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Notes on the seedling morphology of *Pouteria franciscana* Baehni (Sapotaceae)

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ABSTRACT

Seedling morphology studies have contributed to provide useful data in delimiting different levels of taxonomic groups over the past several decades. Thus, the purpose of this note is to describe on the seedling morphology of *Pouteria franciscana* Baehni (known as "abiurana"), a native Sapotaceae species from the floodplain forests of the Amazonian estuary. For the seedling morphology study, ripe fruits were collected in Mazagão municipality, AP, Brazil. The diagnostic character combination of plano-convex cotyledons (green to purple), included radicle in cotyledons, absent endosperm, and PHR seedling type may help indicate the phylogenetic position of *P. franciscana* based on the recent phylogeny of Neotropical Chrysophylloideae.

Keywords: "Abiurana"; Amazonian estuary; Chrysophylloideae; Taxonomy; *Várzea* forest.

Notas sobre a morfologia de plântulas de *Pouteria franciscana* Baehni (Sapotaceae)

RESUMO

Estudos de morfologia de plântulas contribuíram para fornecer dados úteis na delimitação de diferentes níveis de grupos taxonômicos nas últimas décadas. Assim, o objetivo desta nota é fornecer uma descrição sobre a morfologia das plântulas de *Pouteria franciscana* Baehni (vulgarmente conhecida como "abiurana"), uma espécie de Sapotaceae nativa das florestas de várzea do estuário amazônico. Para o estudo da morfologia das plântulas, frutos maduros foram coletados no município de Mazagão, AP, Brasil. A combinação de caracteres diagnósticos de cotilédones plano-convexos (esverdeados a violáceos), radícula incluída nos cotilédones, ausência de endosperma e plântulas do tipo PHR pode ser útil na indicação da posição filogenética de *P. franciscana* com base na recente filogenia de Chrysophylloideae Neotropical.

Palavras-chave: Abiurana, Estuário amazônico, Chrysophylloideae, Taxonomia, Floresta de Várzea.

Introduction

Sapotaceae Juss. is a pantropical woody family divided into three subfamilies: Chrysophylloideae Luerss., Sapotoideae Eaton, and Sarcospermatoideae (Lam) Swenson & Anderb. It is composed of 58 genera and about 1250 species (GOVAERTS et al., 2001; PENNINGTON, 1991; SWENSON; ANDERBERG, 2005; SWENSON et al., 2007). In Brazil, Sapotaceae is represented by 12 genera and approximately 230 species, which occur across a wide variety of habitats, including evergreen to deciduous forests in the Caatinga, Cerrado, Pampa, Pantanal, Amazonia, and Atlantic Coast biomes; the last two being the major centers of diversity for some genera (ALVES-ARAÚJO et al., 2014; BFG, 2015, 2018; PENNINGTON, 1990, 2006; TERRA-ARAUJO et al., 2013; VASCONCELOS et al., 2020a, 2020b).

Pouteria Aubl. is the largest genus of Chrysophylloideae in the Neotropics, with approximately 200 known species that occur in a broad range of habitats, such as lowland rainforests on either white-sand or clayish soils throughout South America (PENNINGTON, 1990, 1991, 2006). Of all Amazonian flora, *Pouteria* is amongst the 10 top most species-rich tree genera (CARDOSO et al., 2017; TER STEEGE et al., 2016). In the Amazonian floodplain forests along the estuary of Amapá state, most of *Pouteria*'s exploited timber species are vulgarly known as "abiurana", and this timber is used by the riverine communities for construction purposes (e.g. houses and pigsties) (QUEIROZ; MACHADO, 2007).

In general, it is very difficult to accurately identify *Pouteria* spp. because there are a large number of species with many morphological variations (PENNINGTON, 1990; VASCONCELOS, 2015). Also, this genus is highly polyphyletic with natural boundaries still unresolved (FARIA et al., 2017). Growing evidences demonstrate that *Pouteria sensu* Pennington (1990, 1991) is unlikely to be maintained with such a delimitation (SWENSON; ANDERBERG, 2005; BARTISH et al., 2005; TRIONO et al., 2007, SWENSON et al., 2008, 2013).

The seedling (early stage of plant development after germination) has long been studied under a taxonomic view (BURGER HZN, 1972; DE VOGEL, 1980; DUKE, 1969; GARWOOD, 2009). Seedling morphology studies have contributed to provide useful data in delimiting different levels of taxonomic groups, especially in Fabaceae (ABOZEID et al., 2017; LÓPEZ et al., 1998; RODRIGUES; TOZZI, 2008), Iridaceae (TILLICH, 2003), Burseraceae (MELO et al., 2007), and Malpighiaceae (BARBOSA et al., 2014). In a floristic context, seedling morphological data allow the indetification of taxa at early stages of development, and are also relevant to plant ecology and conservation studies (GARWOOD, 1996).

Although there are few data concerning seedling morphology of New World *Pouteria*, some studies have demonstrated that seedling morphology is helpful for species-level identifications for some African *Pouteria* (BOKDAM, 1977) and, more recently, for some Amazonian species of Sapotaceae (VASCONCELOS, 2017). Thus, the purpose of this note is to provide a description of the seedling morphology of *Pouteria franciscana* Baehni as well as useful morphological characters and illustrations.

Material and methods

Samples of *P. franciscana* with ripe fruits (Figure 1A–C) were collected at the Experimental Research Station of Embrapa Amapá in Mazagão municipality (0°06'37" S, 51°16'35" W), AP, eastern Amazonia, Brazil (Figure 2). The area is located in the Amazonian estuary, with a predominance of tidal floodplain forests, classified as Alluvial Dense Ombrophilous Forest (IBGE, 2012). The climate type of the region is considered Am (tropical monsoon), according to Köppen-Geiger (ALVARES et al., 2013), with the following mean annual values: precipitation, 2549.7 mm; temperature, 23.8–31.5 °C, and relative humidity, 82.2% (INMET, 2018). The dominant soil type is Typical Eutrophic Ta Melanic Gleysol, shallow, silty, and fertile and it may show some level of acidity, toxicity, and deficiency of certain nutrients (PINTO, 2014).

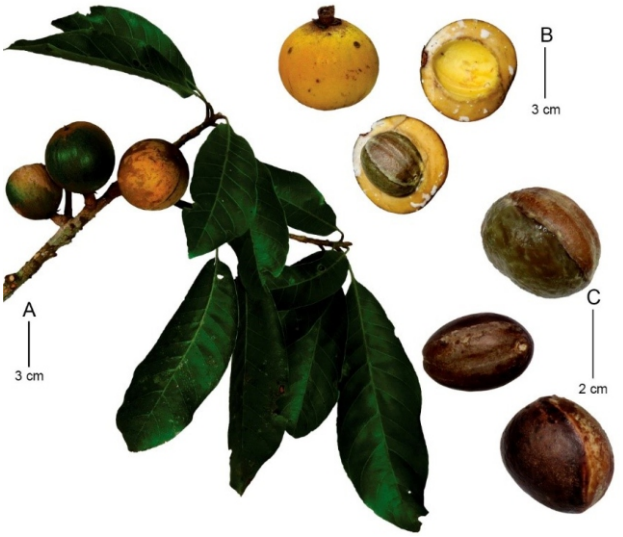

Figure 1. Samples of *Pouteria franciscana* from Amazonian estuary. **A** fruiting branch; **B** fruit; **C** seeds. Photos by Janaina B.P. Costa / **Figura 1.** Amostras de *Pouteria franciscana* do estuário amazônico. **A** Ramo com frutos; **B** fruto; **C** sementes. Fotos por Janaina B.P. Costa.

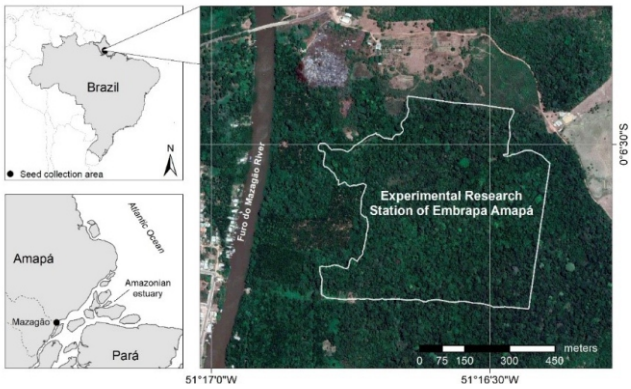

Figure 2. Map showing the *Pouteria franciscana* seed collection area in Amapá state, Brazil / **Figura 2.** Mapa mostrando a área de coleta das sementes de *Pouteria franciscana* no estado do Amapá, Brasil.

Photographs were taken with a Canon PowerShot SX 50 HS camera, the microscopic details with a stereoscope Leica model EZ4D, with a camera coupled (Wetzlar, Germany). Measurements were taken using a digital caliper Carbografite model 150 mm (Rio de Janeiro, Brazil). The terminology follows Harris and Harris (2001), Camargo et al. (2008), and Garwood (2009).

For germination and seedling morphology study, seeds were germinated on plastic trays with sterilized sand (at 150 ºC) and vermiculite (1:1). The seeds were sown under the same light (50% shading) and temperature in greenhouse conditions at Embrapa Amapá, Macapá municipality, AP. The criteria adopted for seed germination was "aerial part emergence" and for seedling formation was "the first expanded leaf (or pair of leaves)" following Camargo et al. (2008). Qualitative and quantitative characters were recorded until the complete development of the third leaf node above cotyledons. Seedling functional types were analyzed according to Pérez-Harguindeguy et al. (2013).

All morphological descriptions presented were based on a single population of this species, which was first recorded in Amapá state by Vasconcelos et al. (2020a). Therefore, morphological features may exhibit some variation among individuals from different populations and regions. The voucher specimens were deposited at the IAN and VIES herbaria: adult plant *C.C. Vasconcelos et al. 2* (IAN 192792, VIES 037630) and seedling *C.C. Vasconcelos et al. 2* (IAN 193215).

Seedling morphology

Initial development. Germination starts with the rupture of the seed coat about 29 days after sowing, followed by the primary root protrusion occurring five days later (34th day). Hypocotyl does not develop. Fleshy cotyledons unfold or remain partially enclosed for a certain time, with the seed coat still attached. The aerial part emergence occurs on the 48th day with the epicotyl going through a brief curvature phase, later becoming erect. Seedling formation occurs 11 days later (59th day), with the emergence of the first leaf pair and the next leaves, later (see Figure 3A–E). Cotyledons longevity is approximately five months. Seed germination and seedling formation are 100% and 70.8%, respectively, with 23.5% of albino seedlings.

Seedling description. Seedling type Phanerocotylar-Hypogeal-Reserve (hereafter PHR), which the cotyledons are specialized for reserve storage or uptake (*sensu* GARWOOD, 2009). Cotyledons plano-convex, green to purple, radicle included in cotyledons; endosperm absent. Epicotyl 10.4–19.2 cm long, cylindrical, sometimes canaliculate near the first leaf node, green-brownish, usually with brown or ferruginous malpighiaceous hairs (trichomes) and brownish lenticels mainly around the base. First node with opposite or subopposite leaves; petiole 0.2–0.5 cm long, green-brownish, with similar trichomes to the epicotyl; blades 6.4–17.4 × 3.4–4.1 cm, oblanceolate, occasionally elliptic or oblong, chartaceous, dark greenish on the upper surface and light greenish on the lower surface, with trichomes similar to epicotyl, especially along primary and secondary veins on the lower blade surface; base cuneate; apex acute or acuminate; leaf margin slightly revolute; venation eucamptodromous, usually brochidodromous near the apex; midrib slightly raised on the upper surface, secondary veins with 14–16 pairs, arcuate; intersecondary veins rare; tertiary veins reticulate. The next leaf nodes are similar to the first leaf pair, but the leaves are spirally arranged and larger. Internodes with a similar surface to the epicotyl. Stipules and cataphylls absent. Axillary bud 7 mm long, showing small tufts (dense indument). Apical bud 23 mm long, conical, densely covered by trichomes similar to the epicotyl. Vernation conduplicate. Latex whitish in all seedling parts. See Figure 3C–H.

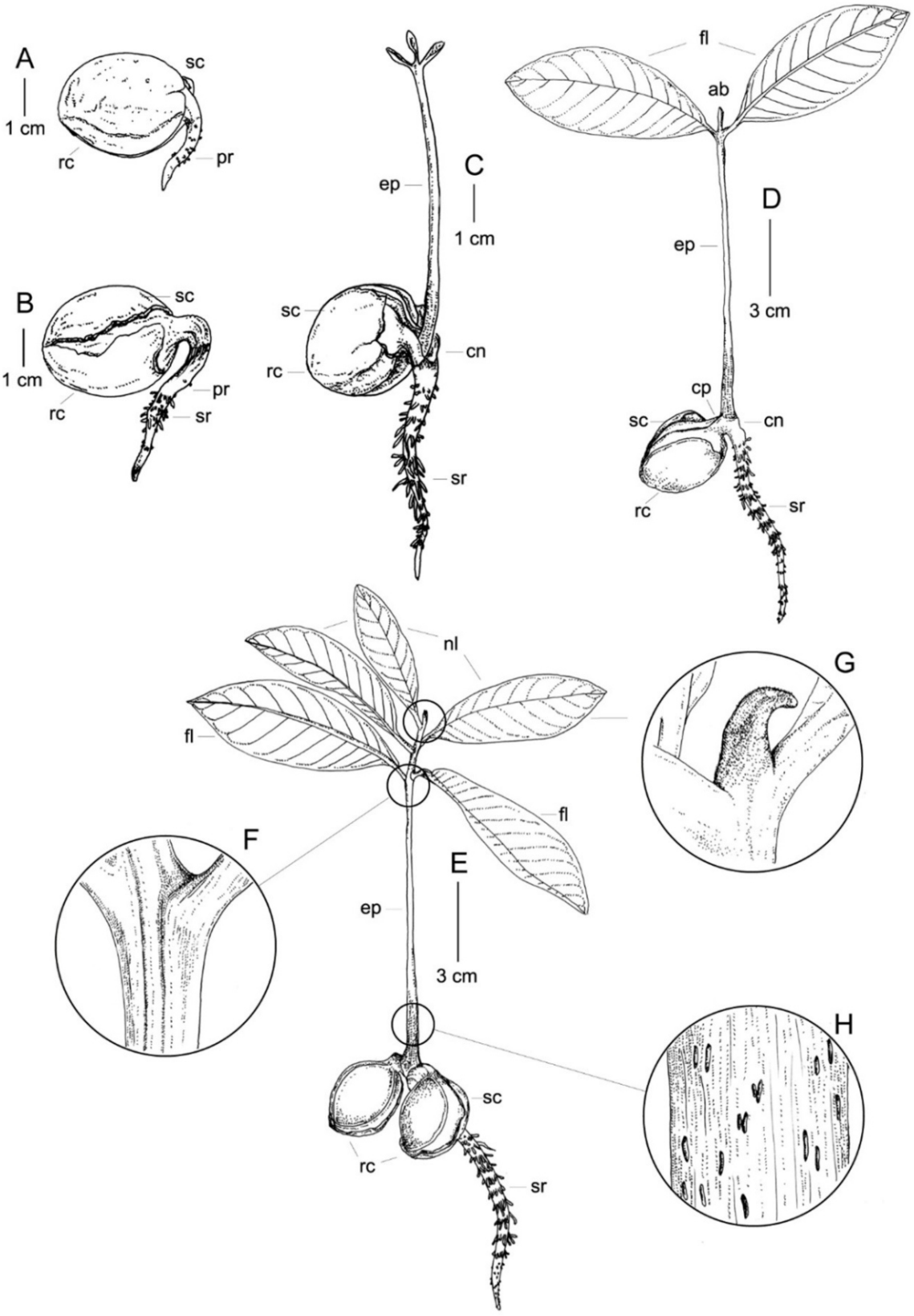

Figure 3. Seedling development of *Pouteria franciscana*. **A** primary root protrusion; **B** secondary root development; **C** epicotyl emergence; **D** expansion of first leaf pair; **E** development of next leaves nodes; **F** detail of canaliculate epicotyl; **G** detail of apical bud pubescent; **H** detail of lenticels on epicotyl. ab: apical bud. cn: cotyledonary node. cp: cotyledonary petiole. ep: epicotyl. fl: first leaf pair. nl: next leaves. pr: primary root. rc: reserve cotyledons. sc: seed coat. sr: secondary root. Drawn by Marisabel U. Adrianzén / **Figura 3**. Desenvolvimento da plântula de *Pouteria franciscana*. **A** protrusão da raiz primária; **B** desenvolvimento de raiz secundária; **C** emergência de epicótilo; **D** expansão do primeiro par de folhas; **E** desenvolvimento dos próximos nós foliares; **F** detalhe do epicótilo canaliculado; **G** detalhe da gema apical pubescente; **H** detalhe das lenticelas no epicótilo. ab: gema apical. cn: nó cotiledonar. cp: pecíolo cotiledonar. ep: epicótilo. fl: primeiro par de folhas. nl: próximas folhas. pr: raiz primária. rc: cotilédones de reserva. sc: tegumento da semente. sr: raiz secundária. Desenhado por Marisabel U. Adrianzén.

Taxonomic note. In the recent phylogenetic study performed on Neotropical Chrysophylloideae, the monophyletic groups were called clades "A–Q" (FARIA et al., 2017: Fig. 2). Results from this study suggest that *Pouteria* sections *Oxythece* and *Rivicoa* are the only monophyletic groups that correspond to Pennington's classification, whereas sections *Antholucuma*, *Franchetella*, and *Pouteria* are polyphyletic. In this background, within *Pouteria* s.s. (*sensu* FARIA et al., 2017), the clade Q corresponds to *Pouteria* section Oxythece.

Pouteria s.s. is distinguished on a combination of characters that includes a non-papillate corolla lobe margin, presence of staminodes, and seeds with plano-convex cotyledons having an included radicle and no endosperm (FARIA et al., 2017). Although, the morphology has repeatedly been demonstrated to

be homoplastic in Sapotaceae (SWENSON et al., 2008), the diagnostic character combination of plano-convex cotyledons (green to purple), included radicle in cotyledons, absent endosperm, and PHR seedling type may suggest that *P. franciscana* be recovered in the clade Q in future studies. This suggestion is also based on the results from Vasconcelos (2017) that identified morphological characters from fruits, seeds, and especially seedlings that would support clades in the phylogeny of Chrysophylloideae suggested by Faria et al. (2017).

The seedling functional types described for *Pouteria* s.s. are CHR (Cryptocotylar-Hypogeal-Reserve), PER (Phanerocotylar-Epigeal-Reserve), and PHR (GARWOOD, 2009; VASCONCELOS, 2017). The CHR type appears to be predominant in clades J, L (= *Chromolucuma*), O, and outside of *Pouteria* s.s in clade I (= *Pouteria* species, which eventually could be resurrected as *Lucuma*). The PER type occurs in clades K (= *Pradosia*), M and P. The PHR type appears to be predominant in clades N and Q, but unlike the species of clade Q, the species in clade N usually having sessile fruits and ornamented exocarp (e.g. *Pouteria torta* and *P. hispida*) (VASCONCELOS, 2017).

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