JUSTICIA DARIENENSIS (ACANTHACEAE: JUSTICIEAE: JUSTICIINAE), A NEW SPECIES ENDEMIC TO A TROPICAL SKY ISLAND IN PANAMA

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ABSTRACT

A new species, **Justicia darienensis** T.F. Daniel & M. Vargas P., is described from a biodiverse "hotspot" in an isolated cloud forest of Darién Province in eastern Panama. It is compared to morphologically and palynologically similar species in southern Central America. *Justicia darienensis* is characterized by a complex inflorescence with heteromorphic (shape and fertility) bracts, white corollas with purple markings on the lower lip, glabrous anther thecae, 4-aperturate pollen, and pubescent capsules. Images of the plant and its pollen are provided.

RESUMEN

Se describe una especie nueva, **Justicia darienensis** T.F. Daniel & M. Vargas P., de un "hotspot" de biodiversidad en un bosque nuboso aislado de la provincia de Darién en el este de Panamá. Se la compara con especies similares en morfología y palinología del sur de Centroamérica. *Justicia darienensis* se caracteriza por una inflorescencia compleja con brácteas heteromórficas (en forma y fertilidad), corolas blancas con marcas moradas en el labio inferior, anteras glabras, polen 4-aberturada y cápsulas pubescentes. Se proporcionan imágenes de la planta y su polen.

Key Words: *Justicia*, Central America, Cerro Chucantí, biodiversity hotspot, pollen

INTRODUCTION

As currently recognized, *Justicia* L. is the largest genus of Acanthaceae consisting of ca. 1,000 species (Manzitto-Tripp et al. 2022) that occur primarily in tropical regions worldwide. Molecular data, however, reveal that the genus is not monophyletic as presently circumscribed (e.g., Kiel et al. 2017). Both morphological and molecular studies are ongoing to resolve how *Justicia* and its relatives in the subtribe Justiciinae should be treated taxonomically. At least 90 species of the genus are currently recognized from the seven countries of Central America (Ulloa Ulloa et al. 2018 and updated; Daniel, unpublished), with numbers of species for each as follows: Belize (11), Costa Rica (39), El Salvador (11), Guatemala (41), Honduras (20), Nicaragua (13), and Panama (30).

The most recent comprehensive account of *Justicia* in Panama (Durkee 1978) was followed by two updated listings of taxa there (D'Arcy 1987; Correa A. et al. 2004). Additional literature dealing with taxonomy and/or occurrences of the genus in Panama includes: Daniel and Wasshausen (1990), Daniel (1993, 1999), Daniel and McDade (1995), and Durkee (1999). Nine species of *Justicia* are believed to be endemic to Panama: *J. allenii* (Leonard) Durkee, *J. cauliflora* Durkee, *J. chiriquiensis* Durkee, *J. fortunensis* T.F. Daniel & Wassh., *J. graciliflora* (Standl.) D.N. Gibson, *J. panamensis* Durkee, *J. readii* T.F. Daniel & Wassh., *J. refulgens* Leonard, and *J. veraguensis* T.F. Daniel & Wassh. Below, we describe another species apparently endemic to a "biodiverse hotspot" in the country, and discuss its macromorphological and palynological characteristics relative to congeners in nearby regions.

MATERIALS AND METHODS

Specimens of *Justicia* were studied at CAS, DS, MO, and PMA; online images of additional specimens at US were observed from Panama and Colombia. Pollen from the holotype of *Justicia darienensis* was studied as

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described by Daniel (1998), and imaged in the Scanning Electron Microscopy Laboratory at the California Academy of Sciences. Palynological terminology generally follows Walker and Doyle (1975). A provisional conservation assessment was not attempted due to lack of sufficient information on overall distribution, population data, and threats.

TAXONOMIC TREATMENT

Justicia darienensis T.F. Daniel & M. Vargas P., **sp. nov.** (**Figs. 1–4**). TYPE. PANAMA. Darién: Reserva Natural Privada Cerro Chucantí, sendero de los helicopteros, a la orilla del camino, 08°47′45″N, 078°27′47″W, 1300 m, 3 Dec 2016 (flr), *M. Vargas, Z. Mijango & I. Arcia 187* (HOLOTYPE: PMA!).

Justicia darienensis is superficially similar to *J. costaricana* Leonard, but differs from that species by its complex inflorescence structure (vs. simple spikes), longer (15–18 vs. 10–14 mm) corollas, apically rounded to truncate (vs. apiculate) fertile bract apices, stationary (vs. laterally diverging) stamens at maturity, glabrous anther thecae (vs. dorsally pubescent upper anther thecae), and 4-aperturate (vs. 2-aperturate) pollen.

Terrestrial **herbs** to ca. 1 m tall. Young stems quadrate to quadrate-sulcate, glabrous. **Leaves** petiolate, petioles to 37 mm long, pubescent (especially adaxially) with flexuose to antrorse eglandular trichomes, blades ovate to ovate elliptic, 80–125 mm long, 35–68 mm wide, length:width = 1.8–2.3, ± rounded to cuneate at base, acute at apex, adaxial surface pubescent (mostly along midvein) with antrorse eglandular trichomes, abaxial surface very sparsely pubescent along major veins with similar trichomes, superficial cystoliths prominent. **Inflorescences** of terminal modified panicles or panicle-like thyrses consisting of modified spicate branches (= dichasia ?, see discussion below) from axils of distal leaves and/or bracts (?; caducous and not seen) to 65 mm long and 27 mm in diameter (measured flat), rachis pubescent with coarse, mostly antrorse to antrorsely appressed eglandular trichomes to 0.5 mm long; axillary spicate branches (= modified dichasia ?) opposite along rachis, sessile to pedunculate (?), multi-flowered, expanded at only one node per flower, branches (= secondary peduncles?) pubescent like rachis. **Bracts** at branch (= dichasial ?) nodes heteromorphic, narrowed proximally into a stalklike base, fertile bracts obovate to spatulate to obdeltate, 8–12 mm long, 2–4 mm wide, rounded to truncate at apex, abaxial surface pubescent with sparse eglandular trichomes 0.1–0.2 mm long and also with mostly subsessile glandular trichomes less than 0.1 mm long, margin ciliate with erect to flexuose eglandular trichomes to 0.8 mm long and also with stipitate glandular trichomes to 0.2 mm long, sterile bracts narrowly oblanceolate to narrowly spatulate, 3.5–5 mm long, 0.2–0.5 mm wide, pubescent like fertile bracts or lacking glandular trichomes. **Bracteoles** subtending flowers narrowly spatulate and often asymmetric, 9–9.5 mm long, 1–1.4 mm wide, pubescent like subtending bracts. **Calyces** deeply and subequally 5-lobed, 5–6 mm long, lobes lanceolate, 4–5 mm long, 0.5–0.8 mm wide, abaxially pubescent with flexuose to antrorse eglandular trichomes 0.1–0.3 mm long, margin whitish-green, ciliate with flexuose eglandular trichomes to 0.5 mm long. **Corollas** white with purple discolorations in a herringbone pattern internally on lower lip and with greenish tinge internally on upper lip, 15–18 mm long, externally pubescent with flexuose to retrorse eglandular trichomes 0.2–0.5 mm long, tube 9.5–12.5 mm long, 1.8–2.5 mm in diameter (measured flat) at base, 2.5–3 mm in diameter (measured flat) at mouth, expanded distally into an obconic throat, narrow proximal portion 6–8 mm long, throat 3–6 mm long, upper lip erect, 3–4.5 mm long, shallowly 2-lobed at apex, lower lip spreading at 90° to upper lip, 3-lobed, 4.5–6 mm long, lobes obovate, 4–5 mm long, 1.7–2 mm wide. **Stamens** inserted near base of throat, 4–7 mm long, filaments glabrous, thecae unequally inserted (overlapping by 0.6–0.7 mm), subparallel to slightly offset, 1.3–1.5 mm long, glabrous, lower theca with a thick basal appendage 0.2 mm long. **Pollen** euprolate, 4-colporate, 8-pseudocolpate, polar diameter (P) 38–46 µm, equatorial diameter (E) 24–28 µm, P:E = 1.4–1.8, interapertural exine bireticulate. **Styles** 13.5–15 mm long, glabrous, stigmas ca. 0.1 mm long, lobes not evident. **Capsules** 10.5 mm long, pubescent with eglandular trichomes. **Seeds** 4, discoid, 2–3 mm long, 2–2.6 mm wide, surfaces smooth.

Phenology.—Flowering: December–January; fruiting: January.

Distribution, habitat, and threats.—Endemic to the Majé Mountains in northwestern Darién Province of eastern Panama (Fig. 3); plants were collected in cloud forest at 1300–1390 meters elevation in the Reserva

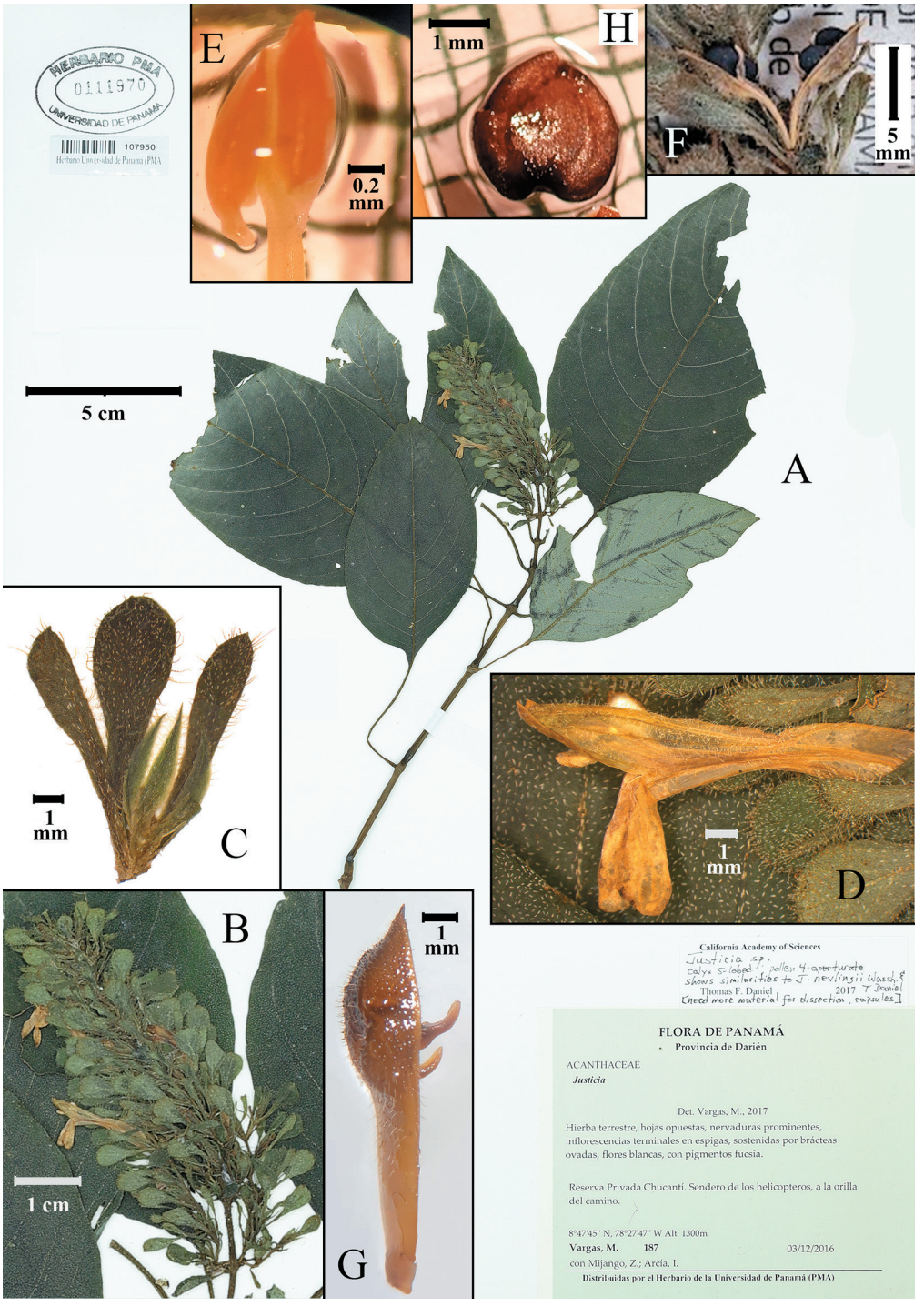

Fig. 1. *Justicia darienensis*. **A.** Holotype (*Vargas 187*). **B.** Close-up of inflorescence on holotype. **C.** Bract, bracteoles, and three calyx lobes from holotype. **D.** Corolla from holotype. **E.** Anther (*Guillén et al. 801*). **F.** Opened capsule with seeds (*Guillén et al. 801*). **G.** Capsule valve (*Guillén et al. 801*). **H.** Seed (*Guillén et al. 801*). Holotype photo by Ron Proctor.

Fig. 2. *Justicia darienensis*, live plants at Cerro Chucantí. **A.** Habit (red arrow indicates stem near base of plant). **B.** Inflorescence with flowers. **C.** Inflorescences. Photos by José Luis Guerra, used with permission.

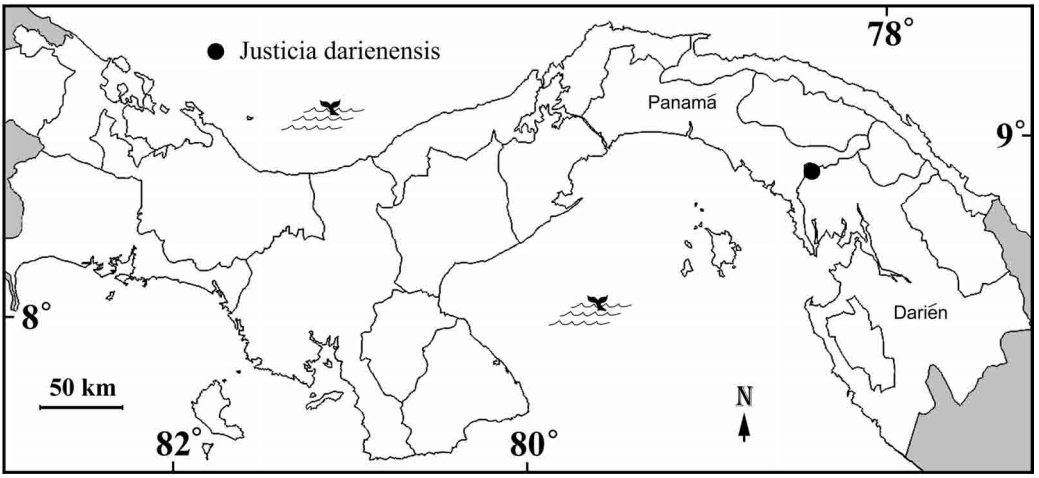

Fig. 3. Map of Panama with outlines of the pr ovinces and comarcas showing the loc ation of *Justicia darienensis* near the bor der of the pr ovinces of Panamá and Darién.

Natural Privada Cerro Chucantí. Cerro Chucantí is the only area within the Serranía de Majé covered predominantly by cloud forest at higher elevations. It is isolated from the nearest equivalent cloud forest in the Cerro Pirre by ca. 120 km of lowland terrain, and thus it is sometimes referred to as a tropical sky island. At least 18 new species of plants, invertebrates, and vertebrates that are known only from the Cerro Chucantí have recently been described (e.g., see articles listed at: http://adoptabosque.org/en/chucanti/new-species/). Although tropical cloud forests have promoted the evolution of endemic species, and some have high levels of biodiversity and endemism, they are threatened by human disturbance, including global warming (e.g., Bubb et al. 2004; Karger et al. 2021). Indeed, the montane rainforest of the lower slopes of Cerro Chucantí face threats from agriculture, logging, and cattle ranching (Batista et al. 2020).

Paratype.—**PANAMA. Darién:** Reserva Natural Privada Cerro Chucantí, área cercana al Campamento del Filo, 08°48′16″N, 078°27′34″W, 28 Jan 2023 (flr, frt), *L. Guillén, J. Guerra, M. Lino & G. Fatacioli 801* (PMA).

DISCUSSION

The inflorescence structure of *Justicia darienensis* is complex and is perhaps not completely understood by us based on the material available (Figs. 1–2). The axillary spicate branches most likely represent modified and expanded dichasia, which consist of sessile flowers in the axils of the fertile bracts with dichasial expansion via secondary peduncles that arise from the axil of the sterile bract at each node. If the inflorescence represents a thyrse, it is modified by the individual flowers being sessile rather than pedicellate. Additional material would be very helpful to better understand the nature of inflorescences in this species.

Justicia darienensis shares numerous characteristics with the Costa Rican endemic *J. costaricana*. Both species have prominent foliar cystoliths; similarly sized, shaped, and colored corollas; heteromorphic bracts of similar shape; similarly sized and pubescent capsules; and similarly sized and oriented anther thecae with the lower one bearing a prominent basal appendage. However, *J. costaricana* differs from *J. darieniensis* in other features, including those listed in the diagnosis above.

Four-aperturate pollen does not appear to be common among species of *Justicia* (Graham 1988; Daniel 2003; Smith et al. 2019). It occurs in at least 19 other species from North America and Central America: *J. angustiflora* D.N. Gibson, *J. aurantimutata* Hammel & Gómez-Laur., *J. chiriquiensis* Durkee, *J. densibracteata* Durkee & McDade, *J. ensiflora* (Standl.) D.N. Gibson, *J. jitotolana* T.F. Daniel, *J. masiaca* T.F. Daniel, *J. multicaulis* Donn.Sm., *J. nelsonii* (Greenm.) T.F. Daniel, *J. neomontana* Bennet & Sum. Chandra, *J. nevlingii* Wassh. & T.F.

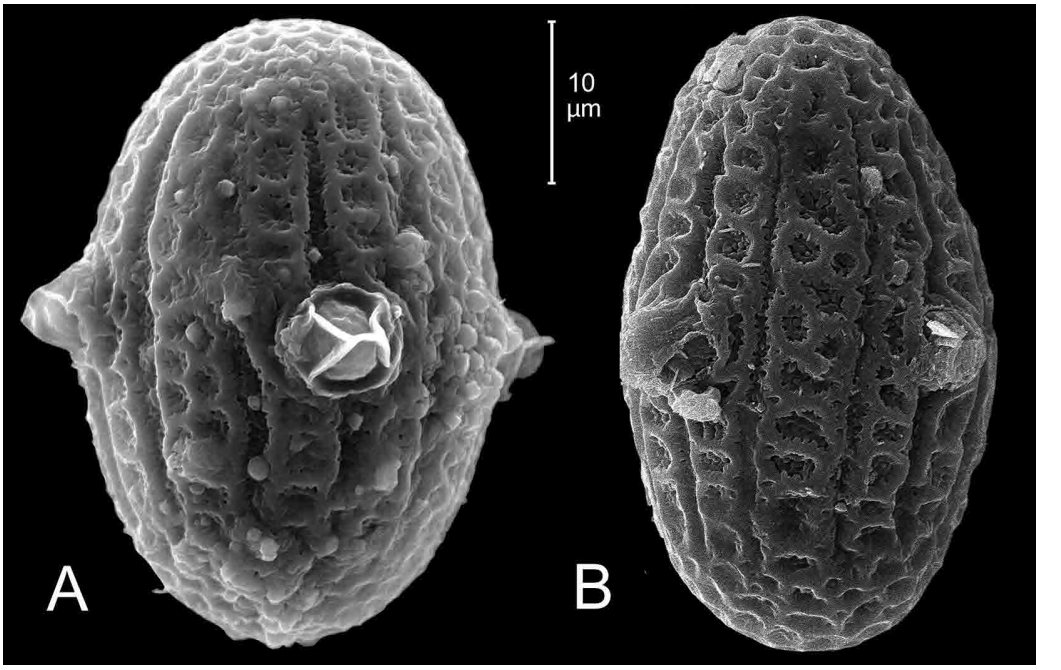

Fig. 4. Pollen of *Justicia darienensis* (*Vargas 187*). A. Apertural view. B. Interapertural view.

Daniel, *J. orosiensis* Durkee, *J. peninsularis* Gómez-Laur. & Hammel, *J. silvicola* D.N. Gibson, *J.* sp. nov. ined. (from Oaxaca, Mexico), *J. tabascina* T.F. Daniel, *J. valvata* T.F. Daniel, *J. warnockii* B.L. Turner, and *J. wrightii* A. Gray (Gibson 1972; Durkee 1986, 1999; Durkee & McDade 1996; Daniel 2003, 2011, unpublished). Although aperture number remains to be determined for several species from southern Central America, pollen with four germinal apertures is currently known from only five species in Costa Rica and/or Panama: *J. aurantimutata*, *J. chiriquiensis*, *J. densibracteata*, *J. orosiensis*, and *J. peninsularis*. Among the 19 species with four apertures occurring north of South America, pollen of some show similarities to that of *J. darienensis*. For example, pollen of *J. aurantimutata* (Gómez-Laurito & Hammel 1994, fig. 7B) from Costa Rica has similar rows of exine flanking colpori, but these are noted to be in a "trema" region, which is not present in *J. darienensis* (Fig. 4). *Justicia aurantimutata* also differs from *J. darienensis* by several macromorphological characteristics, including: stems densely pubescent with trichomes that turn orange when dry, foliar cystoliths inconspicuous, bracteoles 3–4 mm long, and corollas 10–15 mm long. Pollen of another Costa Rican species, *J. densibracteata* (Durkee & McDade 1996, fig. 4C) is nearly identical to that of *J. darienensis*. It appears to differ only by poleward fusion of the adjacent interapertural pseudocolpi. Because such fusion often occurs among pollen of species that also lack it, this presumed difference may not be taxonomically significant. *Justicia densibracteata* also appears to have inflorescences similar to those of *J. darienensis* with heteromorphic and glandular bracts. It differs from *J. darienensis* by: young stems pubescent, bracts and bracteoles lacking a conspicuous stalklike base, fertile bracts 12–22 × 7–12 mm and apically apiculate, bracteoles 11–17 × 4–7 mm, corollas 27–29 mm long, and anther thecae 4 mm long with each bearing a basal spur.

Pollen of Colombian species of *Justicia* is not well documented. In her worldwide study of the genus, Graham (1988) included 20 of the 93 (including at least three non-native) species currently known to occur in Colombia (Wood 2015). Graham specifically attributed pollen types to 17 of these 20, all of which have 2-aperturate grains. *Justicia kirkbridei* Wassh., subsequently described by Wasshausen (1989) from Colombia,

has 3-aperturate pollen. It is probable that some species from that country may also have 4-aperturate pollen; however, based on macromorphological characters, *Justicia darienensis* does not appear to pertain to any of the currently recognized Colombian species (e.g., Leonard 1958; Wood 1988, 2009; Wasshausen 1989).

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REFERENCES

Batista, A., K. Mebert, M. Miranda, O. Garcés, R. Fuentes, & M. Ponce. 2020. Endemism on a threatened sky island: new and rare species of herpetofauna from Cerro Chucantí, eastern Panama. Amphib. Reptile Conserv. 14:27–46.

Bubb, P., I. May, L. Miles, & J. Sayer. 2004. Cloud forest agenda. UNEP-WCMC, Cambridge, UK. http://www.unep-wcmc.org/resources/publications/UNEP_WCMC_bio_series/20.htm. Accessed July 2023.

Correa A., M. D., C. Galdames, & M.S. de Stapf. 2004. Catálogo de las plantas vasculares de Panamá. Autoridad Nacional del Ambiente, Panama. 599 pp.

Daniel, T.F. 1993. Taxonomic and geographic notes on Central American Acanthaceae. Proc. Calif. Acad. Sci. 48:119–130.

Daniel, T.F. 1998. Pollen morphology of Mexican Acanthaceae: diversity and systematic significance. Proc. Calif. Acad. Sci. 50:217–256.

Daniel, T.F. 1999. Taxonomic and distributional notes on Neotropical *Justicia* (Acanthaceae). Proc. Calif. Acad. Sci. 51:483–492.

Daniel, T.F. 2003. A reconsideration of *Megalostoma* (Acanthaceae), a new species, and recognition of a new section of *Justicia*. Proc. Calif. Acad. Sci. 54:371–380.

Daniel, T.F. 2011. *Justicia* (Acanthaceae) in Texas. J. Bot. Res. Inst. Texas 5:595–618.

Daniel, T.F. & L.A. McDade. 1995. Additions to the Acanthaceae of Panama. Ann. Missouri Bot. Gard. 82:542–548.

Daniel, T.F. & D.C. Wasshausen. 1990. Three new species of *Justicia* (Acanthaceae) from Panama. Proc. Calif. Acad. Sci. 46:289–297.

D'Arcy, W.G. 1987. Flora of Panama. Checklist and index. Part I. Monogr. Syst. Bot. Missouri Bot. Gard. 17:1–328.

Durkee, L.H. 1978. Acanthaceae. In: R.E. Woodson & R.W. Schery, eds. Flora of Panama. Ann. Missouri Bot. Gard. 65:155–248.

Durkee, L.H. 1986. Acanthaceae. In: W. Burger, ed. Flora Costaricensis. Fieldiana, Bot. 18:1–92.

Durkee, L.H. 1999. Five new taxa and two new combinations of Acanthaceae from Central America. Novon 9:503–510.

Durkee, L.H. & L.A. McDade. 1996. Three new species of *Justicia* (Acanthaceae) from Costa Rica. Novon 6:13–21.

Gibson, D.N. 1972. Studies in American plants, III. Fieldiana, Bot. 34:57–87.

Gómez-Laurito, J. & B.E. Hammel. 1994. New species in the Acanthaceae of Costa Rica. Novon 4:350–361.

Graham, V.A.W. 1988. Delimitation and infra-generic classification of *Justicia* (Acanthaceae). Kew Bull. 43:551–624.

Karger, D.N., M. Kessler, M. Lehnert, & W. Jetz. 2021. Limited protection and ongoing loss of tropical cloud forest biodiversity and ecosystems worldwide. Nat. Ecol. Evol. 5:854–862. https://doi.org/10.1038/s41559-021-01450-y. Accessed June 2023.

Kiel, C.A. T.F. Daniel, I. Darbyshire, & L.A. McDade. 2017. Unraveling relationships in the morphologically diverse and taxonomically challenging "justicioid" lineage (Acanthaceae: Justicieae). Taxon 66:645–674.

Leonard, E.C. 1958. The Acanthaceae of Colombia. Contr. U.S. Natl. Herb. 31(3):323–781.

Manzitto-Tripp, E.A., I. Darbyshire, T.F. Daniel, C.A. Kiel, & L.A. McDade. 2022. Revised classification of Acanthaceae and worldwide dichotomous keys. Taxon 71:103–153.

Smith, H.J., C. Moran, O. Lachenaud, & I. Darbyshire. 2019. *Justicia gigantophylla* (Acanthaceae), an endangered litter-gathering species from southern Cameroon. Pl. Ecol. Evol. 152:546-553.

Ulloa Ulloa, C. (& 23 others). 2018 on wards. Vascular plants of the Americas (VPA) website. Tropicos, Botanical Information System at the Missouri Botanical Garden, St. Louis, Missouri, USA. http://www.tropicos.org/Project/VPA. Accessed June 2023.

Walker, J.W. & J.A. Doyle. 1975. The bases of angiosperm phylogeny: palynology. Ann. Missouri Bot. Gard. 62:664–723.

Wasshausen, D.C. 1989. New and interesting species of Acanthaceae from Colombia. Revista Acad. Colomb. Ci. Exact. 17:249–257.

Wood, J.R.I. 1988. Colombian Acanthaceae—some new discoveries and some reconsiderations. Kew Bull. 43:1–51.

Wood, J.R.I. 2009. New names, combinations and synonyms in *Justicia* and *Stenostephanus* (Acanthaceae). Kew Bull. 64:49–55.

Wood, J.R.I. 2015. *Justicia*. 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. http://catalogoplantascolombia.unal.edu.co. Accessed June 2023.