ENCYCLIA TULUAENSIS (ORCHIDACEAE: LAELIINAE), A NEW SPECIES FROM A TROPICAL DRY FOREST IN THE DEPARTMENT OF VALLE DEL CAUCA, COLOMBIA

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Abstract. *Encyclia tuluaensis* is a newly discovered orchid species, endemic to the tropical dry forests of Valle del Cauca, Colombia, a region characterized by high biodiversity and significant conservation relevance, primarily due to extensive habitat loss. This species was identified through comprehensive morphological analysis of cultivated specimens at the Juan María Céspedes Botanical Garden, in the municipality of Tuluá, Valle del Cauca. Initially, the species, which we hypothesize belongs to the Andean clade, was misidentified as *Encyclia betancourtiana* during the first collection due to its superficial similarity. However, detailed morphological analysis ultimately revealed significant differences, leading to its recognition as a new species. The species exhibits a range of distinctive floral and vegetative features, including three apical leaves, a pronounced fold in the central lobe of the lip, and marked color changes from anthesis to senescence. This discovery underscores the taxonomic complexity and biodiversity within the genus *Encyclia*, emphasizing the need for continued taxonomic and ecological research. *Encyclia tuluaensis* is part of the Andean species complex and is currently only known from its type locality. It requires particular conservation efforts due to its restricted distribution and the vulnerability of its habitat, which is threatened by deforestation, agricultural expansion, and urban development.

Keywords: systematics, taxonomy, tropical dry forest, Andean clade

Resumen. *Encyclia tuluaensis* es una especie de orquídea recientemente descubierta, endémica de los bosques secos tropicales del Valle del Cauca, Colombia, una región caracterizada por su alta biodiversidad y un significativo valor de conservación, principalmente debido a la extensa pérdida de hábitat. Esta especie fue identificada mediante un análisis morfológico exhaustivo de especímenes cultivados en el Jardín Botánico Juan María Céspedes, en el municipio de Tuluá, Valle del Cauca. Inicialmente, la especie, que pertenece al clado andino, fue identificada erróneamente como *Encyclia betancourtiana* durante la primera colecta debido a sus características similares. Sin embargo, un análisis morfológico detallado reveló finalmente diferencias significativas, lo que llevó a su reconocimiento como una nueva especie. La especie exhibe una serie de características florales y vegetativas distintivas, que incluyen tres hojas apicales, un pliegue pronunciado en el lóbulo central del labelo y cambios de color marcados desde la antesis hasta la senescencia. Este descubrimiento subraya la complejidad taxonómica y la biodiversidad dentro del género *Encyclia*, enfatizando la necesidad de continuar con la investigación taxonómica y ecológica. *E. tuluaensis* forma parte del complejo de especies andinas y actualmente está confinada a su localidad tipo, lo que requiere esfuerzos de conservación enfocados debido a su distribución restringida y la vulnerabilidad de su hábitat, el cual está amenazado por la deforestación, la expansión agrícola y el desarrollo urbano.

Palabras claves: sistemática, taxonomía, bosque seco tropical, clado Andino

Encyclia Hook. (Orchidaceae) is the second most diverse genus within the Neotropical subtribe Laeliinae. Species of *Encyclia* range from southern Florida in the United States, through the Antilles, Mexico, Central America, northern South America (primarily the Andes, mostly below 1500 meters, with a secondary center of diversity in the combined Guianas/Amazon area), southeastern Brazil, and northern Argentina (Dressler and Pollard, 1974; van den Berg and Carnevali, 2005; Leopardi-Verde et al., 2016; Carnevali et al., 2022). Currently, the genus comprises approximately 213 taxa and nothotaxa, of which 180 have been formally described (Carnevali et al., 2022; Ocupa-Horna et al., 2024).

Systematic studies of *Encyclia* have revealed a complex phylogenetic structure, comprising several well-defined internal clades. These clades exhibit distinct geographic affinities, which may or may not correspond with marked morphological and ecological similarities. For instance, certain *Encyclia* species complexes are morphologically diagnosable as monophyletic groups; however, resolving internal relationships within these groups remains challenging (Leopardi-Verde et al., 2016; Bastos et al., 2018; Carnevali et al., 2018a, b; Tamayo-Cen et al., 2020; Carnevali et al., 2022, see differing perspectives in Lipińska et al., 2023). In contrast, some phylogenetic patterns in the

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recovered clades exhibit robust geographic structuring, with less pronounced morphological similarities that include hyperdivergent floral elements, particularly in the labellum (Leopardi-Verde et al., 2016). Additionally, these clades may include elements that demonstrate ecological divergence, such as altitudinal preferences. For example, some topologies suggest cladogenesis events associated with shifts in altitudinal preferences, as seen in the *Encyclia mooreana* complex (Tamayo-Cen, 2022).

The remarkable diversity within *Encyclia*, along with the continuous discovery of new species, underscores the necessity of ongoing exploration and taxonomic refinement. Future efforts could benefit from the use of advanced molecular techniques, such as next-generation sequencing and integrative taxonomy approaches that combine genetic, morphological, and ecological data to refine species boundaries and enhance our understanding of evolutionary relationships. Many regions with suitable habitats remain botanically unexplored or only partially studied, particularly the tropical dry forests of Colombia and the Andean foothills in northern South America (Leopardi-Verde et al., 2014). Consequently, the taxonomic status of several populations requires further evaluation, highlighting the complexity of the genus and the potential for additional discoveries.

During an extensive review of orchids from the tropical dry forests of Valle del Cauca, two specimens deposited in the herbarium of the Juan María Céspedes Botanical Garden (TULV) were initially identified as *Encyclia betancourtiana* Carnevali & I. Ramírez. However, these specimens exhibited morphological characteristics inconsistent with the known description of that species. Consequently, a field investigation was conducted at the botanical garden to examine a cultivated plant in bloom, originating from the same population as the herbarium specimens. Detailed morphological analysis confirmed that the plant represents a new entity, differing from *E. betancourtiana* and other species within the same group. Based on these collections and comparisons with previous specimens from the same region, this species is formally recognized as new to science.

Materials and Methods

The description and illustrations were prepared from the living type specimens cultivated at the Botanical Garden of Juan María Céspedes, deposited in the herbarium of TULV with the accession number 17657 (Fig. 1). Digital images were taken with a Nikon D750 and a Nikkor 105mm f/2.8 macro lens. Sketches from living and preserved specimens were digitized, and the images were used for diagramming a Lankester Composite Digital Plate (LCDP) in Adobe Photoshop® CS6. The new species was described following the botanical terminology by Beentje (2012) and Stearn (1992). Specimens from the herbaria AMES, CICY, CUVC, TULV, and VALLE were consulted, and no further herbarium material referable to this taxon was found.

Taxonomic Treatment

Encyclia tuluaensis J.S. Moreno, Tamayo-Cen, & Carnevali *sp. nov.*

TYPE: COLOMBIA. Valle del Cauca: Municipio de Tuluá, corregimiento de Mateguadua, *ex Hort.* Jardín Botánico Juan María Céspedes, 1085 m, 14 August 2012, *A. Castaño 49* (Holotype: TULV [17657]; Isotype: TULV 17656]) Fig. 2–3.

Encyclia tuluaensis is most similar to *E. betancourtiana*, distinguished by its lip with lateral lobes that are oblong-elliptic (vs. oblong and rounded), and a mid-lobe that is transversely subquadrate-rhomboid (vs. obovate in the new species).

Epiphytic *plant*, up to 80 cm tall including the inflorescence. *Pseudobulbs* heteroblastic, with two distinct internodes, which are located between three prominent nodes in the apical portion, ovoid-cylindrical, apically 2–3 foliate, 5.96–7.54 × 2.7–3.2 cm, smooth when recently developed, rough with time or dehydration, subtended by 1 or 2 white papyraceous, non-persistent sheaths, shredding with age. *Leaves* erect when recently developed; when mature, the leaves bend due to their larger and longer size, causing the plant to arch, 14.32–48.10 × 1.43–3.17 cm, conduplicate, coriaceous, oblong-linear, obtuse. *Inflorescence* apical, borne from the mature pseudobulb, erect to suberect, paniculate, up to 70 cm long, with ca. 60 flowers; peduncle, rachis, and pedicels dark-brown tinged, coarsely verruculose, cylindrical; *peduncle* up to 30 cm long, with 4 internodes; *rachis* up to 50 cm long; floral bract triangular, acute, 2.2–2.5 × 4.2–4.4 mm; *pedicel* up to 2.5 cm. *Ovary* dark-brown at the base, greenish toward the pedicel, costate, straight to sigmoid, terete, distally dilated, verruculose at the base, with the verrucosity diminishing progressively toward the pedicel, 6.2–6.5 mm long. Flowers change color during the period from anthesis to senescence, with greenish-brown sepals and petals when freshly opened, turning red as they age, sepals with yellow margins toward the apex, petals with the base, apex, and margins yellow; mid-lobe of the lip white with the callus white with purple nerves at the base, which turn yellow as they age, lateral lobes yellow with white toward the apex, tinged with red, column yellow, tinged with red dorsally, ventrally, and laterally, anther pale yellow to white, capsule dark-brown. *Sepals* slightly verruculose, oblong-elliptic, slightly concave at the apex, acute, 1.07–1.13 × 0.40–0.43 cm, 7-veined. *Petals* projected forward, slightly concave toward the apex, oblanceolate, subacute, 1.07–1.08 × 0.30–0.33 cm, 6-veined. *Lip* trilobed, 0.97–1.30 × 1.2–1.5 cm expanded; *lateral lobes* with 3–4 dark-red nerves, embracing the column, apex of the lobes curves outward, oblong, inclined at an angle of approximately 30˚ from the vertical axis of the base, rounded, 0.60–0.67 × 0.22–0.24 cm; *mid-lobe* obovate, emarginate, verrucose, undulate margins and a prominently textured surface characterized by parallel ridges and grooves, 0.45–0.58 × 0.58–0.62 cm; callus oblong-elliptic, sulcate, elevated, formed by 4 longitudinal keels that do not reach the apical end of the callus, with a prominent central sulcus, a deep, longitudinal groove running from the base to the trifid apex ending in

FIGURE 1. Holotype of *Encyclia tuluaensis* J.S. Moreno, Tamayo-Cen, & Carnevali, identified initially as *Encyclia betancourtiana* Carnevali & I. Ramírez. Based on *A. Castaño 49* (TULV [17657]).

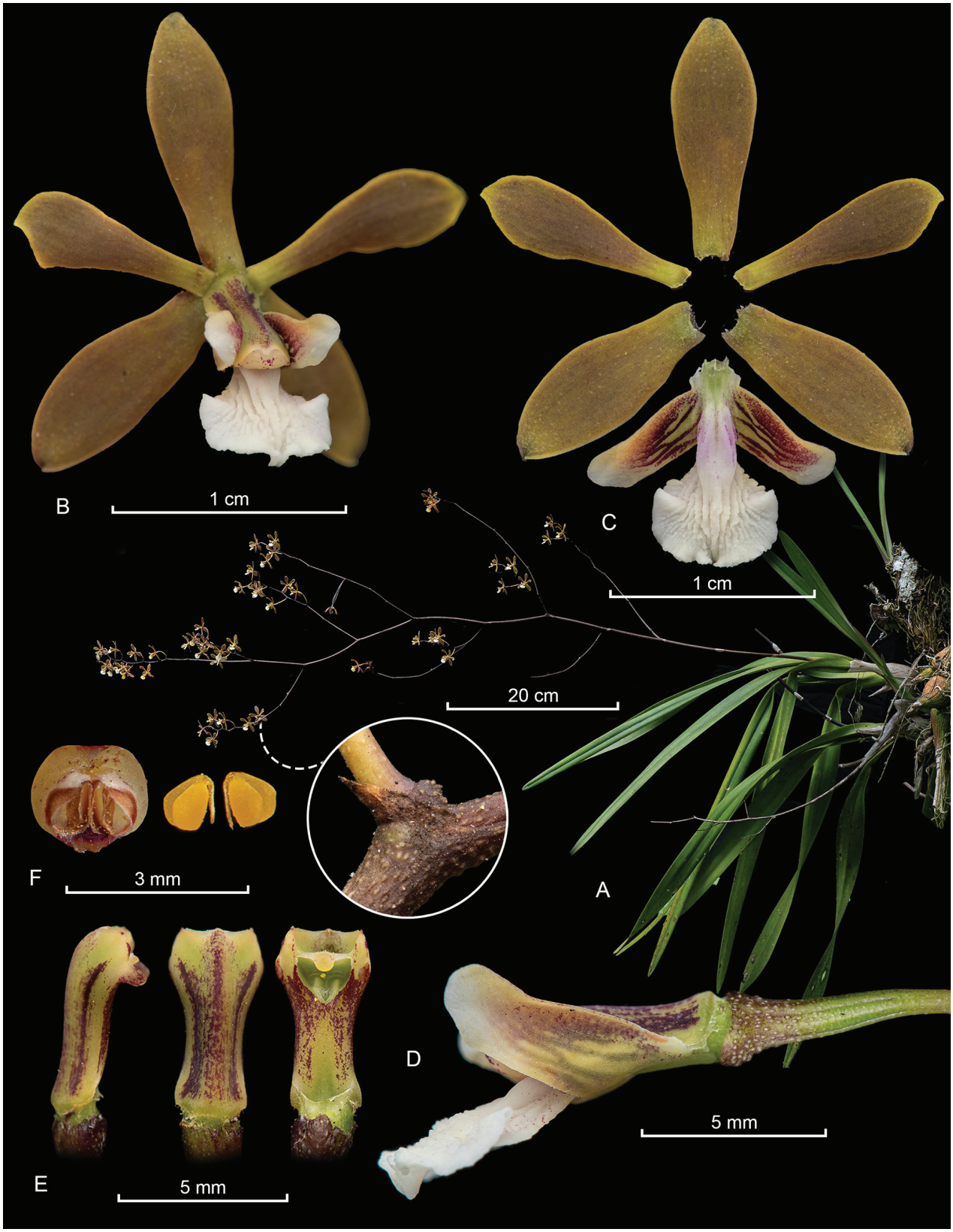

FIGURE 2. LCDP of *Encyclia tuluaensis* J.S. Moreno, Tamayo-Cen, & Carnevali. **A**, habit and growth; **B**, flower **C**, dissected perianth; **D**, lip, column, and ovary; **E**, column, lateral, dorsal, and ventral view; **F**, anther cap and pollinia. LCDP by J. S. Moreno, based on the holotype.

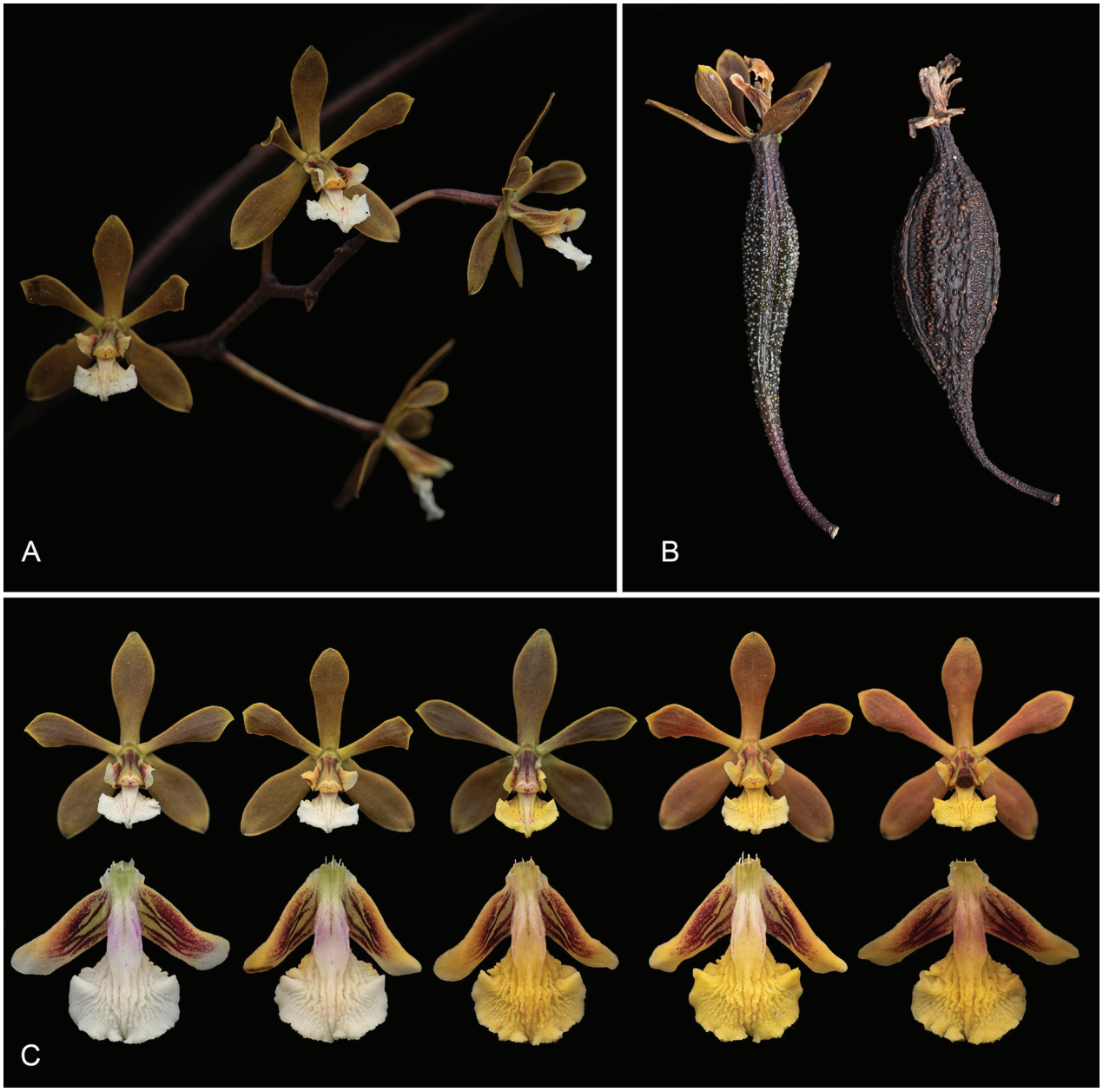

FIGURE 3. *Encyclia tuluaensis* J.S. Moreno, Tamayo-Cen, & Carnevali. **A**, inflorescence; **B**, capsules in two stages of maturation. On the left, the immature ovary with dark brown color, and on the right, the mature ovary with black-purple color. Both show a verruculose (warty) surface; **C**, front view of the flower from anthesis to senescence, showing the progression from initial colors to aged appearance and a detailed view of the lip showing the color transition from initial vivid hues to the final coloration as the flower ages. Photographs by J. S. Moreno.

three central longitudinal keels extending toward the mid-lobe, 0.45–0.46 × 0.19–0.20 cm long. *Column* claviform, in lateral view somewhat curved toward the apex, 5.44–5.79 × 1.67–2.81 mm long, ventral view canaliculated at the base, where the cuniculus is formed, clinandrium superficially tridentate, with a pair of rounded stelidia. *Anther cap* yellow with small, irregularly scattered wine-red spots, lacking a discernible pattern, sub-cordate, 1.74 × 1.89 mm. *Pollinia* 4, in two pairs, 0.94 × 0.53 mm, obovoid, bright yellow, with granular caudicles. *Capsule* verruculose up to 3 cm long.

Additional specimens examined: COLOMBIA. Valle del Cauca: Municipio de Tuluá, corregimiento de Mateguadua, quebrada Valenzuela, 1117 m, 23 June 2010, *G. Reina-Rodríguez & N. H. Ospina-Calderón* 1217 (CUVC).

Toponymy: The name honors the municipality of Tuluá, where the new species was found.

Although we have no molecular evidence for *Encyclia tuluaensis*, the geography and overall morphology suggest that it probably belongs in the Andean Clade. The species in this clade have a lip with a conspicuously raised, sinuous callus that extends toward the central lobe; the nerves may or may not converge with the edge of the margin and end

FIGURE 4. Type specimen photograph of *Encyclia betancourtiana* Carnevali & I. Ramírez. **A**, flower; **B**, plant. Photographs by A. Betancourt.

trifid. They are also markedly verruculose on the pedicel and ovary, as well as on the rachis of the inflorescence, which is coppery brown. This species group of *Encyclia* exhibits thick, elevated, and relatively flat calli with a less pronounced central depression compared to other groups in the genus. Additionally, the keel or nerves originating from the callus and extending into the mid-lobe of the labellum are thick and coarsely verrucose. The column's auricles or wings are small, rounded, and acute, and the capsules are verruculose to warty (Carnevali and Ramirez, 2004). This Andean complex includes such taxa as *E. angustiloba* Schlechter, *E. aspera* (Lindl.) Schltr.B, *E. asperirhachis* Garay, and *E. microtos* (Reichenbach f.) Hoehne. Other species that could be considered relatively similar, and are found outside the Andean clade, include *E. betancourtiana* and *E. parkeri* Reina-Rodr. & Leopardi (Tamayo-Cen, 2022).

The most similar species is *E. betancourtiana* (Carnevali and Ramirez, 2004) (Fig. 4) from western Venezuela, which can be recognized by its lip with lateral lobes that are oblong-elliptic, with an obliquely obtuse to rounded apex, 0.90–0.95 × 0.35 cm, spreading forming an angle of less than 45° in relation to the main *labelar axis* (vs. oblong, rounded, 0.6–0.67 × 0.22–0.24 cm spreading with an angle of approximately 30°) and the mid-lobe is transversally subquadrate-rhomboid, 0.6–0.7 × 0.95 cm (vs. obovate, 0.45–0.58 × 0.58–0.62 cm).

Encyclia aspera (Fig. 5) is distinguished by the short, broad, and rounded lateral lobes of the lip (vs. longer and narrower lateral lobes) and a median lobe with a slightly pronounced wavy margin (vs. a median lobe with markedly defined undulations), which is orbicular to orbicular-elliptic (vs. obovate). Additionally, the labellum of *E. tuluaensis*, when viewed from the front, has an anchor-like shape due to a slight fold in the proximal portion that retracts the labellum slightly, a feature absent in *E. aspera*. This distinct folding pattern gives *E. tuluaensis* a characteristic form not present in *E. aspera*.

Encyclia microtos (Fig. 6), with a restricted distribution in Ecuador and Peru, is also similar to *E. tuluaensis* but differs mainly by its narrower leaves, its oblong-cuneate, acute sepals, about 1.5 cm long (vs. oblong-elliptic, slightly concave at the apex, acute, 1.07–1.13 cm long), with oblong-spatulate, obtuse petals (vs. oblanceolate, subacute), a three lobed lip with the lateral lobes obliquely triangular-oblong, slightly retrorse, and sub-obtuse (vs. oblong and rounded), and a mid-lobe suborbicular from a cuneate base mid-lobe (vs. obovate).

Additionally, described from Colombia and also growing in a tropical dry forest, and probably distributed to Peru, *Encyclia parkeri* (Fig. 7) is also similar to the new species, but it can be recognized by its three-lobed lip with an orbicular to suborbicular mid-lobe, rounded at the apex, 0.70–0.75 × 0.80–0.85 cm (vs. with an obovate, emarginate mid-lobe, 0.45–0.58 × 0.58–0.62 cm). *Encyclia parkeri* also has larger lateral lobes, 0.90–0.95 × 0.30–0.40 cm (vs. shorter 0.60–0.67 × 0.22–0.24 cm). Finally, the callus in *E. parkeri* is sub-rhombic to quadrangular, composed of two broad, high keels running from just above the base of the lip, 0.58–0.65 × 0.24–0.30 cm (vs. oblong-elliptic, sulcate, composed of four longitudinal keels that do not reach the apical end of the callus, 0.45–0.46 × 0.19–0.20 cm wide).

Habitat and ecology: The new species was found growing epiphytically in a tree of *Erythroxylum* sp. in the

FIGURE 5. Type specimens of *Epidendrum asperum* Lindl. **A**, specimen at AMES (barcode 00070082) with a photograph of the holotype in the Lindley Herbarium (K); **B**, close up of the labellum shown in A, drawn by J. Lindley; **C**, detail of the inflorescence, showing the dried flowers from an isotype at E (barcode 00373980).

Botanical Garden Juan María Céspedes, which is located in the district of Mateguadua, 7 km from the municipality of Tuluá. The botanical garden covers an area of 154 hectares of undulating terrain, with elevations ranging between 1050 and 1300 meters above sea level. The average temperature is the same as that of the central plain of the Valle del Cauca department, ca. 25 C, and the annual rainfall averages ca. 1000 mm, with two quarterly rainy periods alternating with two dry periods. It is situated within the life zone known as Tropical Dry Forest.

Conservation status: *Encyclia tuluaensis* is known only from its type locality in the Juan María Céspedes Botanical Garden, located within the Natural Regional Park Mateguadua inTuluá. Despite being found in the most threatened ecosystem in Colombia, the Tropical Dry Forest, its position within the protected park ensures its protection, at least for the type population. Assuming continued protection, the species could be categorized under the criteria of the IUCN as Least Concern (LC). However, because we lack adequate distribution and population information to make a proper assessment and the necessary data to apply the IUCN categorization protocols, we propose categorizing the new species as Data Deficient (DD) (IUCN Standards and Petitions Subcommittee, 2017; IUCN, 2024).

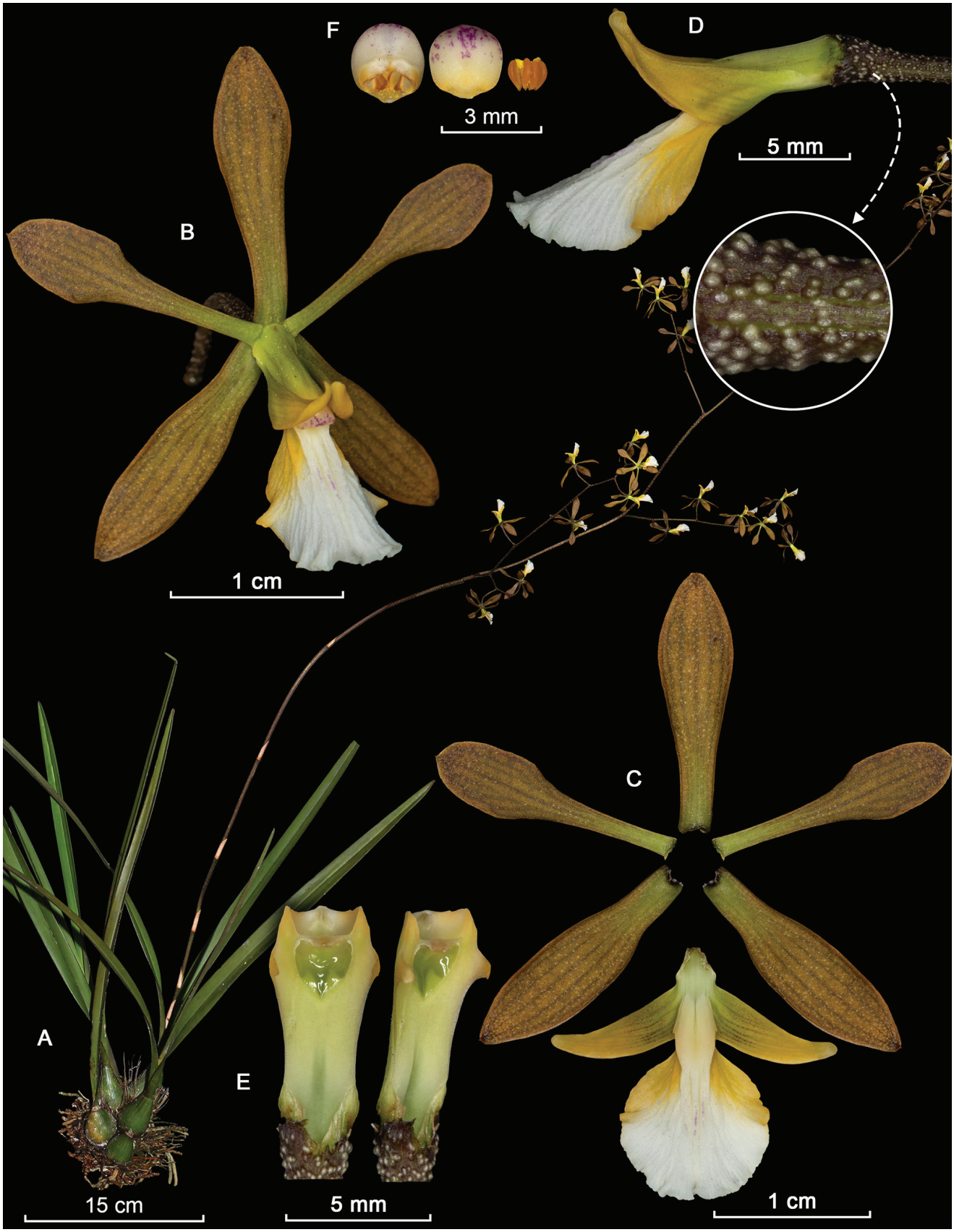

FIGURE 6. LCDP of *Encyclia microtos* (Reichenbach f.) Hoehne. **A**, habit and growth; **B**, flower; **C**, dissected perianth; **D**, lip, column, and ovary; **E**, column, ventral views; **F**, anther cap and pollinia. LCDP by L. Ocupa-Horna based on a plant from Tumbes department, northern Perú.

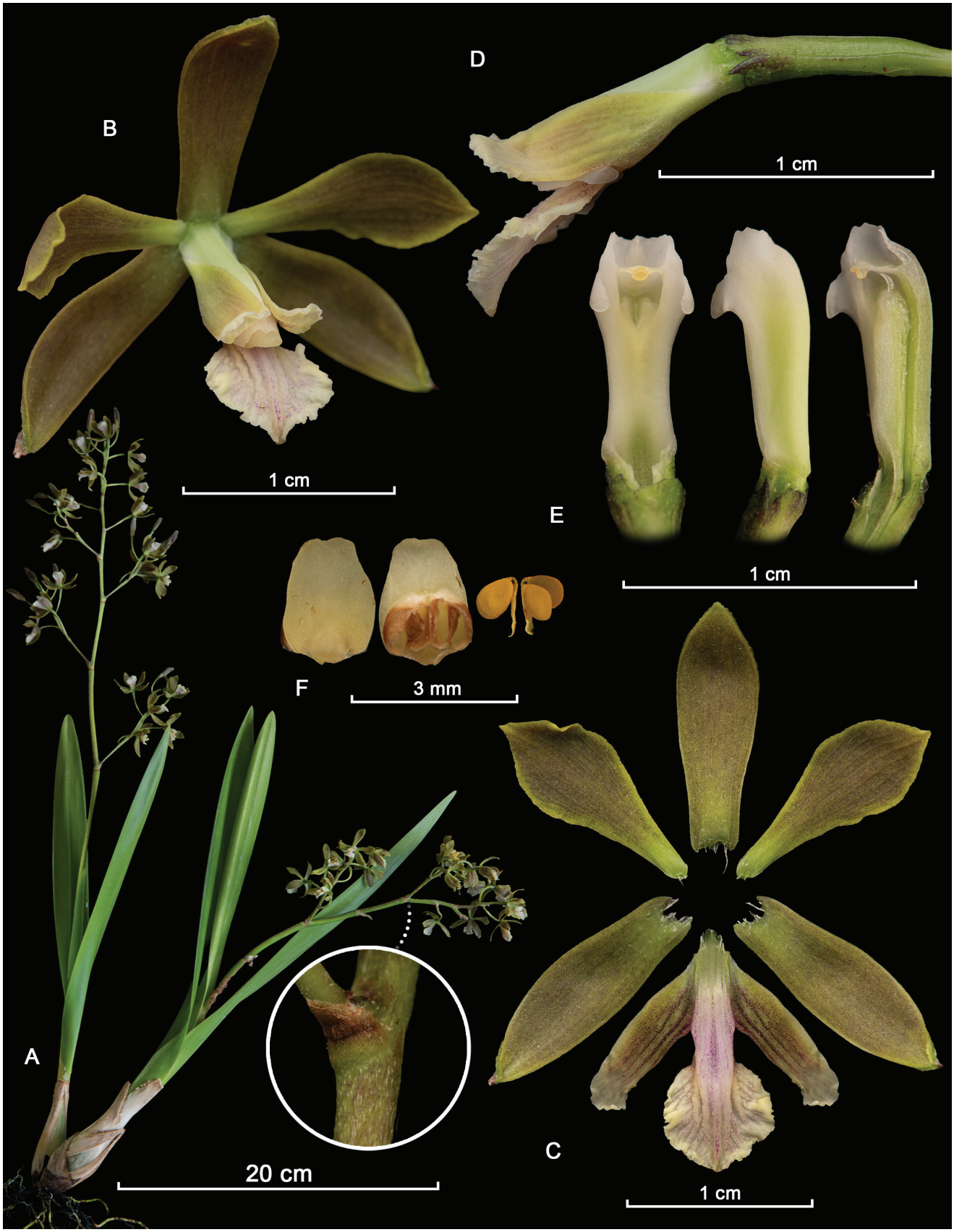

FIGURE 7. LCDP of *Encyclia parkeri* Reina-Rodr. & Leopardi. **A**, habit and growth; **B**, flower; **C**, dissected perianth; **D**, lip, column, and ovary; **E**, column, lateral, dorsal, and ventral view; **F**, anther cap and pollinia. LCDP by J. S. Moreno based on a plant from Colombia.

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