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## Notes on morphology and distribution of *Acmanthera* (A. Juss.) Griseb. (Malpighiaceae), an endemic genus from Brazil

FRANCISCO FARROÑAY<sup>1,\*</sup>, RICARDO DE OLIVEIRA PERDIZ<sup>1</sup>, EDUARDO MAGALHÃES BORGES PRATA<sup>1</sup> & ALBERTO VICENTINI<sup>1</sup>

<sup>1</sup>Instituto Nacional de Pesquisas da Amazônia (INPA)-Programa de Pós-Graduação em Botânica; Laboratório de Botânica Amazônica (LABOTAM), Av. André Araújo, 2.936, 69067-375, Manaus, AM, Brazil

\*Author for correspondence: [ffarro667@gmail.com](mailto:ffarro667@gmail.com)

### Abstract

We present the amended description of the species *Acmanthera minima* and *A. parviflora* based on specimens collected in the Lower Negro River basin and the Serra do Aracá National Park, respectively, in the Amazonas State, Brazil. We also provide photographs, a distribution map, notes on conservation status and a key to all species of the genus *Acmanthera*. We report new records and range extension for *Acmanthera latifolia* and *A. minima*, previously known only for the Negro and Madeira River basins, respectively.

**Keywords:** Amazon, Campinas, Malpighiales, Manaus, oligotrophic habitats, Igapó

### Introduction

*Acmanthera* (A. Juss.) Griseb. in Martius (1858: 28) is a small neotropical genus of Malpighiaceae, comprising seven species of trees, treelets and shrubs, with a distribution restricted to Brazil (Anderson 1975, 1981, 1990). It is one of more than 170 endemic genera of spermatophytes from Brazil (Giulietti *et al.* 2005, BFG 2019). The genus can be recognized by both eglandular petioles and bracteoles, dense parallel tertiary venation, elongated and deciduous stipules, the fourth at each node pressed or fused together to form a sheath enclosing the shoot apex, inflorescence an elongated pseudoraceme, winged anthers and dry indehiscent fruits comprising 3 cocci (Anderson 1975, 1990). *Acmanthera* is also part of the oil-flower group, because it has elaiophores that attract pollinators (mostly specialized bees) (Buchmann 1987).

Molecular (Davis & Anderson 2010) and morphological (Anderson 1978) evidence place *Acmanthera* together with the genera *Coleostachys* A. Juss. (1840: 329) and *Pterandra* A. Juss. (1833: 72) such as the clade *acmantheroids*, which coincides with the *Acmantherae* tribe defined by Anderson (1978). *Acmanthera* occurs in both Amazonia and Cerrado biomes, but is especially well represented in Amazonian forests, with most species growing in riparian and flooded forests (Anderson 1975, BFG 2015). Only one species (*Acmanthera latifolia*) is fairly common; the remaining species were known only from the type material or a couple of collections (Anderson 1975).

*Acmanthera minima* W.R. Anderson (1981: 438) is the only species of the genus that occurs in white-sand vegetation (WSV) formations and was based on a single fruiting specimen, collected at Humaitá district in open WSV locally known as *campinas* (Anderson 1981). *Acmanthera minima* is morphologically similar to *Acmanthera parviflora* W.R. Anderson (1975: 47), another species with an Amazonian distribution, which was based only on flowering specimens (Anderson 1981). Here we report the discovery of a new population of *Acmanthera minima*, and augment the descriptions of *A. minima* and *A. parviflora*. In addition, we provide a distribution map and discuss ecology and conservation status. We report new records of *Acmanthera latifolia* (A. Juss.) Griseb. in Martius (1858: 29).

## Material & Methods

The taxonomic treatment and phenology of the studied species are based on herbarium collections from INPA, MICH, NY, and RB (Herbarium acronyms follow Thiers 2018 and continuously updated), and field observations of *Acmanthera minima* and *A. parviflora*. Terminology used in the morphological description was adopted from Anderson (1978). The distribution map of *Acmanthera* species was based on latitude and longitude data of the collections from the herbaria cited above and the speciesLink network (<http://www.splink.org.br>, accessed in 11/08/2018). In order to determine the conservation status of *Acmanthera minima* and *A. parviflora* according to IUCN categories and criteria (2012), we calculated the extent of occurrence (EOO) and area of occupancy (AOO) using R package red (Cardoso, 2017) in the software R (R Core Team 2018). The distribution map of *Acmanthera* species was generated inside R environment, version 3.5.1 (R Core Team 2018). Field photographs were made using a Nikon D3300 camera. Photographs of dry structures were taken with a Leica M205C stereomicroscope.

## Taxonomy Treatment

*Acmanthera latifolia* (A. Juss.) Griseb. (1858: 28).

Type:—BRAZIL. Pará: *Ferreira s.n.* (MNHN-P-P00310208!). (Fig. 1). = *Pterandra latifolia* A. Juss. (1838: 19).

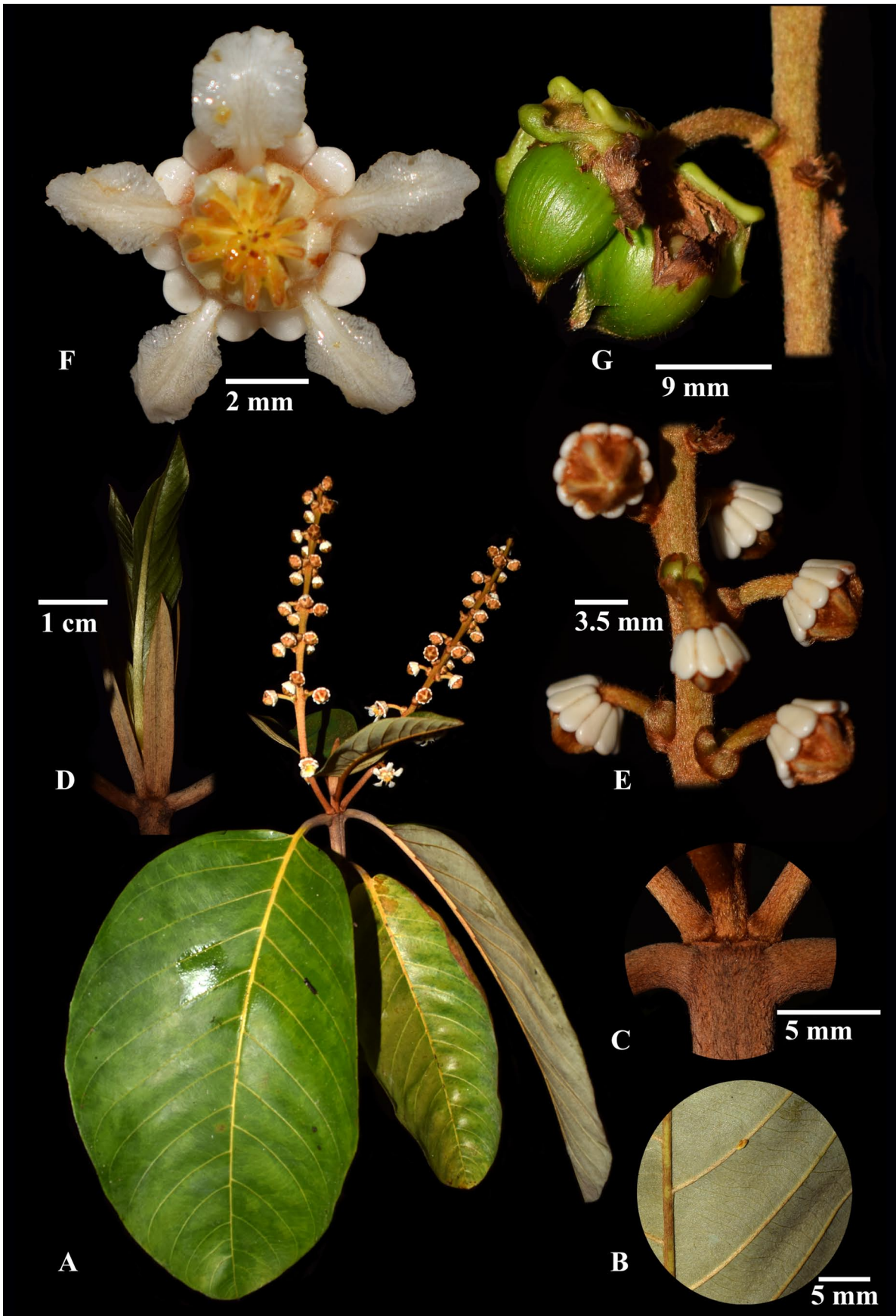
**Comments.**—*Acmanthera latifolia* was collected in tree inventories in Amazon floodplain forests (Ferreira 2000), and aspects about phenology (Ferreira & Parolin 2007) and seedling establishments (Parolin 2002) of this species are also known. Furthermore, Scudeller (2018) reports this species as restricted to the blackwater floodplain forest (*igapó* forest) on the Negro River basin; however, in this work, we report this species for whitewater floodplain forests (*várzea* forest) on the basins of the Purus and Branco Rivers (Fig. 4). The wide distribution of *A. latifolia* in Amazon floodplain forests could be due to long-distance dispersal by water (hydrochory), which was presumed by the presence of inflated aerenchymatous tissue in the fruits (Anderson 1975).

**Additional specimens examined:**—BRAZIL. Amazonas: Mun. Canutama, Rio Purús, 6°30'25" S, 64°33'3" W, elev. 50 m, 1 Sep 2010 [bu], *Prata 302* (INPA!). Mun. Manaus, Rio Cuieiras, 12 Mar 2017 [fl, fr], *Farroñay 95* (INPA!). Roraima: Mun. Caracará, Rio Branco, 0°56'49" N, 61°51'22" W, elev. 34 m, 26 Feb 1979 [fl], *Figlioulo s.n.* (INPA!); 27 Mar 2012 [fl], *Nadrusz 2636* (RB [00708990!]); Mun. Rorainópolis, Rio Jauaperi, 0°47'59" S, 61°33'07" W, 9 Sep 2013 [fl], *Figuereido 1991* (INPA!); Rio Branco, 1°11'59" S, 61°50'51" W, elev. 40 m, 28 Mar 2012 [fl], *Martinelli 17688* (RB [00743720!]).

*Acmanthera minima* W.R. Anderson (1981: 438).

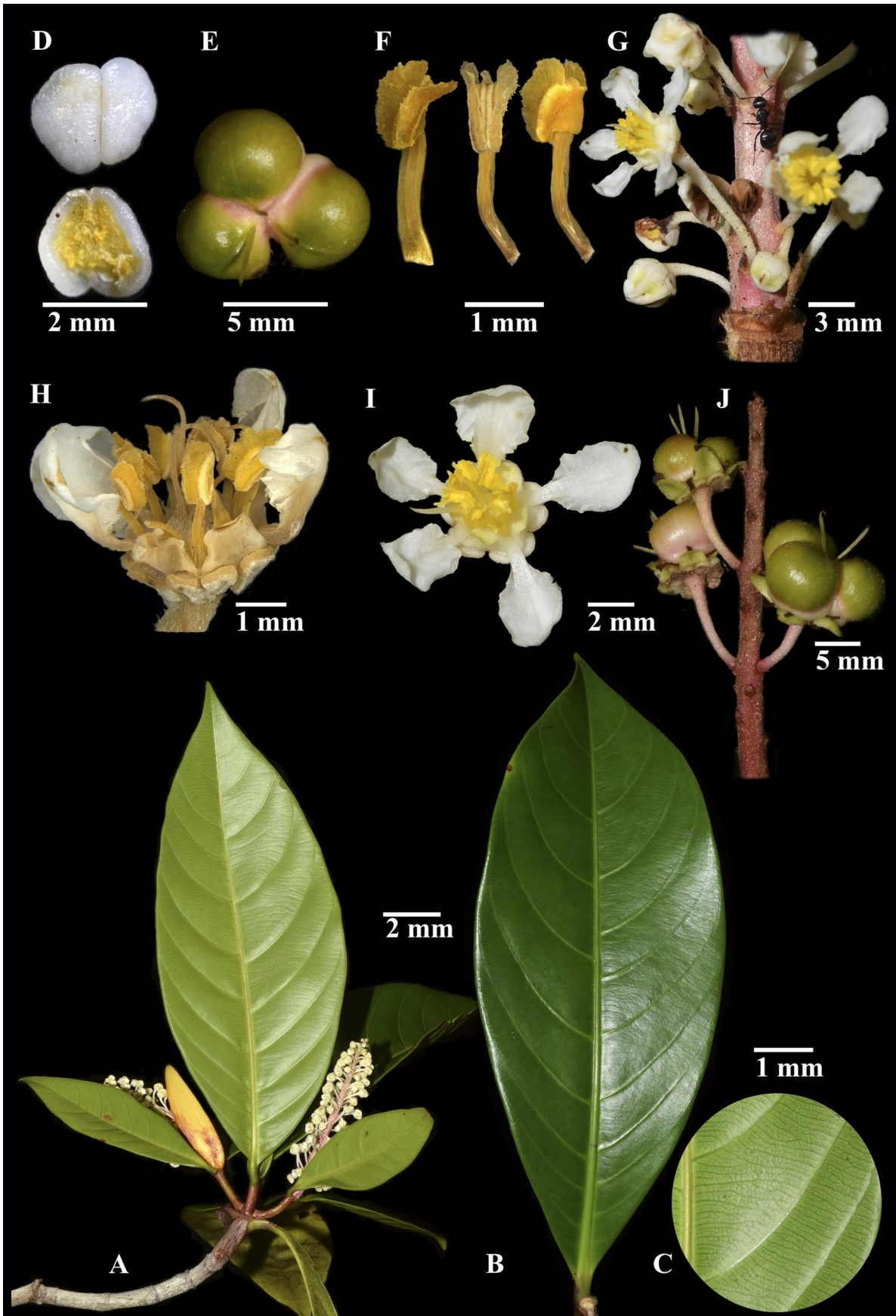
Holotype:—BRAZIL: Amazonas: Rodovia do Estanho, 26 Sep 1979; *Vieira et al. 185* (INPA!; isotype: MICH barcode 1102002!, NY barcode 55063!). (Figs. 2 & 3).

*Shrublet to treelet*, 0.6–6 m tall; vegetative stems early sericeous, soon glabrous. Leaves initially sericeous (at least on the midrib), completely glabrous at maturity; lamina 12.5–17.5 × 5.5–8.5 cm, elliptical, cuneate at the base and then decurrent on the petiole, abruptly short-acuminate at the apex, with 11–14 lateral veins interconnected by many fine scalariform veinlets prominulous on both sides; petiole 6.5–8 mm long; stipules initially sericeous, soon glabrous, 5–8 × 0.7–1 cm, the 4 at a node completely connate to form a single strongly flattened sheath, linear-elliptical in cross-section. Inflorescence 6–12 cm long, densely and persistently sericeous; internode below the inflorescence 1.5–5 cm long, sparsely sericeous; leaves subtending the inflorescence similar to vegetative leaves but smaller, the lamina 5–8 × 1.8–3.2 cm; flowers borne on the pseudoraceme in clusters of 2–3; bracts and bracteoles minute, 0.2–0.4 mm long and wide, triangular or ovate, flat, membranous, persistent or eventually deciduous. Pedicel 7–16.5 × 0.4–0.6 mm, sparsely sericeous. Sepals greenish, 2–3 mm long beyond glands, 1.7–2.4 mm wide, broadly ovate or orbicular, broadly rounded at the apex, glabrous on both sides, membranous at the margin; glands white, 1.2–2.2 mm long, not revolute at the apex. Petals white, glabrous on both sides, eglandular; claw 1–1.6 mm; limb 2.7–2.9 × 2.3–2.5 mm, 4 lateral petals slightly reflexed; posterior petal not strongly differentiated from lateral petals, but spreading to reflexed. Filaments 1.5–2.0 mm long, opposite petals longer than opposite sepals, 0.8 mm wide; anthers with the locules 1–1.3 mm long, the wings 0.9–1.2 × 0.2–0.3 mm, the apical appendage of the connective 0.3–0.4 × 0.2 mm, triangular, flat, membranous, acute and eglandular at the apex, inflexed. Ovary densely pilose-sericeous; styles

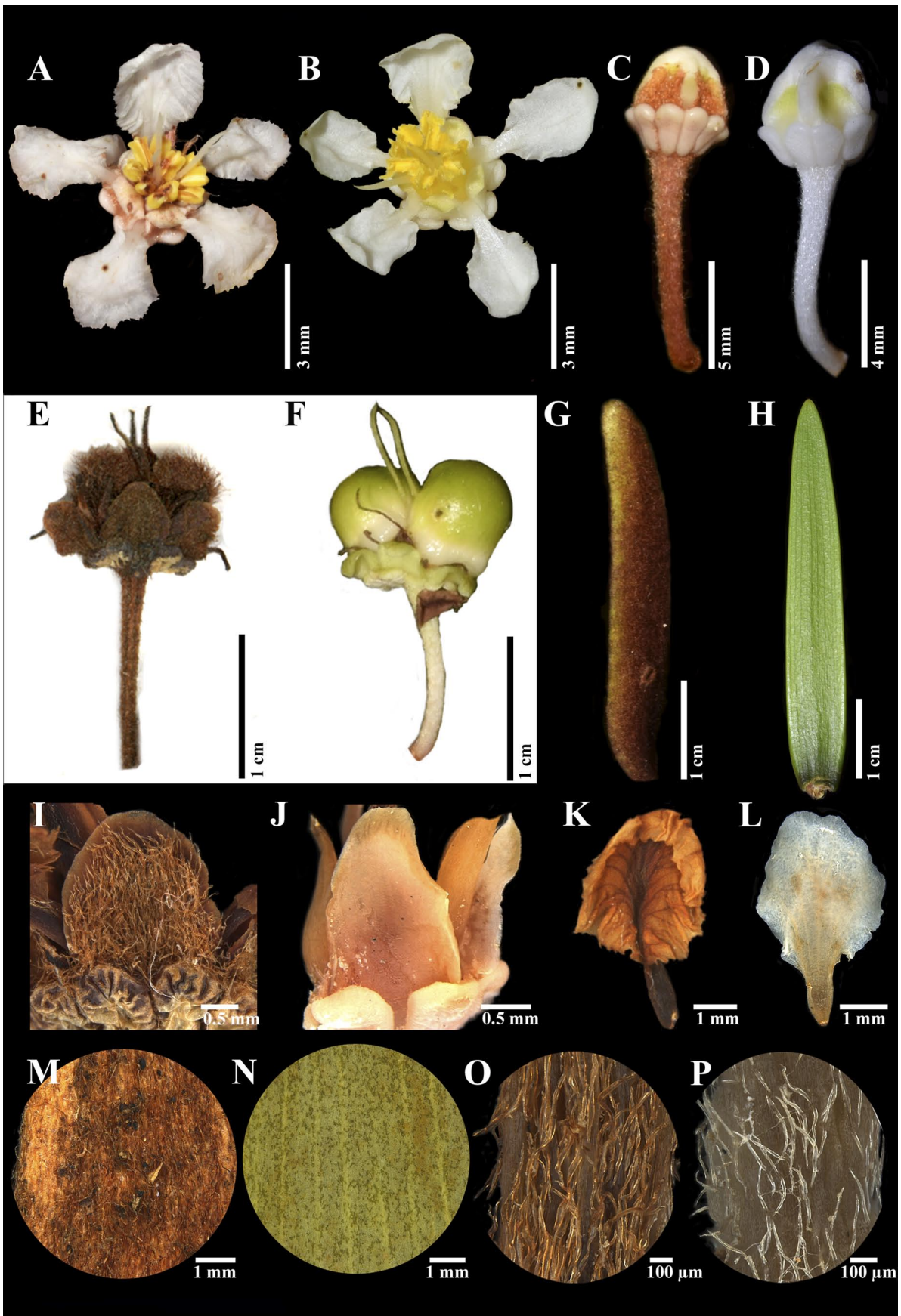


**FIGURE 1.** *Acmanthera latifolia*. **A.** Flowering branch. **B.** Enlargement of abaxial surface of lamina. **C.** Node with scars after fall of stipules. **D.** Stipular sheath with young leaves emerging. **E.** Flower buds on inflorescence axis. **F.** Flower, posterior petal uppermost. **G.** Intact fruit. Plants images from *F. Farroñay 95*.





**FIGURE 2.** *Acmanthera minima*. **A.** Habit. **B.** Leaf surface adaxial. **C.** Enlargement of abaxial surface of lamina. **D.** Glands, adaxial view (above), abaxial view (down). **E.** Intact fruit 3-cocci, adaxial view. **F.** Stamens to show wings and apical appendage, lateral view (left), adaxial view (center), abaxial view (right). **G.** Flowers on inflorescence axis. **H.** Flower (lateral view). **I.** Flower (frontal view) **J.** Fruits on inflorescence axis. Plants images from *Farroñay 1001*.



**FIGURE 3.** *Acmanthera parviflora* and *A. minima*. A–B. Flowers. C–D. Flower buds. E–F. Fruits. G–H. Stipules. I–J. Sepals. K–L. Petals. M–N. Detail of stipule. O–P. Detail of pedicels. (A, C, E, G, I, K, M, O. *Acmanthera parviflora* from Farroñay 185. B, D, F, H, J, L, N, P. *Acmanthera minima* from Farroñay 113, 1001).



3–4 mm long, the stigma apical. Coccus greenish, 3.5–5.2 mm in diameter, spheroidal, sparsely pilose-sericeous, with an inflated, aerenchymatous base. Embryo with the cotyledons thick, unequal, the smaller folded up from the base, the larger embracing it. Pollen grains monad, tricolporate, radially symmetrical, reticulate, spheroidal, tectate, 12–12.5 × 12–12.5 μm.

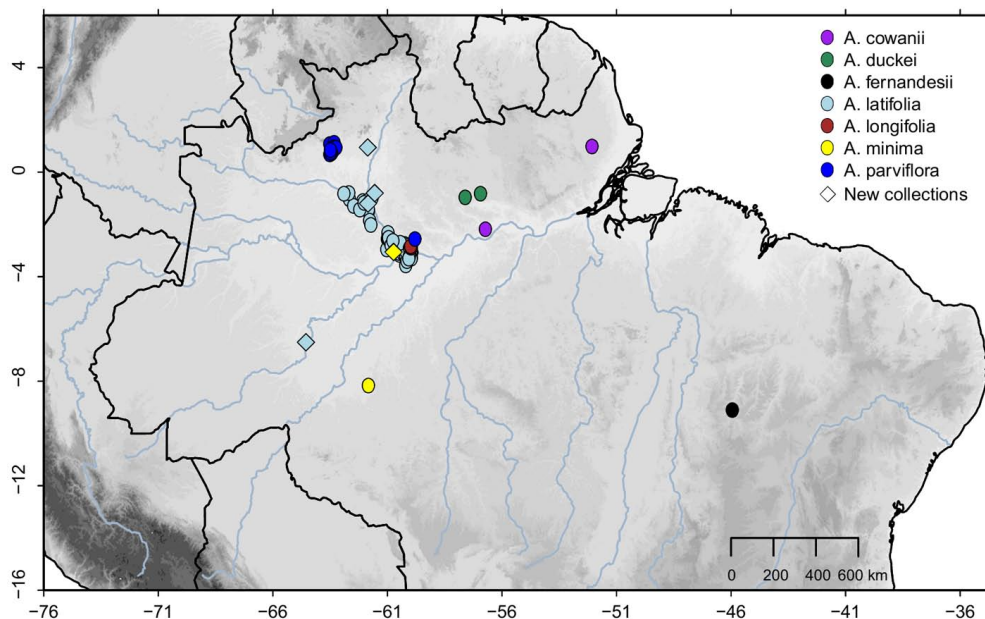
**Distribution and habitat:**—*Acmanthera minima* is endemic in the state of Amazonas, Brazil. It grows in open WSV, usually known as *campinas*, and it is known from only two places: The type locality in Humaita district, currently within the Campos Amazônicos National Park on the Madeira river Basin, the southernmost Amazonian distribution of this genus (Anderson, 1981); in the lower Negro River basin, in an area close to Manaus (Iranduba district), more than 500 km approx. distant from the type locality. The two populations are separated by two major Amazonian Rivers, the Solimões and Madeira (Fig. 4).

**Phenology:**—The fruiting type material was collected in September, and our new records of fruiting specimens were collected in June 2017 and September 2018. Flowering occurs in the dry season, from August to September 2018, coinciding with the highest peak of flowering of the WSV (Alencar 1990). Anderson (1981) mistakenly cited the holotype collection as dating from November, but the correct month is September, as noted on the labels.

**Conservation status:**—*Acmanthera minima* has an EOO of 15431.0 km<sup>2</sup>, AOO of 20 km<sup>2</sup>, and it is known only from two localities, which fits the category Vulnerable, according to criteria B2 from IUCN (2012). The population of *Acmanthera minima* in the SDR Negro River, growing at low densities (82 ind./750m<sup>2</sup>) (Farroñay pers. obs.). Both WSV areas where this species occurs are under constant anthropogenic pressure due to deforestation and white-sand extraction (Adeney *et al.* 2016).

**Comments:**—*Acmanthera minima* was described as the smallest species (60 cm tall) in the genus and was included in sect. *Microglossa*, proposed by Anderson (1975) and comprising 3 additional species: *A. parviflora*, *A. longifolia* Nied. (1914: 32) and *A. fernandesii* W.R. Anderson (1990: 39). These species are endemic to the Amazon Forest, except *A. fernandesii*, which occurs in Cerrado Forest (Fig. 4). Among the species of sect. *Microglossa*, *Acmanthera minima* is morphologically most similar to *A. parviflora*. The differences separating them are emphasized in the amplified descriptions presented and illustrated here (Fig. 3).

**Additional specimens examined:**—BRAZIL. Amazonas: Mun. Iranduba, Reserva de Desenvolvimento Sustentável do Rio Negro, 3°2'44" S, 60°43'41" W, elev. 63 m, 3 Jun 2017 [fr], *F. Farroñay 113* (INPA!); 27 Aug 2018 [fl], *Farroñay 1006* (INPA!); 27 Aug 2018 [fl, fr], *Farroñay 1007* (INPA!); 1 Sep 2018 [fl], *Farroñay 1008* (INPA!); 1 Sep 2018 [fl], *Farroñay 1009* (INPA!).



**FIGURE 4.** Geographical distribution of *Acmanthera* based on herbaria information and Anderson *et al.* (2016). Points of *Acmanthera latifolia* and *A. parviflora* from the Negro River basin are slightly displaced to avoid overlap. New records are represented by the rhomb symbol: light blue for *A. latifolia*, and yellow for *A. minima*.

*Acmanthera parviflora* W.R. Anderson (1975: 47).

Holotype—BRAZIL. Amazonas: Rio Urubú, 12 September 1949, *Fróes 25200* (IAN!; isotype: UB barcode 0037437!). (Fig. 2).

*Treelet* or *tree*, 2–7 m tall; vegetative stems early brown pilose-sericeous, sparsely lenticellate, soon glabrous. *Leaves* initially pilose-sericeous, sparsely sericeous to glabrous at maturity; lamina 12–23 × 4–9 cm, elliptical to obovate, attenuate at the base; apex abruptly acuminate 5–8 mm long; margin entire to slightly revolute, with 15–16 lateral veins interconnected by many fine scalariform veinlets prominent on both sides; petiole 0.8–1.8 cm long; stipules 4–5 × 0.4–0.5 cm, abaxially pilose-sericeous, adaxially glabrous, the 4 at a node completely connate, stipulate sheath flattened, narrowly elliptical in cross-section. *Inflorescence* 7–15.5 cm long, sericeous to pilose-sericeous, internode below the inflorescence 1.5–5 cm long, dark brown pilose-sericeous; leaves subtending the inflorescence similar to vegetative leaves but smaller, the lamina 3.5–9 × 0.7–2.8 cm; petiole 0.3–0.6 cm long; bracts and bracteoles 0.3–0.6 × 0.3–0.6 cm, triangular or elliptical, flat, glandular-callose at base, membranous, glabrous, eventually deciduous. Pedicel 5–10 × 0.3–0.5 mm, sericeous or pilose-sericeous. Sepals pinkish, 1.5–2 × 1.2–1.5 mm, abaxially pilose-sericeous, glabrous at the margin, glands pink, 1.5 mm long, not revolute at apex. Petals whitish pink, glabrous on both sides; claw 1.0–1.2 mm long, limb 2.5–2.9 × 2.0–2.5 mm, minutely denticulate at margin; 4 lateral petals soon reflexed; posterior petal erect, not strongly differentiated from lateral petals, but with a thicker claw and obovate limb. Filaments 1–1.5 × 0.4–0.6 mm; anthers with the locules 0.8–1 mm, the wings 0.7–1 × 2 mm, the apical appendage of connective 0.2–0.3 × 0.2, triangular, flat. Ovary densely pilose, 1 mm high, styles 2.5 mm long, sparsely pilose, with apical stigmas. Coccus reddish, 4–5 × 4–5 mm, spheroid, ventrally flattened, apically rounded, with an inflated rim at the base, densely pilose-sericeous. Pollen grains monad, tricolporate, radially symmetrical, reticulate, subprolate, tectate, 22–22.3 × 18–18.2 µm.

**Distribution and habitat:**—*Acmanthera parviflora* is endemic in the state of Amazonas, Brazil, inhabiting forests at high and low elevations, and has an apparent disjunct distribution (Fig. 4). The type material and one additional collection were recorded in *igapó* forest on the Urubú River near Manaus, Brazil (Anderson, 1975). Prance & Johnson (1992) report the northern distribution of this species in the Serra do Aracá (an outlying sandstone tepui of the Guayana Shield), where it grows in oligotrophic environments (*campo rupestre* and gallery forest along river) on the plateau of this sandstone mountain.

**Phenology:**—Encountered with flowers from July to November, fruiting occurs in February and August.

**Conservation status:**—*Acmanthera parviflora* has an EOO of 2150 km<sup>2</sup>, AOO of 24 km<sup>2</sup>. It is known only from two localities, which makes it fit DD, according to criteria from IUCN (2012).

**Comments:**—*Acmanthera parviflora* is also morphologically similar to *A. fernandesii* in the presence of trichomes on leaves and stipules, but the latter has leaves cordate at base; petioles 1 mm long; stipules 2.8 cm long; anther wings 1.4–1.8 mm long; styles 5.5 mm long. Additionally, our photographic records support the description of the flowers as “roseo esbranquicadas”, as noted on the label of the type collection.

**Additional specimens examined:**—BRAZIL. Amazonas. Mun. Itacoatiara, Rio Urubú, 3°14'30" S, 58°44'43" W, elev. 45 m, 22 Nov 1965 [fl], *W. Rodrigues 7293* (INPA!). Mun. Barcelos, Serra do Aracá National Park, 0°56'54" N, 63°23'20" W, elev. 1200 m, 12 Feb 1984 [fr], *I. Amaral 1524* (INPA!, NY [01039283]!, RB!); 13 Feb 1984 [bu], *A. Tavares 21* (INPA!, NY [01039286]!, RB!); 15 Feb 1984 [fl], *G.T. Prance 29092* (INPA!, NY [01039285]!, RB!); 15 Feb 1984 [fl], *I. Amaral 1582* (INPA!, NY!, RB!); 16 Aug 2011 [fr], *M. Moraes 195* (RB [00766263]!); 17 Aug 2011 [fl], *M. Moraes 213* (RB [00694087]!); 30 Sep 2011 [fl], *Forzza 6584* (RB [00715530]!); 30 Oct 2011 [fl], *G. Martinelli 17239* (RB [00686661]!), 14 Jul 2017 [fl], *F. Farroñay 185* (INPA!).

### Key to the Species of *Acmanthera* (Modified from Anderson 1975)

1. Sepals triangular, acute to obtuse at the apex, completely concealing the petals during enlargement of the bud (Fig. 1. E); appendage of the connective 0.5–1.1 mm long, broad and thick, rounded and glandular at the apex .....2
2. Bracts and bracteoles broadly orbicular and deeply concave, 2.0–4.0 × 2.5–5.0 mm, imbricated around the young bud, often deciduous, with several parallel longitudinal nerves prominent adaxially; petals densely sericeous abaxially .....3
3. Stipules 1.5–3.1 (–4.3) cm long, the stipular sheath plicate, cruciform in cross-section; bracts and bracteoles uniformly chartaceous, densely and uniformly sericeous ..... *Acmanthera latifolia*
- 3'. Stipules 11–12 cm long, the stipular sheath smooth, flattened, very narrowly elliptic in cross-section; bracts and bracteoles chartaceous and sericeous in the center, membranous and glabrous toward the margin ..... *A. duckei*
- 2'. Bracts and bracteoles narrowly triangular and flat, 1.6 × 0.9 mm, often smaller, not at all enclosing the bud, reflexed and persistent, with only the midrib developed and even that obscure; petals sparsely sericeous or glabrous abaxially ..... *A. cowanii*
- 1'. Sepals orbicular, broadly rounded at the apex, already separated in young buds, leaving the petals exposed during enlargement of the bud (Fig. 3. C-D), appendage of the connective up 0.3–0.4 mm long, thin, non-glandular apex .....4

4. Stipules pilose-sericeous or tomentose.....5  
 5. Leaves cordate at base; petiole 1 mm long; stipule 2.8 cm long; anther wings 1.4–1.8 mm long; styles 5.5 mm long *A. fernandesii*  
 5'. Leaves attenuate or cuneate at base; petiole 8–18 mm long, stipule 4–5 cm long; anther wings 0.7–1 mm long; styles 2.5 mm long.....*A. parviflora*  
 4'. Stipules glabrous .....6  
 6. Leaves 23–35 cm long; petiole 1.5–2 cm long; bracts and bracteoles 0.6–0.9 mm long; cocci 9–10 × 7–8 mm.....*A. longifolia*  
 6'. Leaves 12.5–17.5 cm long; petiole 0.6–0.8 cm long; bracts and bracteoles 0.2–0.4 mm long; cocci 3.5–5.2 × 3–5 mm...*A. minima*

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## References

- Adeney, J.M., Christensen, N.L., Vicentini, A. & Cohn-Haft, M. (2016) White-sand Ecosystems in Amazonia. *Biotropica* 48: 7–23.  
<https://doi.org/10.1111/btp.12293>
- Alencar, J.C. (1990) Interpretação fenológica de espécies lenhosas de Campina na Reserva Biológica de Campina do INPA ao Norte de Manaus. *Acta Amazonica* 20: 145–183.  
<https://doi.org/10.1590/1809-43921990201183>
- Anderson, W.R. (1975) The Taxonomy of *Acmanthera* (Malpighiaceae). *Contributions from the University of Michigan Herbarium* 11 (2): 42–50.
- Anderson, W.R. (1978) Byronimoideae, a new subfamily of the Malpighiaceae. *Leandra* 7: 5–18.
- Anderson, W.R. (1981) [“1980”] A New Species of *Acmanthera* (Malpighiaceae). *Systematic Botany* 5 (4): 438–441.  
<https://doi.org/10.2307/2418524>
- Anderson, W.R. (1990) Notes on Neotropical Malpighiaceae—III. *Contributions from the University of Michigan Herbarium* 17: 39–54.
- Anderson, W.R., Anderson, C. & Davis, C.C. (2006) Malpighiaceae. Available from: <http://herbarium.lsa.umich.edu/malpigh/index.html> (accessed 1 September 2018)
- BFG (The Brazil Flora Group) (2015) Growing knowledge: an overview of Seed Plant diversity in Brazil. *Rodriguésia* 66 (4): 1085–1113.  
<https://doi.org/10.1590/2175-7860201566409>
- BFG (The Brazil Flora Group) (2019) Flora do Brasil 2020 em construção. Jardim Botânico do Rio de Janeiro. Available from: <http://floradobrasil.jbrj.gov.br/> (accessed 3 June 2019).  
<https://doi.org/10.1590/2175-7860201566411>
- Buchmann, S.L. (1987) The Ecology of oil flowers and their bees. *Annual Review of Ecology and Systematics* 18: 343–369.  
<https://doi.org/10.1146/annurev.es.18.110187.002015>
- Cardoso, P. (2017) Red - an R Package to Facilitate Species Red List Assessments According to the IUCN Criteria. *Biodiversity Data Journal* 5: e20530.  
<https://doi.org/10.3897/BDJ.5.e20530>
- Davis, C.C. & Anderson, W.R. (2010) A complete generic phylogeny of Malpighiaceae inferred from nucleotide sequence data and morphology. *American Journal of Botany* 97 (12): 2031–2048.  
<https://doi.org/10.3732/ajb.1000146>
- Ferreira, L.V. (2000) Effects of flooding duration on species richness, floristic composition and forest structure in river margin habitat in Amazonian blackwater floodplain forests: implications for future design of protected areas. *Biodiversity & Conservation* 9 (1): 1–14.  
<https://doi.org/10.1023/A:100898981>



- Ferreira, L.V. & Parolin, P. (2007) Tree phenology in central Amazonian floodplain forests: effects of water level fluctuation and precipitation at community and population level. *Pesquisas Botânica* 58: 139–156.
- Giulietti, A.M., Harley, R.M., Queiroz, L.P., Wanderley, M.G. & Van den Berg, C. (2005) Biodiversidade e conservação das plantas no Brasil. *Megadiversidade* 1: 52–61.
- Grisebach, A.H.R. (1858) Malpighiaceae. In: Martius, C.F.P. von, Eichler, A.G. & Urban, I. (Eds.) *Flora Brasiliensis* 12 (1). Fleischer, Leipzig, pp. 28–29.
- IUCN. (2012) IUCN red list categories and criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK.
- Jussieu, A.H.L. (1833 “1832”) Malpighiaceae. In: Saint-Hilaire, A., Jussieu, A.H.L. & Cambessedes, A. (Eds.) *Flora brasiliae meridionalis* (quarto ed.) 3 (22) 5–86. [Paris, apud A. Belin]
- Jussieu, A.H.L. (1838) Malpighiaceae. In: Delessert, J.P.B. (Ed.) *Icones selectae plantarum*, vol. 3. Masson, Paris, pp. 19, pl. 30.
- Jussieu, A.H.L. (1840) Malpighiacearum synopsis, monographiae mox edendae prodromus. *Annales des Sciences Naturelles Botanique* Série 2, 13: 247–291, 321–338.
- Niedenzu, F. (1914) Malpighiaceae americanae III. In: *Arbeiten aus dem botanischen Institut des Kgl. Lyceum hosianum in Braunsberg*, pp. 1–61.
- Parolin, P. (2002) Submergence tolerance vs. escape from submergence: two strategies of seedling establishment in Amazonian floodplains. *Environmental and Experimental Botany* 48 (2): 177–186.  
[https://doi.org/10.1016/S0098-8472\(02\)00036-9](https://doi.org/10.1016/S0098-8472(02)00036-9)
- Prance, G.T. & Johnson, D.M. (1992) Plant Collections from the Plateau of Serra do Aracá (Amazonas, Brazil) and their Phytogeographic Affinities. *Kew Bulletin* 47: 1–24.  
<https://doi.org/10.2307/4110765>
- R Core Team. (2018) *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. Available from: <https://www.R-project.org/> (accessed 26 June 2018)
- Scudeller, V.V. (2018) Do the Igapó trees species are exclusive to this phytophysiognomy? Or Geographic Patterns of tree taxa in the Igapó Forest-Negro River-Brazilian Amazon. In: Myster, R. (Eds.) *Igapó (Black-water flooded forests) of the Amazon Basin*. Springer. pp. 185–207.  
[https://doi.org/10.1007/978-3-319-90122-0\\_12](https://doi.org/10.1007/978-3-319-90122-0_12)
- Thiers, B. (2018 [continuously updated]) *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden’s Virtual Herbarium. Available from: <http://sweetgum.nybg.org/science/ih/> (accessed 13 November 2018)