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Clusia falcata (Clusiaceae), an endangered species with exceptionally narrow leaves endemic to Chiapas, Mexico

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Summary. *Clusia falcata* (Clusiaceae), a new species from Chiapas, Mexico, is described and illustrated. This new taxon is distinctive for its leaves, among the narrowest of all known species, having lanceolate to oblong laminas that are mostly 10 – 15 × 2 – 2.5 cm. The flowers have a quadrangular perianth with succulent petals, and a non-resiniferous androecium and gynoecium. Staminate flowers have a quadrangular androphore bearing 18 – 24 short stamens. Pistillate flowers have 4 pairs of staminodia, with each pair born on an androphore. The species is endemic to montane forests of the Northern and Eastern highlands of Chiapas in Mexico and is currently considered to be endangered.

Resumen. *Clusia falcata* (Clusiaceae), una nueva especie de Chiapas, México, es descrita e ilustrada. Este nuevo taxón se distingue por sus hojas entre las más angostas de todas las especies conocidas, con láminas lanceoladas a oblongas, generalmente de 10 – 15 × 2 – 2.5 cm. Las flores tienen un perianto cuadrangular con pétalos suculentos y androceo y gineceo no resiníferos. Las flores estaminadas tienen un andróforo cuadrangular con 18 – 24 estambres cortos. Las flores pistiladas tienen 4 pares de estaminodios, cada par sobre un andróforo. La especie es endémica de bosques de las montañas del norte y este de Chiapas en México y se considera en peligro de extinción. La especie es endémica de los bosques mesófilos de montaña en las tierras altas al este y norte de Chiapas en México y se considera en peligro de extinción.

Key Words. Neotropics, new species, taxonomy, tropical trees.

Introduction

Clusia L. (Clusiaceae) comprises 300 – 400 species of hemiepiphytic or terrestrial shrubs and trees distributed from Mexico and the Greater Antilles to Bolivia and southeastern Brazil (Gustafsson *et al.* 2007). According to molecular evidence the genus is a strongly-supported monophyletic group (Gustafsson & Bittrich 2002; Gustafsson *et al.* 2007; Luján 2019). One consistent morphological synapomorphy for the genus is the presence of a two- to many-layered hypodermis in the leaves (Vesque 1892; Luján pers. obs.). Other characters that are common across *Clusia* species and that help distinguish it from related genera are fruits with more than one seed per carpel, seed length ≤ 5 mm and non-vascularised seed aril (Gustafsson *et al.* 2007).

At least 13 species of *Clusia* have been reported from Mexico, most of them distributed in montane forests in the southern states of Chiapas, Oaxaca and Veracruz (Tellez *et al.* 2020). The most widespread species in the country, *C. salvinii* Donn.Sm. is common in mid- to high-elevation cloud forests and has been collected up to the northwestern state of Sinaloa (Rzedowski & Zamudio 2001). The range of *C. salvinii* probably represents the latitudinal northern extreme of the natural distribution of the genus in continental America, except for some populations of *C. rosea* Jacq. in southern Florida, although the range of the latter species is likely influenced by its common cultivation and subsequent naturalisation. Before this study, two species of *Clusia* were considered endemic to Mexico, namely *C. pringlei* Lundell, distributed in mid-elevation montane forests of the trans-Mexican volcanic belt and Sierra Madre del Sur, and *C. tetratrianthera* Maguire, which occurs in low to mid-elevation forests in central Chiapas and Veracruz (Maguire 1979).

As part of an ongoing taxonomic revision of *Clusia* for Mexico, a set of specimens were identified as

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representatives of a distinct yet undescribed taxon. Here we provide a description for this new species along with a discussion of its morphological affinities to other taxa in the genus.

Materials and Methods

Herbarium specimens were studied at CAS, CR, MEXU and MO (acronyms follow Thiers, continuously updated) using dissecting stereoscopes. We applied the unified species concept from de Queiroz (2007) in which species are interpreted as separate evolving lineages based on their defining properties. In this case, phenotypic diagnosability and geographic distribution were used as lines of evidence for lineage separation. We followed the terminology of Beentje (2016) to describe morphological characters. Species conservation status was assessed following the IUCN red list categories and criteria (2019). The GeoCat tool (Bachman *et al.* 2011), with a cell width of 2 km, was used to estimate extent of occurrence (EOO) and area of occupancy (AOO).

Taxonomic Treatment

Clusia falcata *Hammel* **sp. nov.** Type: Mexico. Chiapas: Municipio Jitotol, along Río Hondo, 6.5 km N of Jitotol along road to Pichucalco, 1700 m, 27 Oct. 1971, *D. E. Breedlove & R. F. Thorne* 21392 (♂) (holotype: MO! barcode 2611409; isotypes: CAS! 330944, MEXU! 254952).

http://www.ipni.org/urn:lsid:ipni.org:names:77220442-1

Free-standing or hemiepiphyte *shrub*, 3 – 8 m; dioecious; branches cylindrical, epidermis non exfoliating; resin greenish-white. *Leaves* with the petiole 1.5 – 1.8 cm, unwinged, the base excavated and forming a pit in the adaxial portion of the junction between the petiole and the stem; lamina drying dark brown adaxially and light brown abaxially, (8 –) 10 – 15.5 × (1.4 –) 2 – 2.5 cm, narrowly lanceolate to oblong or elliptic, often falcate, base attenuate, apex acute to acuminate, margin slightly revolute; venation pinnate brochidodromous, the principal secondary veins 5 – 8 pairs, 5 – 10 mm apart, forming a 20° – 30° angle to primary vein, prominent abaxially and flat to slightly prominent adaxially; primary vein evident along the entire length of the lamina, the intramarginal vein 1 mm from margin; resin canals visible when dry in the adaxial (more faintly so on the abaxial) surface as thin, more or less continuous, nigrescent lines arising at a very narrow angle from, but eventually more or less parallel to the primary vein. *Inflorescences* slightly deflexed to pendant; dichasia often lacking the central flower, the staminate 4 – 5 × 4 – 8 cm, with 2 – 3 ramifications per node and a total of c. 16 flowers, the peduncle 1 – 3 cm, cylindrical to subquadrate; the pistillate 2 – 3 × c. 1 cm, with 2 or 3 ramifications per node (or ramifications lacking, but with 2 sets of bracts, c. 1 cm apart), with 1 – 5 flowers; bracts (subtending inflorescence branches) and bracteoles (subtending flowers) paired, 1.5 – 2 mm, more or less deltate, the apex acute, abaxially keeled. *Flower buds* 6 – 10 mm in diam. *Flowers* unisexual, lightly, but sweetly aromatic, non-resiniferous, the perianth differentiated into sepals and petals; sepals 4, light green, 5 – 6 × 3 – 4 mm and elliptic (staminate flowers), c. 6 × 6 mm and suborbicular (pistillate flowers); petals 4, erect, light green to dark pink, swollen at the base, succulent, 4 – 6 × 3 – 5 mm, oblong to pandurate (staminate flowers), c. 9 × 6 mm, ovate to suborbicular (pistillate flowers). *Androecium* (staminate flowers), uniform, (1.2 –) 1.5 – 3 mm, the androphore c. 2 × 2 mm, quadrangular with the sides concave due to bulged petal bases, convex; stamens 22 – 24, free, the filaments (0.2 –) 0.5 – 1 mm, anthers 1 – 2 mm, longitudinally dehiscent (Fig. 1). *Gynoecium* (pistillate flowers) with 4 pairs of stamen-like staminodia, alternate to the petals, c. 4 mm (including the androphore), each pair borne on an androphore, c. 2.7 mm; stigmas 4, smooth, discoid, sessile. *Fruits* pale yellow to green when submature, sepals persistent, 4 – 6 × 3 – 3.5 cm in diam., ellipsoid, 4-locular; seeds and arils not seen.

RECOGNITION. *Clusia falcata* can be readily separated from its congeners by its narrow lanceolate to oblong leaves (8 –) 10 – 15.5 × (1.4 –) 2 – 2.5 cm, with a ratio of leaf width to length of 0.17, which are likely the narrowest leaves observed in the genus thus far. Certain material of *C. dukei* Maguire — a species restricted to lowland wet forests on the Atlantic slopes of Costa Rica and Panama — likewise with very narrow and sometimes falcate leaves, has been indicated as worthy of taxonomic recognition (see Hammel 2010). That material has laminas 9.6 – 15 × 1.4 – 3 cm (leaf width to length ratio of 0.18), flowers with similarly 4-merous perianth and succulent petals. That form of *C. dukei* differs from *C. falcata* by its more numerous secondary veins at a wider angle to the primary vein (12 – 15 pairs, 2 – 3 (– 5) mm apart, at 30° – 40° angle vs 5 – 8 pairs, 5 – 10 mm apart, at 20° – 30° angle); and by its androecium with more stamens (32 vs 22 – 24 in *C. falcata*). *Clusia dukei* overall differs by its clear (vs greenish-white) resin, and by its very different configuration of the resin canals, which are relatively short (interrupted) and widely branched lines that sometimes appear to form a mesh, vs the continuous and usually unbranched lines of *C. falcata*, more like those of *C. flava* Jacq. and *C. guatemalensis* Hemsl. These latter two species have flowers with a similar perianth, androecium and gynoecium, but usually with a higher number of stamens, staminodia, and stigmas than in *C. falcata*. Most notably, their leaves are never as long and narrow as those of *C. falcata*.

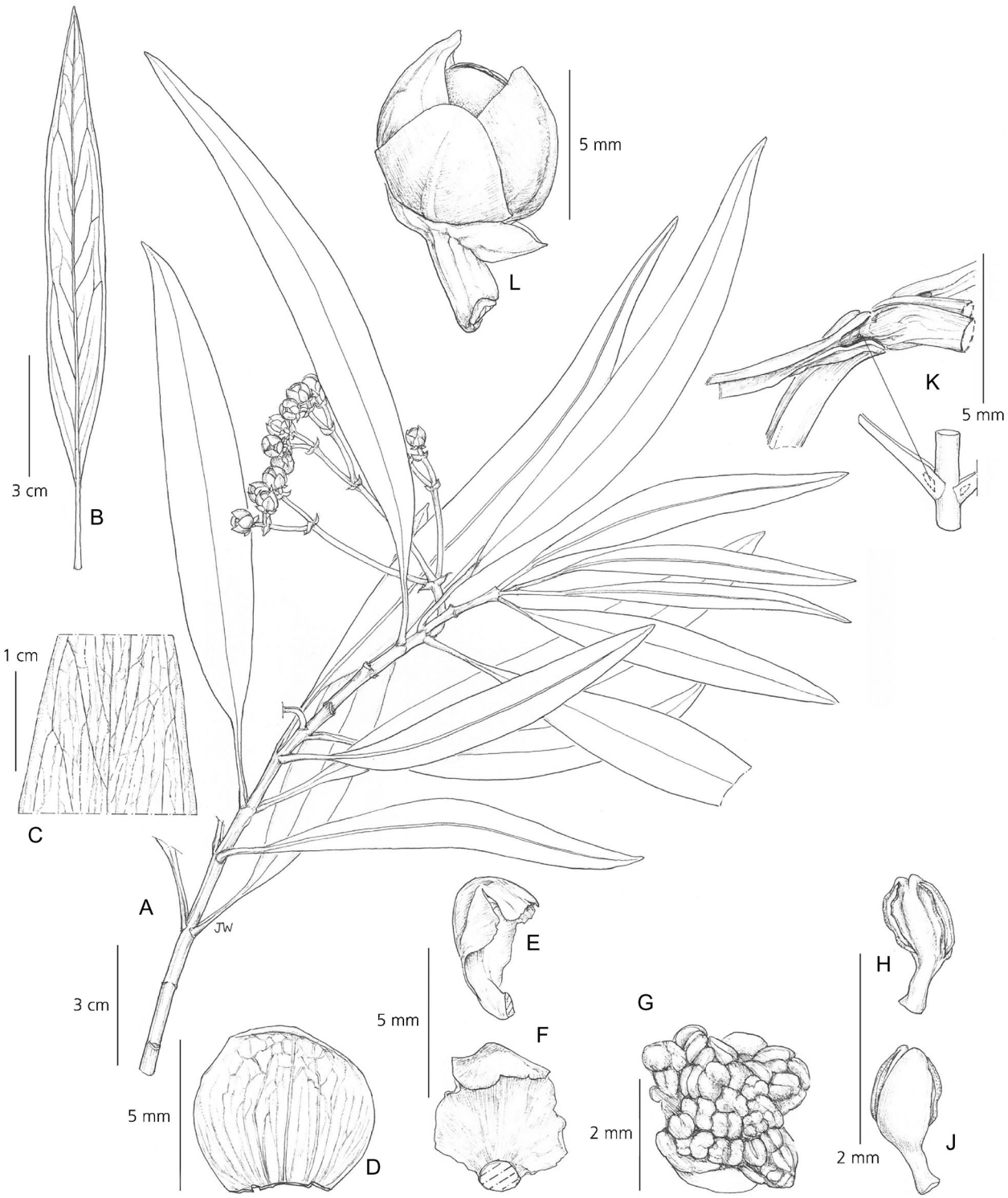
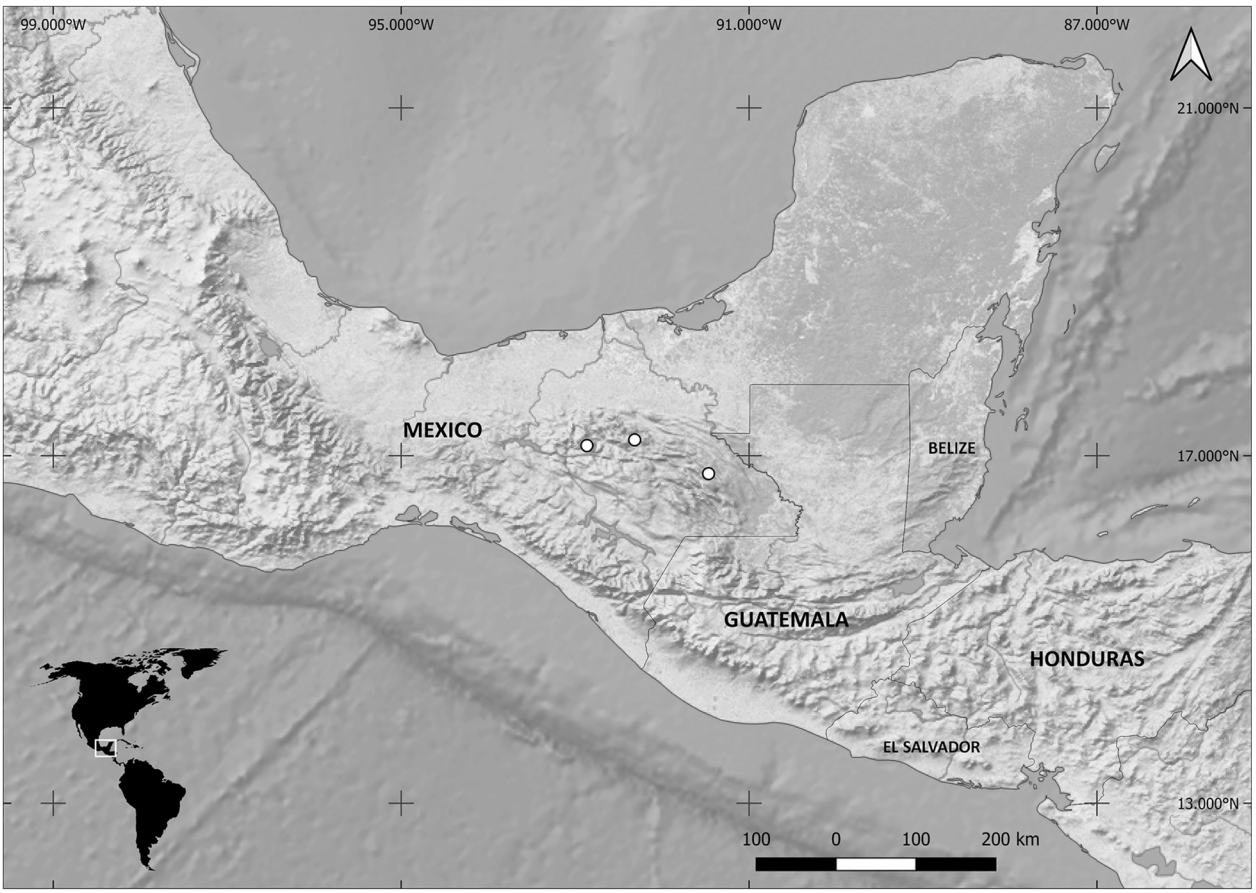


Fig. 1. *Clusia falcata*. **A** habit of flowering staminate branch; **B** leaf showing abaxial surface; **C** detail of adaxial surface of leaf showing resin canals; **D** sepal adaxial side; **E – F** petal side view and adaxial side; **G** androecium; **H – J** stamens; **K** detail of petiole base showing pit in the junction with the branch; **L** staminate flower bud. From *D. E. Breedlove & R. F. Thorne* 21392 (holotype, MO). DRAWN BY JULIET BEENTJE.

DISTRIBUTION. Northern and Eastern highlands of Chiapas (Map 1).

SPECIMENS EXAMINED. **MEXICO.** Chiapas: Municipio Jitotol, along Río Hondo, 6.5 km N of Jitotol along



Map 1. Distribution map of *Clusia falcata* in Chiapas, Mexico.

road to Pichucalco, 1700 m, 27 Oct. 1971, *D. E. Breedlove & R. F. Thorne* 21392 (♂) (holotype: MO! barcode 2611409; isotypes: CAS! 330944, MEXU! 254952). Paratypes: Municipio Ocosingo, limestone area near Laguna Ocotal Grande, c. 25 – 30 km SE of Monte (Cerro) Líbano, which is 43 km E of Ocosingo, 950 m, 20 July – 7 Aug. 1954, *R. L. Dressler* 1689 (♀) (MEXU); Municipio Jitotol, 4 miles N of Jitotol, on the road to Pueblo Nuevo Solistahuacán, 1676 m, Sept. 1971, *R. F. Thorne & E. Lathrop* 41730 (♂) (CAS); Municipio Yajalón, Banco de Grava, 15 Sept. 1983, *A. Méndez Ton* 6664 (♂) (MEXU); Municipio Jitotol, 7 km N of Jitotol on road to Pichucalco (highway 195), in woods along river, upstream from bridge, 14 Oct. 1986, *B. Hammel, E. Martínez & M. Merello* 15692 (♂) 15693 (♀) (CR, MO).

HABITAT. *Clusia falcata* grows on forested slopes with *Pinus*, *Quercus* and *Liquidambar*, and on karst areas in tropical rain forests at 950 – 1700 m.

CONSERVATION STATUS. We estimate an extent of occurrence (EOO) of 1,569.623 km^2 and an area of occupancy (AOO) of 12.0 km^2 for *Clusia falcata*. The species is known from only three localities, and continuous decline in habitat quality is inferred in at least two of them given their proximity to urban centres (the towns of Jitotol and Yajalón respectively). Only one location is within a protected area, the Reserva de Biosfera Montes Azules, which may ensure the long-term stability of that particular plant population. Given the reduced number of known localities and their likely future instability, we assess the conservation status for *C. falcata* as endangered (EN) based on the IUCN criteria B1ab(iii)+2ab(iii).

PHENOLOGY. *Clusia falcata* was collected with flowers in September and October, and with fruits in August.

ETYMOLOGY. The specific epithet of *Clusia falcata* derives from the latin word falcatus, which describes the narrow and curved shape of the leaves, a character not previously observed in the genus.

NOTES. With the aim of identifying the phylogenetic position of *Clusia falcata*, sequencing of nrITS was attempted using tissue from the type specimen, although amplification was unsuccessful, probably because the DNA was highly degraded, which is common in tissues sampled from herbarium specimens. Nevertheless, the presence of a non-resiniferous quadrangular androphore bearing multiple free stamens suggests that *C. falcata* is included in the "*Clusia flava* group" an informal infrageneric species assembly that includes *C. dukei*, *C. flava*, *C. guatemalensis*,

C. lundellii Standl., *C. quadrangula* Bartlett, *C. torresii* Standl. and likely other closely related species from Central America with similar androecial morphology (Hammel 1986). According to molecular evidence, the flava group is a well-supported monophyletic group (Gustafsson *et al.* 2007; Luján 2019) in which hemiepiphytic habit as well as CAM photosynthesis are commonly present (Vargas-Soto *et al.* 2009), and includes most, although not all taxa originally proposed by Hammel (1986).

A general pattern observed in evergreen woody plants is that relatively small leaves are more common at high latitudes, high elevations, nutrient poor, and hot arid conditions (Givnish 1987; Wright *et al.* 2017). Moreover, in some groups (e. g. subtropical bamboos), species with relatively narrower leaves tend to inhabit areas subject to water deficiency (Lin *et al.* 2020). The exceptionally narrow leaves observed in *Clusia falcata* suggest that this species may tolerate conditions of limited water availability. Furthermore, one specimen of *C. falcata* (*R. L. Dressler* 1689 [MEXU]) was collected on a limestone area, which indicates that the species may tolerate soils with high alkalinity and low nutrient levels. Several environmental and genetic factors are involved in determining leaf size and shape, potentially leading to many equally viable leaf strategies for a given environment (Wright *et al.* 2017). Further comparative research is needed to better understand the drivers of leaf size and shape variability in *Clusia*, and to test whether *C. falcata* is adapted to particularly harsh environmental conditions.

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