

# Notes on *Zanthoxylum magnifructum* (Rutaceae), a recently described species from tropical dry forest in Colombia: floral morphology, geographical distribution and sexual dimorphism

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**Abstract.** *Zanthoxylum magnifructum* is a recently described species based on only a fruiting specimen collected in tropical dry forests in the department of Huila in Colombia. An emended description and illustration are presented, including flowers and seeds, which were previously unknown. Comments on its geographical distribution, conservation status, taxonomic affinities, and sexual dimorphism are made. A key for the species of *Zanthoxylum* that occur in tropical dry forest in Colombia is provided.

**Keywords:** Andes, inter-Andean Valleys, Rutoideae, taxonomy.

**Resumen.** *Zanthoxylum magnifructum* es una especie recientemente descrita basada solo en una colección en fructificación, recolectado en el bosque seco tropical en el departamento del Huila en Colombia. Se presentan una descripción e ilustración enmendadas incluyendo flores y semillas, las cuales eran desconocidas hasta la fecha. Se hacen comentarios sobre su distribución geográfica, estado de conservación, afinidades taxonómicas y dimorfismo sexual. Se incluye una clave para las especies de *Zanthoxylum* que ocurren en el bosque seco tropical en Colombia.

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*Zanthoxylum* L. is one of the most diverse genera in the Rutaceae, with about 225 species (Appelhans et al., 2018). It has a primarily pan-tropical distribution (Kubitzki et al., 2011). In the Neotropics, 86 species are recorded (Groppo & Pirani, 2017; Reynel, 2017, 2020), with a center of diversity in the Andean-Amazonian area but also with some species in Canada and Chile (Appelhans et al., 2018).

A review of the Neotropical species of the genus recognized four sections: *Macqueria* Comm. ex Triana & Planch., *Pterota* (P. Browne) Triana & Planch., *Tobinia* (Desv. ex Ham.) Griseb. and *Zanthoxylum* L. (Reynel, 2017). Section *Macqueria* is the most diverse, with 65

species (Reynel, 2020), at present it is divided into seven subgroups. Recent molecular studies, however, show that *Macqueria* is polyphyletic (Appelhans et al., 2018).

In Colombia, 28 species of *Zanthoxylum* occur from sea level to 3300 m elevation (Reynel, 2016, 2017, 2020), indicating the country as one of the most diverse for the genus in the Neotropics. Eleven of these species inhabit the Tropical Dry Forest biome (TDF; Pizano & García, 2014); this is one of most threatened ecosystems in the world (Pizano & García, 2014) and includes the Northern inter-Andean Valleys, one of the richest of the 12 floristic subdivisions of this biome in the Neotropics (DRYFLOR, 2016).

*Zanthoxylum magnifructum* Reynel was described from only a single fruiting specimen collected in the TDF of the Magdalena River valley in the department of Huila in Colombia (Reynel, 2020). It is characterized by having the largest fruit of any Neotropical species of the genus. Recent research in Colombia has added to the knowledge of the morphology, ecology and distribution of *Z. magnifructum*. The original description is emended here to include descriptions of the seeds and the male and female flowers, which were heretofore unknown. Some previously described characters not present in examined specimens are included in square brackets.

Comments about its geographical distribution, taxonomic affinities, and sexual dimorphism are included, and its conservation status according to IUCN criteria is evaluated. Additionally, a key to the species of *Zanthoxylum* that occur in the TDF of Colombia is provided.

***Zanthoxylum magnifructum* Reynel.** Type: Colombia. Huila: Cordillera Oriental, E of La Bodega, on foot trail up río Venado to jct. with río Venadito, 2700 ft. [820 m], 22 Nov. 1944 [fr], *E. Little, Jr. 8980* (holotype: NY-n.v.; isotype: US03305487 [digital image!]). (Figs. 1 and 2.)

*Trees* 15 m tall, gynodioecious [dioecious], semi-deciduous, trunk armed or partially armed; indumentum of simple short straight hairs; branches with growth proleptic, with short zones of clustered leaf and bud-scale scars, glabrous with terminal buds puberulent, with leaves evenly distributed on branches, unarmed or with sparse, straight to slightly incurved spines 2.8–4.1 × 4.2–6.2 mm; lenticels present, up to 2 mm long, periderm peeling off in parts when dry. *Leaves* (8–) 13–22 (–26) cm long, 4–6 (–9)-foliolate, paripinnate or occasionally imparipinnate, lateral leaflets opposite, less frequently subopposite toward the leaf base, medial pair usually longer than other leaflets; petiole 3–7.1 (–10.5) cm long; rachis 3.4–13.3 cm long, 1–2 mm thick, terete, glabrous, unarmed, interjuga 2.2–5.5 (–8) cm long; petiolule 3.3–7.4 mm long; leaflets (3.6–) 5.7–13.2 × (1.6–) 2.2–5.5 (–9) cm, ovate to elliptic or less often oblong, occasionally obovate or orbicular, base acute to obtuse, straight or rounded, decurrent, asymmetrical, apex acute to obtuse, attenuate to acuminate or short-acuminate, occasionally rounded, acumen (3–) 9–12 × 4–6 (–8)

mm, chartaceous, glabrous, usually drying olive-green on both surfaces or pale green below; margin glandular, crenate, entire toward the base, the teeth 3–8 mm apart at the middle; midvein prominulous on both surfaces, secondary veins 5–11 (–12) pairs, prominulous on both surfaces, tertiary veins perpendicular to midvein, reticulate, prominulous on both surfaces; glands 3.7–4 mm diam., rounded, close to the primary vein. *Inflorescences* terminal and subterminal, axes puberulent; bracts 1 (–2) × 0.8–1 (–1.5) mm, triangular-deltoid, glabrous, occasionally absent. *Staminate inflorescences* 2–9 cm long, panicles branched 2–3 times, with more than (30–) 60 flowers, erect; peduncle (0.6–) 2.5–4.5 cm long; secondary axes alternate, forming a 30°–60° (–90°) angle with main axis; pedicels 0.6–0.8 mm long or absent, puberulent; bracteoles 0.4–0.6 mm long, deltate, apex acute, straight or acuminate, glabrous. *Staminate flowers* 5-merous; sepals 1–2 × 1 mm, connate to 1/2 their total length, lobes elliptical, apex acute, straight, convex or rounded, margin erose, glabrous, with one gland 0.5 mm diam., round, medial; petals 3–3.5 × 1.5–1.8 mm, free, elliptical, apex acute, straight or convex, margin erose, saccate, glabrous, with one gland 0.5 mm diam., elliptical or round, apical; stamens 5, exserted 1/3–1/2 their total length, glabrous, filaments 4–4.5 mm long, slender, anthers 1.5 × 0.5 mm, ovate, thecae oblong, free at the base; nectary conical-truncate, lobes 1 × 1.5–2 mm; pistillodes 2–3.1 × 0.6–0.8 mm, pyriform, free. *Pistillate inflorescences* 0.5–4 cm long, racemes, 3–8-flowered, erect; peduncle 0.3–1.4 cm long; pedicels 0.5–2.9 × 1 mm, puberulent; bracteoles 2–7, 0.6–0.8 mm long, deltate, glabrous. *Pistillate flowers* 5 (–6)-merous; sepals (1–) 1.3–2 × 1.2–1.7 mm, connate to 1/2 their total length, lobes elliptic, apex acute, straight, convex or rounded, thick, margin erose, glabrous to glabrate, persistent in fruit, with one gland 0.5 mm diam., round, apical; petals 5–5.3 × 2.5–3 mm, free, elliptic, acute, straight, convex or rounded, glabrous, margin erose, with one gland 0.5 mm long, elliptic or round, apical; staminodes 1–5 or absent, 0.5–1 (–2) × 0.5 mm, ovate to oblong, membranaceous, occasionally with antherodes 0.5–1 × 0.5 mm; gynophore 2 × 2–2.6 mm, long-conic; carpels [2–] 3 [–4], 1.8–2 × 2–2.2 mm, oblong to ovate, 2-lobed at the apex, basally connate 1/3 their total length, obliquely inserted on gynophore, glabrous; style 0.2 × 0.8 mm; stigma 2.2–2.4 mm diam., 0.2–0.4 mm thick. *Fruit* 17–19.3 (–22.7)

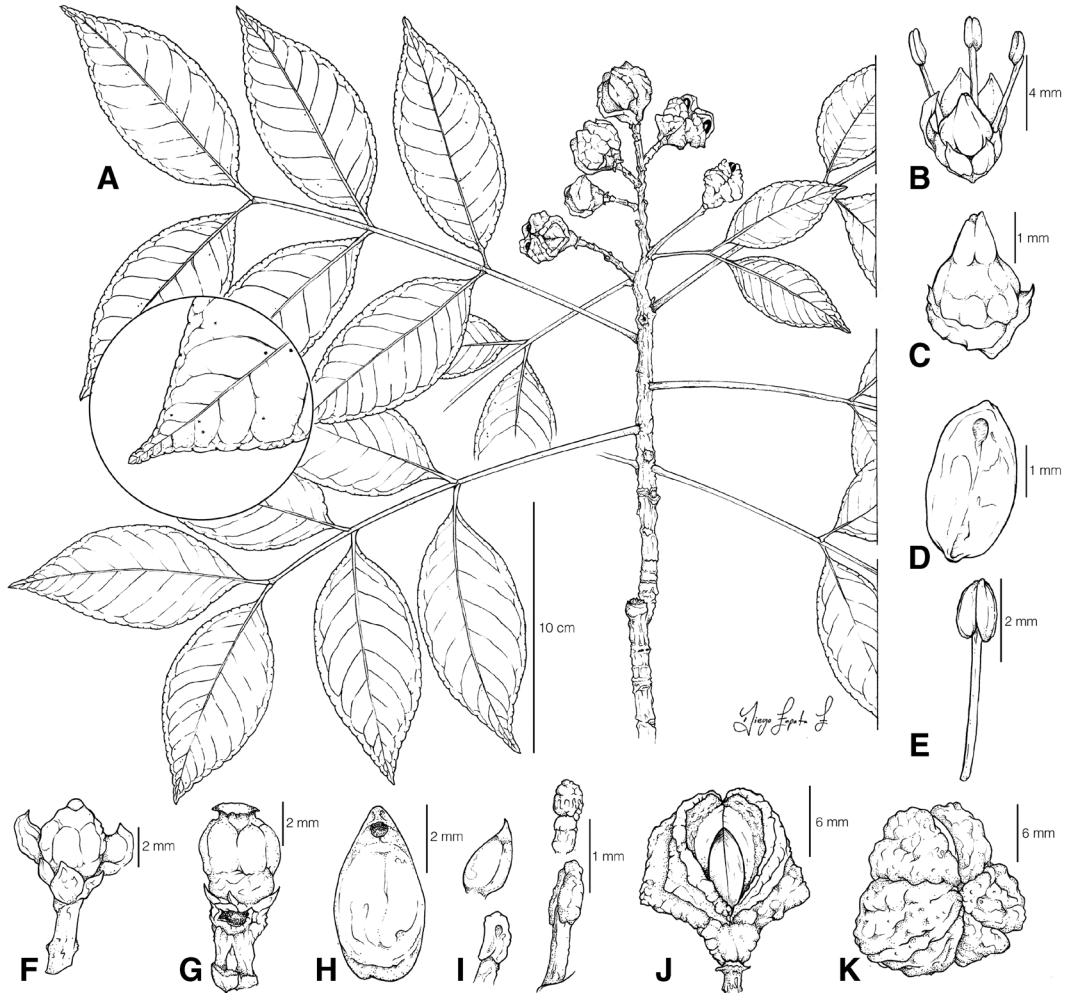


FIG. 1. *Zanthoxylum magnifructum*. A. Fruiting branch and leaves. B. Staminate flower with two petals removed. C. Pistillodes. D. Petal of staminate flower. E. Stamen. F. Pistillate flower with two petals removed. G. Pistillate flower with sepals and petals removed. H. Petal of pistillate flower. I. Types of staminodes. J. Dehiscing fruit with seed inside, lateral view. K. Mature fruit in top view. (A, J, K from Jiménez & Guzmán 2072, HUA; B–H from Jiménez et al. 2139, HUA; I from Londoño et al. 296, HUA; drawing by Diego A. Zapata, HUA illustrator.)

mm diam., up to 24 mm diam. in vivo, [2–] 3 [–4]-follicular [when 3- to 4-follicular, 1 follicle aborting]; gynophore 4.5–6.2 (–7) mm tall, follicles 10.5–13.8 mm long, in vivo up to 16.9 mm long, ovate to subglobose, connate to 2/3 their total length and 1/2 laterally, pericarp 4.2–6.3 mm thick, up to 8 mm thick in vivo, fleshy; seed 5.6–7.2 × 3.2–5.5 mm, ellipsoid, funicular scar 2.4–3.5 × 1.1–1.5 mm, ovate.

**Distribution and habitat.**—*Zanthoxylum magnifructum* is endemic to TDF of northern inter-Andean valleys in Colombia (DRYFLOR,

2016), at 399–1060 m elevation. Specifically, this species has been collected in the Cauca River canyon in the department of Antioquia (Holdridge, 1967; Espinal, 2011), and in the Magdalena River valley in the departments of Huila and Tolima (Fig. 3).

**Phenology.**—The species is known to flower between January and May and fruit between March and November.

**Conservation status.**—We recommend that this species be listed under the IUCN Red List category of Endangered (EN; see IUCN, 2012) due to

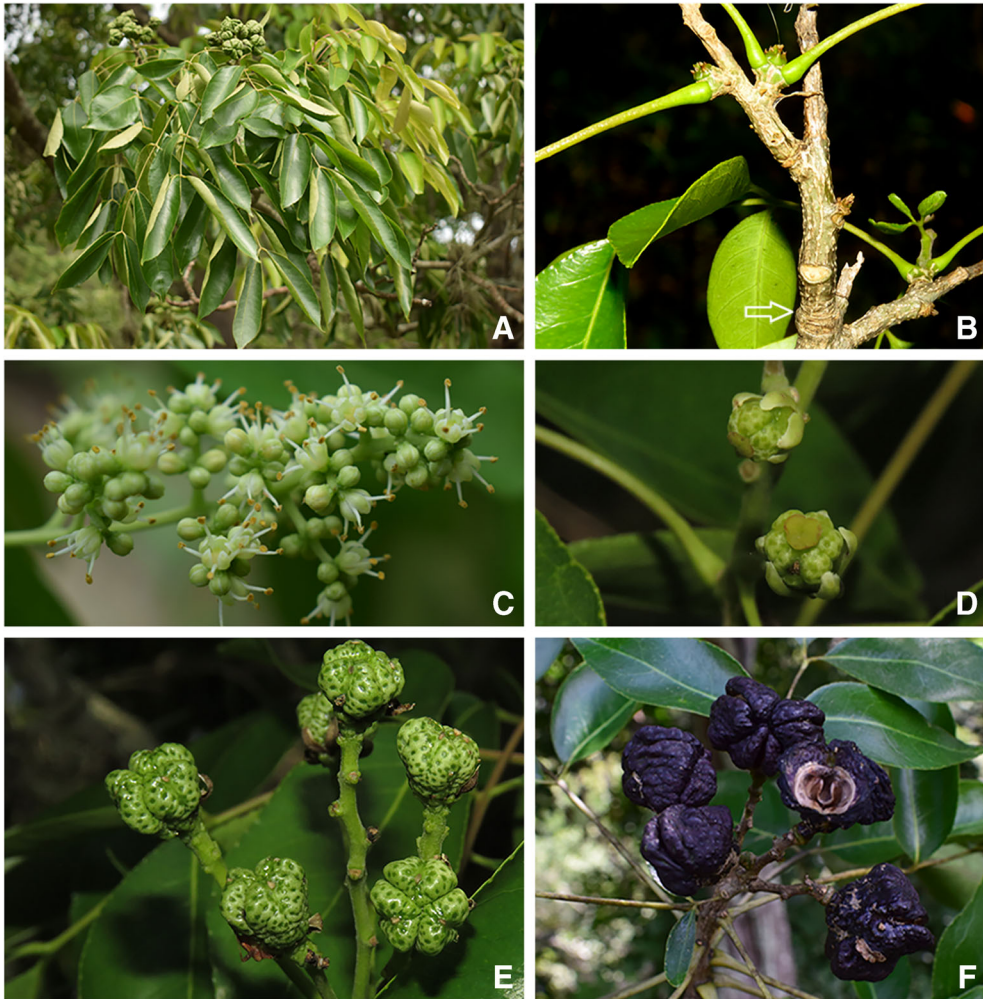


FIG. 2. *Zanthoxylum magnifractum* (photographs). A. Fruiting branch and leaves. B. Detail of the zones of clustered leaf and bud-scale scars. C. Staminate flowers. D. Pistillate flowers. E. Immature fruits. F. Dehiscing fruit. (A from Jiménez *et al.* 2280, CUVC; B, D from Londoño *et al.* 296, HUA; C from Jiménez *et al.* 2139, HUA; E from Londoño *et al.* 297, HUA; F from Idárraga *et al.* 6988, JAUM; A, C, F by J. Jiménez; B, D, E by A. Trujillo.)

its small area of occupancy (32 km<sup>2</sup>), and extent of occurrence (15.101 km<sup>2</sup>) as estimated by the R package “ConR” (Dauby, 2019; Protected Planet, 2019; R Core Team, 2019), its only 4 registered subpopulations, and continuous decrease in the quality of its habitat (i.e., small habitat fragments <500 km<sup>2</sup>, mainly in a matrix of disturbance and severe erosion due to human activity; criteria B1ab (iii) + B2). All subpopulations are less than 20 km from some human population center and occur outside protected areas; three of them are less than 12 km from gold mining concessions, and one, in the valley of the

Cauca River, was partially affected by a hydroelectric project. Paradoxically, that project may currently represent a weak conservation measure for this taxon through the protection of the adjacent forests in the area. Priority should be given to detailed ecological studies of the populations to determine precise conservation measures needed in the species’ highly disturbed habitat.

**Additional specimens examined. COLOMBIA.**  
**Antioquia:** Mun. Buriticá: corregimiento La Angelina, 6°42'15.51"N, 75°51'30.53"W, 711 m, 30 May 2019 [fj], J. Bohórquez *et al.* 1 (HUA). Mun. Liborina: quebrada La

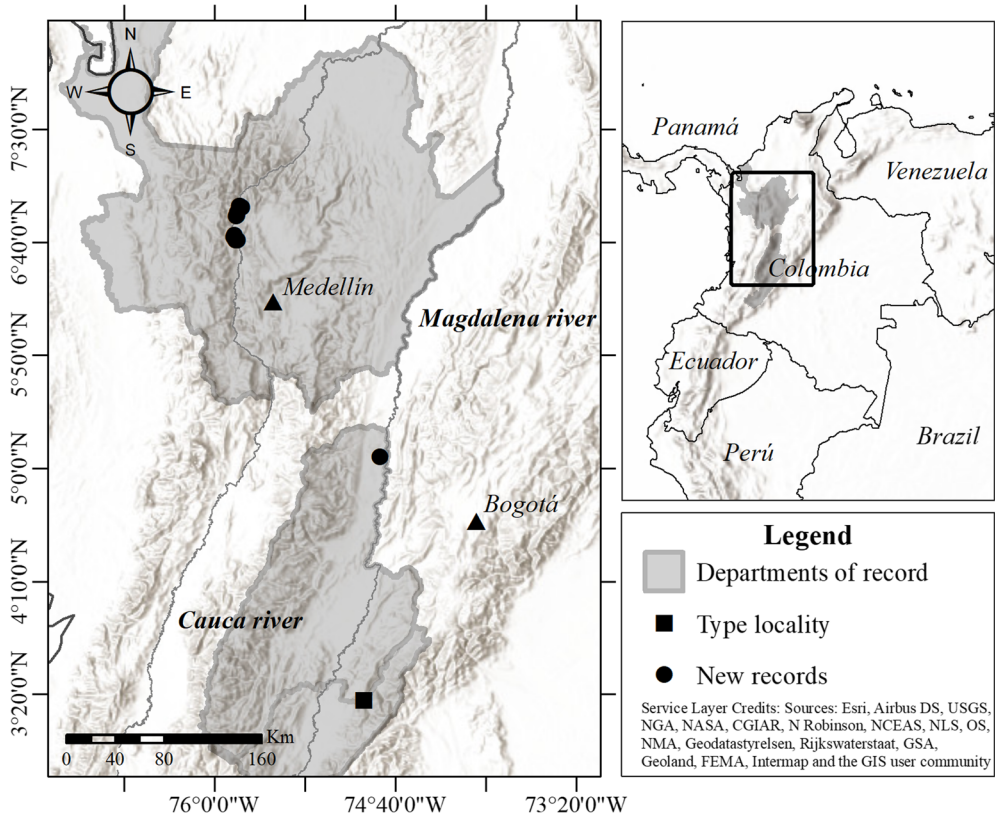


FIG. 3. Distribution of *Zanthoxylum magnifractum*. Departments from north to south: Antioquia, Tolima and Huila (type locality marked).

Sucia, s.m., 20 Jun 2013 [fr], *O. Uribe* 5 (MEDEL). Mun. Sabanalarga: Llanos de Niquia, 1.5 km bajando desde el alto Llanos de Niquia, 6°51'33.7"N, 75°50'15.3"W, 523 m, 6 Nov 2018 [fr], *A. Idárraga* et al. 6988 (JAUM); *ibid.*, 30 Sep 2017 [fr], *J. Jiménez* & *V. Guzmán* 2072 (HUA, JAUM, MEDEL); *ibid.*, 3 Feb 2018 [fl], *J. Jiménez* et al. 2139 (HUA, COL, CUVC, JAUM, MO); *ibid.*, 3 Mar 2018 [fl], *J. Jiménez* & *L. Zapata* 2204 (FAUC); *ibid.*, 10 Jun 2018 [fr], *J. Jiménez* et al. 2280 (CUVC); *ibid.*, 4 Aug 2018 [fr], *J. Jiménez* et al. 2332 (ICESI); *ibid.*, 9 Oct 2018 [fr], *J. Jiménez* et al. 2359 (FAUC); Llanos de Niquia, 6°51'48.8"N, 75°50'6.1"W, 565 m, 9 Oct 2018 [st], *J. Jiménez* et al. 2371 (HUA); Llanos de Niquia, 1.5 km bajando desde el alto Llanos de Niquia, 6°51'33.7"N, 75°50'15.3"W, 523 m, 6 Nov 2018 [fr], *Y. Londoño* et al. 285 (HUA, JAUM); *ibid.*, 5 May 2019 [fl], *Y. Londoño* et al. 296 (HUA, COL, JAUM, MO); *ibid.*, 5 May 2019 [im fr], *Y. Londoño* et al. 297 (HUA, JAUM); vereda Membrillal, 6°53'9.23"N, 75°49'52.11"W, 399 m, 14 Mar 2018 [im fr], *P. Morales* 1320 (HUA); hacienda El Jagüe, 6°55'53.7"N, 75°48'40.5"W, 600 m, 4 Sep 2006 [fr], *C. Velásquez-Rúa* et al. 5361 (JAUM). Mun. Santa Fé de Antioquia: vereda Cativo, 6°40'46.67"N, 75°50'31.54"W, 620 m, 26 May 2016 [im fr], *Z. Cordero* 2368 (MEDEL). **Huila:** Mun. Yaguará, vereda La Floresta, finca Las Mercedes, parcela 21, 12 Dec 2001 [st], *J. Puerta* & *E. Mahecha* 116 (TOLI10741 [digital image]). **Tolima:** [Mun. Armero]: corregimiento de

Méndez, inmediaciones de Guayabal de Armero y Mariquita, hacienda El Cardonal, parcela permanente 1, 5°57.6"N, 74°46'52.7"W, 420 m, 14–25 Jun 2013 [st], *R. González* et al. 1848 (UDBC033849 [digital image]). Mun. Natagaima: 10 Feb 2007 [st], *A. Guzmán* 25 (TOLI9052 [digital image]).

## Discussion

*Taxonomic affinities.*—In keeping with its name, *Zanthoxylum magnifractum* has the largest fruits known in Neotropical *Zanthoxylum*. Within the genus, it is morphologically allied with the species of the *Petiolare* group of section *Macqueria* (Reynel 2017, 2020) due to its simple hairs, apical branchlets with clustered bud-scale and leaf scars, terminal and subterminal inflorescences, predominantly 5-merous flowers, perianth differentiated in two whorls, discoid stigma, calyx persistent in fruit, and follicles laterally connate.

In addition to the similarities with *Zanthoxylum petiolare* A. St.-Hil. & Tul. observed by Reynel (2020), *Z. magnifractum* is similar to *Z. gentryi*

Reynel, a species that occurs in TDF in the department of Valle del Cauca in Colombia, at 600–1500 m elevation, but in contrast to that species *Z. magnifructum* has the lateral leaflets petiolulate (vs. sessile), the leaflet margin crenate (vs. entire), the pericarp 4.2–6.3 mm thick (vs. 1.9–2.4 mm thick), the carpels connate axially and laterally (vs. connate only laterally) and the follicles 10.5–13.8 mm long (vs. 4–8 mm long).

Connate follicles are also present in *Zanthoxylum quinduense* Tul., but *Z. magnifructum* has a lower elevational range than that species (399–1060 m vs. 1500–3000 m) and also differs in the leaf bud scales clustered, leaf scars present (vs. absent), the petioles terete (vs. canaliculate), the follicles laterally connate to 1/2 their length (vs. 1/3), and the fruits fleshy (vs. leathery).

Sterile material of *Zanthoxylum magnifructum* can be confused with *Z. pucro* D. M. Porter because of the similar blade shape, the leaflet margin crenate and the tertiary veins reticulate, but *Z. magnifructum* differs by having smaller leaf size [(8–) 13–22 (–26) cm long vs. 35–70 cm long] and fewer [4–6 (–9) vs. 7–15] and smaller leaflets [(3.6–) 5.7–13.2 × (1.6–) 2.2–5.5 (–9) cm vs. 10–23 × 4–7 cm].

*Sexual dimorphism.*—The Neotropical species of *Zanthoxylum* are mostly dioecious with some polygamodioecious exceptions (Reynel, 2017),

which present male or female individuals with unisexual and hermaphrodite flowers in the same inflorescence (Geber et al., 1999; Reynel, 2017). *Zanthoxylum magnifructum* appears to be a gynodioecious species (Geber et al., 1999), with some individuals that bear only pistillate inflorescences and other individuals that produce mostly staminate inflorescences but have a low percentage of branches bearing pistillate inflorescences, with the pistillate flowers having reduced androecia (Fig. 11). Although Reynel (2020) considered the pistillate inflorescences to be panicles, we consider them to be axillary racemes, where the subtending leaves show a gradual reduction to bracts towards the branch apex.

Gynodioecy has not been reported previously in Neotropical *Zanthoxylum*, maybe because it is not common in the genus or because it can be difficult to detect or interpret; it is reported more frequently in temperate herbaceous lineages than in woody or tropical lineages (Caruso et al. 2016). In this system, the proportions of pistillate flowers on hermaphrodite plants can have subtle and continuous fluctuations inside a population, between populations, or even in one individual from one season to another (Geber et al., 1999). Typically, in arboreal species there is only a low probability that a specimen collected from a hermaphrodite individual will include pistillate flowers.

**Key to the species of *Zanthoxylum* that occur in the Tropical Dry Forest of Colombia**

- 1. Leaves unifoliolate.....*Z. schreberi*
- 1. Leaves with 3 or more leaflets.
  - 2. Petiole winged at least at apex.....*Z. fagara*
  - 2. Petiole unwinged.
    - 3. Apical buds with simple curled hairs, perianth whorls not differentiated, all perianth segments deciduous in fruit.....*Z. mollissimum*
    - 3. Apical buds glabrous or with simple straight or stellate hairs, perianth whorls differentiated into calyx and corolla, calyx persistent in fruit.
      - 4. Leaves with stellate hairs.....*Z. rhoifolium*
      - 4. Leaves with simple straight hairs or glabrous.
        - 5. Perianth whorls 3–4-merous, carpels 1–2, stigma globose.
          - 6. Leaflets with basal domatium, perianth whorls 4-merous.....*Z. limoncello*
          - 6. Leaflets without basal domatium, perianth whorls 3-merous.....*Z. acuminatum*
        - 5. Perianth whorls 5-merous, carpels (2–) 3–5, stigma discoid.
          - 7. Branchlet apices with short zones of clustered leaf and bud-scale scars, follicles partially connate.
            - 8. Lateral leaflets sessile, follicles 4–8 mm long, pericarp 1.9–2.4 mm thick .....*Z. gentryi*
            - 8. Lateral leaflets petiolulate, follicles 10.5–13.8 mm long, pericarp 4.2–6.3 mm thick .....*Z. magnifructum*
          - 7. Branchlet apices without short zones of clustered leaf and bud-scale scars, follicles free.
            - 9. Leaves glabrous, inflorescences axes with transverse lenticels. ....*Z. caribaeum*
            - 9. Leaves with simple hairs, at least in the base of petiole and rachis adaxially, inflorescences axes without transverse lenticels.
              - 10. Leaves with more than 8 leaflets, follicles D-shaped. ....*Z. martinicense*
              - 10. Leaves typically with 4 (–6) leaflets (but leaves from regenerative branches with up to 10 leaflets), follicles ovoid to sub-globose .....*Z. rigidum*

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### Literature cited

- Appelhans, M. S., N. Reichelt, M. Groppo, C. Paetzold & J. Wen.** 2018. Phylogeny and biogeography of the pantropical genus *Zanthoxylum* and its closest relatives in the proto-Rutaceae group (Rutaceae). *Molecular Phylogenetics and Evolution*. 126: 31–44.
- Caruso, C. M., K. Eisen & A. L. Case.** 2016. An angiosperm-wide analysis of the correlates of gynodioecy. *International Journal of Plant Sciences* 177: 115–121.
- Dauby, G.** 2019. ConR: Computation of parameters used in preliminary assessment of conservation Status. R package version 1.2.4. (Downloadable from: <https://CRAN.R-project.org/package=ConR>).
- DRYFLOR.** 2016. Plant diversity patterns in Neotropical dry forests and their conservation implications. *Science* 353 (6306): 1383–1387.
- Espinal, L. S.** 2011. Zonas de vida del departamento de Antioquia. Pp. 235–290. *In*: Callejas & A. Idárraga (eds). Flora de Antioquia: Catálogo de plantas vasculares. Vol 1. Introducción. Programa Expedición Antioquia–2103. Series Biodiversidad y Recursos Naturales. Universidad de Antioquia, Missouri Botanical Garden & Oficina de planeación departamental de la Gobernación de Antioquia. Editorial D’Vinni, Bogotá.
- Geber, M. A., T. E. Dawson & L. F. Delph** (eds.). 1999. Gender and sexual dimorphism in flowering plants. Springer-Verlag, Berlin.
- Groppo, M. & R. Pirani.** 2017. A new species of *Zanthoxylum* (Rutaceae) with a key to the species from Northeastern Brazil. *Phytotaxa* 314 (2): 259–265.
- Holdridge, L. R.** 1967. Life zone ecology. Tropical Science Center. San José, Costa Rica.
- IUCN.** 2012. IUCN Red List Categories and Criteria: Version 3.1. Second edition. IUCN Species Survival Commission. IUCN, Gland and Cambridge.
- Kubitzki, K., J. A. Kallunki, M. Duretto & P. G. Wilson.** 2011. Rutaceae. Pp 276–356. *In*: K. Kubitzki (ed.), The Families and Genera of Flowering Plants. X. Flowering Plants: Eudicots, Sapindales, Cucurbitales, Myrtales. Springer, Berlin.
- Pizano, C. & H. García** (eds). 2014. El bosque seco tropical en Colombia. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH), Bogotá.
- Protected Planet.** 2019. The World Data Base on Protected Areas. (Downloadable from: <https://www.protectedplanet.net/>).
- R Core Team.** 2019. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna. (Downloadable from: <https://www.R-project.org/>).
- Reynel, C.** 2016. *Zanthoxylum*. Pp. 2347–2349. *In*: R. Bernal, S. R. Gradstein & M. Celis (eds.). Catálogo de plantas y líquenes de Colombia. Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá.
- Reynel, C.** 2017. *Zanthoxylum* (Rutaceae). Flora Neotropica Monograph 117. Organization for Flora Neotropica, The New York Botanical Garden Press, Bronx.
- Reynel, C.** 2020. Eight new species of Neotropical *Zanthoxylum* (Rutaceae). *Novon* 28 (1): 1–14.