WEBBIA Journal of Plant Taxonomy and Geography

Firenze University Press
www.fupress.com/webbia

OPEN ACCESS

Citation: Ortiz, O.O., Cedeño-Fonseca, M., Jiménez, J.E., & Hughes, J.M. (2024). The pendent species of *Anthurium* sect. *Porphyrochitonium* from Costa Rica and Panama: synopsis, nomenclatural notes, new species, and conservation status. *Webbia. Journal of Plant Taxonomy and Geography* 79(2): 311-350. doi: 10.36253/jopt-16289

Received: June 24, 2024

Accepted: August 7, 2024

Published: September 3, 2024

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Alistair Hay

ORCID
OOO: 0000-0002-7805-0046
MC-F: 0000-0003-0119-0427
JEJ: 0000-0002-8154-2156
JMH: 0009-0007-6089-7226

The pendent species of *Anthurium* sect. *Porphyrochitonium* from Costa Rica and Panama: synopsis, nomenclatural notes, new species, and conservation status

Orlando O. Ortiz[1,2,3,*], Marco Cedeño-Fonseca[3,4,5], José Esteban Jiménez[4,5,6,7], Jason M. Hughes[8]

[1] *Herbario PMA Universidad de Panamá, Estafeta Universitaria, Panamá City, Panama*
[2] *Coiba Scientific Station (COIBA AIP), Panama City, Panama*
[3] *Botanischer Garten und Botanisches Museum Berlin, Freie Universität Berlin, Königin-Luise-Straße 6-8, D-14195 Berlin, Germany*
[4] *Research Associate, Herbario Luis A. Fournier Origgi (USJ), Centro de Investigación en Biodiversidad y Ecología Tropical (CIBET), Universidad de Costa Rica, P.O. Box 11501-2060, San José, Costa Rica*
[5] *Research Associate, Jardín Botánico Lankester, Universidad de Costa Rica, P.O. Box 302–7050, Cartago, Costa Rica*
[6] *University of Florida Herbarium, Florida Museum of Natural History, 379 Dickinson Hall, 1659 Museum Rd., Gainesville, FL 32611, USA*
[7] *Department of Biology, University of Florida, Gainesville, FL 32611, USA*
[8] *154 Hughes Dr, Camarillo, CA 93010 USA*
*Corresponding author. Email: ortizopma@gmail.com

Abstract. A review of the Costa Rican and Panamanian taxa of *Anthurium* sect. *Porphyrochitonium* with a pendent growth form is presented here. Two new species (*A. cascantei* and *A. embera*) are described and illustrated, and five new synonyms are proposed. We recognize 16 taxa of *Anthurium* sect. *Porphyrochitonium* with pendent growth form distributed in the region: eight exclusively from Costa Rica, one exclusively from Panama, and three species endemic to both countries. *Anthurium gregneversii* is reported as a new record for Costa Rica and the distribution of *A. edtysonii* is extended from Costa Rica to Ecuador. Nomenclatural notes and typifications for *A. friedrichsthalii* Schott and *A. linearifolium* Engl. are included. Information about geographic distribution and habitat, conservation assessments, phenology, and taxonomic comments are provided, along with a dichotomous key to identify the species.

Keywords: Araceae, Conservation, Darién, Fila Anguciana, Fila Costeña, nomenclature, taxonomy, Tinamaste, Turrialba.

INTRODUCTION

Anthurium Schott is a genus of Araceae that stands out for exhibiting a wide spectrum of habits, ranging from terrestrial plants, lithophytes, rheo-

phytes, nomadic vines, hemiepiphytes or epiphytes (Croat 1988; Zotz 2013; Croat and Ortiz 2020). The epiphytes themselves present a wide variety of growth forms (e.g., climbers, rosette like birds' nests or pendent) that can occupy various types of tropical ecosystems (Croat 1986, 1988; Croat and Ortiz 2020). In the pendent growth condition, plants are characterized by having the leaves (both blades and petioles) completely held downwards. *Anthurium* species with pendent growth form can be found in various sections, as in sect. *Pachyneurium* (Schott) Engl. (*A. brenesii* Croat & R.A.Baker, *A. prolatum* Croat & R.A.Baker, *A. protensum* Schott, *A. spectabile* Schott, *A. pseudospectabile* Croat), sect. *Leptanthurium* (Schott) Engl. (*A. fornicifolium* Croat, *A. lutheri* Croat, *A. pallidiflorum* Engl., *A. vittariifolium* Engl.), and sect. *Porphyrochitonium* (Schott) Engl. (the subject of this paper).

Anthurium section *Porphyrochitonium* was initially proposed as one of the 28 rankless "greges" by Schott (1860: 439) and later elevated to sectional status by Engler (1878: 55) (for more taxonomic history information about this group, consult Croat et al. 2022). This group represents one of the most diverse and large sections within *Anthurium*, and ranges principally from Costa Rica to Peru with the greatest diversity of species in northwestern Colombia (Croat and Sheffer 1983; Croat et al. 2022). In Central America, its diversity is found mainly in Costa Rica and Panama, which represent approximately ca. 30% (29 spp.) and 37% (111 spp.) of total recorded species, respectively (Croat 1983, 1986; Croat et al. 2022). Species of this section are characterized by its short internodes, with marcescent and usually fibrous prophylls and cataphylls generally elongate, noncordate leaf blades which are glandular-punctate on at least one surface, and ovaries with more than one ovule per locule (usually 2–4 per locule) (Croat and Sheffer 1983; Croat et al. 2022). They include mainly epiphytic species that occur from lowland humid forests such as mangroves, gallery forests, to mid-elevation humid forests, premontane, montane, and elfin cloud forests; a few are common in seasonal forests (Croat 1986, 1988).

Recent molecular studies in *Anthurium* showed that sect. *Porphyrochitonium* represents a non-monophyletic group, placing its representatives intermixed with species of sect. *Digitinervium* Sodiro (Carlsen and Croat 2013, 2019). Members of the latter section, like *Porphyrochitonium* present black-glandular punctations on the leaves but are differentiated by having steeply ascending basal veins together with numerous more or less scalariform lateral secondary veins arranged in parallel (melastome-like pattern of venation) (Croat 1983, 1986; Croat and Sheffer 1983). Phylogenetic analyses by Carlsen and Croat (2019) placed the studied species of *Porphyrochitonium* and *Digitinervium* in two distinct clades, clade No. 7 (consisting of five *Porphyrochitonium* and three *Digitinervium* taxa) which is sister to clade 6 (involving two species of *Porphyrochitonium* and one taxon of *Digitinervium*) + clade No. 5 (represented by members of sect. *Tetraspermium* Schott (Engl.)). Both sections, *Porphyrochitonium* and *Digitinervium*, comprise great vegetative morphological diversity (especially *Porphyrochitonium*) which can make interpretation of their taxonomic and evolutionary history complicated. This makes it crucial to explore other reproductive morphological characteristics, such as the color of the fruits (Carlsen and Croat 2019), that range from red, yellow or orange to violet-purple to lavender-blue or white (Croat et al. 2022). For example, Carlsen and Croat (2019) included taxa in clade 7 characterized by having berries of distinct colors (red, reddish orange, white, and purple), while those in clade 6 have yellow or pale yellow-orange berries. Perhaps the yellowish berries character could be a diagnostic character within clade 6; however, to confirm this notion, the current backbone of the molecular phylogeny must be increased by including similar congeners, like *Anthurium alticola* Croat, *A. durandii* Engl., *A. collinsii* Croat, *A. cuasicanum* Croat, *A. oxystachyum* Croat, *A. pendens* Croat, *A. supraglandulum* Croat, *A. vanninii* Croat, among others.

In this paper, we review species of *Anthurium* sect. *Porphyrochitonium* with a pendent growth form from Costa Rica and Panama, through extensive field documentation and herbarium work. We describe two new species, one from Costa Rica which is threatened by the expansion of livestock and coffee plantations, and another from Panama. Considering the species described in this work, 16 taxa of the section *Porphyrochitonium* with hanging habit occur in Panama and Costa Rica, eight exclusively from Costa Rica, one exclusively from Panama, and three endemics to both countries. Some of these species are relatively well-documented while others are very poorly documented in the field.

MATERIAL AND METHODS

In order to study and document the morphological characteristics of the taxa in the field, multiple trips were made in and to Costa Rica and Panama from 2017 to 2024. The newly proposed species were documented with photographs, drawings, and herbarium specimens. The plates were made using the Lankester Composite Dissection Plate (LCDP) methodology (Karremans et al. 2020) and the Adobe Photoshop 2021–2023 software.

Species descriptions are formulated based on guidelines established by Croat and Bunting (1979). The habits and growth forms terminology follow Croat (1988), Schimper (1903), Zotz (2013), and Sperotto et al. (2020). The colors of the reproductive structures included in the descriptions were determined using the ArtyClick (2022) online application, which based on a dictionary of more than 1700 entries, allows determining the colors of structures by analyzing an image or photograph accompanied by a match percentage and a unique code for each color. The color matches score, that ranges between 0% and 100%, represents the similarity between the selected color from the photograph and the most similar color from the dictionary. In this work, the evaluated colors are accompanied by their respective code, which were based on match values above 95%. Spadix, spathe, and flower colors were determined using photographs of the structures at anthesis, and fruits only when ripe were considered.

Types and herbarium specimens of *Anthurium* from Costa Rica and Panama housed at B, CR, HLDG, LSCR, MA, MO, PMA, SCZ, UCH, and USJ, were studied. Additionally, type material from A, BM, C, COLU, E, F, G, GH, K, L, M, MO, NY, P, PMA, SCZ, US, were examined digitally using the following online databases: Bioportal (2022), GBIF (2022), HUH (2022), JACQ consortium (2004 onwards), JSTOR (2022), The Field Museum (2022), MNHN (2022), Natural History Museum (2014), NYBG (2022), Reflora (2022), Royal Botanic Garden Edinburgh (2022), Royal Botanic Gardens Kew (2022), Smithsonian Institution (2022), and Universität Zürich (2019). The acronyms of all herbaria follow Thiers (2022). Original protologues of all the names included in this work were reviewed using the online catalogues of the Biodiversity Heritage Library (2022). Typifications follow the International Code of Nomenclature (ICN) rules and recommendations (Turland et al. 2018).

The geographical distribution of taxa was obtained from Croat and Stiebel (2001), Grayum (2003), Correa et al. (2004), Funk et al. (2007), Idárraga-Piedrahita et al. (2011), Dorr and Stergios (2014), GBIF (2022), and TROPICOS (2022). The conservation assessments of all species follow the IUCN Standards and Petitions Committee (2019) guidelines, considering the number of locations, criterion B1 (extent of occurrence: EOO), and criterion B2 (area of occupancy: AOO). The IUCN B criteria values were calculated using the GeoCAT tool (Bachman et al. 2011), and the Rapid Least Concern web application (Bachman et al. 2020). Due to the high demand of the hanging species of *Anthurium* as ornamentals, the coordinates in type localities and cited specimens were omitted to reduce the possibility that the populations will be looted.

TAXONOMY

Anthurium cascantei O.Ortiz & M.Cedeño, **sp. nov**.

Type: Costa Rica. San José, Cantón Pérez Zeledón, distrito San Isidro del General, Fila Tinamaste, 1000 m, 7 Oct. 2022, *M. Cedeño, O. Ortiz & J. Hughes 2511* (holotype USJ; isotypes B, MO). Figure 1.

Diagnosis

Anthurium cascantei differs from *A. orosiense* Croat in having erect inflorescences with the spadices pointing downwards at anthesis (vs. inflorescence pendent), yellowish orange peduncles (vs. reddish), dark purple spadices with 7–8 flowers in the principal spiral (vs. yellowish to brown with 4–5 flowers in the principal spiral), pinkish stigmas (vs. white), and yellow seeds (vs. orange).

Description

Epiphyte, with pendent growth form; stems 6–20 cm long; internodes short, 1.0–2.1 cm long, 0.9–1.8 cm diam.; cataphylls thin, up to 3 cm long, brownish, soon weathering to coarse brown fibers, persisting at base. Leaves pendent; petiole terete, 8.5–22.5 cm long, 2.5–3.5 mm diam., green with white dots, and sparse inconspicuous black glandular punctations; geniculum thick, 1.5–2.4 cm long, weakly sulcate adaxially; blades oblong-elliptic, 23–35 × 5.5–10.4 cm, moderately coriaceous, gradually acuminate at apex, obtuse to rounded at base, broadest at about the middle, the margins straight; upper surface matte, obscurely light-green, glandular-punctate, weakly papillate; lower surface conspicuously black glandular-punctate; midrib acutely raised above becoming flat toward apex; primary lateral veins 14–21 per side, departing midrib at ca. 45°, marked above, scarcely visible below; lesser veins inconspicuous; collective veins arising from the base, slightly loop-connected, 4–6 mm from margin. Inflorescence erect sometimes between 45°–60° (erect peduncles with the spadices pointing downwards) at anthesis; peduncle terete, light-green with white dots, 30–38 cm long; spathe oblong-lanceolate, thin, green at pre-anthesis, light-green, orange-yellow (code #A88F59) with pinkish stains at female anthesis, 10–11.1 × 1.8–2.0 cm, acuminate at apex, revolute basally, curved medially and apically, withering promptly after anthesis; spadix sessile, 17–19.5 cm long, 0.4–0.6 cm diam., brownish to red-orange (code #3E1C14) at anthesis, dark purple at post-anthesis, cylindric to slightly tapered towards apex; flowers 4-lobed, 2.5–3 mm, the sides more or less straight parallel to spirals, sigmoid perpendicular to spirals, 4–6 flowers in the principal spiral, 7–9 flowers visible in the

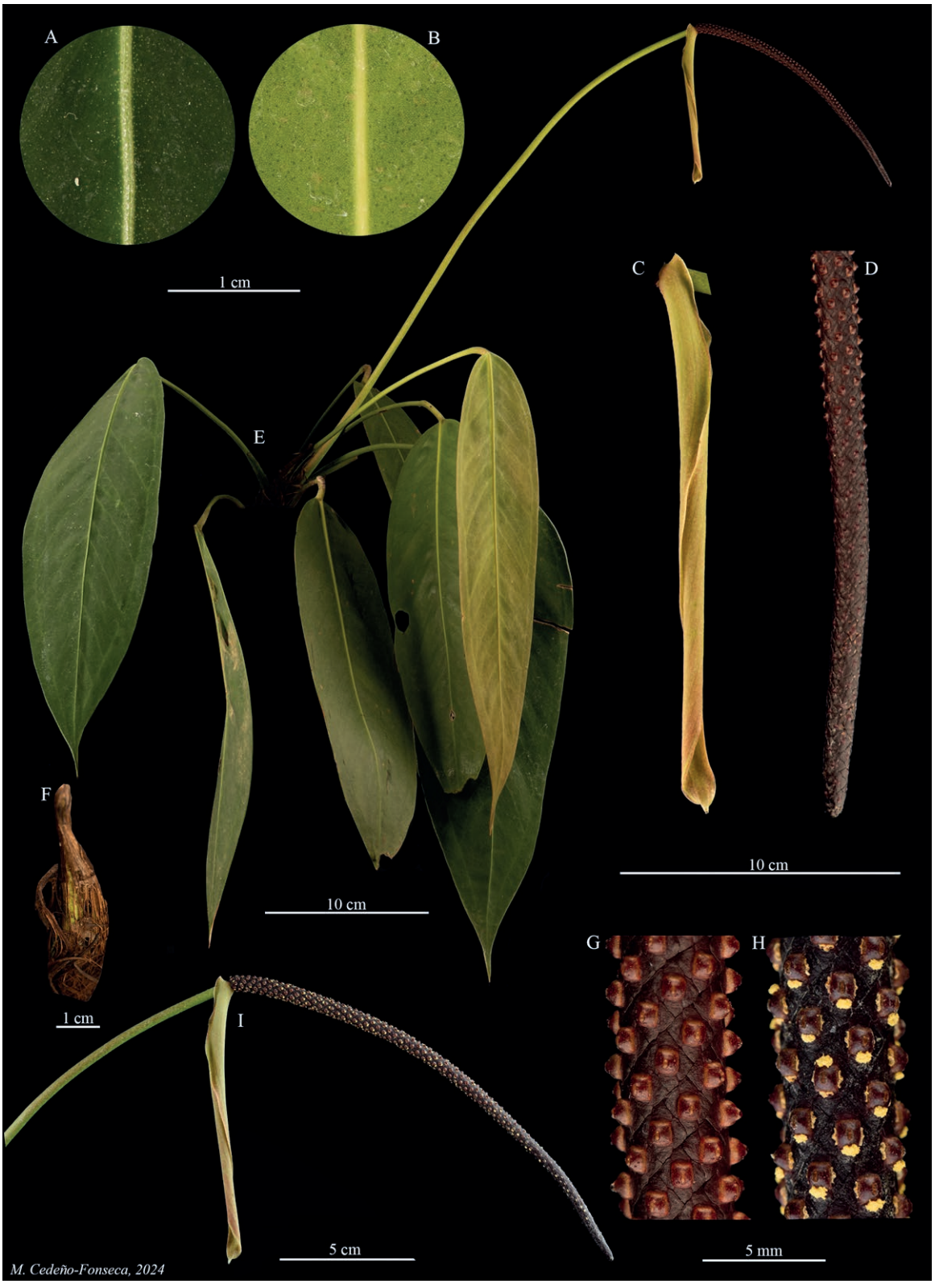

Figure 1. *Anthurium cascantei*. A: detail of the leaf blade on the upper surface; B: detail of the leaf blade on the lower surface; C: spathe; D: spadix; E: habit; F: cataphylls; G: flowers at female anthesis; H: flowers at male anthesis; I: inflorescence. Photographs by A. Serna-Sánchez and Plate by M. Cedeño-Fonseca. All photos from *M. Cedeño et al. 3038* (USJ, Cultivated at Lankester Botanical Garden).

alternate spiral; tepals smooth, glossy, lateral tepals 1.5–1.8 mm wide, brown; pistils slightly raised, orange-red (code #541012); stigma reddish-orange (code #864D1E), ca. 2 mm long; anthers white, held at sides of pistil just above tepals. Infructescence, berries; seeds not seen.

Eponymy

The species is named after the ecologist and botanist Dr. Alfredo Cascante Marín, who has contributed to the study of Neotropical plants, especially the epiphyte flora.

Distribution and habitat

Endemic to Costa Rica, only known from Fila Tinamaste, Pérez Zeledón, San José. It occurs in the *premontane wet forest* of the Pacific watershed in Fila Costeña, in primary and/or secondary forests, at 1000 m elevation.

Conservation status

Anthurium cascantei is a rare species known from two herbarium specimens, both collected from a single location in an unprotected area which is highly pressured by destructive human activities, specifically extensive cattle ranching. Considering the reduced geographic distribution (AOO: ca. 8 km^2) and the threats to its natural habitats, we consider that this species qualifies as Critically Endangered [CR B2ab(iii)].

Remarks

Anthurium cascantei is recognized by its long peduncles, oblong-lanceolate spathes, brownish to red-orange spadices at anthesis, large spathes (10–11.1 cm), orange-yellow to slightly pinkish towards margins, spadices with 4–6 flowers visible in the principal spiral and 7–9 flowers in the alternate spiral, orange-red pistils, and reddish-orange stigmas.

Anthurium cascantei is similar to *A. orosiense* sharing coarse brown fibrous cataphylls, black glandular-punctate (on both surfaces), oblong leaf blades, and long peduncles. However, *A. cascantei* has multiple differences in the inflorescence, especially in the arrangement, colors of both the spadix and the flowers (see the characters listed in the diagnosis). Additionally, there is a marked allopatry between the two species, *A. cascantei* grows in the Southern Pacific of Costa Rica in Fila Costeña, whereas *A. orosiense* is distributed in the Caribbean slope of Talamanca Mountain Range.

Additional specimens examined (paratypes)

COSTA RICA: **San José**: Cantón Pérez Zeledón, distrito San Isidro del General, 1000 m, 7 octubre, 2022, *M. Cedeño & al. 3038* (USJ, Cultivated at Lankester Botanical Garden).

Anthurium chiriquense Standl., Publ. Field Mus. Nat. Hist., Bot. Ser. 22(2): 67. 1940.

Type: Panama. Chiriquí, Bajo Chorro, Boquete Dist., 1800 m, *M. Davidson 283* (holotype F-V0044842F; isotype MO-1154936). Figure 2.

Distribution and habitat

Anthurium chiriquense is endemic to Costa Rica and Panama, and occurs from Coto Brus Cantón, Costa Rica, to Chiriquí Province, Panama, at 1900 to 2400 m in *Premontane wet forest, Premontane rain forest*, and *Lower montane rain forest* life zones.

Phenology

Flowering in February and March.

Conservation Status

This species is known from 11 specimens representing three locations: Fortuna Forest Reserve (eastern Chiriquí in Panama), Boquete (type locality: western Chiriquí in Panama), and Jurutungo (Costa Rica–Panama border). Currently, some parts of Boquete and Jurutungo are under serious disturbance due to livestock or farming-related activities. During recent fieldwork, we observed that the devastation of the natural areas in these sites persists, putting the populations in evident peril. We have calculated this species has an AOO of 44 km^2 and an EOO of 303.5 km^2. Based on the considerations mentioned above, *Anthurium chiriquense* must be considered as Endangered [EN B1ab(iii)+2ab(iii)].

Remarks

The species is distinguished by having pale persistent fibrous cataphylls, long petioles (almost equaling the leaf blade), both leaf surfaces black-glandular-punctate, large oblong-elliptic blades with the collective vein 5–10 mm from the margin, long pedunculate inflorescences, red orange (code #9E5B40) spathes, and long-stipitate, usually coiled, pink (code #FD9FA2) spadices with 3–4 flowers visible per spiral, and globose-ovoid, red orange (code #E55B3C) berries which are beaked at apex. Croat (1986) stated, based on few collections available at the time, that this species is generally epiphytic and does not have coiled spadices. However, during recent fieldwork carried out at the type locality, we documented that this species usually presents a rupicolous or terrestrial habit

Figure 2. *Anthurium chiriquense*. A: adult individual growing terrestrially with pendent leaves; B: inflorescence with the spadix in the female anthesis; C: inflorescence with the spadix in the male anthesis; D: mature infructescence with ripe berries. A–B, D from *O. Ortiz et al. 4222* (PMA); C from *O. Ortiz et al. 2782* (PMA). All photographs by M. Cedeño-Fonseca.

(rarely epiphytic) on steep rocky walls, and coiled spadices pinkish at anthesis, which post-anthesis become straight and change colour to purple-reddish brown.

Anthurium chiriquense is morphologically similar to *A. longistipitatum* due to the similarity in their leaf blades and especially by having slender and long-stipitate spadices. *Anthurium longistipitatum* differs from *A. chiriquense* in having orange red, straight spadices, and flowers with stamens retracted after anthesis (vs. exserted at post-anthesis).

Specimens examined

COSTA RICA. **Puntarenas**: Cantón de Coto Brus, Z. P. Las Tablas, cuenca Terralba-Sierpe, Jurutungo, 2400 m, 6 Mar. 1997, *E. Navarro & A. Picado 673* (INB) [now at CR!]. **PANAMA**. **Chiriquí**: Along trail between N fork of Río Palo Alto and Cerro Pate Macho, ca. 6 km NE of Boquete, 1600 - 1700 m, 6 Feb. 1986, *M.H. Grayum, & al. 6360* (MO!); Boquete, Tree Trek Mountain Resort, 1958 m, 19 Mar. 2017, *O. Ortiz, R. Flores, M. Cedeño & E. Jiménez 2782* (MO, PMA); Vicinity of Bajo Chorro, 1900 m, 20 Jul 1940–22 Jul. 1940, *R.E. Woodson, Jr. & R.W. Schery 678* (MO); Along Quebrada de Arena, N of Carretera del Oleoducto, IRHE Fortuna Hyroelectric Project., 1100 m, 12 Mar. 1982, *S. Knapp & al. 4084* (MO); Cerro Pate [Pata] de Macho ca. 5 mi NE of Boquete, along trail to Continental Divide which leads on to Finca Serrano (Francisco Serrano), pacific slope, 1800–2200 m, 23 Nov. 1979, *T.B. Croat 48558* (MO); Cerro Pate [Pata] de Macho, in forest and pasture below, 1800 - 2330 m, 15 Mar. 1982, *W.J. Kress & al. 82-1377* (MO); Boquete, Bajo Chorro. Rain forest, 15 Feb. 1938, *M.E. Davidson 283* (F, MO); Gualaca, Reserva Forestal Fortuna, Division Continental, 961 m, 6 Mar. 2014, *O. Ortiz & G. Villareal 2127* (MO, PMA); Tree Trek Mountain Resort, 1958 m, 15 Mar. 2021, *O. Ortiz & al. 4222* (PMA).

Anthurium edtysonii Croat, Aroideana 45(2): 127, f. 35, 2022.

Type: Panama. Colón: Portobello, vic. of bridge over Río Viejo, 9 m, 4 km NE of Puerto Pilón, 9 m, 27 Mar. 1974, *M. Nee & E. Tyson 10897* (holotype MO-2251621). Figure 3.

(=) *Anthurium sknappiae* Croat, Aroideana 45(2): 221, f. 83, 2022, **syn. nov**.

Type: Panama. Coclé: Ridge NW of village of Río Blanco de Norte, between Caño Sucio and Río Blanco de Norte, property of Dideymo [Dídimo] Olivera; 350 m, 20 Feb. 1982, *S. Knapp 3679* (holotype MO-3043619).

Distribution and habitat

Anthurium edtysonii occurs from Costa Rica to northern Ecuador, in humid lowland forests below 600 m elevation. It is relatively common on the Pacific slope of Costa Rica. In Panama, it is common to observe it on the entire Caribbean side, less frequent on the Pacific slope.

Phenology

Flowering in March, April. Fruiting in May, August, September.

Conservation Status

This species has a relatively wide geographical distribution (EOO: ca.135,000 km^2), occurs in multiple protected areas and its populations are not facing a potential threat; therefore, we suggest this species to be considered as Least Concern [LC].

Remarks

According to Croat et al. (2022), *Anthurium edtysonii* is characterized by its short-petiolate leaves, sulcate petioles, relative narrowly oblong-oblanceolate leaf blades with the upper surface with an acutely raised midrib, short pale-lineate and epunctate, lower surface elineate and densely glandular-punctate as well as by the long-pedunculate inflorescence with a green spathe and orange yellow (code #C8B560) spadices with 4–5 flowers visible in the principal spiral and 3–4 in the alternate spiral.

Croat et al. (2022) suggested that this taxon seems morphologically closer to *A. iguanitense* Croat, distinguished it by having proportionately shorter, more deeply sulcate petioles, broader oblanceolate-elliptic blades which are 10 times longer than petioles. However, based on the collections of *A. friedrichsthalii* studied, we considered that *A. edtysonii* is morphologically more closely related to *A. friedrichsthalii* than to *A. iguanitense*. The most notable differences found between the neotype of *A. friedrichsthalii* (designated below) and the holotype of *A. edtysonii* is that the latter taxon represents a much more robust plant, with thicker stems, wider leaf blades (4.2–5.4 cm vs. up to 2 cm wide in *A. friedrichsthalii*) that present conspicuously interprimary veins above (vs. obscure or absent), and collective veins more than 1 mm from margin (vs. less or ca. 1 mm). Based on the morphological notion mentioned above, we separated some representative specimens from other localities, which allowed us to expand the geographical range of this spe-

Figure 3. *Anthurium edtysonii*. A: adult individual from Panama (Colón: Portobelo); B: adult individual from Costa Rica (Puntarenas: Dominical). Not collected. All photos by M. Cedeño-Fonseca.

cies and confirm its occurrence in Costa Rica, Colombia, and Ecuador.

Croat et al. (2022), additionally described *A. sknappiae,* a new species that we consider conspecific with *A. edtysonii*, because both share oblong-oblanceolate, usually falcate, blades which have glandular black punctations only on the upper surface, as well as by the long-pedunculate inflorescences with green spathes, and spadices with few flowers per spiral (3–5 flowers). Considering that both taxa share important reproductive and vegetative characters, we propose here the synonymy of *A. sknappiae* under *A. edtysonii*. These two names have equal priority, because both were published in the same article, however, we chose *A. edtysonii* for practical reasons taking into account the alphabetical order.

Selected specimens examined

COSTA RICA. **Puntarenas**: P.N. Corcovado, Península de Osa, Estación El Tigre, Cabecera Río Agujas, Finca Azofeifa, 200–300 m, 8 May 1994, *R. Aguilar & al. 3251* (CR, MO). Cantón Golfito, distrito Puerto Jiménez, Playa Matapalo, (Planta cultivada en el Jardín de Jason Mark Hughes), 20 M, 13 Jun. 2020, *M. Cedeño 1906* (USJ); Reserva Forestal Golfo Dulce, Osa Península, Rancho Quemado, in forest and forest edges at S end of valley, 160 m, 3 May 1988, *B.E. Hammel & al. 16824* (MO); Parque Nacional Corcovado, Camaronal from behind the lab. building to the water tanks, 0 m, 8 Apr. 1988, *C. Kernan 392* (MO); **San Jose**: Cantón Turrubares, distrito San Luis, Sobre el camino al pueblo La Potenciana, 720 m, 18 Jun. 2020, *M. Cedeño & al. 1898* (USJ); Turrubares, Reserva Biológica Carara, Valle del Tárcoles, Puesto Carara, Montañas Jamaica, lado este, bosque primario entre Carara y Sur, 200–500 m, 3 Apr. 1993, *B.E. Hammel & al. 18910* (CR); Z.P. Cerro de Turrubares, Cuenca del Tárcoles, San Pablo de Turrubares, 100–200 m, 8 Dec. 2004, *D. Santamaría 303* (CR, MO). **PANAMA**: **Colón**: Near Salamanca Hydrographic Station on the gorge of the R. Pequení, 70 - 80 m, 15 Dec. 1934, *C.W. Dodge & al. 16523A* (MO); Along Río Viejo, between the Portobelo road and Quebrada Ruíz, 4 km NE of Puerto Pilón, 29 Sept. 1973, *M. Nee 7172* (MO); Santa Rita lumber road, about 5 miles from Highway, 8 Apr. 1971, *T.B. Croat 14187* (MO); **Panamá Province**: Parque Nacional Chagres, Sección Boquerón, Río San Juan de Pequeni, 31 Aug. 1999, *Florpan, A. Espinosa & al. 4486* (MO!, PMA); **Darién**: S of El Real, headwaters of Rio Pirre at fork known as Dos Bocas, 100 m, 25 Sep.

1969, *H. Kennedy & R.B. Foster 2823* (MO); Área de Manejo Especial de Bahía Piñas, bosque secundario circundante al hotel Tropic Star Lodge, 0 m, 30 Jun. 2018, *O. Ortiz & al. 3031* (PMA). **COLOMBIA**: **Chocó**: zona de Urabá, Cerros del Cuchillo, camino de Macondo al Cuchillo, bosque primario perturbado, bmh-T, 20–540 m, 17 Apr. 1988, *D. Cárdenas 1712* (MO). **ECUADOR**: **Esmeraldas**: Along road from San Lorenzo to Ricaurte, 2 km from main Lita to San Lorenzo Road, 64 m, 11 Oct. 2012, *T.B. Croat & al. 104162* (MO).

Anthurium embera O.Ortiz & M.Cedeño, **sp. nov**.

Type: Panama. Darién, Distrito de Chepigana, corregimiento Puerto Piña, Bahía Piña, cima de Cerro Venado, 1235 m, 29 Nov. 2022, *M. Cedeño, & O. Ortiz, N. Köster & R. da Pena 2842* (holotype PMA; isotype: B). Figure 4.

Diagnosis

Anthurium embera differs from *A. cascantei* in having pendent inflorescences with shorter peduncles of 12.5–13.8 cm long (vs. erect inflorescences with longer peduncles of 30–38 cm long), short and thick, pinkish-red spathes of 2.3–2.6 cm long (vs. thin and longer orange-yellow pinkish spathes of 10–11.1 cm long), and shorter spadices of 7.0–7.4 cm long, with 2–3 flowers in the principal spiral (vs. longer spadices of 17–19.5 cm, with 4–6 flowers in the principal spiral).

Description

Epiphyte, with pendent growth form; stems 6–15 cm long; *internodes* short, 1.0–2.0 cm long, 1.5–2.8 cm diam.; *cataphylls* thin, up to 4.3 cm long, brownish, fibrous. Leaves pendent; *petiole* terete, 9.5–32.5 cm long, 2.0–3.5 mm diam., green with sparse inconspicuous black glandular punctations; geniculum distinct, 1.2–2.0 cm long, weakly sulcate adaxially; *blades* oblong-elliptic to ovate, 14.5–16 × 3.5–4.2 cm, moderately coriaceous, gradually acuminate at apex, obtuse to rounded at base, broadest at about the middle, the margins straight; *upper surface* green, very glossy, lacking black glandular-punctations, weakly papillate; *lower surface* mate, conspicuously black glandular-punctate; *midrib* acutely raised above becoming flat toward apex; *primary lateral veins* 8–10 per side, departing midrib at ca. 45° angle, sunken above, plane and scarcely visible below; lesser veins inconspicuous; *collective veins* arising from the base, slightly loop-connected, 3–5 mm from margin. *Inflorescence* pendent at anthesis; *peduncle* terete, reddish-orange (code #C47451), 12.5–13.8 cm long; *spathe* oblong-lanceolate, thick, pinkish-red (code #F08080) at anthesis, 2.3–2.6 × 0.4–0.5 cm, truncate at apex, revolute in all its extension, perpendicular forming an angle between 90–110° to the spadix; *spadix* sessile, 7.0–7.4 cm long, 0.4–0.6 cm diam., reddish orange (code #A2653E) at anthesis, cylindric; *flowers* 4-lobed, 1.0–1.3 mm, the sides more or less straight parallel to spirals, sigmoid perpendicular to spirals, 2–3 flowers in the principal spiral, 5–6 flowers visible in the alternate spiral; tepals smooth, glossy, lateral tepals 1.5–1.8 mm wide, pinkish; pistils slightly raised, orange red (code #9E5B40); stigma red-orange (code #AF593E), ca. 1 mm long; anthers white, held at sides of pistil just above tepals. *Infructescence*, *berries* and *seeds* not seen.

Etymology

The species is named honoring the indigenous Comarca Emberá.

Distribution and habitat

Endemic to Panama, only known from the top of Cerro Venado in Puerto Piña, Darién. It occurs in the *premontane wet forest* of the Pacific watershed, on primary forests, from 1200–1300 m elevation.

Conservation status

Anthurium embera is a rare species known only from the type specimen, collected in the protected area of Darién National Park. It grows in quite remote areas, in a special montane habitat (elfin forests, see Myers 1969), which is characterized by comprising forests with an extremely humid understory and a relatively low canopy (usually less than 15 m high) (Gradstein and Salazar 1992). Furthermore, elfin forests of Darién comprise a unique flora where many endemic species occur (Ortiz et al. 2019). These forests, due are located on mountain ridges that are almost inaccessible, are generally not threatened by destructive anthropogenic activities. However, the surrounding ecosystems, such as evergreen, semi-deciduous, deciduous forests and wetlands, are highly threatened, mainly by deforestation due to indiscriminate logging and forest fires. Probably the greatest threat facing *Anthurium embera* and its natural habitats is climate change (perhaps enhanced by the alteration of adjacent ecosystems), possibly related to alterations in biogeochemical cycles (Foster 2001), such as hydrological cycles, the formation of orographic rains and horizontal precipitations, typical conditions of elfin cloud forests (Myers 1969; Stadtmüller 1986; Whiteman 2000). Due to the potential threats mentioned above, we recommend tentatively considering this species as Critically Endangered [CR B2ab(iii)]

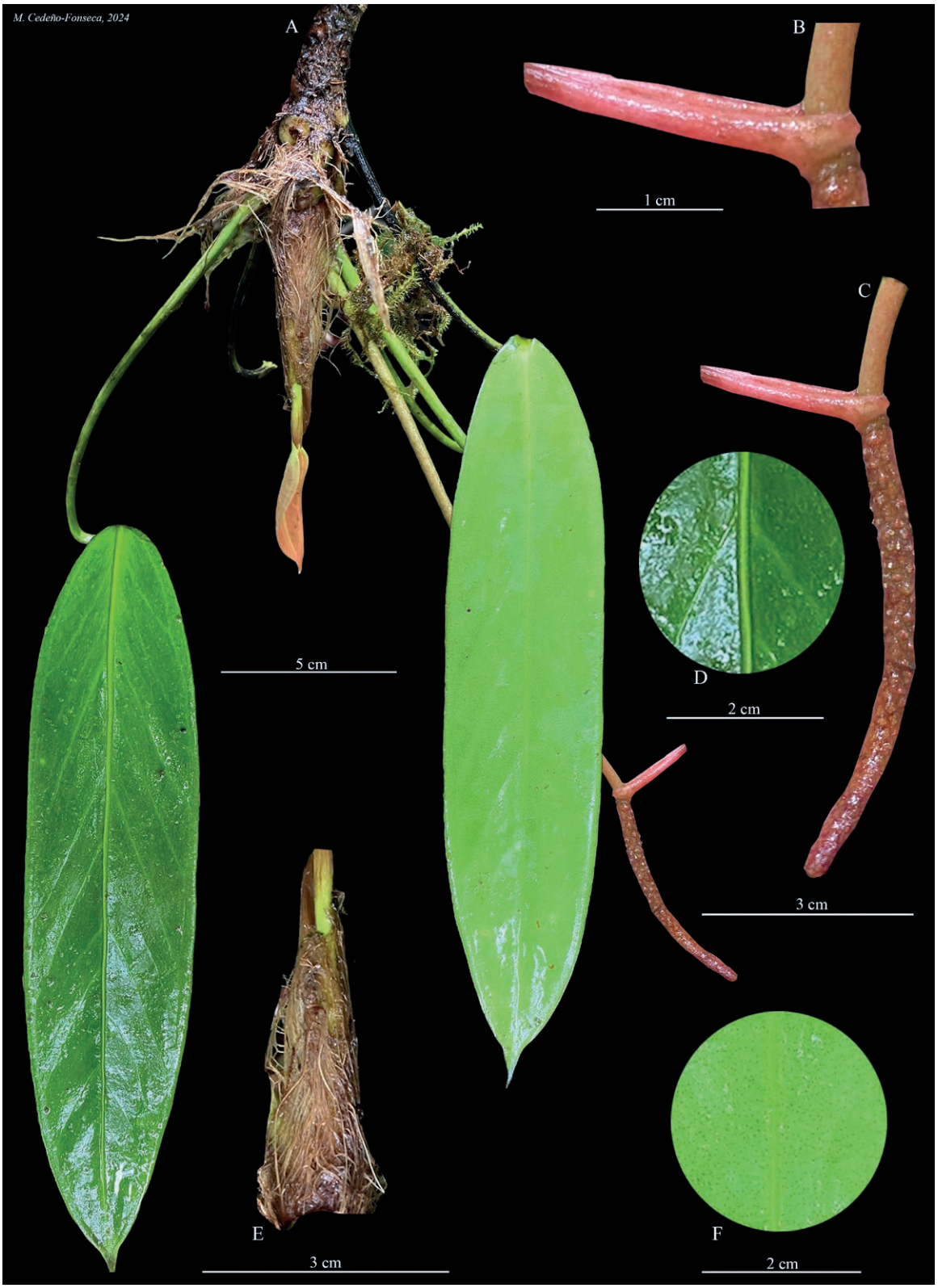

Figure 4. *Anthurium embera*. A: habit; B: spathe; C: inflorescence at female anthesis; D: detail of the leaf blade on the upper surface; E: cataphylls; F: detail of the leaf blade on the lower surface. all from *M. Cedeño et al. 2842* (PMA; type collection). Plate and photos by M. Cedeño-Fonseca.

Remarks

Anthurium embera is recognized by its oblong-elliptic to ovate leaf blades, and pendent inflorescences with relatively short pinkish-red spathe and reddish orange spadix compared with most of the species with pendent leaves. *Anthurium embera* is morphologically similar to *Anthurium cascantei* because share coarse brown fibrous cataphylls and oblong leaf blades. Both can be distinguished based on the morphological characteristics listed in the diagnosis, and also there is a conspicuous allopatry between the two species. *Anthurium embera* grows in eastern Panama in Darién province, whereas *A. cascantoi* is distributed in the Fila Costeña of the Pacific of Costa Rica.

This new taxon could also be confused with *A. edtysonii*, because both species have relatively wide leaf blades, lack black glandular punctations on the upper surfaces, as well as their pendent inflorescences. However, *A. embera* differs in having very glossy leaf blades on the upper surfaces (vs. mate), 8–10 pairs of lateral primary veins (vs. 14–20 pairs of primary lateral veins), and reddish orange spadices with 5–6 flowers visible in the alternate spiral (vs. orange yellow spadices with 3–4 flowers visible in the alternate spiral).

Anthurium friedrichsthalii Schott, Oesterr. Bot. Wochenbl. 5(9): 65. 1855.

(º) *Anthurium gracile* (Rudge) Lindl. var. *friedrichsthalii* (Schott) Engl., Bot. Jahrb. Syst. 25: 370. 1898.

Type: "Habit in Guatemalae [Nicaragua or Costa Rica] Insula Cativo," *Friedrichsthal s.n.* (holotype: W, destroyed). **Neotype (designated here)**: [illustration] H. W. Schott's *Icones Aroideae et Reliquiae No. 332* (Schott 1984) [Figure 5], deposited in the Natural History Museum of Vienna, also available in the microfiche edition (Nicolson 1984). Figures 5, 6.

(=) *Anthurium linearifolium* Engl., Bot. Jahrb. Syst. 25: 370. 1898.

Type: "Columbia [Panama]: ad arbores in silvis densis ad flumen Rio Chaques [Chagres], in isthmo panamensi," Apr. 1888, *F.C. Lehmann 4538* (B-100247071, **lectotype designated here**, negative at F barcode F0BN011966; isolectotypes F, F-0044933F, K, K-000434205).

(=) *Anthurium perangustum* Croat, Aroideana 45(2): 207–208, f. 76, 2022, **syn. nov**.

Type: Panama. Panamá Province: El Llano-Cartí Road, 9.6 from Interamerican Hwy, ca. 350 m, 26 May 1975, *S. Mori & J. Kallunki 6392* (holotype MO-2274535).

Distribution and habitat

The species is distributed from Nicaragua to Colombia and now in Ecuador, at elevations from sea level to usually 800 m. In Costa Rica and Panama, it is common in *tropical moist forest*, but also occurs in *premontane wet forest* and *tropical wet forest* life zones. The occurrence of *Anthurium friedrichsthalii* for Ecuador is confirmed here, representing a new country record. The representative collection, *C. Aulestia 216* (MO), was collected in the north of the country, in the Awá Ethnic Reserve, Centro Guadualito.

Phenology

Flowering and fruiting throughout the year.

Conservation Status

Anthurium friedrichsthalii has a wide-ranging distribution (EOO: 1,039,724 km^2; AOO: 15,700 km^2), and it is not facing any important threats, therefore it must be considered as Least Concern [LC].

Nomenclature

Schott (1855) stated in the protologue of *Anthurium friedrichsthalii*, that the plant inhabits in "Guatemalae Insula Cativo," but also cited the naturalist and explorer Emanuel von Friedrichsthal (as "Friedrichsthal") as collector. It is known that Friedrichsthal carried out fieldwork during 1837–1841, visiting the Antilles, United States, Mexico, and Central America (Wurzbach 1858; Stevens and Montiel 2001; Grayum et al. 2004; Taracena-Arriola and Sellen 2006; Jiménez-Madrigal 2022). According to the biographical information available (Wurzbach 1858), Friedrichsthal, in 1837, undertook a long journey to Central American lands. In 1838, starting from the Caribbean coast, he explored the Río San Juan between Nicaragua and Costa Rica, then made expeditions upwards to Cocibolca lake (known also as Nicaraguan Lake), passing through Acoyapa, and arriving to the port of San Juan del Sur on the Pacific coast of Nicaragua. In 1839 and 1840, Friedrichsthal carried out other field trips to El Salvador, Guatemala, Belize, United States, and Mexico (Yucatán) (Taracena-Arriola and Sellen 2006). Later, in 1841, he returned to Europe (specifically Vienna). With the information gathered during that time, Friedrichsthal prepared maps, plant specimens, and notes on the natural history, archeology, and cultural aspects of the places visited (Wurzbach 1858; Taracena-Arriola and Sellen 2006).

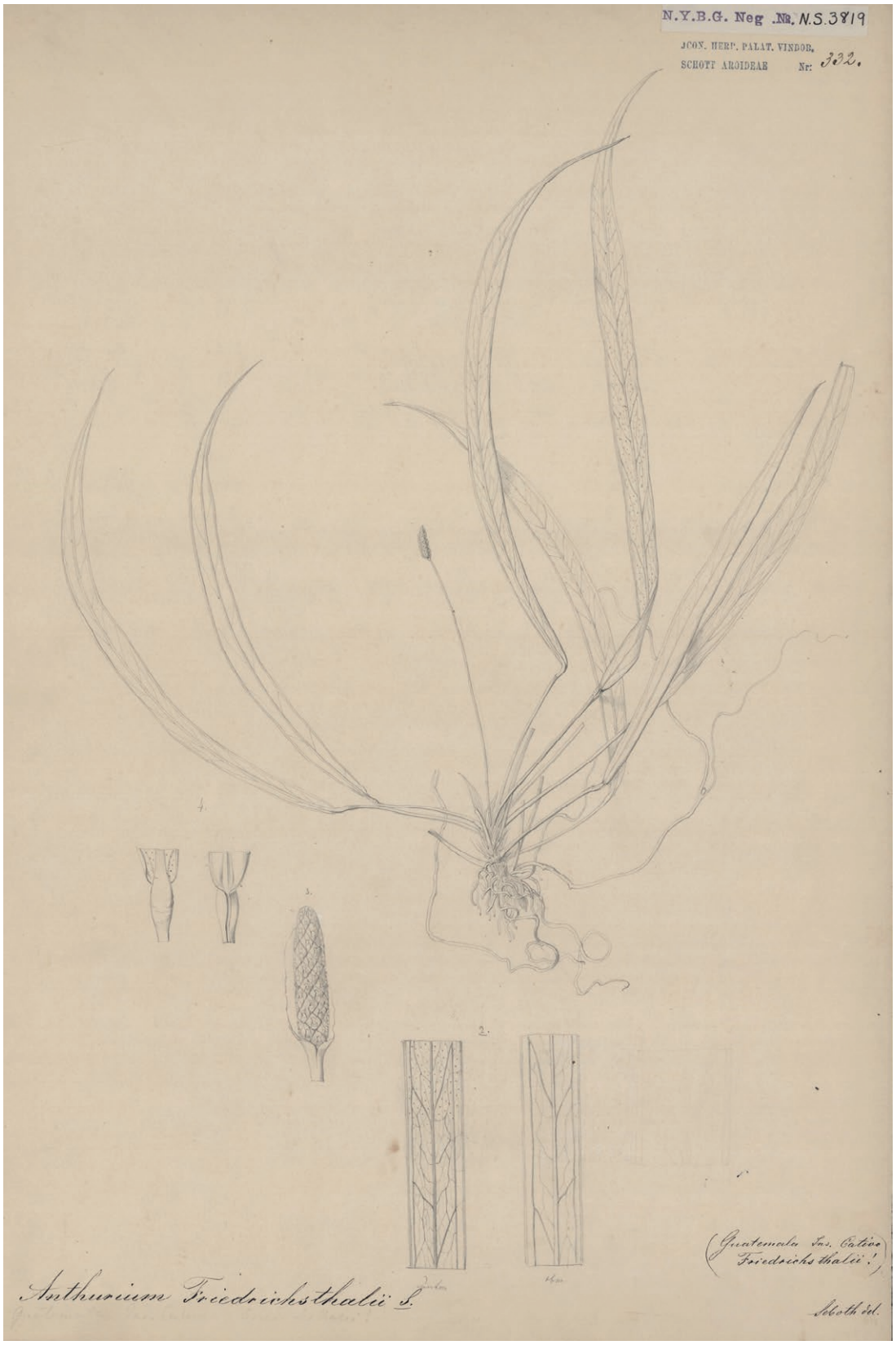

Figure 5. Neotype of *A. friedrichsthalii*. Scan image courtesy of the Naturhistorisches Museum Wien (used with authorization).

Figure 6. *Anthurium friedrichsthalii*. A: habit; B: inflorescence at female anthesis; C: ripe berries. All from *M. Cedeño et al. 2019* (USJ). Photos by M. Cedeño-Fonseca.

Almost all the Central American herbarium material collected by Friedrichsthal contains labels indicating that the specimens were collected in "Guatemala". However, historical evidence (Taracena-Arriola and Sellen 2006) and location notes included on the labels suggest that Friedrichsthal collected in several Central American countries, not only in Guatemala. This confusion seems to be related to the geopolitical situation presented in Central America at that time (1837–1840). In that period, most Central American territory was occupied by the former "Federal Republic of Central America" (1824–1838, although the fiction of union was preserved until Guatemala officially separated in 1847), made by Guatemala, El Salvador, Honduras, Nicaragua, and Costa Rica, with Guatemala City as the capital for a long time (Smith 1963). The historical facts mentioned match well with Friedrichsthal's explorations in Central America, therefore is likely that Friedrichsthal, when citing "Guatemala" on his labels, was referring to the Federal Republic of Central America (see Gerrit Davidse's comments for this taxon in TROPICOS 2022). Thus, the original material used for the description of *A. friedrichsthalii* probably came from Nicaragua or Costa Rica where it is distributed. The locality "Cativo Island" mentioned in the original protologue is unknown and we were unable to locate it. Currently, *A. friedrichsthalii* is only known from SE Nicaragua to Ecuador, and there are no subsequent records from Honduras, El Salvador, Guatemala, Belize, and Mexico (Croat 1986; Croat and Stiebel 2001; Grayum 2003; TROPICOS 2022).

Almost all the original material of *Anthurium* species housed at W, studied by Schott, were destroyed during World War II (Riedl and Riedl-Dorn 1988), including the presumed holotype of *A. friedrichsthalii* (Christian Bräuchler pers. comm., 2022), which was cited by Engler (1905: 89) as deposited in the "K. K. Hofmuseum Wien." Although much of the material collected by Friedrichsthal is now in W and GOET (Wagenitz 1982), unfortunately, as yet, it has been impossible to locate any original material of *A. friedrichsthalii* in those herbaria or the rest of the herbaria consulted.

In the absence of original material, we propose the illustration Icones Aroideae et Reliquiae No. 332, prepared for Schott by Joseph Seboth, as the neotype of *Anthurium friedrichsthalii* (Fig. 5). This illustration includes some elements cited in the protologue of the species and adequately matches with the morphological features incorporated in the original diagnosis. Also, it should also be noted that it bears a presumably contemporary note indicating that it is a drawing of the Friedrichsthal specimen, nevertheless does not include a specific date; consequently, the illustration No. 332 should be treated as a neotype rather than lectotype (see Coelho and Mayo 2007).

Regarding the heterotypic synonym *Anthurium linearifolium*, when Engler (1898) published this name, he cited only the collection "*F. C. Lehmann 4538*," without indicating the herbarium where the specimen was deposited, which was not a requirement at the time. We traced three specimens at B, F, and K, which all seem to match the original diagnosis, and bear the stated collector and number. In agreement with Art. 9.12 of ICN (Turland et al. 2018), the specimen at B (barcode 100247071) is here designated as lectotype since it bears Engler's handwriting and agrees with the protologue and the type locality. Furthermore, the B specimen was cited by Engler (1905), supporting the notion that Engler himself probably used it to prepare the original description.

Remarks

Anthurium friedrichsthalii is recognized by having a pendent habit, strap-shaped leaves, leaf blades black-glandular-punctate only on the lower surfaces, collective veins less or ca. 1 mm from the margin, long-pedunculate, hanging inflorescences, lanceolate, green spathes, sessile, long-tapered, yellowish orange (code #E3A857) spadices at anthesis, with 4–6 flowers visible in the principal spiral and 4–5 flowers visible in the alternate spiral, and oblate-obcordate (truncate at apex with a central depression), pale yellowish orange (code #FF9F00) berries.

This species could be confused with juvenile plants of *Anthurium utleyorum* Croat & R.A. Baker and *A. pendens* Croat, due to the elongated leaf blades; but both species differ by having markedly black glandular-punctate blades on both surfaces. Additionally, *A. pendens* has darker leaf blades (when dry) and *A. utleyorum* has ovoid red berries.

Recently, Croat et al. (2022) described *Anthurium perangustum* based on a single collection from eastern Panama, which is very similar to the neotype of *A. friedrichsthalii* designated here. Croat et al. (2022) suggested that *A. perangustum* differs by having short peduncles (5.3 cm long), a green spathe (white in the original label), a green tinged, purplish spadix (noted as red in the original label), as well by the leaf blades with upper midrib narrowly raised above, the surface moderately smooth on drying, that is finely and acutely ridged. We argue here that *A. perangustum* is conspecific with *A. friedrichsthalii* because almost all diagnostic characters cited are present in the examined specimens of *A. friedrichsthalii*, including blade shape, lack of interprimary veins and black glandular punctations on the upper surface, shape of the spadix and the number of flowers per spiral. The only unusual character in the holotype of *A. perangustum* is the presence of a noticeably short peduncle. Nevertheless, this can be an aberrant specimen of *A. friedrichsthalii* (since there are many collections in the same locality), or this character could be considered a morphological variation of the species. We have visited the type locality of *A. perangustum* multiple times (it is a widely botanized site), and we have only documented specimens that match *A. friedrichsthalii*.

Selected specimens examined

COSTA RICA: **Alajuela**: Cantón San Carlos, distrito Cutris, Camino a Chorreras. Borde de bosque sobre los potreros, 258 m, *M. Cedeño & al. 2019* (USJ); 3 miles north of San Miguel, 380 m, 26 May 1976, *T.B. Croat 35650* (MO). **Cartago**: Paraíso, Atlantic rainforest, collected Feb. 1989 by Clarence Kl. Horich, in cultivation at MO, headwater range of Río Naranjo (confluent of Río Reventazón), north of Quelitaleo de Cachí, on one old tree along trail with very rare *Anthurium tenerum* on same tree, 1350 m, 30 Nov. 1990, *T.B. Croat 71839* (MO); Turrialba, Río Tuis, near La Suiza, 600 m, 4 May 1956, *L.O. Williams & A. Molina 19573* (MO). **Guanacaste**: 3.5 km N of Santa Elena on road to San Gerardo, 0.5 km N of junction road and Río Negro, 1540 m, 20 Aug. 1988, *W.A. Haber & W. Zuchowski 8626* (CR). **Heredia**: Finca La Selva, the OTS field station on the Río Puerto Viejo just E of its junction with the Río Sarapiquí, 100 m, 14 Jun. 1981, *B. E. Hammel & J. Trainer 10881* (MO); La Selva Biological Station, 100 m, 1 Feb. 1987, *R. Antibus & P. Lesica 4158* (MO); **Limón**: Camino entre Fila Dimat y Río Uren, finca de Hermógenes Pereira, 22 Oct. 1985, *L. D. Gómez & al. 23764* (MO); Hacienda Tapezco-Hacienda La Suerte, 29 air km W of Tortuguero, area of low hills and mounds, a few small streams, 40 m, 21 Mar. 1978, *C. Davidson & al. 7102* (MO). **PANAMA**: In Bäumen, dichten Wäldern am Rio Chagres, Isthmus von Panama, s.d., *F. C. Lehmann 4538* (MO); **Bocas del Toro**: North coast of Escudo de Veraguas Island, 5 m, 8 Aug. 1987, *G. McPherson 11425* (MO); Vicinity of Fortuna Dam, along pipeline road leaving road to Chiriquí Grande at continental divide, 2.8 road-miles from divide, 850–

950 m, 25 Jun. 1986, *G. McPherson 9670* (MO); **Chiriquí**: Punta Burica, El Chorogo. Desde la Finca de Fernando Chavarria, hacia el Río San Bartolo cabecera y afluentes, 16 May 2007, *J.E. Aranda & al. 3940* (MO, PMA, SCZ); Burica Peninsula. Primary forest, San Bartolo Limite, 12 mi. (20 km) west of Puerto Armuelles, 400–500 m, 24 Feb. 1973, *R.L. Liesner 191* (MO!). **Coclé**: Continental Divide on road to Coclesito, in patch of forest near road, 1500 ft, 20 Jun. 1978, *B. E. Hammel 3507* (MO); Road from La Pintada to Coclesito, 600 m, 07 Feb. 1983, *C.W. Hamilton & G. Davidse 2877* (MO); **Colón**: Santa Rita Ridge, ca. 12 km from Transistmian Highway, 28 Jun. 1978, *B.E. Hammel 3650* (MO); Parque Nacional Chagres, Sección Boquerón, Río Juan de Pequeni, 24 Mar. 1999, *Florpan & al. 3818* (MO); **Darién**: Punta Cocalito, on large rock on beach, 24 Feb. 1982, *C. Whitefoord & A. Eddy 296* (MO); Parque Nacional del Darién, ridge between Río Topalisa and Río Pucuro, ca. 17 km E of Pucuro, Mi Casita to La Laguna, 600–850 m, 15 Oct. 1987, *G. de Nevers & al. 8347* (MO); **Panamá Province**: Parque Nacional Altos de Campana, Buena Vista, Bejuco, Chame, 24 Feb 1999, *Florpan & al. 3294* (MO); El Llano-Carti road, about 4.6 miles north de junction with Pan-American Highway, trail to east, 300 m, 14 May 1988, *G. McPherson 12523* (MO); **Guna Yala Comarca (San Blas)**: El Llano-Cartí Road, Km 19.1, 350 m, 19 Mar. 1985, *G. de Nevers 5186* (MO); El Llano-Cartí Rd. Km 19.1, 350 m, 14 Jun. 1985, *G. de Nevers & H. Herrera 5849* (MO); El Llano-Cartí Road, Km 26.5, 200 m, 9 Apr. 1985, *G. de Nevers & al. 5272* (MO). **Veraguas**: Ridge of Cordillera de Tute, trail to Cerro Tute, above Escuela Agrícola Alto de Piedra, just W of Santa Fé, 800–1350 m, 5 Jun. 1982, *S. Knapp & R.L. Dressler 5423* (MO); Vicinity of Santa Fe along ridge which extends to summit, trail begins from edge of a plantation along the road less than 1 km from the Escuela Circlo Alto de Piedra, on road to north going to Rio San Luis, 800–950 m, 29 Jun. 1987, *T.B. Croat 67000* (MO).

Anthurium gregneversii Croat, Aroideana 45(2): 142–143, fig. 42, 2022.

Type: Panama. Bocas del Toro: Oleoducto Road, near Continental Divide, Fortuna Dam area, 1000 m, 5 Feb 1984, *H.W. Churchill, G. de Nevers & H. Stockwell 4619* (holotype MO-3210675). Figure 7.

Distribution and habitat

Anthurium gregneversii is endemic to Panama and Costa Rica (new record).

Conservation Status

This species is known from four collections made in two locations: Costa Rica (Moravia, Chirripó) and Panama (Bosque Protector Palo Seco, Bocas del Toro). Currently, the Panama occurrence, despite being within the limits of a protected area (Palo Seco), lacks effective protection, because the habitats of this site are continually altered by extensive livestock and indiscriminate logging activities. Due to the mentioned threats and based on the calculated parameters (EOO: 2488.6 km^2, AOO: 16 km^2), we consider this species under the Endangered category [EN B1ab(iii)+B2ab(iii)].

Phenology

Flowering in February.

Remarks

Anthurium gregneversii is characterized by its oblong blades, short peduncles, pinkish spathes spadices at anthesis, with up to five flowers per spiral. According to Croat et al. (2022), this taxon is closest to *A. crassiradix* subsp. *purpureospadix* Croat, differing mainly by many floral and vegetative characters. However, we think that this taxon is more closely related morphologically to *A. utleyorum* Croat & R.A. Baker, mainly due to the shape of the leaf blades and inflorescences. *Anthurium gregneversii* differs from *A. utleyorum* by having pink spadices at anthesis (vs. red orange), which have fewer flowers in the alternate spiral (4–5 vs. 5–9). This taxon was known only from the type specimen collected in the continental division between the provinces of Chiriquí and Bocas del Toro in Panama, now recorded in Costa Rica by three more specimens.

Specimens examined

COSTA RICA: **Cartago**: Upper Río Naranjo headwaters, above Quelitales de Cachi, ca. 1350 m, 2 Aug. 1989, *T.B. Croat & C. Horich 69774* (MO); Turrialba, Chirripó, Moravia de Chirripó, bosque nuboso, 1602 m, 13 May 2021, *M. Cedeño & J.M. Hughes 2482* (USJ); **Limón**: Almirante, Divide between the headwaters of the upper Río Xichiari and the headwaters of the upper Río Boyei, 1300 m, 12 Aug. 1995, *G. Herrera 8441* (INB, MO). **PANAMA**: **Bocas del Toro**: Bosque Protector Palo Seco, Sendero El Verrugoso, 802 m, 6 Feb. 2013, *O.O. Ortiz & al. 1245* (MO, PMA).

Figure 7. *Anthurium gregneversii*. A: adult individual with pendent leaves (from Panama); B: inflorescence with the spadix in the female anthesis (from Panama); C: adult individual with pendent leaves (from Costa Rica); D: inflorescence with the spadix in the female anthesis (from Costa Rica). A–B from *O. Ortiz & al. 1245* (PMA); B–C from *M. Cedeño & J.M. Hughes 2482* (USJ) A–B photos by O. Ortiz. B–C photos by M. Cedeño-Fonseca.

Anthurium jicoteense Croat, Aroideana 45(2): 162–163, 165, f. 53, 2022.

Type: Costa Rica. Cartago: Cantón Turrialba, Distrito Tayutic, Jicotea, Finca La Pradera, subiendo la Fila hacia San Antonio, 14 Jun 1995, 1400 m, *G. Herrera 7886* (holotype MO-05036250; isotype CR).

Distribution and habitat

Anthurium jicoteense is known only from the type locality in Costa Rica, in Turrialba Province, found at 1400 m in a *Premontane rain forest* life zone.

Conservation Status

This taxon is only known from a single collection, which was collected in an area that currently has deforestation caused by unsustainable agricultural activities. During the field work carried out recently, it was impossible to locate additional specimens, so it could represent a rare species. Due to documented threats to the natural habitats where this species occurs, we recommend considering this species as Critically Endangered [CR B2ab(iii)].

Phenology

Flowering in June.

Remarks

Anthurium jicoteense is characterized by its moderately long-petiolate leaves with the petioles only about half as long as the blades, narrowly oblong-elliptic, grayish drying, dark green, matte and glandular-punctate, paler and glandular-punctate below, with the primary lateral veins less conspicuous than the collective veins, long-pedunculate inflorescence with a reddish-brown spathe and a long tapered green spadix. Due to the leaf blade shape and the absence of black glandular punctations on the upper surface, this species is more similar to *A. tayuticense*, which differs by having fewer primary lateral veins (15–27 vs. 12–14 pairs), and reddish-brown spadices with flowers 5 visible per spiral (vs. red orange spadices with more than 7 flowers visible per spiral).

Anthurium longistipitatum Croat, Monogr. Syst. Bot. Mo. Bot. Gard. 14: 129, figs 107 & 108. 1986.

Type: Panama. Chiriquí: along road between Gualaca and the Fortuna Dam site on the Río Chiriquí, 22.7 mi. beyond the bridge over the Río Está, 11.8 mi. N of Los Planes de Hornito, 10.7 mi. N of jet. to tunnel, *T.B. Croat 48670* (holotype MO-2738911; isotypes K-K000434286, PMA-161). Figure 8.

(=) *Anthurium monroi* Croat, Aroideana 45(2): 186, f. 66–68, 2022. **syn. nov.**

Type: Panama. Bocas del Toro: Ridge N of Campamiento Lucho, 2000 m, 18 Mar 2004, *A.K. Monro & E. Alfaro 4475* (holotype MO-5881318; isotypes BM, INB, MEXU, PMA).

Distribution and habitat

Anthurium longistipitatum occurs from Costa Rica to western Panama in Chiriquí Province and Ngöbe-Buglé Comarca, at 1100–2000 m in *premontane* and *lower montane rain forest* life zones.

Conservation Status

This species is known from at least five occurrences of which four are currently in protected areas (Fortuna Forest Reserve in Panama, La Amistad International Park between Costa Rica and Panama, and Monteverde Biological Reserve in Costa Rica). Considering its natural distribution, this species comprises an EOO of approximately 6508 km^2 and an AOO of 136 km^2. Currently, its populations are not pressured by destructive anthropic activities such as livestock or unsustainable agriculture. In the lack of data on population size, and contingent upon successful protection of the protected areas, *A. longistipitatum* can be provisionally assessed as Least Concern [LC].

Phenology

Flowering and fruiting throughout the year.

Remarks

Anthurium longistipitatum is recognized by its epiphytic habit, pendent growth form, long petioles, coriaceous leaf blades which are black-glandular punctate on both surfaces, orange yellow (code #FFFBDC) spathes, long-stipitate, orange red (code #DE7E5D) spadices with 3–4 flowers visible in the principal spiral, 6–8 flowers visible in the alternate spiral, and globose or subglobose, red orange (code #AA2704) berries (when ripe) which are truncate at apex (with a central depression). *Anthurium longistipitatum* is morphologically similar to *A. chiriquense*, due to the same size and shape of the leaf blade, as well as its long-stipitate spadices. But the latter differs from *A. longistipitatum* in having red orange spathes, pink, usually coiled spadices at anthesis, spadices with 3–4 flowers visible in the alternate spiral, and flowers with exserted stamens at post-anthesis.

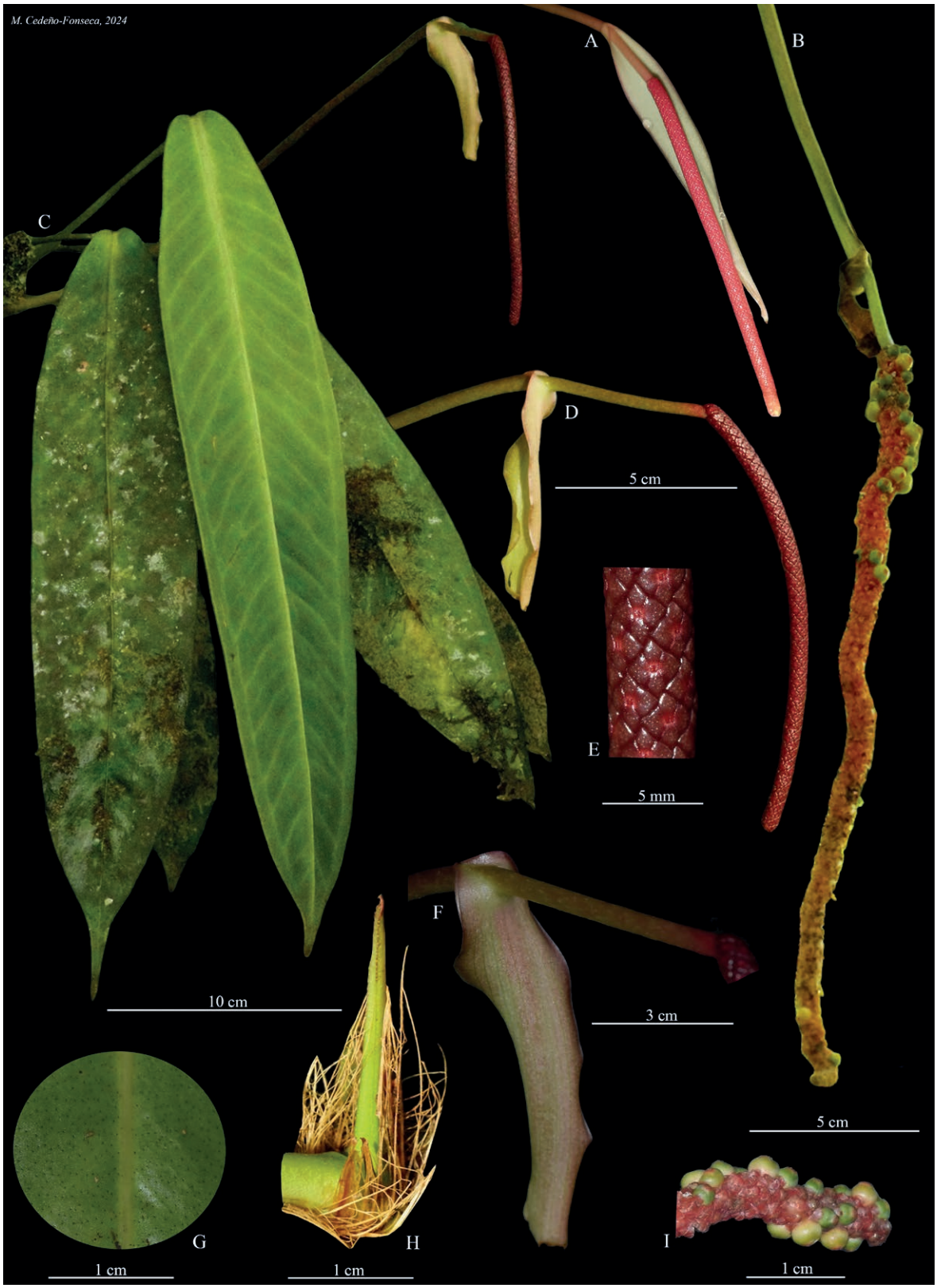

Figure 8. *Anthurium longistipitatum*. A: inflorescence at pre-anthesis; B: infructescence; C: habit; D: inflorescence at female anthesis; E: flowers at female anthesis; F: spathe at female anthesis; G: detail of the leaf blade on the lower surface; H: cataphylls; I: berries. All from *O. Ortiz et al. 4235* (PMA). Plate and photos by M. Cedeño-Fonseca.

Croat et al. (2022) recently described *Anthurium monroi*, a species which appears to us morphologically identical to *A. longistipitatum* to which no comparison was made in the protologue of *A. monroi*. Based on the documentation carried out in the type locality of *A. longistipitatum*, we propose here to place *A. monroi* as a synonym of *A. longistipitatum*. Both taxa share significant morphological characters, such as the shape and texture of the leaf blade, the color of the spathe (orange yellow), the presence of a noticeable stipe, orange-red spadices, and globose or subglobose berries which are truncated at apex [cf. figure 8 vs. Croat et al. (2022): figs 66–68)]. Croat et al. (2022) described *A. monroi* with green to cream spadices, however, a photograph of the holotype in the field, which was included in the original protologue (Croat et al. 2022: 189), clearly shows that the spadix is orange red.

Specimens examined

COSTA RICA: **Alajuela**: San Ramón. Reserva Biológica Monteverde, Cordillera de Tilarán, Valle del Río Peñas Blancas, Quebrada el Valle, 1600 m, 17 Aug. 1993, *E. Bello & E. Cruz 5232* (CR, MO). **Limón**: Talamanca, Cordillera de Talamanca, Río Lori, Cerro junto al paso del Sendero de Ujarrás a San José Cabécar, 1900 m, 22 Mar. 1993, *Á. Fernández 782* (CR); Cordillera de Talamanca, siguiendo fila frente unión Queb. Kuisa/ Río Lori. de Ujarrás a San José Cabécar, 1850 m, 21 Mar. 1993, *G. Herrera 5963* (CR, MO); P.N. Cordillera de Talamanca; Cordillera de Talamanca. Margen izquierdo unión Queb. Kuisa a Río Lori, entre Ujarrás y San José Cabécar, 1850 m, 22 Mar. 1993, *G. Herrera & W. Gamboa 5988* (CR, MO). **PANAMA**. Fortuna or Cerro Colorado, 20 May 1991, *S.W. Ingram & D. Atwood 980* (MO). **Bocas del Toro**: ca 5 km ENE of Cerro Pate Macho near Finca Serrano, NE of Boquete, in forest near trail along ridge N of Finca Serrano, 12 Feb. 1979, *B. E. Hammel 6171* (MO); Along trail on divide separating Chiriquí and Bocas del Toro, 1150 m, 22 Oct. 1985, *G. McPherson 7231* (MO); Changuinola, bosque secundario, cerca de la quebrada, zona pantanosa con pocos árboles de más de 20m, de altura, 19 Apr. 2008, *A. de Sedas & D. Solano 701* (MO, PMA); PILA, Point 8, ca 3km from estación de Alto Uri, valley bottom, relatively flat, tree height ca 25m, dbh range 40–50cm., 1500 m, 16 Apr. 2008, *D. Santamaría & al. 7361* (MO, PMA); **Ngobe Buglé Comarca**: Cerro Colorado, border of Chiriquí and Bocas del Toro provinces, along intersection of Bocas Road with main ridge road, 11.8 km from Chami [Chame] along path headed into Bocas del Toro, 1400–1700 m, 24 Oct. 1977, *J.P. Folsom 6135* (MO); Cerro Colorado, 9.2 miles W of Chamé, along trail E of road which leads down to stream, 1450–1480 m, 6 Jul. 1988, *T.B. Croat 69072* (MO); Cerro Colorado, along road between Río San Felix and mining exploration camp, 7 mi W of Chamé, along trail through Guaymí village, 1500 m, 8 Jul. 1988, *T.B. Croat 69175* (CR, MO, PMA); 12 km above Chami Copper Mine near Cerro Colorado, along path down to river., 3000–4000 f, 21 Jun. 1986, *W.J. Kress & al. 86-1956* (MO!); Bocas & Chiriquí, Cerro Colorado mine area, in elfin woods on divide road, along trail into Bocas and in woods on Pacific slope, from Chami station to ca. 9 miles along road, 1100–1750 m, 27–31 Mar. 1986, *B.E. Hammel & J. Trainer 14917* (MO); N of San Félix at Chiriquí-Bocas del Toro border, on Cerro Colorado copper mine road along continental divide. Lower Montane rain forest (cloud forest, trees to 5 m tall), 5000–5500 ft, 4 May 1975, *S.A. Mori & J. A. Kallunki 5853* (MO); **Chiriquí**: 15 km N of Hornito on road to La Fortuna, 4000 ft, 17 Feb. 1979, *B.E. Hammel 6248* (MO); Fortuna hydroelectric project, along trail uphill behind camp, 1200–1400 m, 21 Mar. 1978, *B.E. Hammel 2125* (MO); Fortuna, Fortuna Field Station, Cordillera de Talamanca, 7 Dec. 1997, *D.W. Roubik & L. Quiroz 1275* (MO); Vicinity of Fortuna Dam, 1250 m, 28 Apr. 1986, *G. McPherson 9102* (MO); Near Fortuna Dam, along trail near forestry station towards river, 1150 m, 23 Oct. 1985, *G. McPherson 7265* (MO); Fortuna Dam area, N of reservoir, Quebrada Bonito to E of road, 1100 m, 23 May 1984, *H.W. Churchill 5261* (MO); Fortuna Dam area, along Quebrada Bonito to E of road, 1100 m, 8 Feb. 1984, *H.W. Churchill & al. 4816* (MO); Fortuna Dam area, along Quebrada Bonito to E of road, 1100 m, 08 Feb 1984, *H.W. Churchill & al. 4817* (MO); Fortuna Dam area, at the Continental Divide, bog at edge of Oleoducto road, 1200 m, 6 Feb. 1984, *H.W. Churchill & al 4659* (MO); Fortuna Dam Site, top of mountain above camp to south., 1700 m, 13 Sep. 1977, *J.P. Folsom & al. 5400* (MO); Fortuna Dam Project Area, slope NW of confluence of Rio Hornito and Rio Chiriqui, 1050–1100 m, 10 Nov. 1980, *K.J. Sytsma & W.D. Stevens 2205* (MO); Windswept ridge 8 km N of Los Planes de Hornito, IRHE Fortuna Hydroelectric Project, 1250–1300 m, 9 May 1982, *S. Knapp 4999* (MO); Along road and into forests 10 km N of Los Planes de Hornito, IRHE Fortuna Hydroelectric Project, 1100–1200 m, 10 May 1982, *S. Knapp 5027* (MO); Along road and into forests 10 km N of Los Planes de Hornito, IRHE Fortuna Hydroelectric Project, 1100–1200 m, 10 May 1982, *S. Knapp 5033* (MO!); Trail to the Río Hornito, 11 km N of Los Planes de Hornito, IRHE Fortuna Hydroelectric Project, 1100–1200 m, 12 May 1982, *S. Knapp 5109* (MO); Border of Bocas del Toro/Chiriqui provinces, Continental Divide above Quebrada Arena, Carretera del Oleoducto, IRHE

Fortuna Hydroelectric Project, 1150–1200 m, 19 Jun. 1982, *S. Knapp & M.R. Vodicka 5665* (MO); Chiriqui-Bocas del Toro, ca 5 km N of Fortuna Dam, trail along Continental Divide, 1200–1300 m, 25 Apr. 1988, *S.A. Thompson 4955* (MO); Along continental divide on Cerro Colorado, on upper mining road 20–28 miles from San Félix., 1200–1500 m, 14 Mar. 1976, *T.B. Croat 33402* (MO); Cerro Colorado, along mining road 24 mi above bridge over Río San Félix, north of village of San Félix, primary forest along road, 1430–1500 m, 22 Nov. 1979, *T.B. Croat 48496* (MO); Along road to Fortuna dam site on Río Chiriquí, N of Gualaca, 7.7 mi beyond Francisco Linare's lane, 19.2 mi beyond bridge over the Río Está, 9.1 mi beyond Los Planes de Hornito, 8 mi beyond jct. in road to tunnel, 1300 m, 27 Nov. 1979, *T.B. Croat 48753* (MO); Along road to Fortuna dam, site N of Gualaca on Río Chiriqui, 17.8 miles beyond the bridge over Río Está, 7.7 miles beyond Los Planes de Hornito, 6.6 miles beyond junction of road to the tunnel, 1400 m, 28 Nov. 1979, *T.B. Croat 48762* (MO); Along road between Gualaca and the Fortuna dam site 10.1 mi NW of Los Planes de Hornito, 1300 m, 8 Apr. 1980, *T.B. Croat 49818* (MO); Along road between Gualaca and Fortuna dam site, 7.9 mi beyond (NW) of Los Planes de Hornito, 1300 m, 9 Apr. 1980, *T.B. Croat 49933* (MO); Along road between Gualaca and Fortuna dam site, 10.1 mi NW of Los Planes de Hornito, 1250 m, 10 Apr. 1980, *T.B. Croat 50029* (MO); Along road between Fortuna Lake and Chiriquí Grande, 4.5-5 km N of dam over Fortuna Lake, 1100–1135 m, 8 Mar. 1985, *T.B. Croat 60081* (MO); Along the road to the Fortuna Dam site, N of Gualaca, 22.7 mi beyond the bridge over the Río Está, 11.8 mi N of Los Planes de Hornito, 10.7 mi N of jct. to tunnel, 1400 m, 26 Nov. 1979, *T.B. Croat 48670* (MO); Along road from Gualaca to Fortuna dam site, 5.9 mi NW of Los Planes de Hornito, 1370 m, 9 Apr. 1980, *T.B. Croat 49888* (MO); Vicinity of Fortuna Dam in valley of Río Chiriqui, along aquaduct to water source for IRHE facilities near dam, 1200–1300 m, 22 Jun. 1987, *T.B. Croat 66621* (MO); Fortuna Dam Area, trail to Meteorological Station of Río Hornito, beginning 0.5 km S of Centro de Cientificos, 23 Jun 1994, *T.B. Croat & G. Hua Zhu 76301* (CR, MO); Along the road between Gualaca and the Fortuna Dam site, at 10.1 mi NW of Los Planos de Hornito, 1300 m, 8 Apr. 1980, *T.M. Antonio 4082* (MO); Gualaca, Reserva Forestal Fortuna, Sendero de la Quebrada Alemán, 1390 m, 11 Dec. 2013, *O. Ortiz & al. 1881B* (MO, PMA); Reserva Forestal Fortuna. Sendero Samudio., 1205 m, 6 Nov. 2013, *O. Ortiz & al. 1784* (MO); Chiriquí, Reserva Forestal Fortuna, s.d., *O. Ortiz & al. 4235* (PMA).

Anthurium loratum Croat, Aroideana 45(2): 176-177, f. 58–59, 2022.

Type: Costa Rica. Cartago: 1.5 miles E of Cachi, 10.2 miles NE of junction at Paraiso, 1300–1350 m, 5 Feb. 1979, *T.B. Croat 47085* (holotype MO-2769783; isotypes MO-2815924, INB).

Distribution and habitat

Anthurium loratum is endemic to Costa Rica, known only from Cartago Province a *Premontane wet forest* life zone.

Phenology

Flowering in February.

Conservation Status

This species is known from one locality, along disturbed forests from Cartago. During the field work carried out recently, we were able to observe that the habitats near the registered location are highly threatened by activities related to the extensive coffee crops. Because of this, we consider this species Critically Endangered [CR B2ab(iii)].

Remarks

Anthurium loratum is characterized by its terete glandular-punctate heavily sheathed petioles, strap-shaped narrowly and weaky attenuated blades glandular-punctate on both surfaces, more than 25 primary lateral veins per side, two pairs of basal veins, a long-pedunculate inflorescence (32–35 cm long), lanceolate spathes, and cylindroid spadices of 10–12 cm long, with 4–5 flowers visible in the principal spiral and 5–6 flowers in the alternate spiral. According to Croat et al. (2022), this taxon is similar to *A. pendens* Croat, which differs by having the blade narrowly oblanceolate with the peduncle shorter than the petioles. Furthermore, because this species presents strap-shaped narrow leaf blades, it could also be confused with *A. friedrichsthalii* and *A. gregneversii*. Among the most notable differences between *A. loratum* and *A. friedrichsthalii* is that the latter taxon comprises smaller plants that lack a prominent petiole sheath and black glandular punctations on the upper surface. In the case of *A. gregneversii*, it differs from *A. loratum* also by lacking a prominent petiole sheath and having fewer lateral primary veins (up to 25 pairs), as well as shorter peduncles (up to 14 cm long). The specimens *Croat & Horich 69774* and *Herrera 8441* from Limón Province, were included in the original protologue of *A. loratum* as paratypes (Croat et al. 2020). Nevertheless, they corre-

spond to *A. gregneversii*, because both lack a long petiole sheath and have noticeably shorter peduncles.

Anthurium orosiense Croat, Aroideana 45(2): 202, fig. 74, 2022.

Type: Costa Rica. Cartago: Tapantí Hydroelectric Reserve along Río Orosi, 4.5 km beyond small bridge which crosses river inside the reserve, along road to the diversion dam, 1500–1700 m, 23 Jun. 1976, *T.B. Croat 36123* (holotype MO-2390064; isotype INB). Figure 9.

Distribution and habitat

Anthurium orosiense is known only from Tapantí Hydroelectric Reserve in Cartago Province (Río Grande de Orosi) at ca. 1500 m in a *Premontane rain forest* life zone.

Phenology

Flowering in June.

Conservation Status

This species is only known from two collections, made in the same location (Moravia, Chirripó). Currently, the habitats surrounding this location are threatened by extensive coffee planting, which represents a short and long-term danger for the species. Considering the restricted distribution of this taxon (AOO = 8 km^2), we recommend considering this species as Critically Endangered [CR B2ab(iii)].

Remarks

Anthurium orosiense is characterized by having terete petioles, more or less equalling the blades, narrowly oblong-elliptic blades with obscure primary lateral veins, black glandular punctations on both surfaces, pendent inflorescences with pinkish red (code #D5869D) peduncles, green, linear-lanceolate spathes, and narrowly tapered, reddish orange (code #EDB381) spadices at anthesis, red (code #990012) infructescences, bright orange red (code #9F2305) berries, and reddish orange (code #A2653E) seeds. *Anthurium orosiense* is similar to *A. utleyorum* Croat & R.A.Baker which differs by having usually smaller and narrower, more coriaceous blades with the collective veins closer to the margin and by having a shorter, more prominently tapered purplish spadix with protruding pistils.

Specimens examined

COSTA RICA: **Cartago**: Cantón Turrialba, distrito Chirripó, Moravia de Chirripó, Bosque nuboso, 1602 m, 13 enero 2021, *M. Cedeño & al. 2404* (USJ).

Anthurium pendens Croat, Monogr. Syst. Bot. Mo. Bot. Gard. 14: 153–156. 1986.

Type: Panama. Colón: Santa Rita Ridge Road, along trail at end of road that goes to Río Indio, beginning 10.6 km from Transisthmian Hwy., 3 km beyond hydrographic station, ca. 380 m, *T.B. Croat 34296A* (holotype MO-2815427; isotypes K-K000434254, PMA-190). Figure 10.

Distribution and habitat

The species occurs from eastern Panama to Colombia, at sea level to 1000 m in *tropical wet* and *lower montane rain forest* life zones.

Conservation Status

This species has a relatively wide distribution (EOO: 23,868 km^2; AOO: 72 km^2), and its populations are not confronting significant threats, consequently *A. pendens* could be considered as Least Concern [LC].

Phenology

Flowering and fruiting throughout the year.

Remarks

Anthurium pendens is characterized by its epiphytic habit, pendent growth form, very elongate, oblanceolate, leaf blades glandular-punctate on both surfaces, with up to 12 pairs of primary lateral veins, green flat spathes, brownish gray (code #86775F), straight spadices with 5–6 flowers visible in the principal spiral, 7–8 flowers visible in the alternate spiral, gray (code #929591) stigmas, and pale yellowish orange (code #FF9F00), oblate berries.

The species is morphologically related to *A. wendlingeri*, which has similar, elongate, coriaceous, and black-glandular punctate leaf blades, but that species differs from *A. pendens* by having usually numerous primary lateral veins (up to 24 pairs), generally coiled spathes and spadices, whitish stigmas, and oblong-globose red berries.

Specimens examined.

PANAMA: **Colón**: Río Guanche, 1-4 km upstream from Portobelo Road, 0–100 m, 10 Dec. 1973, *A.H. Gentry 8815* (MO); Below Cerro Bruja, beyond Mino, Selby 85-119, 100–200 m, 19 Feb. 1986, *E.A. Christenson 1212* (MO); Santa Rita Ridge Road, along the trail at end of road which goes to Río Indio, beginning 10.6 km from Transisthmian Hwy, 3 km beyond hydrographic station, 380 m, 13 Apr. 1976, *T.B. Croat 34296A* (MO); Río Guanché above bridge on Portobelo Road; ca. 3 to

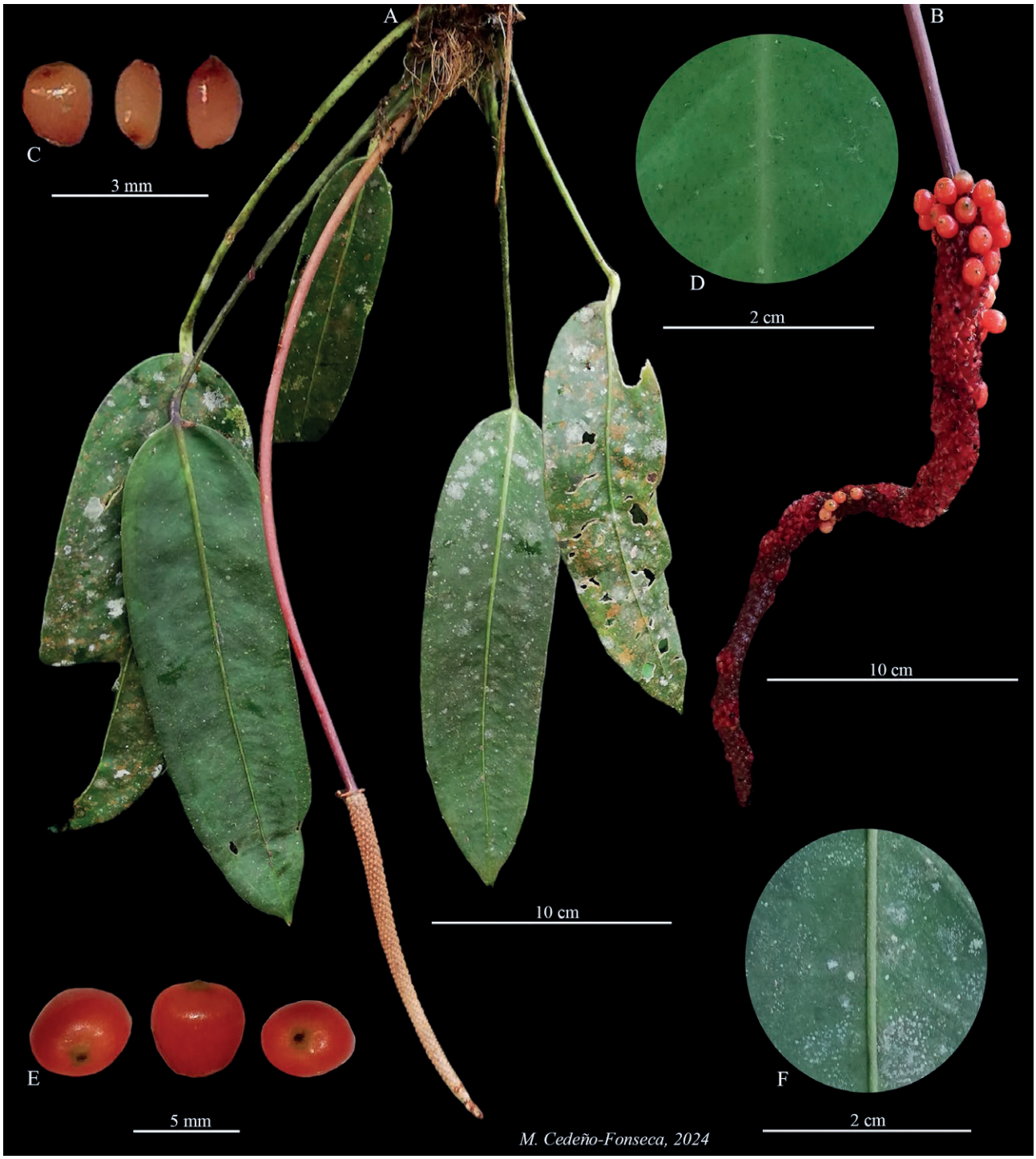

Figure 9. *Anthurium orosiense*. A: habit; B: infructescence; C: seeds; D: detail of the leaf blade on the lower surface; E: ripe berries; F: detail of the leaf blade on the upper surface. All from *M. Cedeño et al. 2404* (USJ). Plate and photos by M. Cedeño-Fonseca.

5 km above bridge, 50–200 m, 8 Jul 1976, *T.B. Croat 37006* (MO); Below Cerro Bruja along Río Escandaloso beyond Mino #2, 100–200 m, 18 Mar. 1982, *W.J. Kress & S. Knapp 82-1393* (MO). **Darién**: Cerro Sapo, 2500 ft, 01 Feb. 1978, *B.E. Hammel 1199* (MO); Cerro Sapo, ca. 5 km south of Garachiné, along ridge at north approach

Figure 10. *Anthurium pendens* from Panama (Colón). A: adult individual with pendent habit; B: infructescence in development. Photos by M. Cedeño-Fonseca.

to cerro, 600–800 m, 23 Mar. 1986, *B.E. Hammel & al. 14831* (MO); South of Garachine on western slope of Serranía Sapo, above place called Casa Vieja, along boundary trail of Darién National Park, 550–830 m, 25 May 1991, *G. McPherson & al. 15384* (MO); W side of SW ridge leading to Alturas de Nique, headwaters of Río Coasí, 350 m, 27 Dec. 1980, *R.L. Hartman 12296* (MO); Middle slopes on W side of Cerro Pirre, 550–760 m, 28 Jun 1988, *T.B. Croat 68887* (MO). **Panamá Province**: Chepo. Along new El Llano-Cartí road, 8–12 km N of El Llano, 400–450 m, 12 Dec. 1973, *M.H. Nee & al. 8758* (MO!); road from Panamerican Highway to Cerro Jefe, summit, 21.7 km from Panamerican Highway, forest after pastured area, 700–1000 m, 22 Jun. 1977, *J.P. Folsom 3849* (MO). **Guna Yala Comarca (San Blas):** Nusagandi, El Llano-Cartí Road, 19.1 km from Interamerican Hwy, 350 m, 6 Nov. 1984, *G. de Nevers 4205* (MO); El Llano-Cartí Road, Km 19.1, 350 m, 8 Mar. 1986, *G. de Nevers & H. Herrera 7280* (MO).

Anthurium tarrazuense Croat, Aroideana 45(2): 231, fig. 88. 2022.

Type: Costa Rica. San José: Tarrazú, Nápoles, Ladera Oeste de Cerro Pito, 1500 m, 1 Dec. 1995, *G. Herrera, A. Cascante & J. Sánchez 8799* (holotype CR-196066). Figure 11.

Distribution and habitat

Endemic to Costa Rica, known only from Tarrazú, Nápoles on the slopes of Cerro Pito at 1500 m in a *Premontane wet forest* life zone.

Phenology

Flowering in December.

Conservation Status

This species is only known from one location in an area highly threatened by extensive and unsustainable

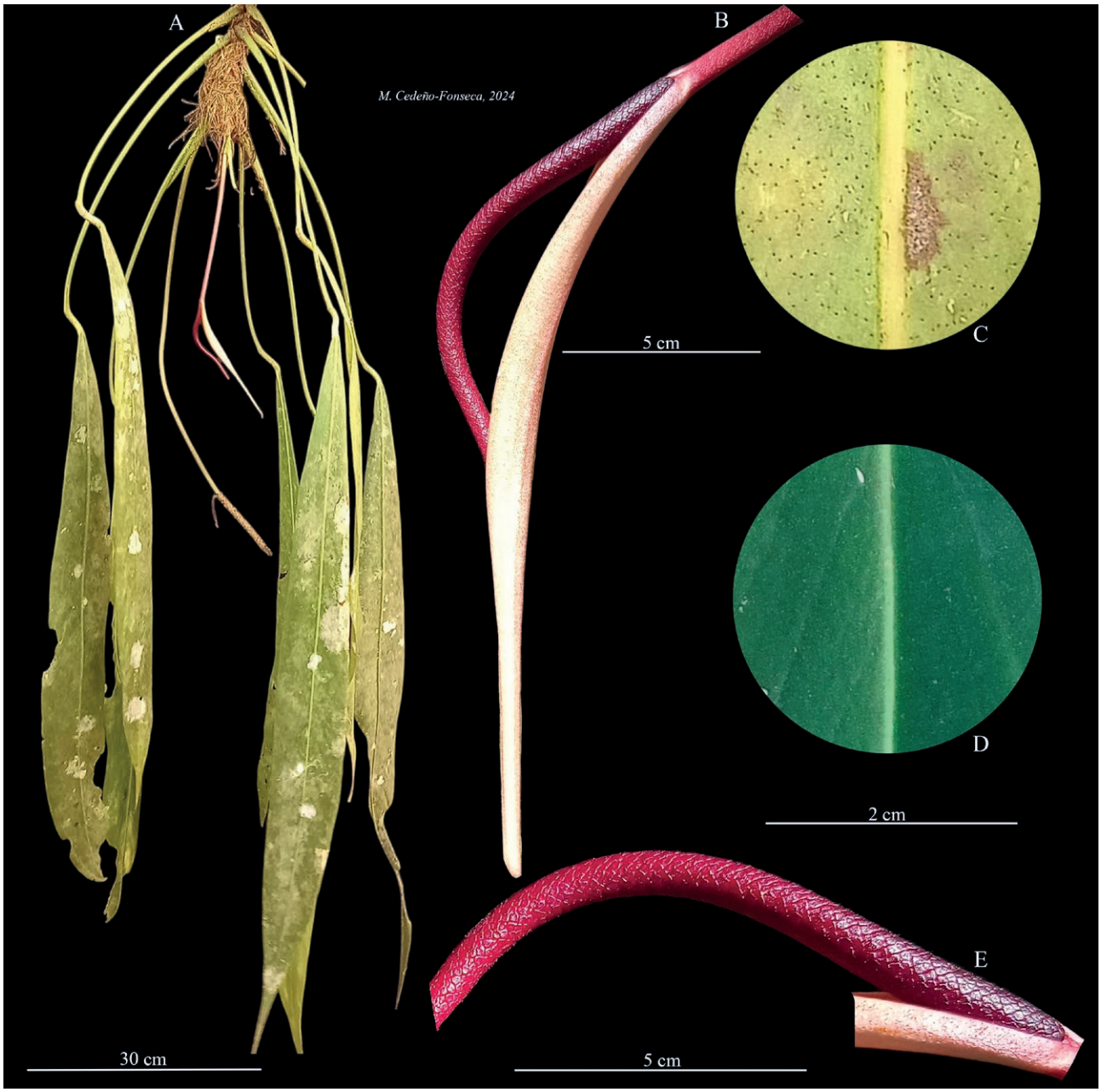

Figure 11. *Anthurium tarrazuense*. A: habit; B: inflorescence at female anthesis; C: detail of the leaf blade on the lower surface; D: detail of the leaf blade on the upper surface; E: flowers at female anthesis. Photos by Florian Wollinger. Plate by M. Cedeño-Fonseca.

planting of coffee crops. Fieldwork carried out in the type locality and surroundings suggest that *Anthurium tarrazuense* is not a common species, because just one individual was found. Unfortunately, we did not voucher the individual. Considering the threats to its natural habitats and its restricted distribution (AOO = 4 km^2), we recommend listing this species as Critically Endangered [CR B2ab(iii)].

Remarks

Anthurium tarrazuense is recognized by having narrow, long-petiolate leaves, glandular-punctate only on the lower surface, long-pedunculate pendent inflorescences, pinkish red (code #E75480) peduncles, yellowish orange (code #FAECCC) slender spathes, and long, bright pinkish red (code #A9203E) spadices at anthesis.

Due to the long petioles and long peduncles, *Anthurium tarrazuense* could be confused with *A. orosiense*, but the latter differs owing to its leaf blades with glandular black punctations on both surfaces (vs. only on the lower surface in *A. tarrazuense*) and several primary lateral veins (16–18 vs. 6–10 pairs).

Anthurium tayuticense Croat, Aroideana 45(2): 234, fig. 89. 2022.

Type: Costa Rica. Cartago: Cantón Turriaba. Distrito Tayutic. Vereda Grana de Oro, 2 km E., trail to Llanos del Quetzal, 1200 m, 28 July 1995, *G. Herrera & A. Cascante 8157* (holotype MO-5036242; isotype CR). Figures 12, 13.

(=) *Anthurium nutans* Croat, Aroideana 45(2): 199, fig. 73, 2022, **syn. nov.**

Type: Costa Rica. Heredia: Atlantic slope of Volcán Barva, between Río Peje and Río Sardinalito, 700–800 m, 3 Apr 1986, *M.H. Grayum 6714* (holotype MO-3489956; isotype INB).

Distribution and habitat

Anthurium tayuticense is endemic to Costa Rica, known only from Alajuela, Heredia and Cartago Province of Costa Rica from 700–1200 m elevation in a *Premontane wet forest* life zone.

Phenology

Flowering in January. Fruits have been collected in May and July.

Conservation Status

Anthurium tayuticense is a rare species known from three herbarium specimens, all collected from a single location in an unprotected area which is highly pressured by destructive human activities, specifically extensive cattle ranching. Considering the reduced geographic distribution (AOO = ca. 4 km^2) and the threats to its natural habitats, we consider that this species qualifies as Critically Endangered [CR B1a(iii)+2ab(iii)].

Remarks

This species is distinguished by its epiphytic habit with a pendent growth form, persistent and fibrous reddish-brown cataphylls, pendent leaves, terete petioles, glandular-punctate (only below), usually oblong to elliptic or narrowly ovate to elliptic leaf blades which are glossy on the lower surfaces, 30–45 pairs of primary lateral veins, pendent, short-pedunculate and sessile inflorescences, straight spathes, red orange (code #8C472F), straight spadices (brown at post-anthesis) at anthesis, with more than 7 flowers visible per spiral, and globose-elliptic, reddish orange (code #F8481C) berries.

Anthurium tayuticense could be confused with *A. pendens* and especially *A. wendlingeri*, because all share similar habit, growth form and long petioles and leaf blades. *Anthurium pendens* differs from *A. tayuticense* in having narrowly linear-oblanceolate leaf blades, fewer primary lateral veins (up to 12 vs. 15–27 pairs) departing midrib at 10–20° angle (vs. 35–40°), and pinkish spadices at anthesis (vs. red orange). *Anthurium wendlingeri* (both var.*wendlingeri* and var. *horichii*) differs from *A. tayuticense* in having markedly oblong leaf blades (vs. oblong-elliptic), fewer primary lateral veins (up to 24 vs. up to 45 pairs), coiled spadices with 4–6 flowers visible in the principal spiral (vs. straight spadices with more than 7 flowers visible in the principal spiral), and oblong-globose berries (vs. globose-elliptic).

According to Croat et al. (2022), *Anthurium tayuticense* is most closely related to *A. jicoteense* Croat which differs in having obtusely and broadly sulcate petioles, narrower leaf blades (less than 7 cm wide), and green spadices with only 5 flowers visible per spiral (vs. red orange with more than 7 flowers per spiral). *Anthurium nutans*, also described by Croat et al. (2022) from Heredia (Costa Rica), is very similar to *A. tayuticense*, since both have oblong leaves lacking black glandular punctations above, several primary lateral veins and peduncles shorter or equal than the spadix. Recent explorations in the type locality of *A. nutans* confirmed that this taxon is conspecific to *A. tayuticense* (see the specimen *Cedeño et al. 2655*, USJ). Consequently, we consider *A. nutans* a synonym of *A. tayuticense*.

Specimens examined

COSTA RICA: **Alajuela**: Cantón Grecia, distrito Río Cuarto, Laguna Hule, 900 m, 31 Oct. 2022, *M. Cedeño & al. 2655* (USJ!); **Cartago**: Turrialba, Tres Equis, 800 m, 13 Mar. 2021, *M. Cedeño et al. 2403* (USJ!, PMA!); Turrialba, Tayutic, área no protegida, Vereh, Grano de Oro, 2 km al este, camino a Llanos del Quetzal, 1200 m, 28 julio 1995, *G. Herrera & A. Cascante 8157* (CR!); Cantón Turrialba, distrito Tres Equis, 800 m, 13 May 2021, *M. Cedeño & al. 2393* (B!, USJ!).

Figure 12. *Anthurium tayuticense*. A: adult individual with blade bullate and developing infructescence and peduncle 6 cm long; B: adult individual with leaves pendent and tilted at an angle of 65° to 90°; C: adult individual with mature infructescence and reddish orange ripe berries; D: adult individual growing up to 15 m about the ground with long inflorescence. – A from *M. Cedeño et al. 2403* (USJ); B from *M. Cedeño & al. 2393* (USJ). All photos by M. Cedeño-Fonseca.

Anthurium utleyorum Croat & R.A.Baker ('*utleyi*'), Brenesia 16 (Supl. 1): 100. 1979.

Type: Costa Rica, Alajuela: 2 km N of Angeles Norte de San Ramon, ca. 1200 m, *J. Luteyn 3695* (holotype DUKE-233270). Figure 14.

Distribution and habitat

Anthurium utleyorum is endemic to Costa Rica at 800 to 1700 m in *premontane* and *lower montane rain forest* life zones.

Figure 13. *Anthurium tayuticense*. A: habit; B: black glandular punctuations on blade abaxial surface; C: stem with short internodes and fibrous cataphylls and roots; D: inflorescence, spadix (right) and spathe (left); E: detail of the flowers on the spadix; F: ripe fruits on the spadix; G: fruit; H: seed. Drawn by Maíra Cordero Pagoaga from *M. Cedeño & al. 2393* (USJ).

Figure 14. *Anthurium utleyorum*. A: adult individual with pendent habit; B: inflorescence with the spadix in female stage; C: mature infructescence with red orange berries; D: spadix with ovoid berries beaked at the apex. A–D from *J.E. Jiménez & al. 5492* (USJ). Photos by J.E. Jiménez.

Phenology

Flowering and fruiting throughout the year.

Conservation Status

This species is known from three locations which are found in two protected areas (and their buffer zones), such as Alberto Manuel Brenes Biological Reserve and Monteverde Cloud Forest Biological Reserve. Its geographical distribution includes approximately an EOO of 2552.6 km^2 and an AOO of 108 km^2. At present, the populations located in the buffer zones (outside protected areas) are experiencing extensive cattle ranching, destructive agricultural activities, and livestock-related activities, which poses an obvious threat to the conservation of the species. Based on the information mentioned above, *A. utleyorum* qualifies as Endangered [EN B1a(iii)+2ab(iii)].

Remarks

Anthurium utleyorum is characterized by its epiphytic habit, pendent growth form, oblong to oblong-elliptic, glandular-punctate leaf blades (on both surfaces), with 14 to 20 pairs of primary lateral veins, orange red (along margins) (code #905D5D) to orange yellow (along middle parts) (code #8A8360) spathes and red orange (code 81422C) spadices at anthesis, with 4–5 flowers in the principal spiral and 5–9 flowers visible in the alternate spiral, and red orange (code #F8481C), markedly ovoid berries which are beaked at the apex.

Because of the similar habit and leaves, *Anthurium utleyorum* could be confused with *A. cascantei, A. friedrichsthalii,* and *A. gregneversii* (for more details, see the discussion under *A. gregneversii*). *Anthurium cascantei* differs from *A. utleyorum* primarily in having dark purple spadices with 7–8 flowers in the principal spiral and 4–5 flowers visible in the alternate spiral (vs. red orange spadices with 4–5 flowers in the principal spiral and 5–9 flowers visible in the alternate spiral), and oblate-obcordate berries (vs. ovoid). *Anthurium friedrichsthalii* differs in having yellowish orange spadices with 3–4 flowers visible in the principal spiral, and pale yellowish orange, oblate-obcordate berries.

We consider that the specimens of from the Cordillera de Guanacaste (Santa María Volcano) previously identified as *Anthurium utleyorum*, do not correspond to this entity. In fact, Grayum (2003) stated that these collections, characterized by remarkably small plants with eglandular blades on the upper surface, could represent a different entity. We agree with Grayum's proposal, nevertheless we considered that these specimens rather seem to be more morphologically related to the *Anthurium lancifolium* complex, such as *A. albifructum* (Croat) O.Ortiz & Croat, *A. dichrophyllum* Croat, *A. gracililaminum* Croat, and *A. lancifolium* Schott. Members of *A. lancifolium* complex are characterized by their small size, eglandular (on the upper surface), lanceolate leaf blades, and relatively tiny spadices with few flowers per spiral. In order to be more conclusive with the identity of these specimens, it is necessary to document their reproductive characters in the field.

Specimens examined

COSTA RICA: **Alajuela**: Reserva Forestal San Ramón, Los Ángeles, Colonia Palmareña, cuenca media de Río San Lorenzo, camino a la mina de yeso, 1100 m, 22 Feb. 1991, *G. Herrera 4947* (CR); Reserva Forestal San Ramón, Los Ángeles, Colonia Palmareña, cuenca media de Río San Lorenzo, camino a la mina de yeso, 1100 m, 22 Feb. 1991, *G. Herrera 4954* (CR, MO); Reserva Forestal de San Ramón, 800–1000 m, 3 Nov. 1986, *G. Herrera & V. Mora 182* (MO); Reserva Forestal de San Ramón, 800–1000 m, 26 Jan. 1987, *G. Herrera & al. 412* (MO); Along road between San Ramón and Balsa, at Angeles Norte, primary cloud forest on slopes, 1250 m, 2 Feb. 1979, *T.B. Croat 46846* (MO); Sendero pantanoso hacia el Río Peñas Blancas, 1540–1575 m, 18 Jun. 1985, *W.A. Haber & E. Bello 1673* (MO); San Ramón. Bajo La Balsa, 1100 m, 4 Mar. 1983, *A. Carvajal 464* (MO); 15 km northwest of San Ramón by air, Cerro Azahar, headwaters of Río San Pedro, by road, 9 km northwest of San Ramón to Piedades Norte, then 3 more km northwest to La Paz, then left on jeep road 1.7 km to cluster of houses, then left again on jeep road 4–5 km to top of ridge, 1400–1500 m, 14 May 1983, *R.L. Liesner& al. 15497* (MO). **Cartago**: Turrialba, Chirripó, Moravia de Chirripó, Bosque nuboso, 1602 m, 13 May 2021, *M. Cedeño 2484* (USJ). **Guanacaste**: Monteverde 2 km N Santa Elena on road to San Gerardo. Hills above Río Negro. Atlantic slope near continental divide, 1550 m, 31 Jan. 1989, *W.A. Haber 9042* (MO); Monteverde 5 km N Santa Elena on road to Las Nubes, Finca San Bosco road, Río Negro, atlantic slope, 1400 m, 10 Nov. 1988, *W.A. Haber & W. Zuchowski 8745* (CR, MO). **San José**: Vásquez de Coronado, Cascajal, Fincas Privadas del Clodomiro Picado, 1487 m, 16 Feb. 2021, *J.E. Jiménez & F. Oviedo-Brenes 5492* (USJ).

Anthurium wendlingeri G.M.Barroso var. ***wendlingeri***, Bol. Soc. Venez. Ci. Nat. 26(109): 151. 1965.

Type: Costa Rica, Cartago, Turones [Pavones], Turrialba, 700 m, *Wendlinger s.n.* (holotype RB-18049). Figure 15.

Figure 15. *Anthurium wendlingeri* var. *wendlingeri*. A: adult individual with pendent habit and purple spathe and spadix in the Caribbean of Costa Rica; B: inflorescence with purple spathe and cream spadix in female stage in the Caribbean of Costa Rica; C: adult individual with pendent habit and coiled spadix in the Caribbean, Chagres of Panama; D: coiled spadix in the Caribbean Fortuna of Panama. A. Not collected; B from *M. Cedeño al. 2394* (USJ); D: from *O. Ortiz & F. Miranda 1250* (PMA). Photos A–C by M. Cedeño-Fonseca; D. by O. Ortiz.

Distribution and habitat

The species ranges from Nicaragua to Colombia at 250 to 1700 m elevation.

Phenology

Flowering and fruiting throughout the year.

Conservation Status

Anthurium wendlingeri var. *wendlingeri* has a broad geographical distribution (EOO = 118,954 km^2; AOO: 244 km^2), and it is not confronting any critical threats, hence this species must be considered as Least Concern [LC].

Remarks

Anthurium wendlingeri var. *wendlingeri* is distinguished by its epiphytic habit, pendent growth form, coriaceous, oblong, elongate, usually bullate, glandular-punctate leaf blades (on both surfaces), 10–24 pairs of primary lateral veins, usually coiled, solid burgundy (code #9E1E29) spathes, and generally coiled spadices with 4–6 flowers visible in the principal spiral and 8–10 flowers visible in the alternate spiral, and oblong-globose red berries (code #C11B17). *Anthurium wendlingeri* var. *wendlingeri* could be confused with *A. tayuticense* (in Costa Rica) and *A. pendens* (in Panama), due to their pendent growth forms and elongated leaves. But both species differ from *A. wendlingeri* in having generally flat spathes and straight spadices throughout most of their length.

Historically, the color of the spadix of *Anthurium wendlingeri* var. *wendlingeri* has been ambiguous, as it has been described as pale green to white or grayish white (Croat 1983, 1986), pale green before anthesis and dark purple-violet at anthesis (Croat and Stiebel 2001), white to tan or grayish (Grayum 2003), white (Croat 2022), or white to gray-white (Croat et al. 2022). Due to this discrepancy, some authors (Croat and Stiebel 2001; Croat 2022) argued that there is a possibility that Barroso (1965), who defined the spadices in the original protologue as "atropurpureus", may have described the species using plants of different species. Recently, Croat (2022) indicated the possibility that Barroso (1965) may have prepared the description using plants of *A. wendlingeri* (var. *wendlingeri*) and the recently described *A. kubickii* (= *Anthurium wendlingeri* var. *horichii*) from a locality very close to the *locus classicus* of *A. wendlingeri* (var. *wendlingeri*). The problem with this notion is that it is based on the possibility that Barroso (1965) performed the description using more than two specimens, however, in the original protologue of *A. wendlingeri* only a single specimen (holotype) was cited. On the other hand, we consider that the discrepancy regarding the coloration of the spadix is linked to inadequate field work and poor understanding of the species throughout the development of the inflorescence. Extensive documentation of this species in the field allowed us to determine the color of the spadices during different phases of the development: at anthesis spadices can be dark rose (code #B34559) and creamy white (code #F6F0BC) at type locality, or grayish-white (code #F6F4F5; Costa Rica and Panama), at post anthesis spadices are reddish-orange (code #9E6842), during fruit development are brownish (code #825E29), and when fruits are ripe the spadices become rose brown (code #B28580). Our observations at the type locality of *A. wendlingeri* suggested that the color of the spadix between dark rose and white is a natural variation of the species, even within the same population (see Figs. 15 A–B).

Specimens examined

COSTA RICA: **Alajuela**: Reserva Biológica de San Ramón, road from Las Lagunas to Colonia Palmareña, 850–1100 m, 30 May 1986, *G. C. de Nevers & al. 7787* (MO); Alajuela, Along Río Sarapiquí just upstream from crossing of road from San Miguel to Colonia Carvajal, 375 m, 18 Aug. 1990, *M. H. Grayum & N. Murakami 9945* (MO); San Ramón, Estación Biológica Alberto Manuel Brenes, 850 m, 3 Jul. 2003, *R.C. Moran & M. Mora 6882* (MO); **Cartago**: Turrialba, Tres Equis, 800 m, 13 May 2021, *M. Cedeño & al. 2394* (USJ); Turrialba, Parque Nacional Barbilla, Cuenca del Matina, sendero principal junto al río, 300–400 m, 20 Sep. 2000, *E. Mora & E. Rojas 1502* (MO). **Heredia**: 3 miles south of Cariblanco, 760 m, 28 May 1976, *T.B. Croat 35830* (MO); **Limón**: Reserva Indígena Talamanca Camino entre Sukut y Amubri por la fila Tsiurábeta, 700–900 m, 9 Jul. 1989, *B.E. Hammel & al. 17614* (MO); Llanuras de Santa Clara, river-shore junction and jungle below Hacienda El Zorro, north of road to Guapiles, along Rio Danta, 250 m, 1983, *C.K. Horich s.n.* (MO); Talamanca, Bratsi, Reserva Indigena Bri Bri, 1.7 km southwest of Kivut, 6.1 km southwest of Alto Lari, 0–1450 m, 12 Mar. 1992, *H.H. Schmidt & R. Aguilar 651* (MO); Cordillera de Talamanca between headwaters of Río Madre de Dios and Quebrada Barreal, 400 - 440 m, 5 Sep. 1988, *M.H. Grayum & al. 8807* (CR, MO); Limón, Cerro Muchilla, Fila Matama, Valle de la Estrella, 850 m, 5 Apr. 1989, *G. Herrera & al. 2510* (CR, MO); Pococí, Río Costa Rica, 250 m, 15 Feb. 1989, *C. K. Horich s.n.* (MO!); Talamanca, Cordillera de Talamanca. Río Coén, 800 m aguas arriba unión Queb. Kirigú, de Ujarrás a San José Cabécar, 1700 m, 28 Mar. 1993, *Á. Fernández 860* (CR); Croriña, Cerro Cruibeta, afluentes de Quebrada Lumbeta, 550

m, 20 Jul. 1989, *G. Herrera 3320* (MO); Camino de Fila Dimat (casa de Hermógenes Pereira) hasta Soki [Tsaki], pasando por la quebrada Sha [Sheaub?], 26 Oct. 1985, *L.D. Gómez & al. 23850* (MO); **Puntarenas**: San Vito de Java, Las Cruces, from R.G. Wilson, Greenhouse #17. Acc. No. 681267, 11 Mar. 1982, *F.P. Darke D-795* (MO); San Vito, as Selby 77-1989, 31 May 1986, *E.A. Christenson 1525* (MO); **San José**: Tarrazú, San Marcos de Tarrazú between Cerro Toro and Cerro Hormiguero along the road between Basuero de Tarrazú and Esquipulas, vicinity of Cerro Hormiquero, 1100–1200 m, 5 Sep. 1996, *T.B. Croat 78902* (MO). **PANAMA**: **Bocas del Toro**: Gualaca-Chiriquí Grande, 1.6 mi N of Continental Divide, 850 m, 29 Mar. 1993, *T.B. Croat 74925* (MO); Along road between Gualaca and Chiriquí Grande, 9.4 mi N of the Continental Divide (border of Bocas del Toro and Chiriquí Provinces) 14 mi N of bridge over Fortuna Lake, along river banks, 175 m, 25 Jun. 1987, *T.B. Croat 66821* (MO). **Coclé**: Caribbean side of divide at El Copé, 200–400 m, 3 Feb 1983, *C.W. Hamilton & G. Davidse 2659* (MO); El Valle, end of road leading to Turístico Hotel, walking up into crevasse between the central and the eastern hill of the three rim masses soaring above El Valle, 11 May 1977, *J.P. Folsom 3108* (MO); La Mesa, 4 km N of El Valle, 875 m, 3 Jan. 1974, *M.H. Nee & J.D. Dwyer 9168* (MO); Along road past Furlong's Finca, due N of Cerro Pilón, 880 m, 22 Jul. 1976, *T.B. Croat 37517* (MO); Received from R.M. Cirino, originally collected in Panama, Coclé Province: Cerro Tute, 22 Jun. 2005, *T.B. Croat 95418* (MO); Vicinity of La Mesa, N of El Valle de Antón, along steep slopes above water reservoirs, ca. 1 km W of road between Finca Mandarinas and Finca Furlong, 800–900 m, 12 Jul. 1987, *T.B. Croat 67181* (MO); La Mesa, above El Valle de Antón, ca. 2 km W of Cerro Pilón on slopes of steep hill, 860–900 m, 21 Jul. 1976, *T.B. Croat 37329* (MO); Along road between Llano Grande and Coclesito (north of Pintada), 4 mi N of Llano Grande, 600 m, 28 Jan. 1980, *T.M. Antonio 3595* (MO); La Pintada, along road between Llano Grande and Coclecito (N of La Pintada), 4.0 mi N of stream at Llano Grande, 550 m, 7 Dec. 1979, *T.B. Croat 49221* (MO). **Colón**: Santa Rita Ridge, east of transisthmian highway, 300–500 m, 16 Dec. 1972, *A.H. Gentry 6604* (MO); Along road into Santa Rita, east of Agua Clara rain gauge, 4 Mar. 1973, *H. Kennedy 2749* (MO); Santa Rita Ridge lumber road near Agua Clara weather station, 24 Sep. 1968, *M.D. Correa & R.L. Dressler 1053* (MO); Santa Rita Ridge Road, along trail at end of road which goes to Río Indio, beginning 10.6 km from Transisthmica Hwy, 3 km beyond hydrographic station, 380 m, 13 Apr. 1976, *T.B. Croat 34295* (MO); Donoso, San Juan del General, Conseción del Proyecto Mina de Cobre Panama, Botija, sendero dorado, 199 m, 12 Jan 2015, *J. De Gracia 843* (MO). **Darién**: Parque Nacional del Darién, slopes of Cerro Mali, headwaters of S branch of Río Pucuro, ca. 22 km E of Pucuro, 1300–1400 m, 21 Oct. 1987, *H. Cuadros & al. 3950* (MO). **Panamá**: Parque Nacional Altos de Campana, Buena Vista, Chame, 1 Apr. 2000, *Florpan & al. 4707* (MO); Cerro Jefe region, c. 1.5 miles along Río Pacora road from junction with Cerro Jefe road, 750 m, 23 Jan. 1986, *G. McPherson & M. Merello 8130* (MO); Road past Altos de Pacora, 3–3.5 mi NE of Altos de Pacora, 7.8–8.2 mi above Pan Am Highway, 11.1–11.6 mi beyond Lago Cerro Azul, 700–750 m, 19 Jun. 1988, *T.B. Croat 68678* (MO, SCZ); Chepo, along new El Llano-Cartí road, 8–12 km N of El Llano, 400–450 m, 12 Dec. 1973, *M.H. Nee & al. 8735* (MO); El Llano-Cartí Road, 10–12 km from junction with Inter-American Highway, 410 m, 30 Oct. 1974, *S.A. Mori & J.A. Kallunki 2854* (MO); El Llano-Cartí Road in vicinity of Gorgas Lab Mosquito Control Project site at km 12, 250 m, 1 Aug. 1974, *T.B. Croat 26033* (MO); Panamá, vicinity of Cerro Jefe, 4.6 km beyond peak on road to Altos de Pacora, 26.3 km from the Inter-American Highway, 600 m, 12 Jun. 1976, *T.B. Croat 35917* (MO). **Guna Yala Comarca (San Blas)**: Boundary trail on Llano-Cartí road, 350 m, 27 Jan. 1986, *G. McPherson & M. Merello 8173* (MO); El Llano-Cartí Road, 19.1 km from Interamerican Hwy. Continental divide trail E of camp, 325 m, 28 Aug. 1984, *G. de Nevers 3781* (MO); Trail to Cerro Camucañala from Río Titamibe, 60–100 m, 28 Jan. 1985, *G. de Nevers & al. 4705* (MO). **Veraguas**: Santa Fe, Vicinity of Escuela Agricola Alto Piedra near Santa Fe, 0.3 mi beyond the fork in the road near the agricultural school toward Atlantic coast, along trail to top of Cerro Tute, 1050–1150 m, 29 Nov. 1979, *T.B. Croat 48914* (MO); Along western fork of road beyond Escuela Agrícola Alto Piedra, NW of Santa Fé, Pacific slope, 0.6 mi beyond fork in the road1300–1350 m, 1 Dec. 1979, *T.B. Croat 49046* (MO); Valley of Río Dos Bocas along road between Escuela Agricola Alto Piedra and Calovebora, 15.6 km northwest of Santa Fé, along trail to Santa Fé, steep forested hill east of river, 450–550 m, 31 Aug. 1974, *T.B. Croat 27659* (MO).

Anthurium wendlingeri G.M.Barroso var. ***horichii*** Croat, Aroideana 45(2): 256, figs 102 & 103. 2022. Figure 16.

Type: Cultivated Missouri Botanical Garden ex COSTA RICA. Limón: Llanuras de Santa Clara, Atlantic rain forest, rare, pendulous epiphyte on tall old trees of shore-jungle along lower Río Costa Rica near Hacienda "El Zorro Cruel", 250 m, originally collected by Clarence

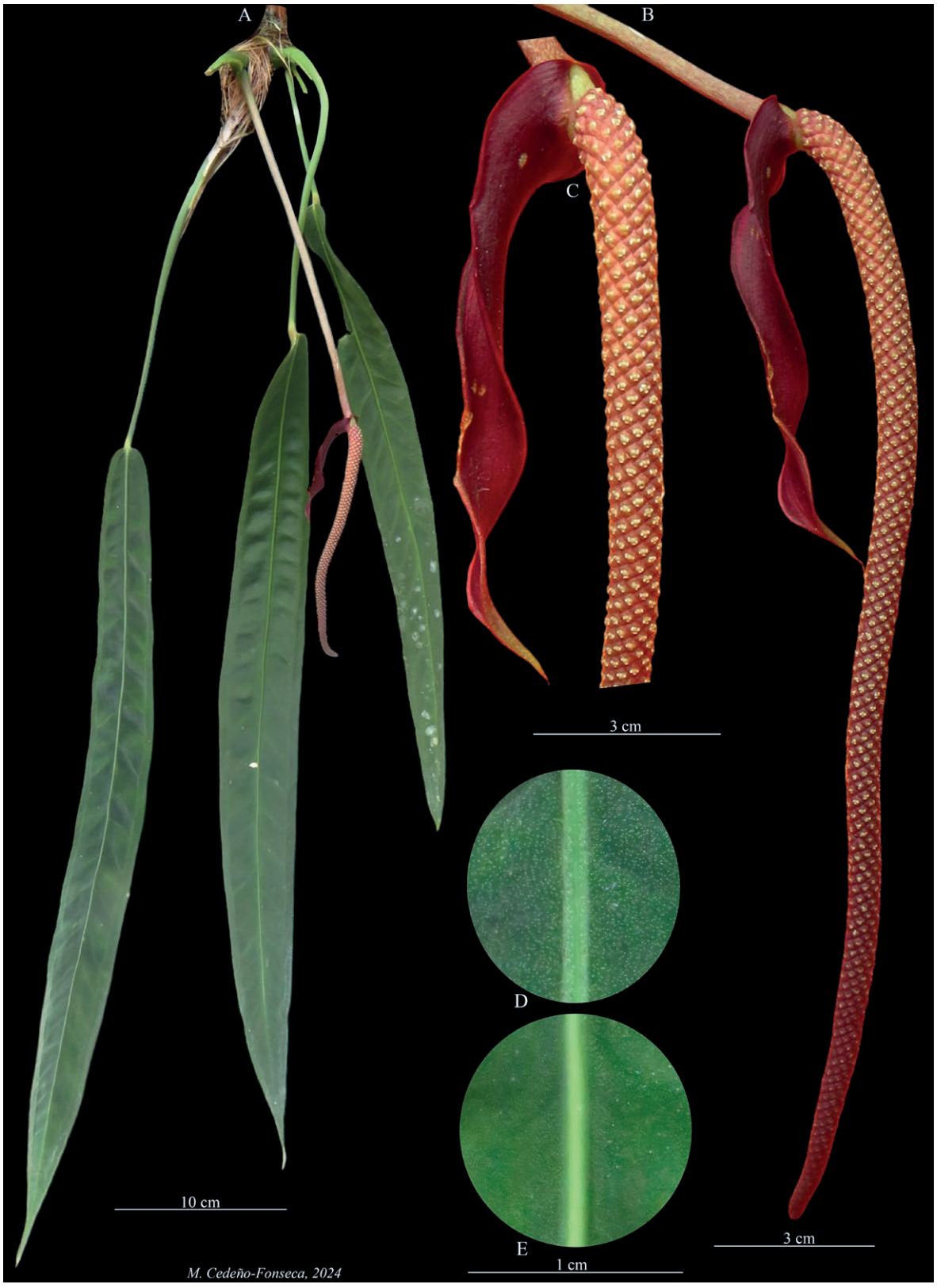

Figure 16. *Anthurium wendlingeri* var. *horichii*. A: habit; B: Inflorescence at male anthesis; C: Spathe and flowers at male anthesis; D: detail of the leaf blade on the upper surface; E: detail of the leaf blade on the lower surface. Photos by Oscar Cubero. Plate by M. Cedeño-Fonseca.

Horich; vouchered Mar. 1990, *T.B. Croat 71837* (holotype MO-5451888; isotypes CR, K, US).

(=) *Anthurium kubickii* Croat, Aroideana 45(3): 34, figs. 3 & 5–10. 2022, **syn. nov.**

Type: Costa Rica. Limón: Guayacán Rainforest Reserve, along CR Hwy #10, in foothills above Siquirres, 450 to 610 m, primary forest, *T.B. Croat & B. Kubicki 108730* (holotype MO-6813000; isotypes CR, K, US).

Distribution and habitat

Anthurium wendlingeri var. *horichii* is endemic to Costa Rica, known only from the Caribbean slope of the Talamanca Mountain range, at 250–610 m in a *Tropical wet forest* to *Premontane wet forest* life zone.

Phenology

Flowering in March and July.

Conservation Status

This taxon is only known from one location (between Llanuras de Santa Clara and Siquirres), which includes a protected area (Guayacan Rainforest Reserve). However, the forests surrounding this reserve are highly threatened (cf. Croat 2022: fig. 1), by extensive monocultures of banana, pineapple, and oil palm crops. Considering the threats present around the existing locality and the possible effects of monocultures, such as the fragmentation of the possible natural habitats that this species could be occupying in the region, we suggest including this taxon as Critically Endangered [CR B2ab (iii)].

Remarks

This taxon is characterized by having sulcate petioles, narrowly oblong to oblong-oblanceolate, more than 10 times longer than wide, dark green and velvety blades, pendent, long-pedunculate inflorescence with red (code #E30022) spathes, pinkish red (code #893843), sessile spadices at anthesis (purplish violet at post anthesis) with 5–6(7) flowers visible per spiral, and orange red (code #FF3F00), subglobose berries. Croat et al. (2022) proposed *A. wendlingeri* var. *horichii* arguing that this variety differs from the typical *A. wendlingeri* concept, by having pink spadices at anthesis (purplish after anthesis) that do not develop a tight spiral before anthesis.

Croat et al. (2022) recently described *Anthurium kubickii* from a zone very close to the type locality of *A. wendlingeri* var. *horichii*. These two taxa were defined using the same combination of diagnostic characters (straight, pinkish red spadices) (cf. Croat et al. 2022: 256 vs. Croat 2022: 34), however, they were not directly compared in their respective protologues. After examining type material of both names, we concluded that they are the same taxon, because in addition to sharing the previously mentioned characters, both have bullate leaves (when fresh), and spadices with stamens exserted after anthesis. Furthermore, it should be noted that the holotype of *A. wendlingeri* var. *horichii*, cited in the original protologue by Croat et al. (2022), comes from a material originally collected by Clarence Horich (from Limón: Llanuras de Santa Clara in 1995), which was grown at Munich Botanical Garden. In the case of the *A. kubickii* (Croat 2022), a paratype was included that was collected by Horich (with the provenance only cited as 'Costa Rica') also cultivated at Munich Botanical Garden. This indicates that both protologues involved materials based on collections that were probably from the same locality or origin, which were previously documented by Horich.

According to the ICN (Turland et al. 2018), neither of the names in question (*A. kubickii* and *A. wendlingeri* var. *horichii*) has nomenclatural priority over the other because priority only operates within the same rank (Art. 11.2). In this case, we adopt the variety name *A. wendlingeri* var. *horichii* instead of the species level *A. kubickii*, based on the concept of morphological variety (Duistermaat 1987, Hamilton and Reichard 1992, Grayum 1996), in which the rank of variety is considered appropriate when there is a minor morphological difference without any geographical or ecological distinction. This taxonomic proposal is based on the fact that both A. *wendlingeri* var. *wendlingeri* and *A. wendlingeri* var. *horichii* occur sympatrically (documented at Heredia, Horquetas), and do not have significant differentiation based on a combination of substantial morphological characters, both taxa only differ in the presence of a spiral spadix which can be white or pink in *A. wendlingeri* var *wendlingeri*, whereas *A. wendlingeri* var. *horichii* has straight pink spadices becoming purplish violet after anthesis.

Both the reviewed herbarium material of *A. wendlingeri* var *wendlingeri* and the field work suggested the existence of specimens with other small morphological differentiations (such as the case of the populations from western Panama with white and extensively spiraled spadices; fig. 15D), but to have a better taxonomic conclusion, it is necessary to make a revision of all material throughout its entire distributional range (Nicaragua to Colombia), accompanied by molecular phylogenetic studies.

Specimens examined

COSTA RICA: Cultivated at Munich Botanical Garden ex Costa Rica, originally collected by Clarence

Horich, *J. Bogner 2684* (M); Cultivated at Munich Botanical Garden ex Costa Rica: Llanuras de Santa Clara, Hacienda El Zorro Cruel, 1995, *Botanische Garten München 92/3437* (MO); **Heredia**: Horquetas, 11 Jul 2024, *O. Cubero 022* (USJ).

CONSERVATION STATUS AND ITS POTENTIAL THREATS

According to the results obtained through the conservation assessments, eight species are listed as Critically Endangered (CR), three are Endangered (EN), and five are Least Concern (LC) (Table 1). *Anthurium edtysonii, A. friedrichsthalii, A. pendens,* and *A. wendlingeri* var. *wendlingeri* do not require urgent attention, due to its wide distribution (including protected localities) and do not present significant threats. *Anthurium longistipitatum*, despite its restricted distribution (EOO = 6508 km^2), we consider it to be LC since its populations occur in a preserved area with effective protection, which does not pose any risk of threat to its conservation.

The taxa with the highest risk of threat, based on their geographic distribution and potential threats, are *Anthurium cascantei*, *A. embera*, *A. jicotense, A. wendlingeri* var. *horichii, A. loratum*, *A. orosiense*, *A. tarrazuense*, and *A. tayuticense* (all assessed as CR), followed by *A. chiriquense*, *A. gregneversii,* and *A. utleyorum* (all assessed as EN) (Table 1). Almost all these species occur in Costa Rica (except *A. embera*; Table 1) and face common threats, including habitat loss due to destructive non-sustainable activities such as extensive ranching and large-scale agricultural practices (Fig. 17). These localities are not supported by legislative instruments that regulate land use change, resulting in a drastic reduction of the forest area where these species grow. Additionally, coffee crops are being established on steep slopes, up to 70°, spreading towards the uppermost part of the mountains and further fragmenting the remnants and disrupting the connectivity of natural biological corridors (Cedeño-Fonseca et al. 2020).

Another potential threat to the conservation of the species is the continuous unsustainable extraction of wild plants for illegal sale on the black market. Many individuals of *Anthurium*, are often boosted by online sales through social media or internet stores, which usually do not have any regulation or restriction (Olmos-Lau and Mandujano 2016; Lavorgna 2014; Lavorgna et al. 2018; Frantz 2021, Lavorgna and Sajeva 2021). One of the triggers of this problem is the sale of plants considered "rare" or "exclusive" (many of them endemic), since it causes a certain demand in the market which is supplied by a few providers, which triggers the monopoly and inflation, so much so that plant prices can reach exorbitant sums (Frantz 2021). This leads people to acquire them through any means (either for trade or for private collections), which encourages unsustainable extraction of adult plants *in situ*. Currently, many pendent *Anthurium* are highly valued as ornamentals, but this growing demand has the consequence that several

Table 1. Conservation status and distribution of *Anthurium* sect. *Porphyrochitonium* species with a pendent growth form from Costa Rica and Panama.

Taxon	UICN category	Distribution
Anthurium cascantei	Critically Endangered [CR]	Costa Rica
Anthurium chiriquense	Endangered [EN]	Costa Rica and Panama
Anthurium edtysonii	Least Concern [LC]	Costa Rica to Ecuador
Anthurium embera	Critically Endangered [CR]	Panama
Anthurium friedrichsthalii	Least Concern [LC]	Nicaragua to Ecuador
Anthurium gregneversii	Endangered [EN]	Costa Rica and Panama
Anthurium jicoteense	Critically Endangered [CR]	Costa Rica
Anthurium longistipitatum	Least Concern [LC]	Costa Rica and Panama
Anthurium loratum	Critically Endangered [CR]	Costa Rica
Anthurium orosiense	Critically Endangered [CR]	Costa Rica
Anthurium pendens	Least Concern [LC]	Panama and Colombia
Anthurium tarrazuense	Critically Endangered [CR]	Costa Rica
Anthurium tayuticense	Critically Endangered [CR]	Costa Rica
Anthurium utleyorum	Endangered [EN]	Costa Rica
Anthurium wendlingeri var. horichii	Critically Endangered [CR]	Costa Rica
Anthurium wendlingeri var. wendlingeri	Least Concern [LC]	Nicaragua to Colombia

Figure 17. A: Fila Anguciana threatened by illegal logging for the establishment of local crops; B: Cerro Anguciana threatened by the establishment of livestock at 1400 m elevation; C–D Naranjo de Dota threatened by illegal logging for the establishment of coffee plantations. Photos by M. Cedeño-Fonseca.

species (many endemic) are being "hunted" in the field (often without collection permits) and sold on the black market deprived of any regulation, which could seriously compromise the conservation of these species *in situ* (Kaminski et al. 2012; Phelps and Webb 2015), due to the deterioration of their habitats added to the continuous extraction of wild individuals (Lande 1998; Peres 2001; Rosser and Mainka 2002; Campos et al. 2019). Unfortunately, this could drive to the extinction of these species in the wild, just as it has happened with species of other aroid genera, such as *Aglaonema*, *Alocasia*, *Caladium*, *Cryptocoryne*, and *Scindapsus* (Oldfield 1983; Brown 1984; Burnett 1985; Boyce 1995).

Key to the pendent *Anthurium* sect. *Porphyrochitonium* from Costa Rica and Panama

1. Leaf blades mostly more than 10 times longer than wide **2**

– Leaf blades generally less than 10 times longer than wide **6**

2. Leaf blades usually bullate (when fresh); spadices tapered (narrow towards the apex); berries red, oblong-globose, beaked at apex..... **3**

– Leaf blade flat; spadices cylindroid; berries pale yellowish orange, oblate-obcordate, truncate at apex **4**

3. Inflorescences at anthesis with straight (never coiled), pinkish red spadices..... ***A. wendlingeri var. horichii***

– Inflorescences at anthesis with coiled, dark rose, creamy white or grayish-white spadices. .... ***A. wendlingeri var. wendlingeri***

4. Leaf blades oblanceolate, usually less than 13 times longer than wide; peduncle shorter, 0.5–0.7 times as long as the petiole; spadices brownish ..... ***A. pendens***

– Leaf blades linear, typically more than 13 times longer than wide; peduncle more than 1.2 times longer than the petiole; spadices yellowish orange or reddish.....**5**

5. Leaf blades with black-glandular punctations on both surfaces, drying grayish yellow-brown; spadices with 6–7 flowers visible per spiral.....***A. loratum***

– Leaf blades with black-glandular punctations on the lower surface only, drying yellowish or yellow-brown; spadices up to 4 flowers visible per spiral ..... ***A. friedrichsthalii***

6. Leaf blades eglandular on the upper surfaces (black-glandular punctations on the lower surface only).....**7**

– Leaf blades with black-glandular punctations on both surfaces.....**11**

7 Leaf blades generally more than 8 times longer than wide, usually falcate (easily observable when fresh)..***A. edtysonii***

– Leaf blades less than 8 times longer than wide, never falcate **8**

8 Leaf blades with 15 pairs or more primary lateral veins..... .....***A. tayuticense***

– Leaf blades generally with less than 15 pairs of primary lateral veins **9**

9 Leaf blades narrowly oblong-elliptic, more than 5 times longer than wide; primary lateral veins obscure when fresh; spadices bright red at anthesis.....***A. tarrazuense***

– Leaf blades oblong-elliptic or ovate-oblong, less than 5 times longer than wide; primary lateral veins distinct when fresh; spadices brown, purple or orange at anthesis **10**

10 Leaf blades very glossy on the upper surface (when fresh), not velvety; inflorescences pendent with orange spadices at anthesis; Panama (Darién).....***A. embera***

– Leaf blades matte on the upper surface, velvety; inflorescences erect with brownish to purple spadices at anthesis; Costa Rica (Tinamaste).....***A. cascantei***

11 Spadices markedly stipitate, stipe 1 cm long or more **12**

– Spadices sessile or subsessile, stipe up to 0.6 cm long ... **13**

12. Leaf blades oblong-elliptic to elliptic, 3.2–4.0 times longer than wide; spadices pinkish and usually coiled at anthesis; berries globose-ovoid, beaked at apex ..... ***A. chiriquense***

– Leaf blades oblong-lanceolate to strap-shaped, 4.3–6.6 times longer than wide; spadices orange red and non-coiled (straight); berries globose or subglobose, truncate at apex (with a central depression) ..... ***A. longistipitatum***

13 Leaf blades narrow, mostly less than 4.5 cm wide.....**14**

– Leaf blades generally more than 5 cm wide.....**15**

14 Leaf blades with 20–25 pairs of primary lateral veins; spadices pinkish at anthesis; berries truncate at apex; Costa Rica and Panama.....***A. gregneversii***

– Leaf blades usually with less than 20 pairs of primary lateral veins; spadices red orange at anthesis; berries beaked at apex; Costa Rica.....***A. utleyorum***

15 Leaf blades gray to olive-green when dry; spadices green at anthesis.....***A. jicoteense***

– Leaf blades yellow-brown when dry; spadices yellowish to brown at anthesis. .....***A. orosiense***

ACKNOWLEDGEMENTS

We are grateful to Lyndsay Bilodeau and Richard Frost for their logistics in the field and economic support. Nils Köster, Ramón da Pena, Rodolfo Flores, Kai Squires, Riccardo M. Baldini, Tree Trek Mountain Resort (Boquete, Panama), Tilson Contreras and his family, Linda de Gracia, Alistair Hay, Freedy Miranda, Jean Miranda, Patricia Castillo for the assistance in the field trips made in Panama. We are very grateful to the staff of CR, MO, PMA, SCZ, and USJ. We thank the Art into Acres for their support in the project to document the genus *Monstera* in the Neotropics; Michael Grayum clarifies some nomenclatural aspects included in this paper; Dr Mario Blanco from Universidad de Costa Rica (UCR), and Gerson Villalobos Fontana from Lankester Botanical Garden (Universidad de Costa Rica) for allowing the cultivation of living plants for research, and Dr Jan Grimm for providing access to his private natural reserve in Costa Rica. We thank Leanna McMillin for sending high resolution scans of the photograph of Negative No. 3819, Mario-Dominik Riedl (Naturhistorisches Museum Wien) for sending scans of the neotype of *A. friedrichsthalii*, Indiana Coronado for sharing photographs of some of the examined specimens of *Anthurium friedrichsthalii*, Oscar Cubero for sharing photographs of *A. wendlingeri var. horichii*, Alejandra Serna-Sánchez for photographs of *A. cascantei*, Grettel Solorzano for their support growing the plants *ex situ*, and María Fernanda Cordero Pagoaga for the line drawings. The authors gratefully acknowledge the scholarship received for Mr. Cedeño-Fonseca's doctoral studies from Deutscher Akademischer Austauschdienst (DAAD) Research Grants – Doctoral Programmes in Germany (No. 57507871), the authors also thank IFARHU (Institute for Training and Development of Human Re-sources) from the Panamanian government,

which jointly with SENACYT (National Secretariat for Science, Technology and Innovation) gave a scholarship for doctoral studies to Mr. Ortiz. Most of the fieldwork carried out in Panama was financed by SENACYT under the project No. APY-NI-2022-09, entitled "Diversidad de especies de *Philodendron* (Araceae) en la zona de unión entre Centroamérica y Sudamérica: esclareciendo la evolución de los altos niveles de endemismo en Panamá", which was managed through COIBA AIP. We thank Alistair Hay (NSW) and Michael Grayum (MO) for commenting on an earlier draft, and anonymous referees for valuable feedback on the manuscript.

REFERENCES

ArtyClick. 2022. Color Name Finder. – Published at https://colors.artyclick.com/color-name-finder/ [accessed 24 Jun 2022].

Bachman S, Eliot-Walker B, Barrios S, Copeland A, Moat J. 2020. Rapid Least Concern: Towards automating Red List assessments. Biodiversity Data Journal. 8: e47018.

Bachman S, Moat J, Hill AW, de la Torre J, Scott B. 2011. Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. ZooKeys. 150: 117–126.

Barroso GM. 1965. Especie nueva de *Anthurium* (Araceae) originaria de Costa Rica. Boletin de la Sociedad Venezolana de Ciencias Naturales. 26: 151–152.

Biodiversity Heritage Library. 2022: Biodiversity Heritage Library. Published at http://www.biodiversitylibrary.org [accessed 22 Aug 2022].

Bioportal. 2022. Dutch natural history collections, Bioportal Naturalis - The Netherlands. – Published at https://bioportal.naturalis.nl/?language=en&back [accessed 22 Aug 2022].

Boyce P. 1995. Aroid Conservation. – Curtis's Botanical Magazine. 12: 173–176.

Brown RF. 1984. The new Agloanemas of Thailand. Aroideana. 7: 43–52.

Burnett D. 1985. The Cultivated Alocasia. Aroideana. 7: 67–162.

Campos JLA, Feitosa IS, Albuquerque UP. 2019. Population Ecology of Plant Species Subjected to Extractivism: Collection and Data Analysis Methods. In: Albuquerque U, de Lucena R, Cruz da Cunha L, Alves R (Eds.), Methods and Techniques in Ethnobiology and Ethnoecology. Pp. 293–307. New York, Springer Protocols Handbooks, Humana Press.

Carlsen MM, Croat T.B. 2013. A molecular phylogeny of the species-rich Neotropical genus *Anthurium* (Araceae) based on combined chloroplast and nuclear DNA. Systematic Botany. 38: 576–588.

Carlsen MM, Croat TB. 2019. An analysis of the sectional classification of *Anthurium* (Araceae) comparing infrageneric groupings and their diagnostic morphology with a molecular phylogeny of the genus. Annals of the Missouri Botanical Garden. 104: 69–82.

Cedeño-Fonseca M, Grayum MH, Croat TB, Blanco M.A. 2020. Three new species of *Monstera* (Araceae: Monsteroideae: Monstereae) from the Cordillera de Talamanca in Costa Rica, threatened by the expansion of coffee plantations. Nordic Journal of Botany. 38: 1–13.

Coelho MAN, Mayo SJ. 2007. Typifications of names of Brazilian taxa of *Anthurium* sect. *Urospadix* (Araceae). Taxon. 56: 211–225.

Correa AMD, Galdames C, de Stapf MS. 2004. Catálogo de las Plantas Vasculares de Panamá. Bogotá, Quebecor World.

Croat TB, Baker RA. 1979. The genus *Anthurium* (Araceae) in Costa Rica. Brenesia. 16: 1–174.

Croat TB, Bunting GS. 1979. Standardization of *Anthurium* descriptions. Aroideana. 2: 15–25.

Croat TB, Ortiz OO. 2020. Distribution of Araceae and the diversity of life forms. Acta Societatis Botanicorum Poloniae. 89: 8939.

Croat TB, Sheffer RD. 1983. The sectional groupings of *Anthurium* (Araceae). Aroideana. 6: 85–123.

Croat TB, Stiebel T. 2001. Araceae. In: Stevens WD, Ulloa-Ulloa C, Pool A, Montiel OM (Eds.), Flora de Nicaragua Tomo 1. Pp. 136–188. St Louis, Missouri Botanical Garden Press.

Croat TB. 1983. A revision of the genus *Anthurium* (Araceae) of Mexico and Central America. Part I: Mexico and Middle America. Annals of the Missouri Botanical Garden. 70: 211–420.

Croat TB. 1986. A revision of genus *Anthurium* (Araceae) of Mexico and Central America. Part II: Panama. Monographs in Sustematic Botany from the Missouri Botamical Garden. 14: 1–204.

Croat TB. 1988. The ecology and life forms of Araceae. Aroideana. 11: 4–56.

Croat, TB. 2022. A new species of pendent-leafed *Anthurium* in sect. *Porphyrochitonium* (Araceae) from Costa Rica. Aroideana. 45(3):32–44.

Croat, TB, Grib, JJ, Ortiz, OO, Tsai J, Engineer C, Grace A. 2022. The current status of *Anthurium* sect. *Porphyrochitonium* (Araceae) and allies, with many new species from Central and South America. Aroideana. 45: 48–436.

Dorr LJ, Stergios B. 2014. Araceae. In: Dorr LJ (ed.), Flora of Guaramacal (Venezuela): Monocotyledons. Smithsonian Contributions to Botany. 100: 1–289.

Duistermaat H. 1987. A revision of *Oryza* (Gramineae) in Malesia and Australia. Blumea. 32: 157–193

Engler A. 1898. Beiträge zur Kenntnis der Araceae. VIII. 15. Revision der Gattung *Anthurium* Schott. Botanische Jahrbücher fur Systematik, Pflanzengeschichte und Pflanzengeographie. 25: 351–476.

Engler A. 1905. Araceae-Pothoideae. In: Engler A. (Ed.), Das Pflanzenreich IV.23B. Leipzig and Berlin, Wilhelm Engelmann.

Engler A. 1878. Araceae. In: Martius CFP (Ed.) Flora Brasiliensis. Pp. 25–224. F. Fleischer, Munich, Leipzig.

Foster P. 2001. The potential negative impacts of global climate change on tropical montane cloud forests. Earth-Science Reviews. 55: 73–106. https://doi.org/10.1016/S0012-8252(01)00056-3

Frantz B. 2021. The rare plant market online: from a small circle of experts to an intergenerational worldwide hobby. Master thesis, Université Paris Nanterre.

Funk VA, Berry PE, Alexander S, Hollowell TH, Kelloff CL. 2007. Checklist of the plants of the Guiana Shield (Venezuela: Amazonas, Bolivar, Delta Amacuro; Guyana, Surinam, French Guiana). Contributions from the U.S. National Herbarium. 55: 1–584.

GBIF. 2022. Global Biodiversity Information Facility - Copenhagen, Denmark. Published at https://www.gbif.org/species/search?q= [accessed 22 Aug 2022].

Gradstein SR, Salazar AN. 1992. Bryophyte diversity along an altitudinal gradient in Darién National Park, Panama. Tropical Bryology. 5: 61–71.

Grayum MH. 1996. Revision of *Philodendron* Subgenus *Pteromischum* (Araceae) for pacific and Caribbean Tropical America. Systematic Botany Monographs. 47:1–233.

Grayum MH. 2003. Araceae. In: Hammel BE, Grayum MH, Herrera C, Zamora N. (Eds.), Manual de Plantas de Costa Rica. Vol. II: Gimnospermas y Monocotiledóneas (Agavaceae–Musaceae). Pp. 59–200. St Louis, Missouri Botanical Garden Press.

Grayum MH, Hammel BE, Troyo S, Zamora N. 2004. Historia. In: Hammel BE, Grayum MH, Herrera C, Zamora N. (Eds.), Manual de Plantas de Costa Rica. Vol. I: Gimnospermas y Monocotiledóneas (Agavaceae–Musaceae). Pp. 1–50. St Louis: Missouri Botanical Garden Press.

Hamilton CW, Reichard SH. 1992. Current practice in the use of subspecies, variety, and forma in the classification of wild plants. Taxon. 41(3): 485–498. https://doi.org/10.2307/1222819

Hooker JD. 1876. *Anthurium bakeri*. Curtis's Botanical Magazine. 102: t. 6261.

HUH. 2022. Harvard University Herbaria & Libraries, Botanical Specimens. – Published at https://kiki.huh.harvard.edu/databases/specimen_index.html [accessed 22 Aug 2022].

Idárraga-Piedrahita A, Ortiz RDC, Callejas Posada R, Merello M. 2011. Flora de Antioquia: Catálogo de las Plantas Vasculares del Departamento de Antioquia. (Colombia) Vol. 2. – Bogotá, Editorial D'Vinni.

IUCN Standards and Petitions Committee. 2019. Guidelines for Using the IUCN Red List Categories and Criteria, Version 14. Prepared by the Standards and Petitions Committee of the IUCN Species Survival Commission. Published at http://www.iucnredlist.org/documents/RedListGuidelines.pdf [accessed 22 Aug 2022].

JACQ consortium. 2004 [continuously updated]: Virtual Herbaria Website. Published at https://www.jacq.org/ [accessed 22 Aug 2022].

Jiménez-Madrigal Q. 2022. La gestación y culminación del Manual de Plantas de Costa Rica: una herramienta para el conocimiento y la conservación de la flora neotropical. Revista De Ciencias Ambientales. 56: 268–283.

JSTOR. 2022. Global Plants. Published at https://plants.jstor.org/collection/TYPSPE [accessed 22 Aug 2022].

Kaminski K, Beckers F, Unger JG. 2012. Global internet trade of plants – legality and risks. Bulletin OEPP. 42: 171–175.

Karremans AP, Chinchilla IF, Rojas-Alvarado G, Cedeño-Fonseca M, Damián A, Léotard G. 2020. A reappraisal of Neotropical Vanilla. With a note on taxonomic inflation and the importance of alpha taxonomy in biological studies. Lankesteriana. 20: 395–497.

Lande R. 1998. Anthropogenic, Ecological and Genetic Factors in Extinction and Conservation. Population Ecology. 40: 259–269.

Lavorgna A, Sajeva M. 2021. Studying Illegal Online Trades in Plants: Market Characteristics, Organisational and Behavioural Aspects, and Policing Challenges. European Journal on Criminal Policy and Research. 27: 451–470.

Lavorgna A. 2014. Wildlife trafficking in the internet age. Crime Science. 3: 1–12.

Lavorgna A, Rutherford C, Vaglica V, Smith MJ, Sajeva M. 2018: CITES, wild plants, and opportunities for crime. European Journal on Criminal Policy and Research. 24: 269–288.

MNHN. 2022. Muséum National d'Histoire Naturelle, Botanique. Published at https://science.mnhn.fr/institution/mnhn/item/search/form [accessed 22 Aug 2022].

Myers CW. 1969. The ecological geography of cloud forest in Panama. American Museum Novitates. 2396: 1–51.

Natural History Museum. 2014. Specimens (from Collection specimens). Published at https://data.nhm.ac.uk/dataset/collection-specimens/resource/05ff2255-c38a-40c9-b657-4ccb55ab2feb [accessed 22 Aug 2022].

NYBG. 2022. C. V. Starr Virtual Herbarium. Published at http://sweetgum.nybg.org/science/vh/ [accessed 22 Aug 2022].

Oldfield S. 1983, Trade in endangered species. Aroideana. 6: 83–84.

Olmos-Lau VR, Mandujano MC. 2016. An open door for illegal trade: online sale of *Strombocactus disciformis* (Cactacae). Nature Conservation. 15: 1–9.

Ortiz OO, de Stapf MS, Croat TB. 2019. Diversity and distributional patterns of aroids (Alismatales: Araceae) along an elevational gradient in Darién, Panama. Webbia 74:339–352. https://doi.org/10.1080/00837792.2019.1646465.

Peres CA. 2001. Synergistic effects of subsistence hunting and habitat fragmentation on Amazonian Forest vertebrates. Conservation Biology. 15: 1490–1505.

Phelps J, Webb EL. 2015. "Invisible" wildlife trades: Southeast Asia's undocumented illegal trade in wild ornamental plants. Biological Conservation. 186: 296–305.

Reflora. 2022. Virtual Herbarium. Published at http://reflora.jbrj.gov.br/reflora/herbarioVirtual/ [accessed 22 Aug 2022].

Riedl H, Riedl-Dorn C. 1988. Heinrich Wilhelm Schott's botanical collections at the Vienna Natural History Museum. Taxon. 37: 846–854.

Rosser AM, Mainka SA. 2002. Overexploitation and Species Extinctions. Conserv. Biol. 16: 584–586.

Royal Botanic Garden Edinburgh. 2022. Herbarium catalogue. Published at https://data.rbge.org.uk/search/herbarium/ [accessed 22 Aug 2022].

Royal Botanic Gardens Kew. 2022. The Herbarium Catalogue. Published at http://www.kew.org/herbcat [accessed 22 Aug 2022].

Schimper AFW. 1903. Plant geography upon a physiological basis. Oxford: Clarendon Press.

Schott HW. 1855. Pflanzenskizzen. Osterreichisches botanisches Wocbenblatt. 5: 65–67.

Schott HW.1860. Prodromus Systematis Aroidearum. Mechitarists' Press, Vienna.

Smith RS. 1963. Financing the Central American Federation, 1821-1838. Hispanic American Historical Review. 43: 483–510.

Smithsonian Institution. 2022. The National Museum of Natural History. Botany Collections. Published at https://collections.nmnh.si.edu/search/botany/ [accessed 22 Aug 2022].

Sperotto P, Acevedo-Rodríguez P, Vasconcelos TNC, Roque N. 2020. Towards a Standardization of Terminology of the Climbing Habit in Plants. Botanical Review (Lancaster). 86: 180–210.

Stadtmüller T. 1986. Los bosques nublados en el trópico húmedo: una revisión bibliográfica. Costa Rica: UNU/CATIE.

Stafleu FA, Cowan RS. 1985. Taxonomic literature: a selective guide to botanical publications and collections with dates, commentaries and types. Utrecht, Bohn, Scheltema & Holkema.

Stevens WD, Montiel OM. 2001. Introducción - Reseña de la exploración botánica. In: Stevens WD, Ulloa-Ulloa C, Pool A, Montiel OM (Eds.), Flora de Nicaragua Tomo 1. Pp. 137–188. St. Louis, Missouri Botanical Garden Press.

Taracena-Arriola A, Sellen AT. 2006. Emanuel von Friedrichsthal: su viaje a América y el debate sobre el origen de la civilización maya. Península. 1: 49–67.

The Field Museum. 2022. Botanical Collections. Published at https://collections-botany.fieldmuseum.org/ [accessed 22 Aug 2022].

Thiers B. 2022 [continuously updated]. Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. Published at http://sweetgum.nybg.org/ih/ [accessed 22 Aug 2022].

TROPICOS. 2022. Tropicos online database. Published at http://www.tropicos.org [accessed 22 Aug 2022].

Turland N.J, Wiersema JH, Barrie FR, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Kusber W-H, Li D-Z, Marhold K, May TW, McNeill J, Monro AM, Prado, Price MJ, Smith GF. 2018. International Code of Nomenclature for Algae, Fungi, and Plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Vegetabile. 159. Glashütten: Koeltz Botanical Books.

Universität Zürich. 2019. Zürcher Herbarien. Published at https://www.herbarien.uzh.ch/de/belegsuche.html [accessed 22 Aug 2022].

Wagenitz G. 1982. Index collectorum principalium herbarii Gottingensis, Göttingen. Published at https://www.uni-goettingen.de/en/index+collectorum/186907.html [accessed 22 Aug 2022].

Whiteman CD. 2000. Mountain Meteorology. Fundamentals and applications. New York, Oxford University Press.

Wurzbach von C. 1858. Biographisches Lexikon des Kaisertums Österreich Vierter Teil Egervari - Fürchs. Biographisches Lexikon des Kaieserthums Österrreich. 4: 359–360.

Zotz G. 2013. 'Hemiepiphyte': a confusing term and its history. Annals of Botany. 111: 1015–1020.