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MALAXIS ENGELSII (MALAXIDINAE), A NEW SPECIES FROM THE UPPER MONTANE FOREST OF THE ATLANTIC RAINFOREST IN SOUTHERN BRAZIL

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Abstract. *Malaxis engelsii* is a newly discovered orchid found in the upper montane forests of the Atlantic Rainforest in Paraná, Brazil. This species is characterized by its small size, elliptic leaves, flowers with partially connate sepals at the base, trilobate lip with four cavities, and a longitudinal keel on the adaxial surface of the lip apex. A detailed description, photographs, drawings, and comparison with similar species, *Malaxis cipoensis*, *M. sertulifera,* and *M. ybytus*, are provided. Currently, it is classified according to the IUCN guidelines as "Endangered (EN)".

Resumo. *Malaxis engelsii* é uma orquídea recém-descoberta encontrada nas florestas alto-montanas da Mata Atlântica no Paraná, Brasil. Esta espécie é caracterizada por seu pequeno porte, folhas elípticas, flores com sépalas parcialmente conadas, labelo trilobado com quatro cavidades e uma quilha longitudinal na superfície adaxial do ápice do labelo. Uma descrição detalhada, fotografias, ilustração e comparação com espécies similares, M*alaxis cipoensis*, *M. sertulifera* e *M. ybytus*, são fornecidas. Atualmente, está classificada de acordo com as diretrizes da IUCN como "Em Perigo (EN)".

Keywords/ Palavras-chave: Cloud Forest, Epifitismo, Epiphytism, Floresta Montana, Floresta Nebulosa, Montane forest, New species, Nova espécie, Orchid, Orquídea, Orchid, Taxonomia, Taxonomy

Introduction. *Malaxis* Sol. ex Sw. (Swartz 1788) belongs to the subtribe Malaxidinae Benth. & Hook.f. (Bentham & Hooker 1883) and has traditionally been regarded as a cosmopolitan genus, encompassing over 300 species across the Americas, Asia, and Europe (Cribb 2005). The application of molecular studies has led to reevaluating the subtribal taxonomy (Cameron 2005). Additionally, the existing classification system within *Malaxis* fails to arrange species based on their evolutionary lineages, and the distribution of this genus is probably primarily limited to the Americas, with only a few species extending into the temperate regions of Eurasia (Radins *et al.* 2014).

The upper montane forest ecosystems of the *Floresta Ombrófila Densa Altomontana* (Montane Dense Rainforest), also known as Cloud Forest, are marked by their hydrophilic nature. This is attributed to several characteristics, but primarily due to the persistent presence of clouds at higher elevations on mountains (Bruijnzeel & Hamilton 2000). Within these upper montane ridges, the forest exhibits a singular vertical stratum composed of small-sized trees (Leigh 1975). As a result of the perpetual humidity, these trees provide a habitat for an abundance of epiphytes (Blum *et al.* 2011, Leigh 1975).

In Brazil, ten species of *Malaxis* are registered within the country's territory (Smidt & Santos 2023). However, an ongoing genus revision is revealing new species, indicating that the diversity of *Malaxis* may be underestimated (Santos & Smidt 2023).

A previously undescribed epiphytic *Malaxis* was discovered by examining the collected material from an expedition to the upper montane forests of the *Ibitiraquire* mountain range. Consequently, we present this taxon, providing a detailed description, diagnosis,

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drawing, photographs showcasing the species in its natural habitat, a plate displaying the type collections, illustrations, comparison with morphologically similar species, comments on its ecological features, and conservation status.

Materials and methods. We examined the morphological characteristics of materials collected by *M.E. Engels 6579* (MBM439143) and *G. Hatschbach 817* (MBM49978; SP54728). The first was designated as the holotype due to its excellent material quality, including well-preserved herbarium specimens and spirit material. We followed the morphological terminology guidelines of Rizzini (1977), Beentje (2010), and Stearn (2004) for descriptions, drawings, and plates, which were based on the types. We also used photographs of specimens in their natural environment. For species with morphological similarities, we studied specimens from the following herbaria: BHCB, CEN, CEPEC, CESJ, CRI, EFC, ESA, FLOR, FURB, HRCR, HST, HUCS, HUEFS, HVASF, IAN, ICN, INPA, IPA, JOI, MAC, MBM, MBML, MO, OUPR, PACA, PEL, RB, RFA, RON, SP, SPF, UB, UEC, UFP, UPCB, and USP. Regarding conservation status, we followed the IUCN (2022) guidelines.

Taxonomic treatment

Malaxis engelsii T.F.Santos & E.C.Smidt, ***sp. nov.*** (Fig. 1–4).

TYPE: Brazil. Paraná: Campina Grande do Sul, Trilha para o Morro Getúlio e Caratuva, 954m, 15 January 2019, *M.E. Engels 6579* (holotype: MBM-439143!). Brazil. Paraná: Piraquara, Queimada, Morro Albino de Souza, 27 December 1947, *G. Hatschbach 817* (paratype: MBM-49978!; SP-54728!). Fig. 2.

Diagnosis: It is most similar to *M. sertulifera* (Barb. Rodr.) Pabst due to its occurrence in montane forested environments, size of the vegetative parts, and lip morphology. However, it can be distinguished by the denser inflorescence in flower numbers, the presence of a longitudinal keel on the adaxial surface of the lip apex, acute lateral lobes of the lip instead of acuminate, and the presence of acute column wings instead of inconspicuous and rounded (Fig. 3).

Plant 40–70 mm tall, epiphytic, rhizome inconspicuous. *Roots* 8–40 mm long, thick. *Pseudobulbs* 5–10 × 4–5 mm, ovoid, covered by whitish to brownish deciduous foliaceous sheets. *Leaves* 20–45 × 20–31 mm, alternate, two per pseudobulbs; several layers of leaf sheets that are enveloped by cataphylls 10–30 mm long, imbricate in each other from the base to near the apex, lamina elliptic to ovate, round to cordate, cordiform, membranaceous, margin entire, apex obtuse to slightly acute, base rounded or cordate. *Inflorescence* 64–120 mm long, corymbose; floral bracts triangular, greenish. *Flowers* non-resupinate, twisted pedicels 2–8 mm long. *Ovary* pedicellate cylindric 1.0 × 1.5 mm. *Dorsal sepal* 2.2–2.7 × 1.0–1.4 mm, whitish-green, turning orangish with age, oblong or oblong-lanceolate, apex acute, margin entire, 3-veined. *Lateral sepals* 1.7–2.0 × 1.0–1.5 mm, whitish green, turning orangish with age, partially connate, ovate, apex acute, margin entire, 3-veined. *Petals* 1.5–2.0 mm, whitish-green, turning orangish with age, linear, usually twisted, apex acute, margin entire, 1-veined. *Lip* 1.2–1.5 × 1.1–1.2 mm, orange, rarely greenish, trilobate, truncate, acute, concave, lateral lobes incurved, apex acute, mid lobe ovate, apex acute, margin entire, disk with four obovate cavities, internal central portion is divided by a thickened pandurate costa, margin entire, longitudinal keel on the adaxial surface of the lip apex. *Column* yellowish, long, wide, erect, dorsoventrally complanate; wings acute. *Pollinarium* with four ovoid naked pollinia. *Fruits* not seen.

Additional specimens examined (similar species). *Malaxis sertulifera*; Distrito Federal: Brasília. Reserva Ecológica do IBGE, 21.II.2003, *J.A.N. Batista 1398* (BHCB, CEN). Minas Gerais: Aiuruoca, Parque Estadual da Serra do Papagaio, 18.I.2008, *J.A.N. Batista 2441* (BHCB).

Etymology: In honor of Mathias Engels, the botanist who rediscovered the species in the field.

Distribution and ecology: Only known in Brazil from two collections, have been documented in the Atlantic Rainforest of Paraná state, Brazil. The species was first recorded by *G. Hatschbach 817* in 1947 within the *Baitaca* mountain range (25º24'S, 49º00'W) (Fig. 5A, C) in the Piraquara municipality. It was rediscovered 72 years later in 2019 in a nearby region by *M.E. Engels 6579* in

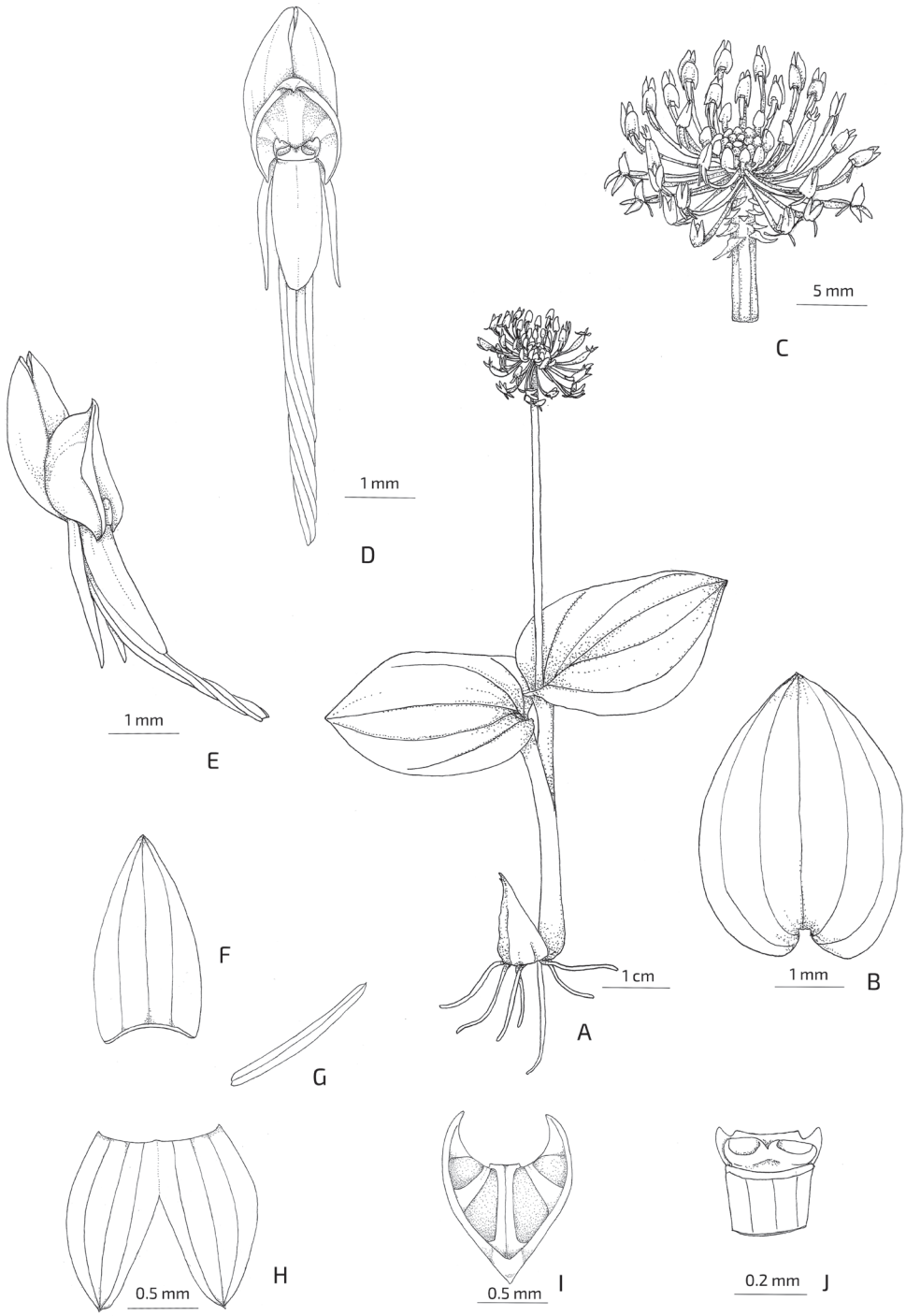

Figure 1. *Malaxis engelsii* illustration. **A**. Habit. **B**. Leaf blade. **C**. Inflorescence. **D**. Frontal view of the flower attached to the pedicel. **E**. Lateral view of the flower attached to the pedicel. **F**. Dorsal petal. **G**. Petal. **H**. Connate lateral sepal. **I**. Lip. **J**. Column. Illustration by L.K.R. Hinoshita, based on the holotype, spirit material, and photographs.

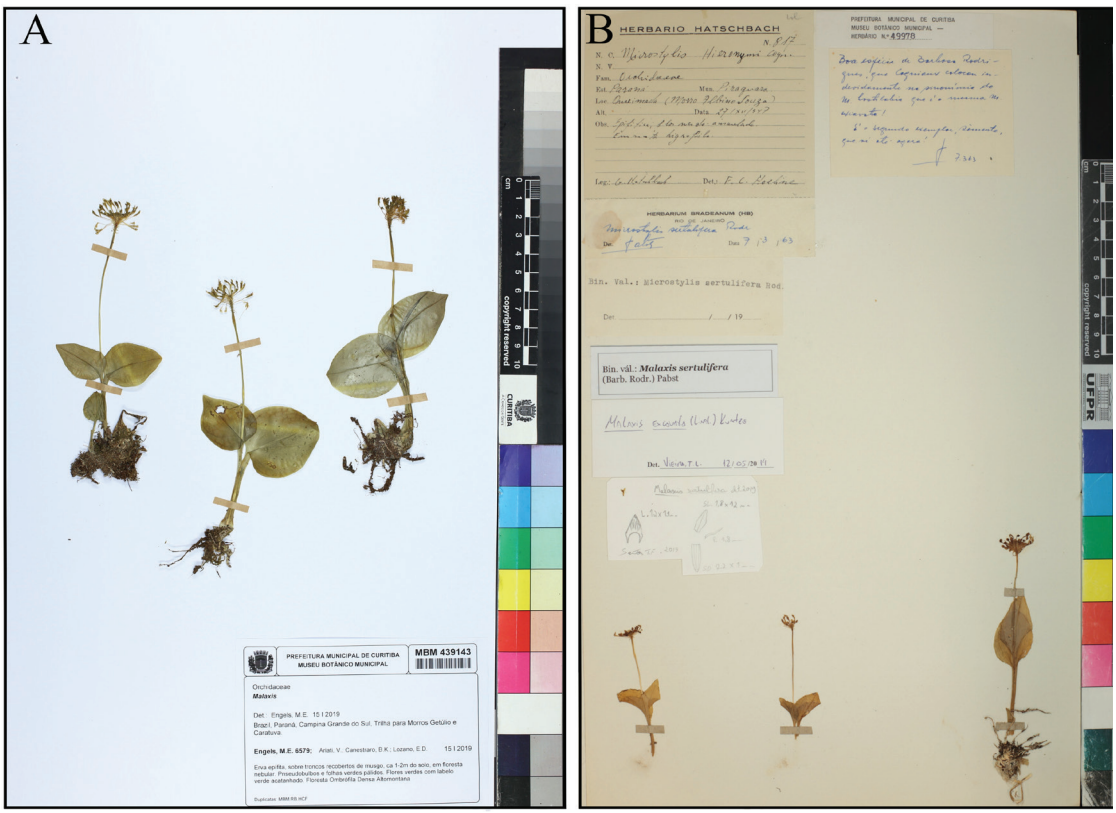

FIGURE 2. Type specimens of *Malaxis engelsii*. **A**. Holotype (MBM 439143). **B**. Paratype (MBM 49978).

the *Ibitiraquire* mountain range (25º14.5'S, 48º50'W) (Fig. 5B, D) of the Campina Grande do Sul municipality. Both localities belong to the *Serra do Mar* of Paraná, a range of elevations formed by tectonic processes involving vertical movements that originated during the Cenozoic era (Almeida 1998, Santos *et al.* 2006). This mountainous region currently separates the inland region from the coastal area of the Paraná state (Maak 1981).

The presence of Mixed Ombrophilous Forest defines the landscape, ecotones between Mixed Ombrophilous Forest and Dense Ombrophilous Forest, and Dense Ombrophilous Forest on higher elevations, with the summits of mountains marked by the presence of the subformation of upper montane forest (Scheer & Mocochinski 2009).

Malaxis engelsii was found as an epiphyte (Fig. 4B, D, E) within hydrophilic environments near streams in the cloud forests of *Serra do Mar* in the *Ibitiraquire* and *Baitaca* mountain range (Fig 5C, D), representing the only known strictly epiphytic species of *Malaxis* in Brazil. However, it should be noted that further fieldwork may reveal the presence of terricolous plants within the same habitat, potentially expanding our understanding of the species distribution and ecological preferences.

CONSERVATION STATUS: In accordance with the IUCN guidelines (2022), despite the limited records of collections making it impossible to delineate the extent of occurrence (EOO) of the taxon, the most plausible inference is that it falls under the Endangered (EN) category. As a result, further research and collection endeavors are imperative to preserve this species.

Discussion. *Malaxis engelsii* differs from most Brazilian *Malaxis* due to its reduced vegetative and reproductive parts size. However, it shares morphological similarities with *M. cipoensis* F.Barros, *M. sertulifera*, and *M. ybytus* T.F.Santos & E.C.Smidt. The following characteristics can differentiate these species: in terms of habit, vegetation domain, and biome, *M. engel-*

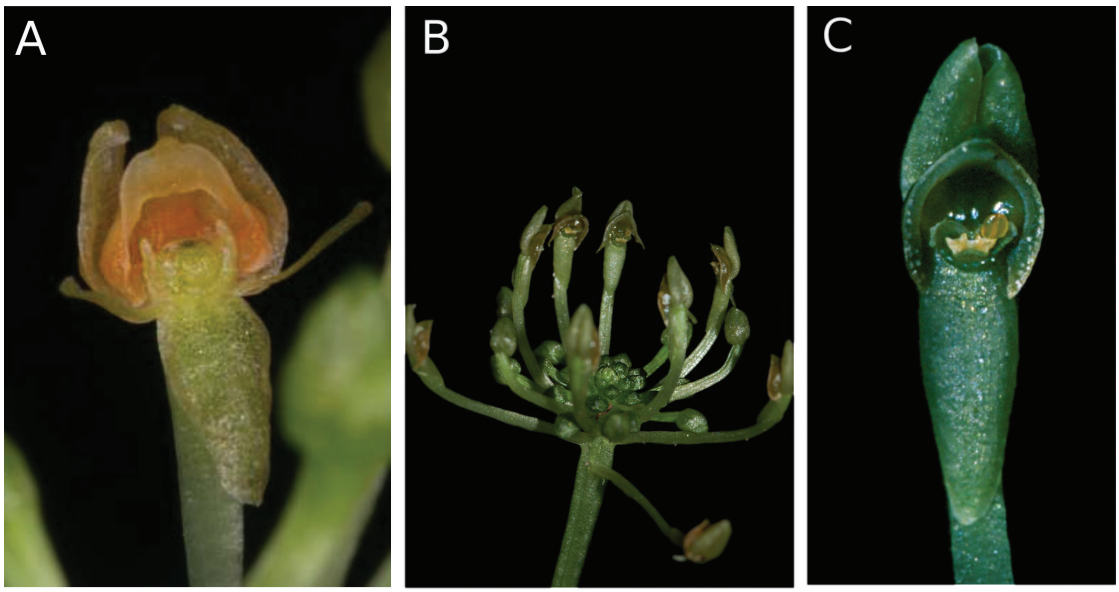

Figure 3. *Malaxis engelsii* and *M. sertulifera*. **A**. Flower of *M. engelsii*; it is possible to observe the longitudinal keel on the adaxial surface of the lip apex and the acute column wings. **B**. Inflorescence of *M. sertulifera*; low density in flower numbers. **C**. Flower of *M. sertulifera*; it is possible to observe the column with rounded wings and the acuminate lateral lobes of the lip. Photographs by Eric de Camargo Smidt (A) and João Aguiar Nogueira Batista (B–C).

sii occurs in the upper montane forest of the Atlantic Rainforest biome. In contrast, *M. cipoensis* is usually found in the *Campos Rupestres* of the Cerrado biome. *M. sertulifera* occurs in any forested environment, but predominantly in the Cerrado biome. Conversely, *M. ybytus* is exclusive to the *Campos de Altitude* of the Atlantic Rainforest biome (Santos & Smidt 2023).

When examining leaf types and shapes, *M. engelsii* is recognized for its flat leaves with elliptic or cordiform shapes, whereas *M. cipoensis* features flat to slightly conduplicate leaves with elliptic shapes. *Malaxis sertulifera* shows lanceolate to oblong-lanceolate leaves, and *M. ybytus* oblong to oblong-elliptic leaf shapes.

Lip characteristics further differentiate these species. *M. engelsii* features a lip with acute lateral lobes and four lip cavities while *M. cipoensis* displays a lip with rounded lateral lobes, and two lip cavities. Additionally, *M. engelsii* is the only species featuring a longitudinal keel on the adaxial surface of the lip apex.

The shape of their column wings differs; *M. engelsii* has an acute column wing, while *M. sertulifera* and *M. ybytus* are inconspicuous and rounded.

These *Malaxis* species exhibit various distinct characteristics encompassing their habitat preferences and flower attributes. These variations serve as essential criteria for differentiating them and contribute to our understanding of their taxonomy and ecological niches in the diverse Brazilian ecosystems.

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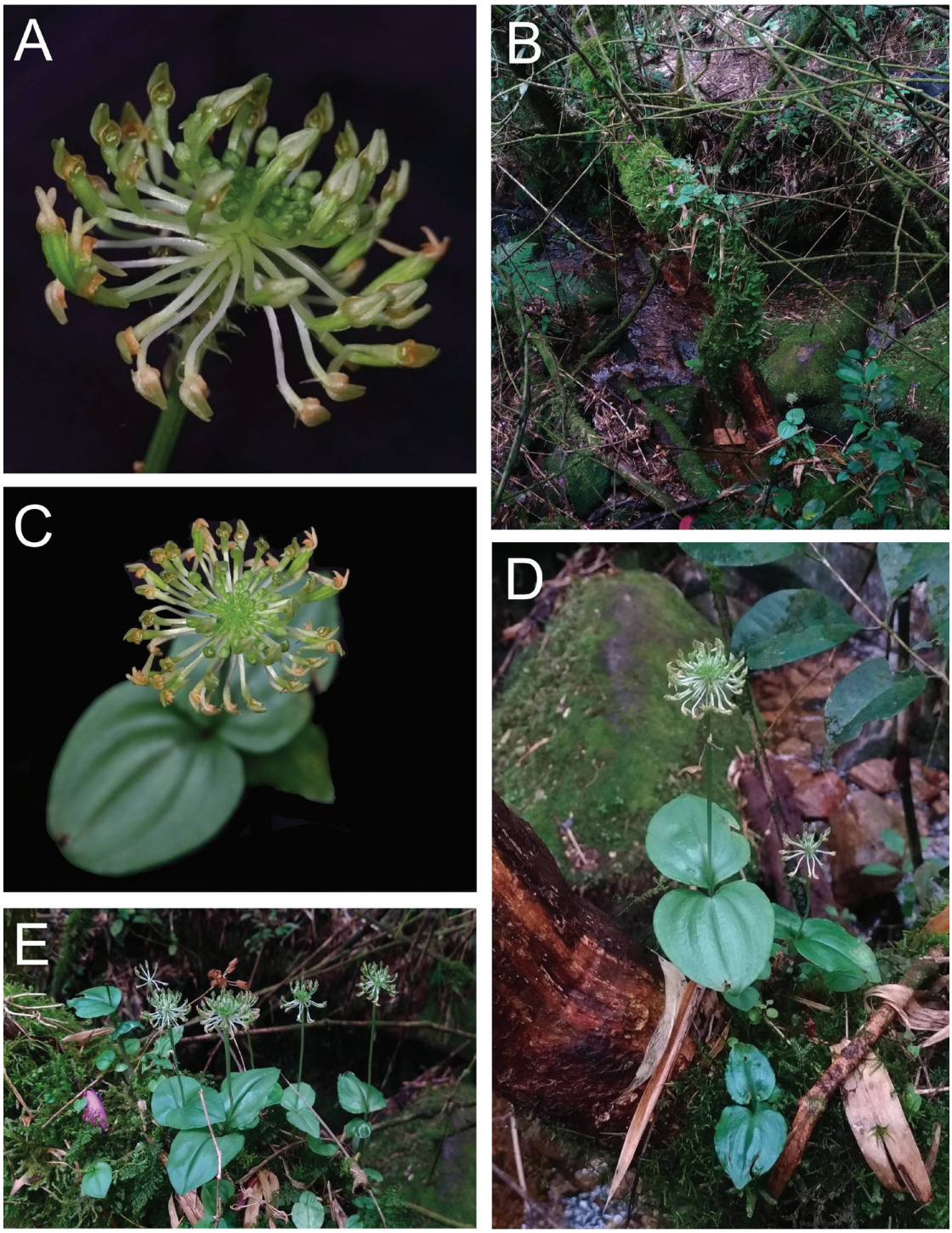

FIGURE 4. *Malaxis engelsii* in the habitat. **A**. Inflorescence viewed from the side. **B**. Population of *M. engelsii* near a stream. **C**. Inflorescence viewed from above. **D**. Zoom in on an individual of *M. engelsii* epiphyte at the base of the host plant. **E**. Zoom in on the epiphytic population of *M. engelsii*. Photographs by M. Engels.

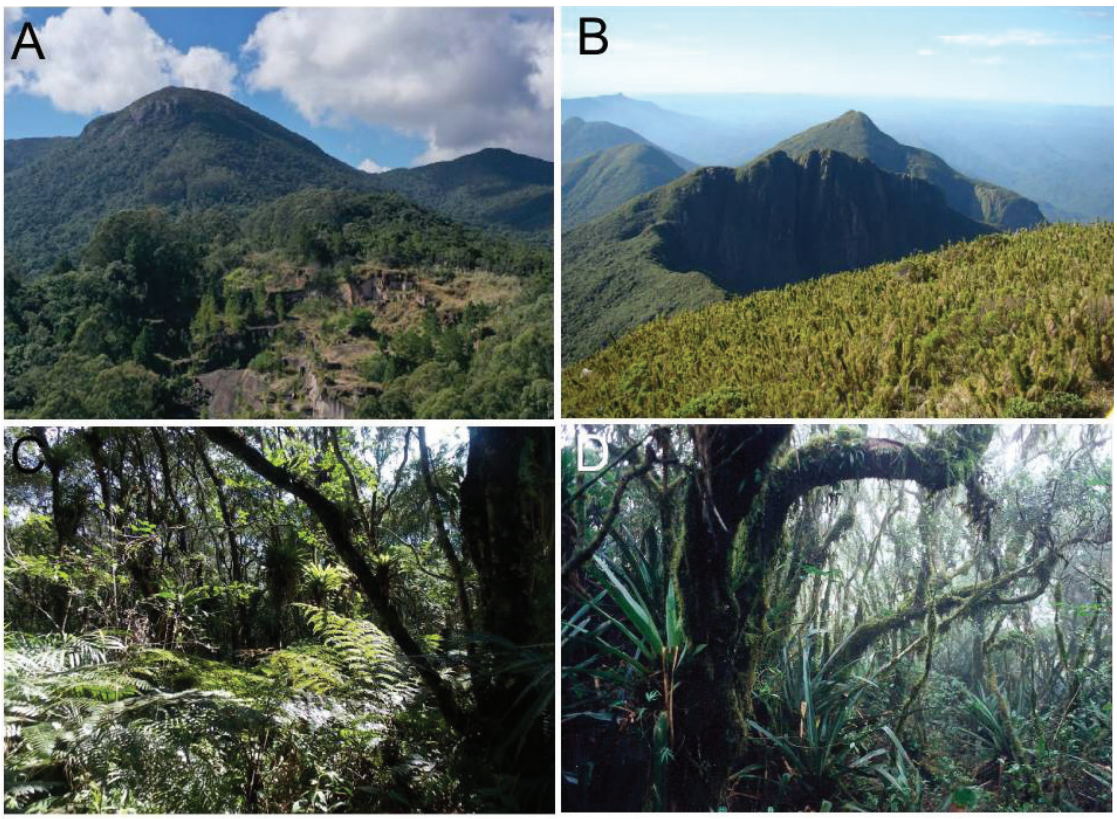

Figure 5. *Baitaca* and *Ibitiraquire* mountain ranges within the Paraná region of *Serra do Mar*. **A**. *Baitaca* Mountain range. **B**. *Ibitiraquire* mountain range. **C**. Cloud Forest within *Baitaca*; abundant epiphytes. **D**. Cloud Forest within *Ibitiraquire*; abundant epiphytes. Photographs by Marcos Klingelfus (A, C) and Rodrigo de Andrade Kersten (B, D).

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