A new endemic species of *Amyris* (Rutaceae) from the Magdalena River Valley in Colombia

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Abstract. ***Amyris pacis***, a new species from the Magdalena River Valley in Colombia, is described and illustrated, including comments about its geographical distribution, habitat, phenology, conservation status and taxonomic affinities. The new species appears to be closely related to *A. trimera* due to its unifoliolate leaves and trimerous flowers, but differs from it by its longer leaflet blades with the base rounded to subtruncate, or occasionally subcordate (vs. cuneate), and secondary veins slightly ascending (vs. more strongly ascending). Being a threatened and endemic species, and one of the few species with trimerous flowers, it should be included in further studies to determine appropriate conservation plans and to improve knowledge about the morphology of species with trimerous flowers in Neotropical Rutaceae.

Keywords: Amyridoideae, plant taxonomy, Sapindales, threatened species, trimerous flowers.

Resumen. ***Amyris pacis***, una nueva especie proveniente del valle del río Magdalena en Colombia, es descrita e ilustrada, incluyendo comentarios sobre su distribución geográfica, hábitat, fenología, estado de conservación y afinidades taxonómicas. La nueva especie parece estar estrechamente relacionada con *Amyris trimera* por la presencia de hojas unifolioladas y flores trímeras, pero se diferencia de ella por sus láminas foliolares más largas con la base redondeada a casi truncada, o en ocasiones ligeramente cordada (vs. cuneada), y venas secundarias ligeramente ascendentes (vs. más fuertemente ascendentes). Debido a que es una especie endémica y amenazada, y una de las pocas con flores trímeras, sería interesante incluirla en estudios posteriores para determinar planes de conservación adecuados y mejorar el conocimiento sobre la morfología de especies con flores trímeras en las Rutaceae Neotropicales.

Amyris P.Browne is an American genus of Rutaceae comprising ca. 50 species distributed from the southern United States and the Antilles to Bolivia (Gereau, 1991; Cornejo & Kallunki, 2009). The species of *Amyris* are recognizable for being unarmed shrubs or trees (sometimes spinescent on the axillary buds or apex of leaflets) with unifoliolate, trifoliolate or more foliolate imparipinnate (sometimes palmately trifoliolate) leaves, axillary or terminal inflorescences, actinomorphic, diplostemonous flowers, free petals, the androecium free from the corolla, the anthers with a glandular connective, a unicarpellate gynoecium, and indehiscent drupaceous single-seeded fruits (Gereau, 1991; Kubitzki et al., 2011; Hernández-Barón et al., 2018).

Amyris is part of Amyridoideae Link, a subfamily restricted to the Americas and recently re-established through phylogenetic analyses (Appelhans et al., 2021). A close phylogenetic affinity between *Amyris* and Old World Rutaceae (Aurantieae Rchb.) was hypothesized by Urban

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(1896) in his revision of *Amyris*, and recently mentioned by Groppo et al. (2012) in their phylogenetic analyses of the family. Subsequently, Appelhans et al. (2021) showed that Amyridoideae is indeed more closely related to groups distributed in the Old World, such as Aurantioideae Eaton and Haplophylloideae Appelhans, Bayly, Heslewood, Groppo, Verboom, P.I.Forst., Kallunki & Duretto, than to other Neotropical Rutaceae.

Amyris is most diverse in the Antilles, Mexico, and Central America. Only eight species were accepted by Gereau (1991) for South America, and three new species were subsequently described (Cornejo, 2009; Cornejo & Kallunki, 2009; Palacios, 2015). For Colombia, six species have been recently reported (Idárraga, 2011; Gradstein & Bernal, 2016), these mainly occurring in equatorial climates (climate type A in Kottek et al., 2006). The type of a seventh species, *A. trimera* Krug & Urb., was collected in Colombia (Urban, 1896), but that species was not included in the synopsis of Gereau (1991) or in recent regional floristic treatments (Idárraga, 2011; Gradstein & Bernal, 2016).

Our ongoing taxonomic studies of Rutaceae in Colombia recently revealed the existence of a new endemic species of *Amyris* in the Magdalena River Valley, which is herein described and illustrated. Discussion of its geographical distribution, habitat, phenology, conservation status and taxonomic affinities is provided.

Materials and methods

All names listed under *Amyris* and morphologically similar genera (e.g. *Stauranthus* Liebm.) were consulted in the Tropicos database (Tropicos.org, 2021), and their original descriptions, types, when available through the JSTOR Global Plants project (http://plants.jstor.org) or respective virtual herbaria, were examined. Representative specimens in the MO and Colombian herbaria CAUP, COL, CUVC, FMB, HUA, HUQ, ICESI, JAUM, MEDEL, TOLI, TULV, VALLE were examined in-person, while specimens in UDBC were studied as digital images (acronyms according to Thiers, 2016). The six specimens of the new species cited herein are deposited in COL, HUA, JAUM and UDBC.

The description and illustration of the new species are based on examination of herbarium specimens, with the aid of a stereomicroscope. Flower and fruit measurements were taken from rehydrated material. Terminology for venation patterns follows Ellis et al. (2009). Measurements and observations of *Amyris trimera* were taken from the protologue of that species (Urban, 1896: 610–611), and from a digital image of original material for the species at LE (LE 00014654) and analyzed with the software AxioVision 4.8.2.0.

The geographical distribution map was made using ArcGIS 10.5, and the conservation status was evaluated according to the categories and criteria of IUCN (2012) and assessed by the R package "ConR" (Dauby, 2019).

Taxonomic treatment

Amyris pacis Londoño-Ech., A.M.Trujillo & Gereau, **sp. nov.**—Type: Colombia, Santander, mun. Girón: sector Trigueros, parte alta arriba de la carretera nueva Bucaramanga–Barranca, 7°5′47.59″N, 73°22′26.38″W, 470 m, 1 Apr 2017 (fr.), *H. David et al. 5807* (holotype: HUA no. 213430 barcode HUA 0014753 [!]). (Figs. 1 and 2.)

Diagnosis.—Haec species *Amyridi trimerae* Krug & Urb. quoad folia unifoliolata et flores trimeros similis, sed ab ea lamina foliolari longiore [(9.8–)11.9–17.6(–21.3) vs. 4–10.2 cm longa], basi rotundata usque subtruncata vel interdum subcordata (vs. cuneata) ac venis secundariis leviter adscendentibus cum costa angulum 40°–73° formantibus (vs. valde adscendentibus angulum 13°–41° formantibus) distinguitur.

Shrub or tree 3–10 m tall, glabrous throughout; branchlets lenticellate, with interspersed zones of bud scales clustered in rings; bud scales 1.7–2.1 × 1.8–2.5 mm, apiculate at apex, transversely oblong below the apiculum, caducous. *Leaves* alternate, 1-foliolate; petiole (0.6–) 1.7–4.1 (–5.3) cm long, terete, pulvinulate at base, with inconspicuous longitudinal ribs, glandular-punctate; petiolule (1.9–) 2.3–4.2 (–6.3) mm long, terete, wrinkled in dried material; blade (9.8–) 11.9–17.6 (–21.3) × (5–) 6.2–8.6 (–9) cm, ovate or occasionally elliptic; base rounded to subtruncate, occasionally subcordate, basal insertion on petiolule symmetrical or occasionally slightly asymmetrical; apex acute to broadly acuminate, frequently mucronate or slightly retuse; glandular-punctate, the glands more evident on abaxial surface; margin entire, slightly revolute; midvein abaxially prominent, wrinkled at insertion on petiolule and striate toward apex, adaxially

Fig. 1. Holotype of *Amyris pacis*.

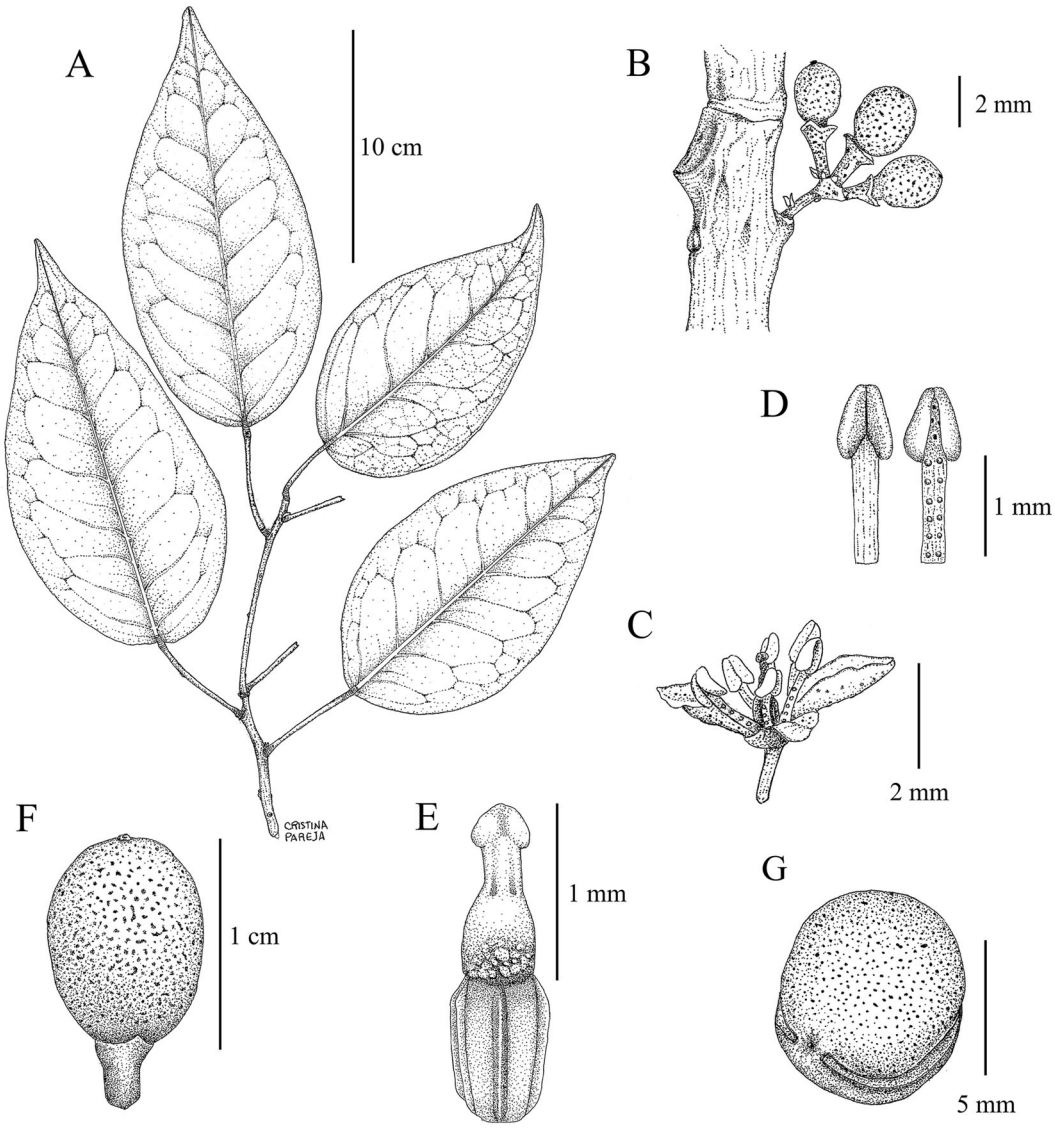

Fig. 2. *Amyris pacis.* **A.** Habit. **B.** Fruiting raceme. **C.** Flower. **D.** Stamen, adaxial and abaxial view. **E.** Disc and gynoecium. **F.** Fruit. **G.** Cotyledons. [A, C–E from *D. A. Zapata et al. 1986*; B from *J. P. Tobón & L. Torralba 2209;* F from *H. David & L. A. Figueroa 5155;* G from the holotype. Drawn by Ana C. Pareja, HUA illustrator.].

impressed to prominulous; secondary veins 7–11, abaxially prominent, adaxially prominulous, eucamptodromous basally, becoming brochidodromous distally, slightly ascending, forming a 40°–73° angle with midvein; intersecondary veins present, tertiary veins reticulate, marginal vein present, of same thickness as tertiary veins. *Inflorescence* a short solitary raceme or a fascicle of short racemes, usually axillary, occasionally terminal or extra-axillary, borne on leafy branchlets or occasionally on leafless branchlets, main axis including peduncle 2.3–3.9 mm long; bracts 0.8–1.2 × ca. 0.5 mm, ovate, apex acute, margin erose, arising below pedicel insertion; bracteoles 2 at base of pedicels, ca. 0.5 × 0.3 mm, ovate, apex acute, margin erose; pedicels 1–1.8 mm long, terete. *Flowers* 3-merous; sepals 3, 0.5–0.9 mm long, connate 0.2–0.5 mm at base, lobes 0.5–

1 mm wide, ovate, acute at apex, margin erose; petals 3, 2.6–3.1 × 1.2–1.6 mm, elliptic, apex acute to rounded, cucullate, white, glandular-punctate, erect at anthesis, margin erose; stamens 6 (3 antesepalous and 3 antepetalous), subequal, the antesepalous slightly longer than the antepetalous, filaments 1.1–1.8 × 0.2–0.3 mm, linear, complanate, inserted at base of disc, glandular-punctate, anthers 0.7–0.9× 0.4–0.6 mm, ovate, dorsifixed, connective abaxially with 1–4 glands, glands ca. 0.1 mm long, elliptic or orbicular, thecae narrowly ovate, free at base; disc ca. 0.8 mm high, 6-ribbed, glandular-punctate; gynoecium ca. 1 mm high, ovary ca. 0.5 × 0.4 mm, ovoid, 1-carpellate, style ca. 0.2 × 0.2 mm, terete, stigma 0.3 × 0.3 mm, capitate. *Fruit* a drupe 7.7–10.3 × 6.7–10.2 mm, spheroid to ellipsoid, rugose, black at maturity; *seed* ca. 8.5 × 7.2 mm, spheroid, testa papery, embryo straight, cotyledons planoconvex, thick.

Distribution and habitat.—*Amyris pacis* is endemic to Colombia, where it has been collected only in the Magdalena River Valley Biogeographic Region (Bernal, 2016), along the western foothills of the Cordillera Oriental, in the municipalities of Betulia and Girón in Santander Department and the municipality of La Esperanza in Norte de Santander Department (Fig. 3). This species inhabits disturbed forest patches in Equatorial climates (Am, Aw climate types; Kottek et al., 2006), at elevations of 202–470 m.

Phenology.—Herbarium specimens indicate flowering in October and fruiting in October and between February and April.

Etymology.—The epithet "*pacis*" means "of peace". It refers to the hope for a permanent peace in Colombia, as well as a peace process that allows conservation of the biodiversity of the country.

Conservation status.—The species appears to have a very limited geographical distribution (EOO =119 km^2, AOO =12 km^2). Of the six collection localities, five are geographically clustered in Santander and may belong to a single population separated from the other known population in Norte de Santander by more than 50 km distance. Only one collection locality is located inside a protected area. Two others are under direct threat of habitat loss, as suggested by the following factors: small area of habitat fragments (<10 km^2), distances of less than 30 km from populated centers, location within a petroleum concession (one site) or possibly impacted by a recent hydroelectrical project (the other site), and the fact that the Magdalena River Valley is one of the deforestation hotspots of Colombia (Sanchez-Cuervo & Aide, 2013), where deforestation exceeds 81,000 ha/year (Idárraga et al., 2016). Therefore, *Amyris pacis* is given a preliminary assessment of Endangered (EN) under Red List criterion B: B1ab(iii)+2ab(iii) (IUCN, 2012).

***Additional specimens examined.*—COLOMBIA. Norte de Santander:** mun. La Esperanza: Límite entre las Veredas Morrocoyes y Raiceros, 7°37′11.32″N, 73°22′38.94″W, 202 m, 28 May 2021 (st.), *A. E. Ojeda 1344* (HUA). **Santander:** mun. Betulia: sector puente el tablazo, en la parte media, 7°2′2.34″N, 73°20′29.89″W, 460 m, 11 Feb 2015 (im. fr.), *H. David & L. A. Figueroa 5155* (HUA); El Tablazo, a un costado del puente sobre la vía San Vicente de Chucurí-Lisboa, 7°2′45.4″N, 73°20′22.2″W, 400 m, Mar 2017 (im. fr.), *J. P. Tobón & L. Torralba 2209* (JAUM); El Tablazo, a un costado del puente sobre la vía a San Vicente de Chucurí, 7°2′8.8″N, 73°20′32.1″W, 383 m, 13 Oct 2016 (fr.), *D. A. Zapata et al. 1891* (COL [image], UDBC [image]). Mun. Girón: finca Cruces, sector Puerto La Cruz, vía Barrancabermeja-Bucaramanga, 7°5′23.1″N, 73°22′31.8″W, 408 m, 15 Oct 2016 (fl.), *D. A. Zapata et al. 1986* (JAUM).

The assignment of the new species in *Amyris* is supported by its actinomorphic and diplostemonous flowers, free petals, androecium free from the corolla, anthers with glandular connective, unicarpellate ovary, and indehiscent, drupaceous single-seeded fruit. Based on its unifoliolate leaves and trimerous flowers, *Amyris pacis* appears to be closely related to *A. trimera*, a geographically proximal species from Norte de Santander Department, Colombia. Gereau (1991) described another species, *A. macrocarpa*, as also having unifoliolate leaves and a trimerous calyx, but other vegetative and reproductive characters distinguish it from *A. pacis* and *A. trimera*; see Table 1 for comparative characters among these three species.

With the discovery of the new species, six species of *Amyris* are known from Colombia: *A. balsamifera* L., *A. ignea* Steyerm., *A. pacis*, *A. pinnata* Kunth, *A. sylvatica* Jacq., and *A. trimera*. Previous records of *A. crebrinervis* Gereau and *A. macrocarpa* Gereau in Colombia by Idárraga (2011) and Gradstein and Bernal (2016), were based on dubiously identified incomplete specimens. *Amyris pacis*, being a threatened endemic species, deserves more detailed study of its conservation status and ecology to determine appropriate conservation actions.

In the original description of *Amyris trimera*, both staminate and pistillate flowers were reported, which were described respectively as having the

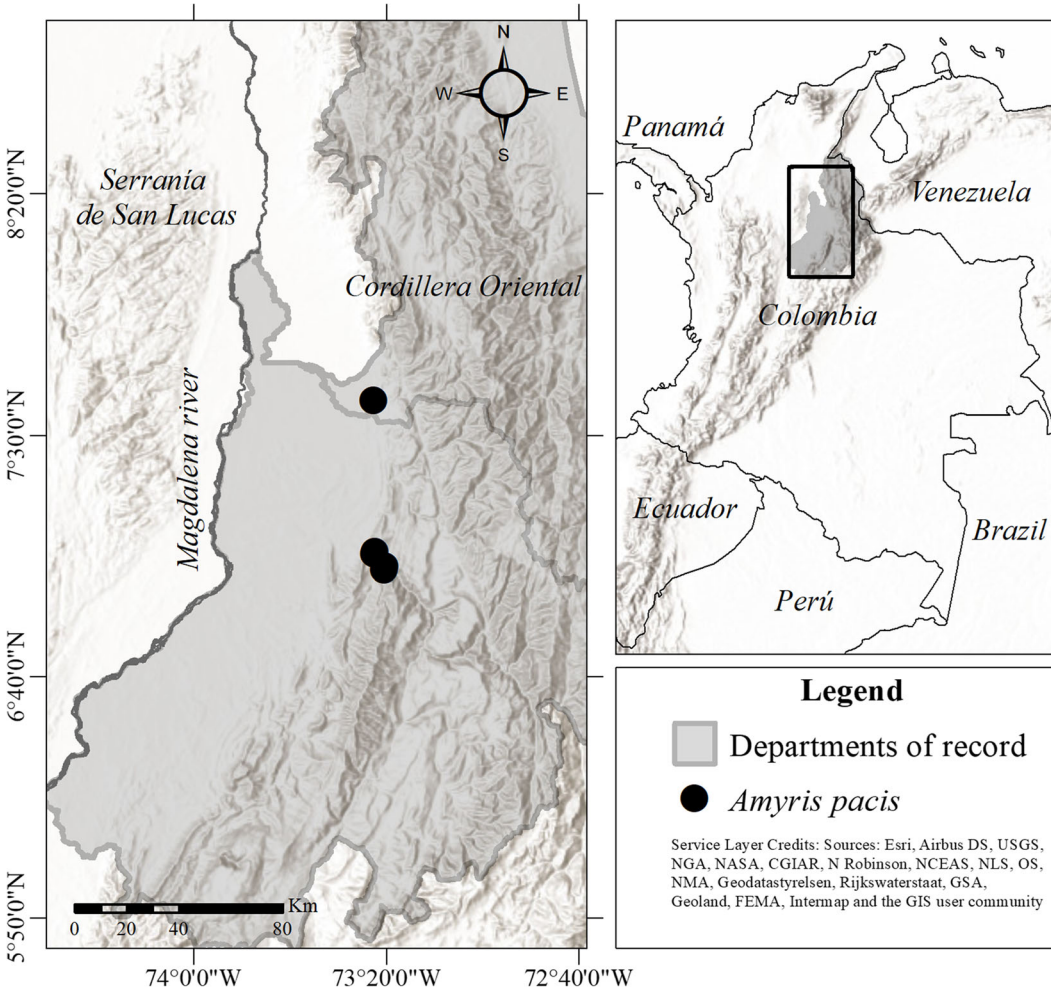

Fig. 3. Geographical distribution of *Amyris pacis*. Departments of record from north to south: Norte de Santander and Santander.

Table 1. Comparative characters of *Amyris macrocarpa*, *A. pacis*, and *A. trimera*.

	A. macrocarpa	*A. pacis*	*A. trimera*
Petiole length (cm)	0.3–1	(0.6–) 1.7–4.1 (–5.3)	(0.8–) 1.3–1.9 (–2.5)
Leaflet length (cm)	9.5–16.3	(9.8–) 11.9–17.6 (–21.3)	4–10.2
Leaflet width (cm)	3.3–4.8	(5–) 6.2–8.6 (–9)	(1.5–) 2–4 (–4.9)
Shape of leaflet base	cuneate	rounded to subtruncate, occasionally subcordate	cuneate
Number of secondary veins	7–11 (–15)	7–11	4–7
Angle between secondaries and primary veins (°)	47–71	40–73	13–41
Inflorescence length (mm)	up to 14	2.3–3.9	3.9–13
Drupe length (mm)	12–17	7.7–10.3	unknown

gynoecium and androecium remarkably reduced, although in the former, the gynoecium still developed ovules (Urban, 1896). These "imperfectly dioecious" flowers are unique within the genus. Indeed, Urban (1896) placed *A. trimera* in its own section, *A.* section *Amyridastrum* Urb., based on that feature, along with the flowers being trimerous and the petals erect in anthesis (vs. hermaphroditic, tetramerous flowers and divaricate-patent or reflexed petals in section *Euamyris* Urb.). He even suggested that the distinctiveness of the species could almost justify that it be placed in its own genus. Although *A. pacis* also exhibits trimerous flowers and erect petals, in the only available flower both the androecium and gynoecium are well developed. These two species should be included in broader morphological and developmental studies to clarify the observations of Urban (1896) about the sexual functionality of the flowers, and to improve knowledge of the species of *Amyris* with trimerous flowers. Another priority will be to include these species in phylogenetic analyses to determine their relationships within *Amyris*.

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Declarations

Conflicts of interest statement

The authors declare that there are no conflicts of interest.

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