When necessary, descriptions were complemented with data from additional material. Also, we included in the taxonomic descriptions the information obtained and confirmed by the anatomical analysis. Data on distribution, habitat, and phenology were obtained from herbarium vouchers, literature, and field notes. Distribution maps were created using ArcGis 10.1 (ESRI 2012).

Results and Discussion

Extrafloral nectaries and domatia in *Anacardium*

In Pará, six species of *Anacardium* were recorded: *A. amapaense* J.D.Mitch., *A. giganteum* W.Hancock *ex* Engl., *A. humile* A.St.-Hil., *A. microsepalum* Loes., *A. occidentale* L., and *A. spruceanum* Benth. *ex* Engl.

The structures analyzed here consist of glandular trichomes organized in groups. They may be found in depressions (*Anacardium giganteum*, *A. microsepalum*, *A. occidentale*, and *A. parvifolium*) (Fig. 1a-b; d-g) or cavities (*A. amapaense* and *A. spruceanum*) (Fig. 1c; h-j) located in the axils of secondary veins on the abaxial surface. The depressions have a rounded shape and a shallow orifice in the central region, while cavities have a linear or narrowly lanceolate shape and a deep, pit-like orifice (Mitchell & Mori 1987; Mitchell 1992). The cells below the trichomes have a polygonal form, are thick-walled, and may compose one or more layers (Fig. 1d-m). The glandular trichomes are multicellular and multiseriate with a unicellular stalk and a secretory head that is elongated in the anticlinal direction. The number of cell series ranges from two to eight, while the number of cells in each series ranges from two to six (Fig. 1j-l). In view of the anatomical similarities between the structures observed by us for *Anacardium amapaense*, *A. giganteum*, *A. microsepalum*, *A. occidentale*, *A. parvifolium*, and *A. spruceanum*, and the extrafloral nectaries (EFNs) described by Lacchia *et al.* (2016) for *A. humile*, we believe that what we observed are also EFNs.

The polygonal cells below the trichomes are similar to those impregnated with suberin that surround the tissue of many secretory structures in other plants (Paiva & Machado 2005; Paiva *et al.* 2007; Filgueira *et al.* 2016). According to Lüttge (1971), this suberin impregnation of cell walls could block the return of exudates to the inner tissues. Thus, we believe that the polygonal cells below the trichomes of the analyzed species could be contributing to the storage of secretion (possibly nectar) by these structures.

Moreover, anatomical characterization allowed us to identify possible domatia in *Anacardium giganteum*, *A. microsepalum*, *A. occidentale*, and *A. parvifolium*. The presence of domatia in *Anacardium* was indicated by Mitchell (1992), due to their similarity to mite domatia found in other genera of Anacardiaceae. However, subsequent works identified these structures as EFNs in *Anacardium humile* (Lacchia *et al*. 2016) and *A. occidentale* (Wunnachit *et al.* 1992; Rickson & Rickson 1998). Studies carried out with other families of angiosperms have already reported an association between EFNs and domatia (Leroy *et al.* 2008; Weber *et al.* 2012; Marazzi *et al.* 2019), which could be the case for the species analyzed here, although field observations and histochemical tests are needed to support this hypothesis.

Taxonomic treatment

Anacardium L., Sp. Pl. 1: 383. 1753.
Type: *Anacardium occidentale* L.

Trees, shrubs or subshrubs. Trunks aerial or underground. Branches cylindrical, fissurate, sparsely or densely lenticellate, brown. Leaves simple, alternate, usually congested at the apex of branches; petioles flattened, subcaniculate or caniculate on the adaxial surface; blades coriaceous or chartaceous, margin entire, concolorous or discolorous, venation brochidodromous, glandular trichomes in cavities or depressions in the axils of

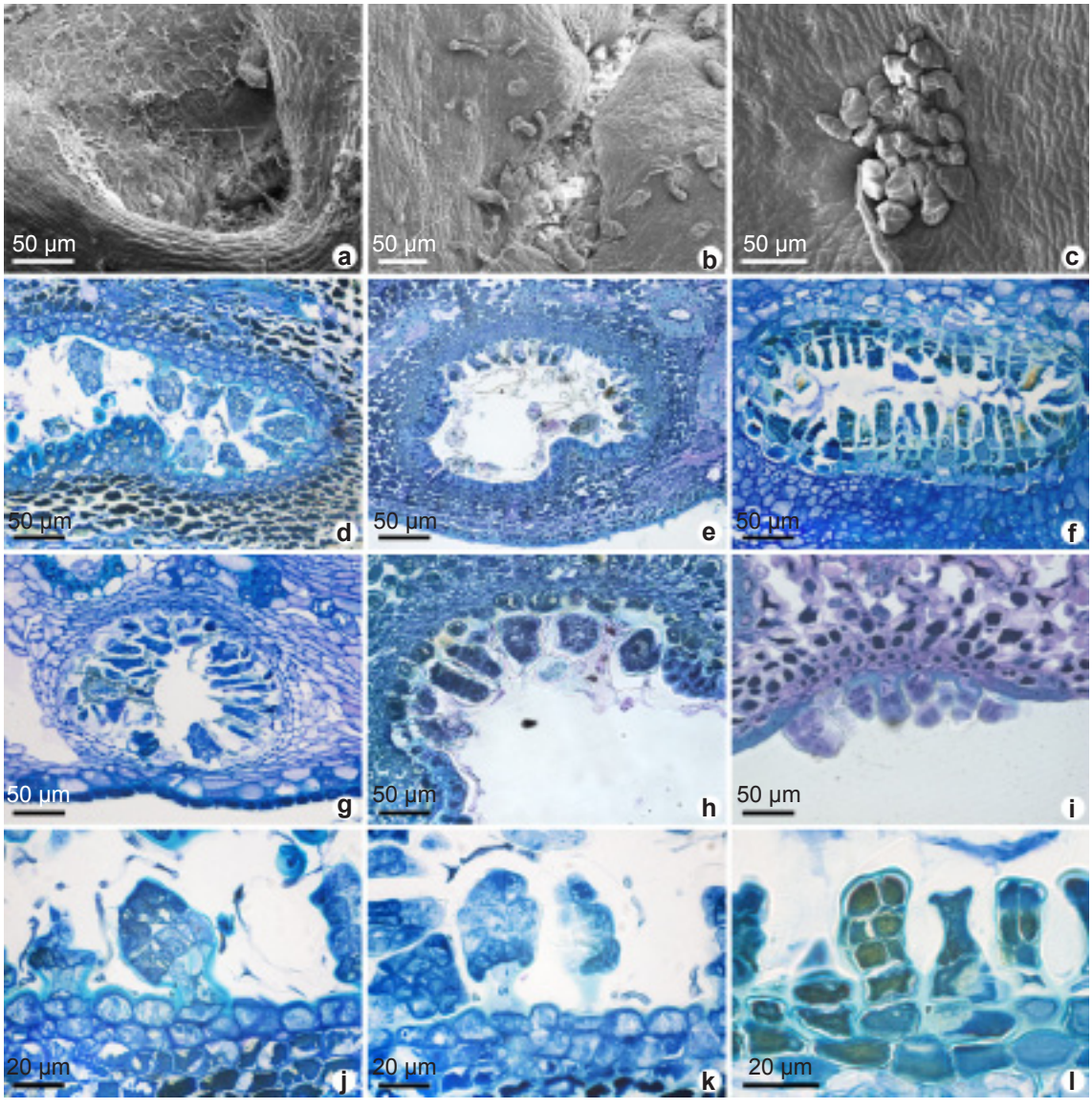

Figure 1 – a-c. Front view of the axils of secondary veins on the abaxial surface of leaves under SEM – a. *Anacardium microsepalum*; b. *A. occidentale*; c. *A. spruceanum*. d-i. cross sections of leaves showing glandular trichomes within cavities or depressions located in the axils of secondary veins on the abaxial surface – d. trichomes found within depression in *A. giganteum*; e. trichomes found within depression in *A. microsepalum*; f. trichomes found within depression in *A. occidentale*; g. trichomes found within depression in *A. parvifolium*; h. trichomes found within cavity in *A. amapaense*; i. trichomes found within cavity in *A. spruceanum*. j-l. detail of glandular trichomes – j-k. *A. giganteum*; l. *A. occidentale*.

secondary veins on the abaxial surface. Inflorescences axillary or terminal, paniculate. Bracts persistent or not, margin entire. Flowers staminate or bisexual. Bracteoles persistent or not, margin entire. Calyx pentamerous, gamosepalous, green; sepals equal, apex acute, margin entire. Corolla pentamerous, gamopetalous, cream-colored with pink or red lines; petals reflexed or revolute, apex acute, margin entire. Stamens 8–9, heterodynamous, 1–4 exserted, with one much longer; filaments connate basally, erect or curved; anthers persistent or not, globoid. Carpel 1, unilocular; ovary ovoid or globoid; style lateral or central, length longer than or equal to those of the exserted stamens in the bisexual flowers; stigma globoid; pistillodes in the staminate flowers. Drupes leathery, reniform; hypocarps present or absent, fleshy, pyriform, yellow, orange or red. Seeds fleshy, free from the endocarp, reniform.

Key to the species of *Anacardium* in the state of Pará, Brazil

1. Leaves with glandular trichomes in depressions in the axils of secondary veins on the abaxial surface ... 2
   2. Leaves widely obovate, greenish blades ... 2. *Anacardium giganteum*
   2'. Leaves oblong, elliptic, obovate or oblanceolate, brownish or blackish blades ... 3
      3. Flowers with pedicels 1.5 mm long, petals revolute, ovary pubescent at the apex; fruits without hypocarp ... 4. *Anacardium microsepalum*
      3'. Flowers with pedicels 2–4 mm long, petals reflexed, ovary glabrous; fruits with hypocarp ... 4
         4. Trunk underground; leaves oblanceolate; flowers with petals 7–7.5 mm long; fruits with hypocarp 0.5–2 cm long ... 3. *Anacardium humile*
         4'. Trunk aerial; leaves oblong, elliptic or obovate; flowers with petals 9–11 mm long; fruits with hypocarp 4–10 cm long ... 5. *Anacardium occidentale*
1'. Leaves with glandular trichomes in cavities in the axils of secondary veins on the abaxial surface ... 5
   5. Leaves chartaceous, glandular trichomes in externally pubescent cavities, petioles 0.5–1 cm long; flowers with petals 4.5–5 mm long ... 1. *Anacardium amapaense*
   5'. Leaves coriaceous, glandular trichomes in externally glabrous to glabrescent cavities, petioles 1.5–4 cm long; flowers with petals 7–8 mm long ... 6. *Anacardium spruceanum*

1. ***Anacardium amapaense*** J.D.Mitch., Brittonia 44(3): 331. 1992. Figs. 2a-d; 3

Tree, 18–40 m tall. Trunk aerial. Branches sparsely lenticellate, pubescent. Petioles 0.5–1 cm long, caniculate on the adaxial surface, pubescent; blades 6–14.5 × 3.5–6.6 cm, elliptic or obovate, apex acute or acuminate, rarely truncate, base cuneate or attenuate, chartaceous, discolorous, adaxial surface dull, dark brown or black, glabrous, primary vein immersed or flattened, abaxial surface dull, light brown, pubescent along the primary vein, primary vein prominent, 10–17 pairs of secondary veins, glandular trichomes in externally pubescent cavities. Inflorescences 2–3.8 cm long, axillary or terminal, pubescent. Bracts not persistent. Bracteoles not persistent. Pedicels 1–2 mm long, pubescent. Sepals 1–2 × 1 mm, elliptic or lanceolate, pubescent. Petals 4.5–5 × 1–1.5 mm, oblong or lanceolate, revolute, pubescent. Stamens 8–9, 1–5 mm long; filaments 0.5–4.5 mm long, curved; anthers 0.5 mm long. Carpel 2.3–5.4 mm long; ovary 1.2–1.3 × 1.5 mm, globoid, glabrous; style 1–4 mm long, central; stigma 0.1 mm long; pistillode 0.5 mm long. Fruit unknown.

Examined material: Bragança, Road Bragança to Viseu, 4 km, west of Curapati and Rio Piriá, 10.XI.1965, fl., *G.T. Prance & T.D. Pennington 2061* (UB). Breves, perto do Igarapé Arapijó, transecto para inventário florestal, Q1-107, 7-30.VII.1956, fl., *J.M. Pires et al. 5143* (IAN); transecto para inventário florestal, 32-2, 7-30.VII.1956, *J.M. Pires et al. 5628* (IAN). Jacundá, Remansão, área a ser inundada pela represa da Hidrelétrica de Tucuruí, 10.IV.1981, fl., *A.S.L. Silva et al. 1622* (MG); km 117 da Rodovia Belém-Brasília, 23.I.1960, fl., *E. Oliveira 410* (IAN, UB); km 276 da Rodovia Belém-Brasília, 26.VII.1960, fl., *E. Oliveira 932* (IAN). Moju, amostra 1-P 25-369, 25.VIII.1975, fl., *N.T. Silva 3975* (IAN). Paragominas, trilha Cikel Brasil Verde S.A., 03°28.20'S, 48°46.57'W, 23.IX.2002, fl., *J.C. Oliveira & A.M. Ferreira 376* (IAN, MFS). Ulianópolis, Fundação Floresta Tropical, 3-7.VI.2000, fl., *L.C.B. Lobato et al. 2568* (MG). Viseu, Rio Piriá, Igarapé Pitoró, 20.VIII.1958, fl., *R.L. Fróes 34625* (IAN, MG).

Figure 2 – a-d. *Anacardium amapaense* – a. flowering branch; b. detail of cavity with glandular trichomes in the axil of a secondary vein on the abaxial leaf surface; c. flower; d. petal. e-i. *A. giganteum* – e. flowering branch; f. detail of depression with glandular trichomes in the axil of a secondary vein on the abaxial leaf surface; g. flower; h. petal; i. fruit. j-n. *A. humile* – j. flowering branch; k. detail of depression with glandular trichomes in the axil of a secondary vein on the abaxial leaf surface; l. flower; m. petal; n. fruit. o-s. *A. microsepalum* – o. flowering branch; p. detail of depression with glandular trichomes in the axil of a secondary vein on the abaxial leaf surface; q. flower; r. petal; s. fruit. t-x. *A. occidentale* – t. flowering branch; u. detail of depression with glandular trichomes in the axil of a secondary vein on the abaxial leaf surface; v. flower; w. petal; x. fruit. y-c'. *A. spruceanum* – y. flowering branch; z. detail of cavity with glandular trichomes in the axil of a secondary vein on the abaxial leaf surface; a'. flower; b'. petal; c'. fruit. (a-d. *L.C.B. Lobato et al. 2568*; e-h. *J.M. Pires & N.T. Silva 11073*; i. *W.A. Archer 7813*; j-k. *N.T. Silva 719*; l-n. *A. Gély 369*; o-r. *P. Cavalcante 1125*; s. *J.G. de Carvalho-Sobrinho et al. 1504*; t-u. *O.C. Nascimento et al. 898*; v-w. *A.E.S. Rocha et al. 297*; x. *O.C. do Nascimento BPM215*; y-b'. *N.T. da Silva 5137*; c'. *M.R. Santos 683*).

Additional material: BRAZIL. AMAPÁ: Rio Araguari, Pedra Fina Camp and between Camps 12 and 13, 10.X.1961, fl., *J.M. Pires et al. 51650* (IAN, UB).

This species occurs in Brazil and French Guiana (Mitchell 1992; Silva-Luz *et al.* 2020). In Pará, it is recorded from *terra firme* forests. Flowers observed from April to January. *Anacardium amapaense* can be distinguished from the other species of *Anacardium* occurring in Pará by the usually acuminate leaf apex and glandular trichomes located in externally pubescent cavities in the axils of secondary veins on the abaxial surface.

2. *Anacardium giganteum* W.Hancock *ex* Engl., *Fl. bras*. 12(2): 409. 1876. Figs. 2e-i; 3

Tree, 5–38 m tall. Trunk aerial. Branches densely lenticellate, pubescent to glabrescent. Petioles 0.5–1.2(–2) cm long, flattened or subcaniculate on the adaxial surface, pubescent; blades 8–23.8 × 4.8–12.9 cm, widely obovate, apex acute, rounded, truncate or emarginate, base cuneate, attenuate or asymmetric, coriaceous, concolorous, adaxial surface lustrous, light green, pubescent to glabrescent along the primary vein, primary vein immersed, abaxial surface dull or lustrous, light green, pubescent along the primary vein, primary vein prominent, 8–23 pairs of secondary veins, glandular trichomes in externally glabrous to glabrescent depressions. Inflorescences 8.8–19.3 cm long, axillary or terminal, pubescent. Bracts 1–1.5 cm long, obovate, apex rounded, base attenuate, pubescent. Bracteoles 2–4 mm long, lanceolate or deltoid, apex acute, base truncate, pubescent. Pedicels 1.5–2.5 mm long, pubescent. Sepals 1–3 × 1–1.5 mm, elliptic, lanceolate or deltoid, pubescent. Petals 3–6 × 1–2.5 mm, oblong or lanceolate, revolute, pubescent. Stamens 8–9, 1.6–5.1 mm long; filaments 1–4.5 mm long, erect or curved; anthers 0.6 mm long. Carpel 4.1–5.6 mm long; ovary 1.5 × 1 mm, ovoid, pubescent at the apex; style 2.5–4 mm long, lateral; stigma 0.1 mm long; pistillode 0.7–9 mm long. Drupe 2 × 2.5 cm; hypocarp 0.9 × 0.6 cm.

Examined material: Acará, Rio Acará, 24.XII.1948, fl., *J.M. Pires 1435* (IAN, NY-photo). Almeirim, Mt. Dourado, Estrada do Munguba, km 4, 21.XI.1979, fl., *N.T. Silva 5206* (INPA, MG). Anajás, Ilha de Marajó, Rio Anajás and Vista Alegre, 0º57'S, 49º48'W, 4.XI.1987, fl., *G.T. Prance et al. 30275* (INPA, MG). Belém, IPEAN, Reserva Mocambo, 7.X.1967, fl., *J.M. Pires & N.T. Silva 11073* (IAN); near Escola de Veterinária, 12.XI.1942, fr., *W.A. Archer 7813* (IAN). Belterra, em mata ao longo da Rodovia BR-163 (Santarém-Cuiabá) no km 174, 24.X.1975, *M. Barbosa & Humberto 83-02* (UB). Bragança, Benjamin Constant, Vivenda Vitória, 23.XI.2001, fl., *A. Reed 2* (IAN). Breves, perto do Igarapé Arapijó, 5.XI.1958, fl., *T.N. Guedes 658* (IAN, NY-photo). Moju, 4.XII.2012, fl., *E.D. Cruz 669* (CEN, IAN). Oriximiná, Comunidade Jauari, Lago do Jamaru, 1º30'20"S, 56º09'21"W, 23.VIII.2008, *D.R. Oliveira & M.O.V. Almeida 203* (INPA); Porto Trombetas, Mineração Rio do Norte, Estrada da Mina, km 25, lado esquerdo, 5.III.1988, fl., *E. Soares 406* (INPA). São Domingos do Capim, Vila Pedreira, 7.IX.1999, *A.G. Nave & A. Novello 23* (ESA). São Miguel do Guamá, beira do Rio Guamá, 27.X.1948, fl., *G.A. Black & R.B. Foster 48-3320* (IAN, INPA). Santarém, Reserva Florestal de Curuá-Una, Estrada Zero, 14.IV.1967, *M. Silva* (INPA 27683). Tucuruí, Cagancho, área nuclear n° 1, margem direita do Rio Tocantins, I.1981, *P. Lisboa et al. 2064* (MG).

Additional material: BRAZIL. AMAZONAS: Presidente Figueiredo, 10.III.1986, fr., *C.A. Cid Ferreira et al. 6695* (INPA).

This species occurs in Bolivia, Brazil, Colombia, Guyana, Peru, Suriname, and Venezuela (Mitchell & Mori 1987; Silva-Luz *et al.* 2020). In Pará, it is recorded from *terra firme* forests and *várzea* forests. Flowers and fruits observed from October to March. *Anacardium giganteum* is characterized by widely obovate leaves (mean width of 8.8 cm), with lustrous blades on the adaxial surface. The species is similar to *Anacardium spruceanum*, but *A. giganteum* presents concolorous and greenish leaf blades (*vs*. discolorous and brownish), with glandular trichomes located in depressions in the axils of secondary veins on the abaxial surface (*vs*. in cavities), and flowers with pubescent ovary at the apex (*vs*. glabrous).

3. *Anacardium humile* A.St.-Hil., Ann. Sci. Nat. 23: 272. 1831. Figs. 2j-n; 3

Subshrub, 0.2–2 m tall. Trunk underground. Branches sparsely lenticellate, glabrous. Petioles 0.2–1.5 cm long, caniculate on the adaxial surface, pubescent to glabrescent; blades 7.6–24.3 × 2.5–7.6 cm, oblanceolate, apex rounded, truncate, retuse or emarginate, base cuneate or attenuate, coriaceous, concolorous, adaxial surface dull or lustrous, light brown, glabrous, primary vein immersed or flattened, abaxial surface dull or lustrous, light brown, pubescent to glabrescent along the primary vein, primary vein prominent, 9–16 pairs of secondary veins, glandular trichomes in externally glabrous to glabrescent depressions. Inflorescences 12–15.3 cm long, terminal, pubescent. Bracts not persistent. Bracteoles 3–5 mm long, lanceolate

or deltoid, apex acute, base truncate, pubescent. Pedicels 2–3 mm long, pubescent. Sepals 2–3 × 1 mm, oblong, elliptic or lanceolate, pubescent. Petals 7–7.5 × 1–1.5 mm, oblong or lanceolate, reflexed, pubescent. Stamens 8–9, 2–9.5 mm long; filaments 1.5–9 mm long, erect; anthers 0.5 mm long. Carpel 8.1 mm long; ovary 2 × 1.5 mm, globoid, glabrous; style 6 mm long, central; stigma 0.1 mm long; pistillode 0.8 mm long. Drupe 0.6–1.5 × 0.8–1 cm; hypocarp 0.5–2 × 0.3–1 cm.
Examined material: São Félix do Xingu, Gorotire, fl. and fr., *A. Gély 369* (MG); Região Gorotire, 29.VII.1962, fl., *N.T. Silva 719* (IAN); Reserva Florestal de Gorotire (Kayapó-Indian Reservation), surroundings of Gorotire Village at Rio Fresco, 7º47'S, 51º7'W, 17.I.1983, *G.K. Gottsberger & D.A. Posey 121-17183* (NY-photo).
Additional material: BRAZIL. MATO GROSSO: Nova Brasilândia, estrada entre Riolândia (Frieira) e Marzagão, ca. 25 km NNW (em linha reta) de Nova Brasilândia, 14°45'S, 55°04'W, 7.X.1997, fr., *V.C. Souza et al. 20196* (ESA). Paranatinga, próximo a cabeceira do Córrego das Antas, 18.VIII.1990, fl., *M. Macedo & I. Assumpção 1730* (INPA). TOCANTINS: Mateiros, Parque Est. do Jalapão, Vereda do Bebedouro, 15.VIII.2004, fl. and fr., *J.M. Rezende et al. 994* (CEN, UEC).

This species occurs in Bolivia, Brazil, and Paraguay (Mitchell & Mori 1987; Silva-Luz *et al.* 2020). In Pará, it is recorded from Amazonian savannahs. Flowers and fruits observed from July to October. The occurrence of *Anacardium humile* for the state had been previously indicated (Pereira *et al.* 2014). However, in Flora do Brasil 2020 (Silva-Luz *et al.* 2020), the record of this species for Pará was not included. *Anacardium humile* differs from the other species of *Anacardium* occurring in Pará because it presents a subshrub habit and oblanceolate leaves. This species resembles *Anacardium occidentale*, but *A. humile* has flowers with shorter petals (7–7.5 *vs*. 9–11 mm long) and fruits with smaller hypocarp (0.5–2 × 0.3–1 *vs*. 4–10 × 2–5 cm).

4. *Anacardium microsepalum* Loes., Verh. Bot. Vereins Prov. Brandenburg 48: 175. 1907.

Figs. 2o-s; 3

Tree, 3–18 m tall. Trunk aerial. Branches sparsely lenticellate, pubescent to glabrescent. Petioles 0.8–1.6 cm long, subcaniculate or caniculate on the adaxial surface, pubescent;

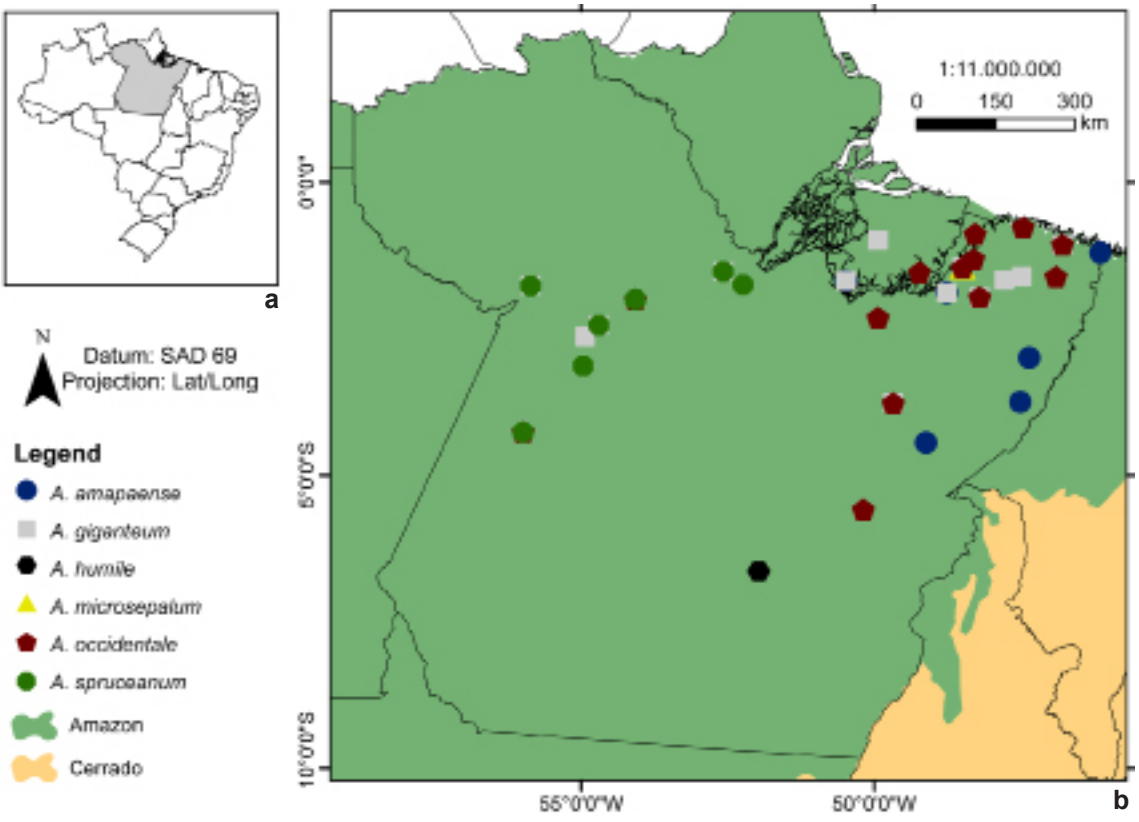

Figure 3 – a-b. Distribution map of *Anacardium* in the state of Pará, Brazil – a. Brazil; b. distribution of *Anacardium* in Pará.

blades 8.1–20 × 4–8.6 cm, elliptic or obovate, apex acute, base cuneate, coriaceous or chartaceous, concolorous, adaxial surface dull or lustrous, light brown, glabrous, primary vein immersed or flattened, abaxial surface dull or lustrous, light brown, pubescent along the primary vein, primary vein prominent, 9–14 pairs of secondary veins, glandular trichomes in externally glabrous to glabrescent depressions. Inflorescences 1.9–8.5 cm long, axillary or terminal, pubescent. Bracts not persistent. Bracteoles not persistent. Pedicels 1.5 mm long, pubescent. Sepals 1–1.5 × 0.5–1 mm, ovate, pubescent. Petals 2–3 × 1–1.5 mm, elliptic or obovate, revolute, pubescent. Stamens 8, 2–4 mm long; filaments 1.5–3.5 mm long, erect; anthers 0.5 mm long. Carpel 5.6 mm long; ovary 1.5 × 1 mm, globoid, pubescent at the apex; style 4 mm long, lateral; stigma 0.1 mm long; pistillode 0.5 mm long. Drupe 1.2–3.1 × 1.4–2.2 cm; hypocarp absent.
Examined material: Belém, Horto do Museu Goeldi, árvore 966, 4.IV.1961, fl., *P. Cavalcante 1125* (MG).
Additional material: BRAZIL. AMAZONAS: Manaus, Cachoeira Baixa do Tarumã, 26.XII.1962, fl., *W. Rodrigues et al. 4940* (INPA); Cachoeira Grande, III.1912, fl., *E. Ule 8907* (RB); Igarapé Mindú, 3.III.1943, fl., *A. Ducke 1196* (MG); Parque 10, 5.III.1956, fl., *Dionísio* (INPA 3560); Rio Negro, XII.1901, fl., *E. Ule 5965* (MG); Silva "igapó" secus Igarapé Mindú, 28.I.1936, fl., *A. Ducke 138* (NY-photo). Presidente Figueiredo, Rebio Uatumã, Entorno, Estrada da Morena, Corredeira da Anta, ca. 40 km de Balbina, 23.III.2007, fr., *J.G. de Carvalho-Sobrinho et al. 1504* (INPA).

This species occurs only in Brazil (Mitchell & Mori 1987; Silva-Luz *et al.* 2020). In Pará, it is recorded from *terra firme* forests and *várzea* forests. Flowers and fruits observed from December to April. *Anacardium microsepalum* is characterized by flowers with globoid and pubescent (at the apex) ovary and fruits without a hypocarp.

5. *Anacardium occidentale* L., Sp. Pl. 1: 383. 1753 Figs. 2t-x; 3

Tree or shrub, 1.5–10 m tall. Trunk aerial. Branches sparsely or densely lenticellate, pubescent to glabrescent. Petioles 1.5–2 cm long, flattened or subcaniculate on the adaxial surface, pubescent to glabrescent; blades 5–16.1 × 3–9.5 cm, oblong, elliptic or obovate, apex acute, rounded, truncate, retuse or emarginate, base cuneate or asymmetric, coriaceous, concolorous or discolorous, adaxial surface dull or lustrous, dark brown or light brown, glabrous, primary vein immersed or flattened, abaxial surface dull or lustrous, light brown, pubescent to glabrescent along the primary vein, primary vein prominulous or prominent, 8–21 pairs of secondary veins, glandular trichomes in externally glabrous to glabrescent depressions. Inflorescences 4–18.2 cm long, axillary or terminal, tomentose to pubescent. Bracts 1–2 cm long, obovate, apex rounded, base attenuate, pubescent. Bracteoles 2–4 mm long, lanceolate, apex acute, base truncate, pubescent. Pedicels 2–4 mm long, pubescent. Sepals 3–4 × 1–2 mm, elliptic, triangular or obovate, pubescent. Petals 9–11 × 1.5–2 mm, lanceolate or ovate, reflexed, pubescent. Stamens 8–9, 1.5–11 mm long; filaments 1–10.5 mm long, erect or curved; anthers 0.5–0.9 mm long. Carpel 9–10 mm long; ovary 1.5–1.7 × 1.5 mm, ovoid, glabrous; style 8–8.5 mm long, central; stigma 0.2 mm long; pistillode 0.5 mm long. Drupe 1.5–3 × 1–2 cm; hypocarp 4–10 × 2–5 cm.
Examined material: Acará, Boa Vista, 15.VI.1979, fl., *O.C. Nascimento et al. 898* (MG). Belém, Marco da Légua, XII.1896, fl., *J. Huber* (MG 543); Campus de Pesquisa do Museu Paraense Emílio Goeldi, 26.IX.2011, fl., *A.S. de S. Pereira 21* (MFS). Benevides, Benfica, 27.IX.1984, fl., *L. Carreira 996* (MG). Bragança, Comunidade Marieteua, 2.X.1999, fr., *M. Rios et al. 585* (IAN). Colares, 29.XII.1953, fl., *R.L. Fróes 30639* (IAN). Itaituba, Serra do Cachimbo, arredores da Base Aérea do Cachimbo, próximo do Lago Azul, 26.IV.1983, fl., *M.N. Silva et al. 117* (INPA, RB, UB). Marabá, Serra Sul, 11.VII.1986, *A.T. Oliveira Filho 18510* (UEC). Maracanã, Vila da Penha, 8.II.2007, fr., *O.C. do Nascimento BPM215* (MG). Monte Alegre, Serra da Paituna, próxima à Pedra do Pilão, a 30 km de Monte Alegre, 6.XI.1987, fl. and fr., *C.A. Cid Ferreira 9459* (INPA, MG). Muaná, Ilha de Marajó, margem esquerda do R. Atuá, próximo Mariaí, 27.X.1970, fl., *E. Oliveira 5360* (IAN). Oeiras do Pará, Rio Proaná, Lago da Romana, 15.VIII.2000, fl., *C.A. Cid Ferreira 12050* (INPA, RB). Santa Luzia do Pará, Região do Araguaia, 30.VI.1953, fl., *R.L. Fróes 29954* (IAN). Salinópolis, Praia da Marieta, 25.X.2005, fl. and fr., *A.E.S. Rocha et al. 297* (MG). Tucuruí, Santa Rosa, 12.IX.1983, fl., *F.E. Miranda et al. 596* (INPA).
Additional material: BRAZIL. AMAZONAS: Humaitá, Estrada Humaitá-Jacareacanga, km 150, a 60 km ao Sul, 21.VI.1982, fl., *L.O.A. Teixeira et al. 1267* (INPA, MBM).

This species occurs in Belize, Bolivia, Brazil, Caribbean, China, Colombia, Costa Rica, El Salvador, Ecuador, French Guiana, Gabon, Guatemala, Guyana, Honduras, Madagascar, Mexico, Nicaragua, Panama, Peru, Suriname, and Venezuela (Mitchell & Mori 1987; Silva-Luz *et al.* 2020). However, its occurrence outside the Neotropics is due to cultivation, which is mainly

related to the high consumption of its hypocarp (Mitchell & Mori 1987). In Pará, it is recorded from the Amazonian savannahs and *restingas*, and is cultivated in forest fragments. Flowers and fruits observed from April to February. *Anacardium occidentale* can be distinguished from the other species of *Anacardium* occurring in Pará by having flowers with longer petals (9–11 mm long) and fruits with a longer hypocarp (mean length of 7 cm). Affinities with *Anacardium humile* are discussed in the comments of that species.

6. *Anacardium spruceanum* Benth. *ex* Engl., *Fl. bras*. 12(2): 410. 1876. Figs. 2y-c'; 3

Tree, 10–45 m tall. Trunk aerial. Branches sparsely or densely lenticellate, pubescent. Petioles 1.5–4 cm long, flattened or caniculate on the adaxial surface, pubescent; blades 7–19.6 × 3–9.8 cm, elliptic or obovate, apex acute, rounded, retuse or emarginate, base cuneate, attenuate or asymmetric, coriaceous, discolorous, adaxial surface dull or lustrous, dark brown, pubescent to glabrescent along the primary vein, primary vein immersed or flattened, abaxial surface dull, light brown, pubescent to glabrescent along the primary vein, primary vein prominulous or prominent, 6–20 pairs of secondary veins, glandular trichomes in externally glabrous to glabrescent cavities. Inflorescences 2.5–11.2 cm long, axillary or terminal, tomentose to pubescent. Bracts 1–2 cm long, obovate, apex rounded, base attenuate, pubescent. Bracteoles 2–3 mm long, lanceolate or deltoid, apex acute, base truncate, pubescent. Pedicels 1–2 mm long, pubescent. Sepals 3–4 × 1–1.5 mm, elliptic, lanceolate or ovate, pubescent. Petals 7–8 × 1–2 mm, oblong or lanceolate, revolute, pubescent. Stamens 9, 4–7 mm long; filaments 3.5–6.5 mm long, erect; anthers 0.5 mm long. Carpel 5.1 mm long; ovary 2 × 1.6 mm, ovoid, glabrous; style 3 mm long, central; stigma 0.1 mm long; pistillode 0.6 mm long. Drupe 2 × 2.3 cm; hypocarp 1–2.2 × 1.4–2.5 cm.

Examined material: Almeirim, Mt. Dourado, 27.VII.1979, fl., *N.T. Silva 5137* (MG). Belterra, Zona S. Jorge, BR-165, km 91, 4.X.1974, *Raimundo 091.40.03* (IAN). Itaituba, Estrada Santarém-Cuiabá, BR-163, km 1227, com penetração de ± 5 km dentro da mata, margeando o Igarapé Lauro, 19.V.1983, fl., *I.L. Amaral et al. 1322* (INPA, MG, RB, UB). Monte Alegre, campos altos das Chapadas do Lago Jacaré-capá, 9.IX.1953, fl., *R.L. Fróes 30573* (IAN). Porto de Moz, alto Rio Jaraucú, 27.IX.1955, fl., *R.L. Fróes 32122* (IAN, MG). Oriximiná, Flona Saracá-Taqüera/IBAMA, Porto Trombetas, 16.I.2003, fr., *R.P. Salomão et al. 985* (MG). Santarém, Flona do Tapajós, linha 14, bloco 4, 8.X.2003, *I.S. Santos et al. 29* (IAN).

Additional material: BRAZIL. AMAZONAS: Manaus, Reserva Florestal Adolpho Ducke, 29.VII.2016, *A.S. de S. Pereira et al. 131* (UEC). Presidente Figueiredo, represa de Balbina on Rio Uatumã, ca. 5 km E of dam near upper housing complex, 10.VII.1986, fl., *W. Thomas et al. 5440* (INPA, MG).

This species occurs in Bolivia, Brazil, French Guiana, Guyana, Suriname, and Venezuela (Mitchell & Mori 1987; Silva-Luz *et al.* 2020). In Pará, it is recorded from *terra firme* forests. Flowers and fruits observed from May to January. *Anacardium spruceanum* can be distinguished from the other species of *Anacardium* occurring in Pará by having longer petioles (mean length of 2.7 cm) and glandular trichomes located in externally glabrous cavities in the axils of secondary veins on the abaxial surface. Affinities with *Anacardium giganteum* are discussed in the comments of that species.

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