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## *Ternstroemia acajetensis* (Pentaphylacaceae), a new species from the cloud forest in central Veracruz, Mexico

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### Abstract

*Ternstroemia acajetensis* Cast.-Campos & Palacios-Wassenaar *sp. nov.* is described and illustrated. This new taxon is part of the arboreal and shrub strata of cloud forests, *Quercus* forests, and *Pinus-Quercus* forests in the mountains of the states of Veracruz, Puebla, and Oaxaca, Mexico. This species is related to *T. sylvatica* and *T. huasteca*, which grow in similar environments. However, the new species can be differentiated from the others by the length of the peduncle, the shape of the petals, the color of the flowers, and the length of the prolongation of the connective in the anthers.

**Keywords:** Acajete, cloud forest, Flora of Mexico, *Ternstroemia*, Veracruz

### Resumen

Se describe e ilustra a *Ternstroemia acajetensis* Cast.-Campos & Palacios-Wassenaar *sp. nov.* Este taxón forma parte de los estratos arbóreo y arbustivo de los bosques de niebla, bosques de *Quercus* y bosques de *Pinus-Quercus* en las montañas de los estados de Veracruz, Puebla y Oaxaca, México. Esta especie tiene similitud con *T. sylvatica* y *T. huasteca*, las cuales habitan en ambientes similares. Sin embargo, se distingue de estas especies por la longitud del pedúnculo, la forma de los pétalos, el color de las flores y la longitud de la prolongación del conectivo en las anteras.

**Palabras clave:** Acajete, bosque de niebla, Flora de México, *Ternstroemia*, Veracruz

### Introduction

The family Pentaphylacaceae is represented by 12 genera and approximately 345 species, which were included within the Theaceae until 2003 (Stevens 2001; APG II 2003), or within the Ternstroemiaceae and Sladeniaceae (Weitzman *et al.* 2004). The family comprises three tribes: Pentaphylacaceae (a monospecific genus), Freziereae (nine genera and about 240 species), and Ternstroemieae (two genera and 103 species) (Stevens 2001; Weitzman *et al.* 2004).

The genus *Ternstroemia* Mutis ex Linnaeus f. (1782: 264) has about 100 species, distributed primarily in the Neotropics, but also in the tropics and subtropics of Asia, plus one or two species in tropical Africa (Stevens 2001; Weitzman *et al.* 2004). This genus is characterized by its pseudoverticillate leaves, generally concentrated at the end of branches, glabrous, with entire to crenulated margin, midrib conspicuous, primary veins often inconspicuous, axillary flowers, often solitary, numerous stamens, ovary superior, fruit usually baccate, obturbinate, indehiscent or irregularly dehiscent, style persistent and seeds covered by an aril or sarcotesta (Kobuski, 1942; Weitzman *et al.* 2004).

Most species of *Ternstroemia* in Mexico thrive in humid forests, cloud forests, *Pinus* and *Quercus* forests, with some species occasionally located in coastal habitats, such as *Ternstroemia tepezapote* Schlechtendal & Chamisso (1831: 420–421) in dry forests on coastal dunes. Between nine and 17 species are known for Mesoamerica and Central America (Kobuski 1942; Bartholomew 1988; Santamaría-Aguilar & Lagomarsino 2017), located on the Atlantic and Pacific slopes (Jiménez 2015; Santamaría-Aguilar *et al.* 2015). In Mexico, eight species of *Ternstroemia* are known

(Villaseñor 2016); of these, *Ternstroemia lineata* Candolle (1821: 409–410), *Ternstroemia sylvatica* Schlechtendal & Chamisso (1830: 220), and *T. tepezapote* are widely distributed across the country.

The new species described here has a distribution limited to cloud forests, *Quercus* forests, and *Pinus-Quercus* forests in the states of Veracruz, Puebla, and Oaxaca (Fig. 1). This taxon in addition to the ones already known account for a total of nine taxa of the genus *Ternstroemia* reported for Mexico. A key to the Mexican species of *Ternstroemia* is shown below. Two species mentioned by Villaseñor (2016) (*Ternstroemia hemsleyi* Hochreutiner (1917: 193) and *Ternstroemia sphaerocarpa* (Rose) Melchior (1935: 142) are still under discussion as synonyms of *Ternstroemia tepezapote* and were not included in the key.

### Key to the Mexican species of *Ternstroemia*

1	Leaves spatulate.....	<i>T. lineata</i>
-	Leaves obovate, oblanceolate or elliptical.....	2.
2	Flowers with consistently short peduncle, ca. 1.6 cm long.....	<i>T. sylvatica</i>
-	Flowers with peduncle 2.0 cm long or more.....	3.
3	Leaf margins crenulate-serrulate.....	<i>T. tepezapote</i>
-	Leaf margins entire.....	4.
4	External sepals with denticulate margin, teeth 0.3 mm long.....	<i>T. dentisepala</i>
-	External sepals with glandular-denticulate, erose or entire margin.....	5.
5	Flowers terminal or subterminal, sometimes fasciculate.....	<i>T. huasteca</i>
-	Flowers axillary or cauline towards the end of the branchlets.....	6.
6	External sepals orbicular or suborbicular, apex obtuse.....	<i>T. maltbyi</i>
-	External sepals ovate, apex acute.....	<i>T. acajetensis</i>

### Materials and Methods

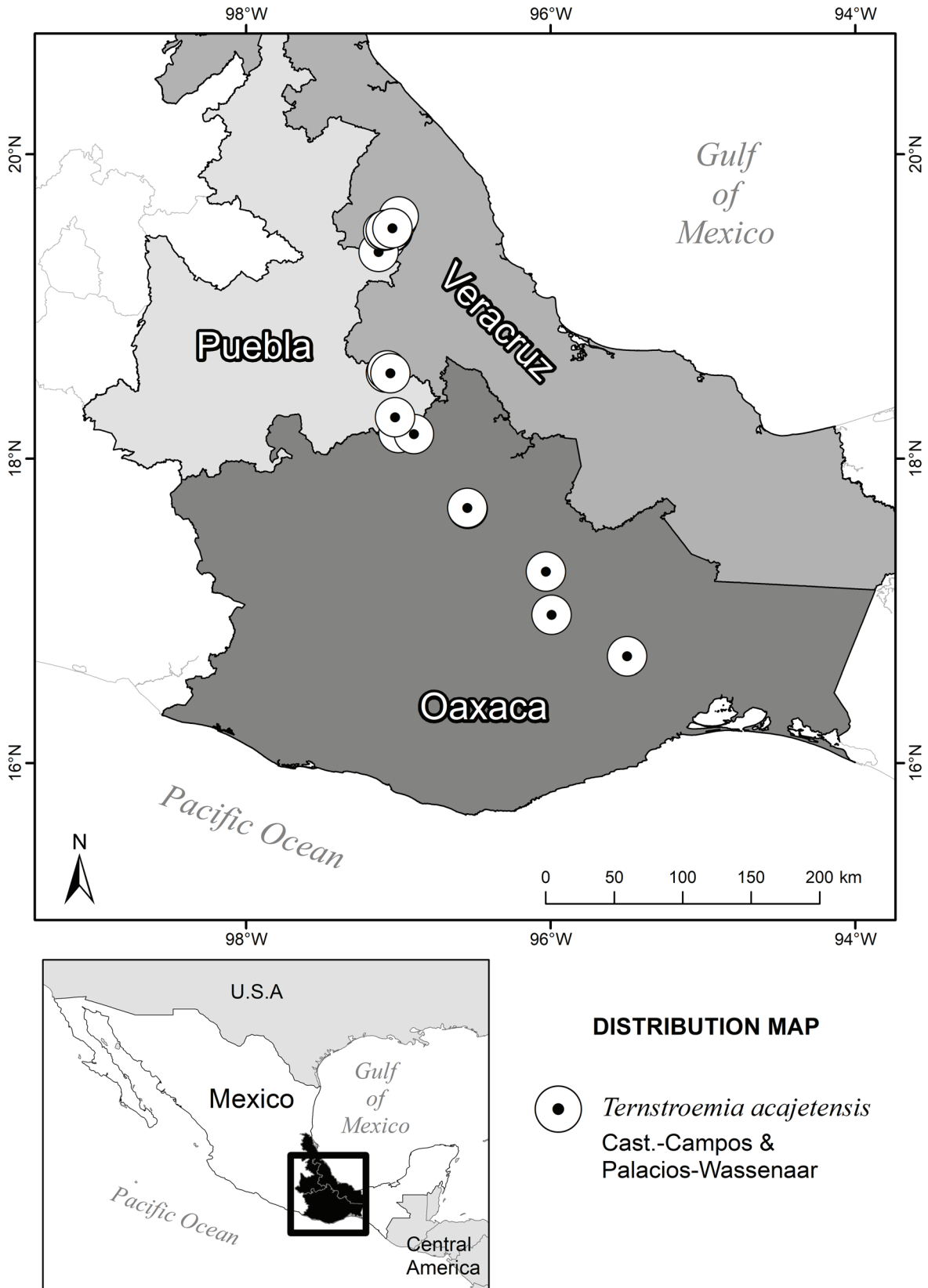
The revision of specimens of the genus *Ternstroemia* (Pentaphylacaceae) deposited in the collections of the major Mexican herbaria, supplemented with the survey of fragments of the original vegetation across the mountainous area of central Veracruz, has led to the finding of specimens that displayed characters that were different from those of the species already described. These differences set the grounds to clearly define that the specimens recently collected corresponded to a new taxon, *Ternstroemia acajetensis* (Figs. 2 and 3a, b). The revision of the original descriptions of the species of the genus and the specimens deposited in collections of some of the most important herbaria of Mexico (ENCB, MEXU, and XAL) determined that the species closest to the new taxon are *T. sylvatica* and *T. huasteca* Bartholomew (1988: 458), which are endemic to Mexico and share similar ecological conditions. Type specimens of *T. sylvatica* and *T. huasteca* were examined by images available at JSTOR Global Plants website (JSTOR 2019). In addition, specimens of *T. sylvatica* from the type locality were collected and examined. The characters on the specimens were examined using a Carl Zeiss microscope (Stemi 2000-C; Barrington, USA). The morphological characters of the new taxon were contrasted with those of the closest species (*T. huasteca* and *T. sylvatica*), highlighting the differences (Table 1). The provisional conservation status of the new species was assessed using the IUCN Red List categories and criteria (IUCN 2012; IUCN 2017).

### Taxonomy

***Ternstroemia acajetensis*** Cast.-Campos & Palacios-Wassenaar, *sp. nov.* (Figs. 2–3a, b).

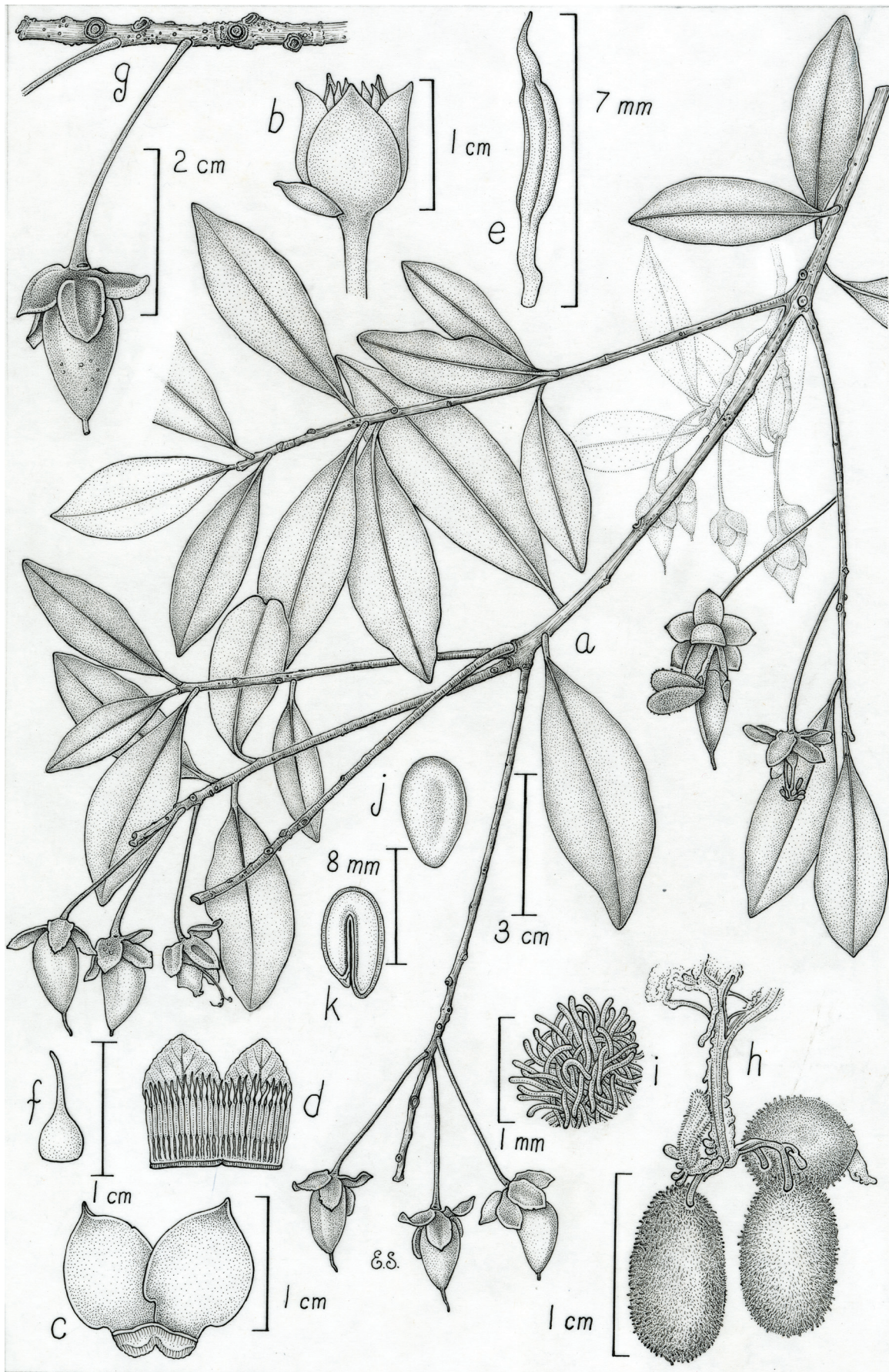
Type:—MEXICO. Veracruz: Municipality of Acajete, Plan de Sedeño-Mesa de la Yerba, 19°33'46.5", -97°00'33.9", 1968 m, 8 March 2019, G. Castillo-Campos et al. 29366 (holotype XAL!; isotypes CHAPA!, ENCB!, MEXU!).

This taxon shows similarities with *T. sylvatica* and *T. huasteca*, both being species with which it coexists under similar ecological conditions in some municipalities of Veracruz, Puebla, and Oaxaca, Mexico. However, *T. acajetensis* differs mainly in the coloration of the external sepals, which are greenish-white, with pink margin externally and shaded in purple internally, while in *T. huasteca* they are pink and in *T. sylvatica*, greenish-white; the peduncle is shorter than in *T. huasteca* and longer than in *T. sylvatica*; the petals are oblong, instead of acute (*T. huasteca*) or suborbicular (*T. sylvatica*) and the extension of the connective in anthers is longer than in both these species.



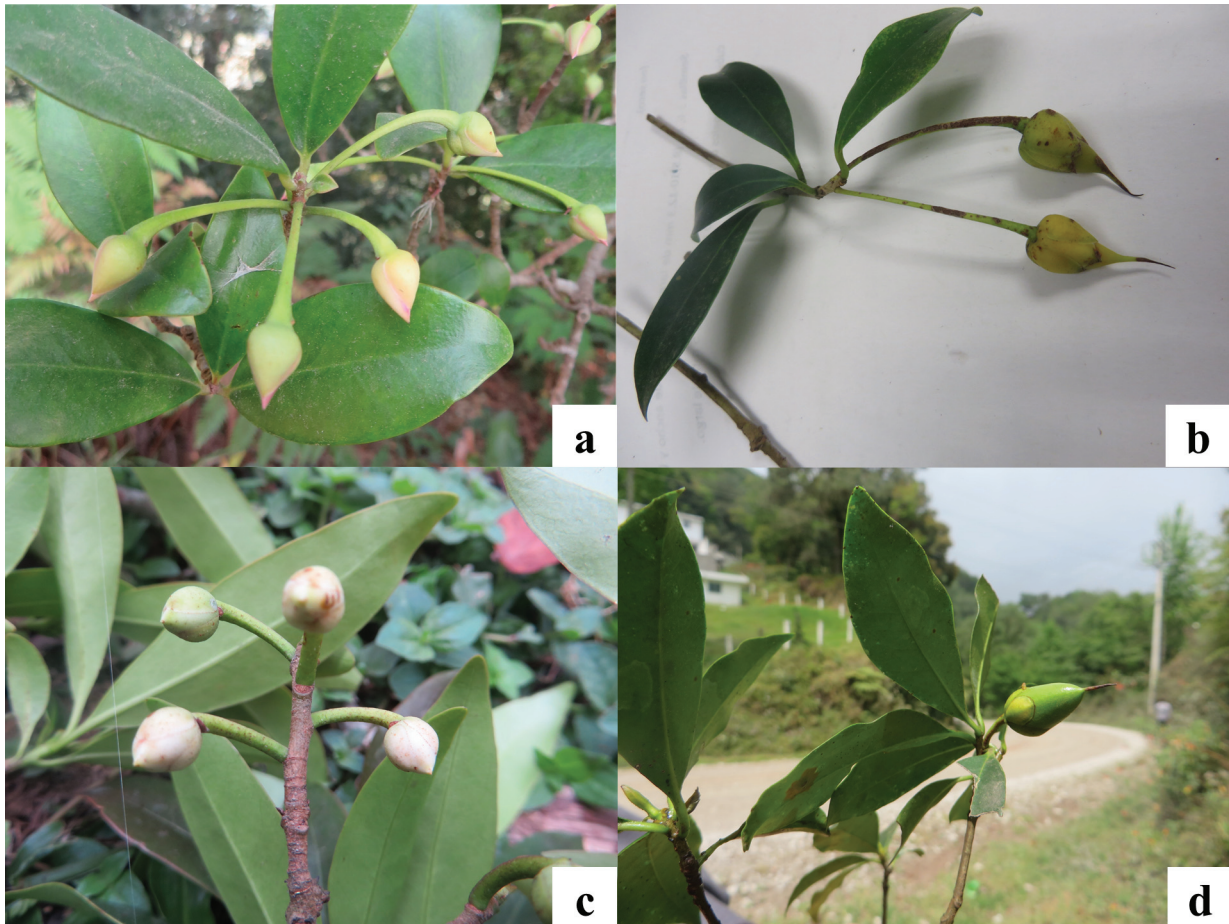
**FIGURE 1.** Location map of *Ternstroemia acajetensis* Cast.-Campos & Palacios-Wassenaar *sp. nov.*





**FIGURE 2.** Illustration of *Ternstroemia acajetensis* Cast.-Campos & Palacios-Wassenaar *sp. nov.*: a, branch with fruits; b, flower; c, detail of sepals; d, detail of stamens adnate to the corolla; e, stamen; f, pistil; g, detail of fruit; h, seeds; i, detail of aril; j, seed without aril; k, embryo. Illustration by Edmundo Saavedra based on the type specimen G. Castillo-Campos *et al.* 29366 (XAL).





**FIGURE 3.** Comparison between *Ternstroemia acajetensis* Cast.-Campos & Palacios-Wassenaar *sp. nov.*; a, flower buds; b, fruit, and *T. sylvatica*; c, flower buds; d, fruit (Photographs by G. Castillo-Campos).

Tree or shrub of 1–10(–15) m tall, trunk brown to gray, with abundant lichens, sparsely cicatricose, verticillate branching in 3–4 lateral branches. Leaves alternate, spirally arranged, dark green, lustrous on the front, pale green on the back, elliptic to narrowly elliptic (4–)5–6.5(–7.5) × (1.5–)2–2.5(–3) cm, entire, glabrous, apex acute, sparsely acuminate, rounded, base shortly decurrent, midrib yellowish green, imprinted, slightly canaliculate adaxially, prominent abaxially, fading to the apex, primary veins inconspicuous adaxially and abaxially, petiole light green to yellowish, sparsely canaliculate to semiterete, (3.5–)5–7(–9) mm long, 1.5–1.9(–2.1) mm diameter. Flowers cauline on terminal branches, occasionally axillary, solitary, white tinged pink on buds, interior with purple shade at anthesis, decussate, peduncles terete, green before anthesis, slightly thickened, flattened at the base of the calyx, (10–)20–40(–45) mm long, (1.4–)2–3(–3.6) mm in diameter at the base of the calyx, (0.6–)1–1.4 mm in diameter at the base of the peduncle; bracteoles usually deciduous, opposite at the base of the calyx or alternate, uneven, triangular, deltate or ovate, 1–2.5 × 1–2 mm wide, succulent, ribbed, mucronate. Sepals 5, basally connate, white-greenish, margin pink externally, purple-shaded internally, succulent, unequal; external sepals 2, ovate, occasionally recurved at anthesis, (7–)7.8–10 × (5.5–)6–8.5 mm, succulent, margin entire or erose, conspicuously or inconspicuously glandular-denticulate at 1/2 basal part, apex acute, conspicuously or inconspicuously mucronate, base cordate; internal sepals 3, lanceolate, oblong, ovate, elliptical, 8–11(–12.5) × 5–8(–8.5) mm, less succulent than external sepals, margin entire, apex acute, usually mucronate. Petals 5, oblong, basally connate up to 1.4–1.6 mm, white with yellow apex, 7.5–8.5 × 4–5 mm, margin erose, apex obtuse or truncated. Stamens 40–60, adnate to the base of the corolla, whorls 1–2, filament thick, basally rectangular, terete from 1/3–1/2 their length, 1.5–2.5(–3) × 0.4 mm. Anthers triangular, lanceolate or oblong, uneven, 2–3.5 × 1–1.3 mm, extension of the connective triangular, 1.4–2.7 long, 0.4–0.5 mm width at the base. Pistil one, 7.5–9 mm long; ovary bilocular, slightly umbonate to conical, 1–2 mm high, 2.5–4 mm in diameter at the base. Style with conical base, (3–)5–7 mm long, persistent on the fruit, stigma punctiform; ovules (6–)7–10(–12) per locule, excentric, 0.8–1 × 0.4–0.5 mm. Fruit green (unripe) to yellow-reddish when ripe, conical-elongated, dehiscence longitudinal to irregular, peduncle light green (unripe) to yellow-green when ripe, calyx greenish-yellow, center internally orange when ripe, persistent with sepals generally adpressed to the fruit, base thickened 1.5 mm in diameter, (1.7–)2–2.5 cm

long, (1–)1.2–1.6 cm in diameter, endocarp 1 mm thick (dry). Seeds (1–)3–6, slightly pyriform or ovoid, flattened laterally, 8–12.3 × (4–)5–5.7 mm, 2.3–3(–3.4 mm) thick, covered by an aril of scarlet-red hairs 0.5 mm long, fleshy, tomentulose, testa creamy-white.

**Geographic distribution and ecology:**—*Ternstroemia acajetensis* is a species of the arboreal and shrub strata of the cloud forest, found on the tops or ridges of hills in mountainous areas, growing on reddish volcanic soils at an elevation of 1968 to 2710 m a.s.l., mainly in cloud forests, *Quercus* forests and *Pinus-Quercus* forests, both primary and disturbed ones. The new collections were carried out in the municipality of Acajete, Veracruz, Mexico, in a cloud forest in the locality of Mesa de la Yerba, at an elevation of 1968 m a.s.l.

The suitable climatic conditions for this species correspond to humid montane climate, with mean annual precipitation between 1000 and 3000 mm, mean annual temperature of 12–23 °C, and annual difference between the coldest and warmest month of 2.5–7 °C (Rzedowski 2006). The typical climate of mountain forests corresponds to the type Cf (humid temperate with rain throughout the year) (Koeppen 1948; Rzedowski 2006).

Adult individuals of the new taxon reach up to 15 m high and are associated in the upper arboreal stratum with *Quercus laurina* Bonpl., *Q. brenesii* Trel., and *Q. affinis* Scheidw. (Fagaceae), *Liquidambar styraciflua* L. (Altingiaceae), *Clethra mexicana* DC. (Clethraceae), *Ulmus mexicana* (Liebm.) Planch. (Ulmaceae), *Carpinus caroliniana* Walter, and *Alnus jorullensis* Kunth (Betulaceae), *Pinus* sp. (Pinaceae), *Alchornea latifolia* Sw. (Euphorbiaceae), *Brunellia mexicana* Standl. (Brunelliaceae), *Zanthoxylum* sp. (Rutaceae), *Oreomunnea mexicana* (Standl.) J.-F. Leroy (Juglandaceae), *Cupressus* sp. (Cupressaceae), *Styrax glabrescens* Benth. (Styracaceae), *Podocarpus* sp. (Podocarpaceae), and *Oreopanax xalapensis* (Kunth) Decne. & Planch. (Araliaceae). In the intermediate arboreal stratum, with *Gaultheria acuminata* Schldl. & Cham. and *Lyonia squamulosa* M. Martens & Galeotti (Ericaceae), *Magnolia schiedeana* Schldl. (Magnoliaceae), *Deppea grandiflora* Schldl. (Rubiaceae), and *Miconia glaberrima* (Schldl.) Naudin (Melastomataceae). In the shrub stratum, with *Rubus* sp. (Rosaceae), *Mikania* sp., *Senecio petasioides* Greenm., and *S. lanicaulis* Greenm. (Asteraceae); and in the herbaceous stratum, with *Pteridium aquilinum* (L.) Kuhn (Dennstaedtiaceae), *Adiantum andicola* Liebm. (Pteridaceae), *Smilax* sp. (Smilacaceae), *Elaphoglossum guatemalense* (Klotzsch) T. Moore (Dryopteridaceae), *Polypodium* sp. (Polypodiaceae), *Selaginella* sp. (Selaginellaceae), *Catopsis paniculata* E. Morren, *Tillandsia imperialis* E. Morren ex Mez, and *Tillandsia* sp. (Bromeliaceae), *Salvia lavanduloides* Kunth (Lamiaceae), *Archibaccharis intermedia* (S.F. Blake) B.L. Turner (Asteraceae), and *Peperomia* sp. (Piperaceae).

**Etymology:**—The name of the new species refers to the municipality of Acajete, Veracruz, an area where it grows and where the type specimen was collected.

**Phenology:**—*Ternstroemia acajetensis* flowers and fructifies practically all year round, except for September.

**Additional specimens examined:**—**MEXICO. Oaxaca:** Mpio. Teotitlán de Flores Magón, Teotitlán del Camino, 29 km NE towards Huautla, *R. Cedillo T. et al. 1641* (MEXU); Mpio. San Jerónimo Tecóatl, Sierra de Huautla, between Puente de Fierro and San Jerónimo Tecóatl, *M. Cházaro B. 2167* (MEXU, XAL); Mpio. San Felipe Usila, Santa Cruz Tepetotutla, 8 km in straight line, S, Perfume river basin, W slope, *C. Gallardo H. et al. 1218* (MEXU, XAL); Mpio. Santa María Tepantlali, Santa María Tepantlali, 0.8 km in straight line, NE of cerro Costoche, towards cerro Campana, Mixe region, *G. Juárez G. 3828* (MEXU); Mpio. San Felipe Usila, Santa Cruz Tepetotutla, 7 km in straight line, S, Perfume river basin, W slope, *J. Meave C. et al. 1627* (MEXU); Mpio. Totontepec, Totontepec, *J. Rivera R. & G.J. Martín 1155* (MEXU); Mpio. Santiago Lachiguirí, behind Cerro de Las Flores, peak of Cerro Chayotepec, 3 km in straight line from Santiago Lachiguirí, *K. G. Velasco et al. 1401* (MEXU). **Puebla:** Mpio. Coyomeapan, at the entrance to Matlahuacala, *V.H. de Gante C. 75* (HUAP, MEXU). **Veracruz:** Mpio. Xico Oxtlapa, 200 m to the E, *R.E. Arriaga C. 169* (MEXU, XAL); Mpio. Acajete, Plan de Sedeño, deviation road to Xalapa-Perote, *J.I. Calzada 5232* (MEXU, XAL); Mpio. Coatepec, La Cortadura, E foothills of Cofre de Perote, *G. Castillo-Campos 21765* (XAL), *22302* (MEXU, XAL), *22897* (XAL); Mpio. Coatepec, reserva La Cortadura, *G. Castillo-Campos & E. Dian 29475, 29541, 29542* (XAL); Mpio. Acajete, road Plan de Sedeño-Mesa de la Yerba, *G. Castillo-Campos et al. 29360, 29375* (XAL); Mpio. Coatepec, Corral de Rajas, downhill, towards Buena Vista, *M. Cházaro B. & C. Reynoso 2741* (XAL, WIS); Mpio. Xico, past Ingenio El Rosario, towards Buenavista, *M. Cházaro B. & H. Oliva 4309* (XAL); Mpio. Acajete, El Zapotal, *A. Francisco-Gutiérrez et al. 95* (XAL); Mpio. Acajete, 5 km east of Acajete, 3 km above (S of) Plan de Sedeño, 5 km S of Hwy between Perote and Xalapa, *L. Kelly & K.C. Nixon 1103* (MEXU), *L. Kelly & S. Rhoades 1277* (MEXU); Mpio. Ixhuacán de los Reyes, Ayahualulco, 2.5 km by road E, 1.6 km by road W of Ixhuacán de los Reyes, *M. Nee 22947* (XAL); Mpio. Xico, Las Cruces, towards La Carabina-Xico, *H. Narave F. et al. 206* (XAL); Mpio. Xico, La Pandura, road to Ingenio El Rosario-Xico, *316* (XAL); Mpio. Astacinga, Xayacatepec, *L.C. Navarro-Pérez 138* (XAL), Mpio. Astacinga, Tepepa, *190* (XAL); Mpio. Tehuipango, Tzompoaleca, *A. Rincón G. & C. Durán-Espinosa 1304* (MEXU, XAL); Mpio. Xico, road for horses, Ingenio del Rosario a Xico, *P. Tenorio L. 15494* (MEXU, XAL); Mpio. Acajete, El Zapotal, towards rancho El Encinal, *P. Zamora C. 2346* (XAL).

**Notes:**—*Ternstroemia acajetensis* grows in localities close to sites where *T. sylvatica* and *T. huasteca* are found;

frequently, specimens of this taxon had been misidentified as *T. sylvatica*. The latter species has been collected in the same area and was described from a very close locality (in the municipality of Rafael Lucio), which is adjacent to Acajete; most likely, this led to its being misidentified as *T. sylvatica*. However, until now, these two species have not been found growing sympatrically. Both species can be differentiated by peduncle length, color of flowers, shape of petals, and length of the extension of the connective in anthers (Table 1).

**Conservation status:**—The distribution of *T. acajetensis* in cloud forests includes areas that are being heavily disturbed and threatened by the change of land use for agricultural purposes and urbanization processes. For instance, the cloud forest where the type specimen was collected is located less than 10 km west of Xalapa, in the center of Veracruz, a city with an expansion of 700% of its urban area during the period 1950–2005, affecting 90% of the original vegetation, and this trend is expected to continue (Benítez *et al.* 2012). Therefore, it is of utmost importance to preserve and protect the habitats where this species thrives, taking into account its restricted distribution, low abundance, and potential threats. In accordance with the IUCN Red List categories and criteria (IUCN 2012; IUCN 2017), the species is assessed as Vulnerable: VU B1a, b (iii). In addition, this species should be considered for inclusion in a protection category (i.e., subject to special protection) in the Mexican Official Standard on threatened species (NOM–059–SEMARNAT 2010).

**TABLE 1.** Comparison between the morphological characters of *Ternstroemia acajetensis* sp. nov. and the morphologically closest species (*T. huasteca* and *T. sylvatica*).

Character	<i>T. acajetensis</i>	<i>T. huasteca</i>	<i>T. sylvatica</i>
Habitat	Tree or shrub	Tree	Shrub or tree
Size (m)	1–15	4–15	1.5–6
Leaf length (cm)	4–7.5	11–13	4–10
Leaf width (cm)	1.5–3	2.5–4	1–3.4
Primary nerves	Inconspicuous	Inconspicuous	Imprinted
Petiole length (mm)	3.5–9	8–10	3–12
Peduncle length (mm)	10–45	30–50	7–16
Persistence of bracteoles	Deciduous	Deciduous	Persistent
Bracteole length (mm)	1–2.5	3–4	2
Size of the external sepals (mm)	7–10 × 5.5–8.5	9–11 × 5–8	4–7 × 4–5
Color of the external sepals	Greenish-white, pink margin externally; shaded in purple internally	Pink	Greenish-white
Size of the internal sepals (mm)	8–12.5 × 5–8.5	8–12 × 6–8	5–9 × 4–6
Sepals apex	Acute	Acute	Rounded
Shape of petals	Oblong	Acute	Suborbicular
Size of petals (mm)	7.5–8.5 × 4–5	7–8 × 4–5	6–8 × 6–7
Length of the extension of the connective in anthers (mm)	1.4–2.7	1	0.2–0.7

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