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# *Deprea zamorae* (Physalideae, Solanoideae, Solanaceae): a new species from southern Ecuador

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## Abstract

*Deprea zamorae* Barboza & S. Leiva (Solanaceae), a new species from southern Ecuador (Loja and Zamora–Chinchipe), is described and illustrated. It is most similar to *D. cyanocarpa*, but differs by the presence of minute teeth on the calyx, the ratio of the corolla tube length to the lobe length, the orientation of the fruiting pedicels, and the color and shape of the fruiting calyx. Its distribution does not overlap with that of any other *Deprea* species. A key for all *Deprea* species is provided.

**Key words:** Endemism, Loja, pollen, taxonomy, seed, Zamora–Chinchipe

## Introduction

*Deprea* Rafinesque (1838: 57) is a small neotropical genus from South America comprising eight species (Garzón–Venegas & Orozco 2007). Based on morphological data, Hunziker (2001) placed the genus in the tribe Solaneae subtribe Witheringiinae Reveal, while Sawyer (2005), based on a morphological phylogenetic analysis, considered *Deprea* to be a member of the tribe Physalideae Miers. Recently, in agreement with Sawyer, Olmstead *et al.* (2008) included *Deprea* in the tribe Physalideae, although the genus was not assigned to any subtribe.

Morphologically, *Deprea* is considered close to *Larnax* Miers (1849: 37) (Barboza & Hunziker 1994, Sawyer 1998, 2005, Hunziker 2001, Garzón–Venegas & Orozco 2006). Sawyer (2005) redefined *Deprea* as a monophyletic group excluding *D. glabra* (Standley 1935: 32) Hunziker (1977: 25) and *D. sylvarum* (Standley & C.V. Morton 1938: 1036) Hunziker (1977: 25), which he transferred to *Larnax* (Sawyer 2001), and proposed *Brachistus* Miers (1849: 262) as its sister group. *Deprea* species are shrubs with showy colored flowers. The corolla is funnel-shaped in the majority of the species, with lobes shorter than the tube or rarely as long as the tube. The stamens are equal, with the basal end of the filament slightly expanded, not thickened, and fused to the corolla tube forming the so–called stapet. The fruiting calyx is accrescent, tightly or loosely enveloping the berry. *Deprea* species grow mostly in humid Andean forests from Colombia to northern Peru and also in central Bolivia, except *D. ecuatoriana* Hunziker & Barboza (1996: 109) which inhabits drier areas with low vegetation in the paramos of Ecuador and Peru (Sawyer 1999).

Recently, due to explorations in previously inaccessable regions of the Andes, several new species have been described (Leiva *et al.* 2005, Sawyer 2007, Garzón–Venegas & Orozco 2007). In recent field trips (2011–2012) to southern Ecuador (Loja and Zamora–Chinchipe), a peculiar *Deprea* species was found whose flowering and fruiting features were different from any other species of this genus. It is described here as a

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new species; a key to differentiate it from its congeners is also provided. Along with the description, pollen and seed information is provided.

## Material and Methods

***Taxonomy***:—The description is based on measurements of living plants taken during field work in Prov. Zamora–Chinchipe and examination of herbarium specimens loaned from or studied at the AAU, COL, CORD, F, HAO, MO, NY, QCA, QCNE, S, and U herbaria. Field observations and morphological examinations were conducted using a stereomicroscope with dried material or specimens preserved in FAA solution or 70% alcohol. Measurements of dried material were made from dissections of flowers rehydrated in hot water. Information about flower, fruit, and seed color was taken mainly from our own observations in the field. The morphology of the trichomes was analyzed with a Zeiss Axiophot microscope equipped with a a digital camera. The map indicates the distribution of the new species as well as the other species of *Deprea*. The conservation status proposed here follows the Red List Categories and Criteria, version 12.1 (IUCN 2012).

***Pollen and seeds***:—Pollen was obtained from dry anthers of herbarium specimens or fresh anthers fixed in FAA in the field. Samples for light microscope observations were mounted in glycerin. For scanning electron microscopy (SEM), non–acetolysed grains were mounted on an SEM stub in a few drops of 70% alcohol and allowed to dry. Samples were coated with gold/palladium and examined using a JEOL JSM 35 CF SEM (LABMEM, National University of San Luis, Argentina). Measurements are based on 15 pollen grains from 5 collections (marked with an asterisk in *Additional specimens examined*), including the type specimens. Descriptive terminology follows Punt *et al*. (2007) and Hesse *et al*. (2009).

Seeds were processed according to Lester & Durrands (1984) for SEM. In brief, seeds were soaked in distilled water for 1 h, rinsed 3 times in distilled water and then in 5–10% commercial bleach for 15 minutes. The seeds were then washed twice and treated with a driaselase enzyme solution (driaselase 0.5% in Sorenson's phosphate buffer). The seeds were incubated in the enzyme solution for 48 hs at 30ºC under discontinuous agitation, washed with distilled water and air dried, and coated with gold/palladium.

## Taxonomic Treatment

***Deprea zamorae*** Barboza & S. Leiva, *sp. nov.* (Fig. 1, 2 A–D, 3, 4).

Type:—ECUADOR. Zamora–Chinchipe: Límite del PN *Podocarpus*, desvío de la ruta principal en el límite entre Prov. Zamora–Chinchipe/Loja, a 600 m del desvío, 2750 m, 15 November 2011 (fl, fr), *C. I. Orozco, G. Barboza, S. Leiva & A. Orejuela* 3926 (holotype COL!, isotypes COL!, CORD 00006744!, CORD 00006745!, HAO!, QCA!).

*Deprea zamorae* can be distinguished from other *Deprea* species by the purple indumentum and purple color of the young branches and leaves, the narrowly campanulate corolla with the tube as long as or slightly longer than the lobes, and the urceolate orange or reddish orange accrescent calyx with minute teeth that tightly invests the berry.

Shrubs (0.5–)1.5–3 m high, much branched; older stems green, terete, hollow, glabrous, longitudinally ridged, 2–2.3 cm diameter at the base; young stems green with purple nodes, densely covered by simple non-glandular transparent trichomes, the trichomes intense purple at the tips of the branches; sympodial units unifoliate. Leaves alternate and in branch forks; blades (5–)7–8(–9.5) cm long, 3–5 cm wide, elliptic, slightly fleshy, dark green with purple–lilac colored veins beneath, densely pubescent on both surfaces, mainly on the abaxial surface, with patent simple or occasionally branched trichomes on the veins, the margin entire, repand, the apex acuminate, the base attenuate and unequal; petioles 1–1.5 cm long, purple with transparent patent indumentum. Secondary veins 6–8 pairs, impressed on the adaxial surface and prominent on the abaxial surface, forming a strong reticulum with other minor veins. Inflorescence axillary, usually 2 or 3(–5) - flowered, the flowers opening asynchronously; flowering pedicels pendent, widening slightly distally, 11–17 mm long, densely pubescent, the hairs transparent or purple and patent; buds ovoid, purplish green. Calyx

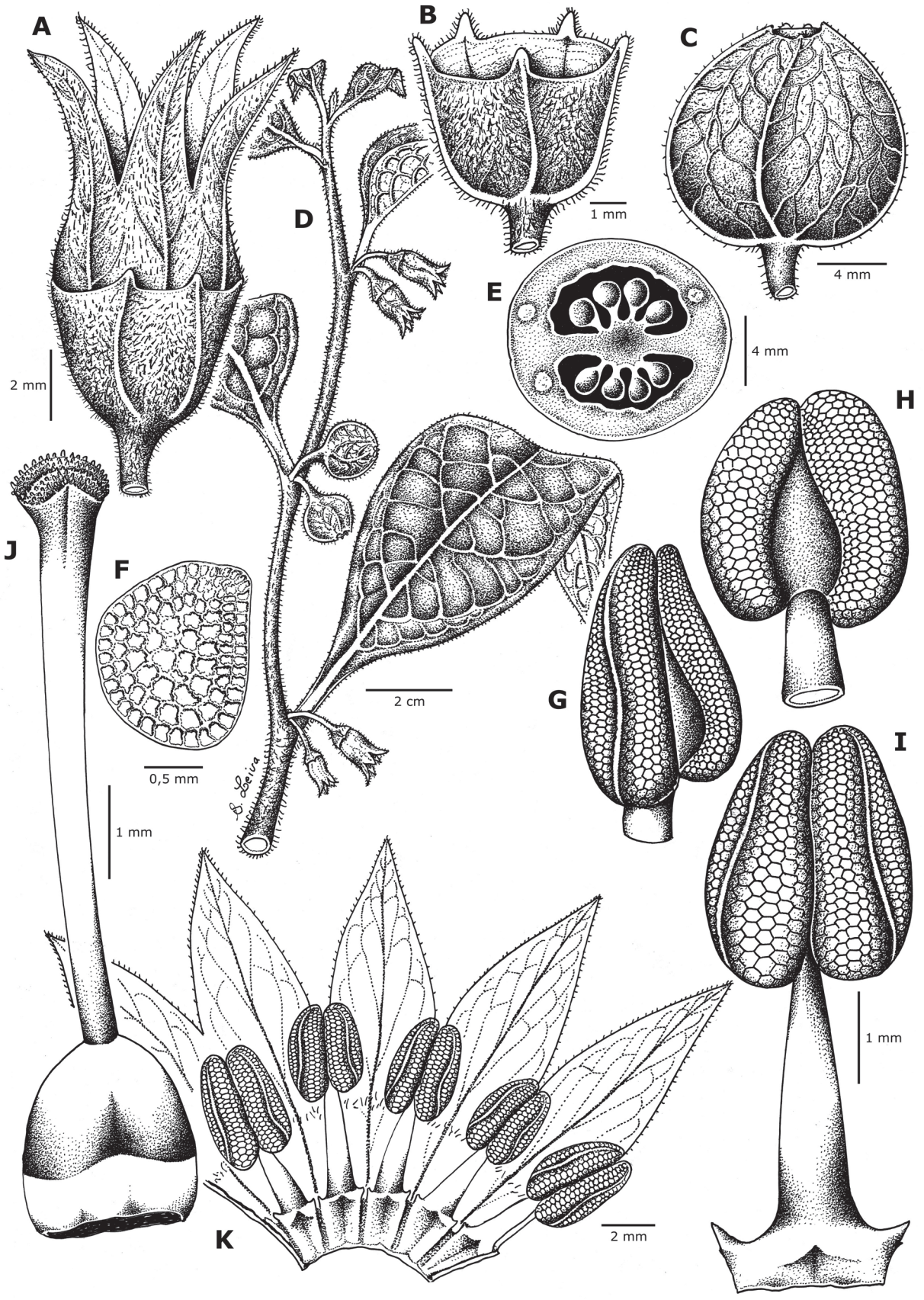


**FIGURE 1.** *Deprea zamorae*. A. Flower. B. Calyx. C. Fruit surrounded by accrescent calyx. D. Flowering branch. E. Ovary in cross section. F. Seed. G–I: Anthers in lateral, dorsal and ventral views, respectively. J. Gynoecium. K. Corolla, ventral view. From *Orozco et al.* 3926. Drawing by Segundo Leiva González.

intensely purple, cup-shaped, 3.2–5 mm long, densely with long uniseriate, glandular trichomes and purple non-glandular trichomes, glabrous inside, the main veins prominent, shortly 5-toothed, the teeth triangular, mostly obtuse, greenish inside, unequal, 0.3–0.6 mm long, 0.3–0.5 mm wide; tube 2.8–3.5 mm long. Corolla almost entirely purple and yellowish cream proximally, narrowly campanulate, (10–)13–14.5 mm long; lobes as long as or slightly shorter than the tube, ca. (5–)7.5–8 mm long, 3–3.7 mm wide, triangular, slightly reflexed, purple on both surfaces, with glandular and non-glandular trichomes on both surfaces and on margins; tube swollen, 5–6.5 mm long, 5–6.1 mm wide, with a ring of relatively short non-glandular trichomes half way to the base inside and with the same tube indumentum outside. Filaments cream basally and purple distally, glabrous, equal or subequal, (3–)3.9–4.5 mm; anthers exserted, oblong, purple, ca. (2–)2.5–2.7 mm long, 1.9–2 mm wide, the connective cream; filament base expansion cream, 1.5–2 mm long. Ovary glaucous, pyriform, slightly 5-angled, ca. 1.5–1.8 mm long, 1.5–1.7 mm wide, the nectary yellowish cream, inconspicuous; style exerted, cream or sometimes lilac, glabrous, 5.3–6.6 mm, widening distally; stigma dark green, capitate, somewhat bilobed, 0.8–1 mm diameter. Berry ovoid or slightly globose, flattened at the apex, (8–)10–11 mm long, 9–11(–13) mm diameter, orange or reddish orange at maturity; stone cells 12–15 per fruit, yellowish white; fruiting pedicels pendent, the fruiting calyx accrescent, urceolate, orange or reddish orange, tightly enveloping the berry up to the apex, slightly 5–10-costate. Seeds 75–80 per fruit, ovoid to reniform, compressed, yellowish brown, 1.5–1.7 mm long, 1.5–1.6 mm wide; testa reticulate.

**Etymology**:—The name refers to the distribution of the species in southern Ecuador in Zamora-Chinchipe Province.

**Phenology**:— Flowering and fruiting from April to November.

**Distribution and Habitat**:—Endemic to southern Ecuador (Prov. Loja and Zamora–Chinchipe, Fig. 3) between 2200–2900 m in fragments of primary wet montane forests. It grows in black, clayey, and rich soils in association with *Baccharis* (Asteraceae), *Brachyotum* (Melastomataceae), *Rubus* (Rosaceae), *Weinmannia* (Cunoniaceae), *Puya* (Bromeliaceae), *Chusquea* (Poaceae), *Cortaderia* (Poaceae), among others. It is usually found along roadsides and on steep slopes.

**Conservation Status**:—The conservation status of this species would be vulnerable (VU) under criteria B2 (a, b), known at 7 locations and the extent of occurrence below 2,000 $km^2$ (IUCN Red List Criteria 2012).

**Anatomical observations**:—*Deprea zamorae* has purple and whitish cream simple glandular and verrucose simple and branched non–glandular trichomes. Long simple eglandular trichomes cover the vegetative organs, pedicels, calyx, and corolla; they consist of (2–)4–9 elongate cells, the distal cell acute (Fig. 4 A). Branched trichomes are very rare on mature stems and leaves; they appear occasionally in young leaves and inside the corolla (Fig. 4B). Papillae (Fig. 4C) and very short trichomes, some of them branched, are present on the calyx and apex and margins of the corolla lobes while trichomes of 3–8 rectangular to isodiametric cells, the distal one obtuse, cover the basal ½ length of the corolla tube interior (Fig. 4D). Glandular trichomes can be short or long; the former have a unicellular stalk and a globose multicellular head (Fig. 4E). These are common on both leaf surfaces and on the adaxial calyx surface, and less frequent on the corolla. The second type of glandular trichome has a 3–5-celled stalk and a unicellular oblong head (Fig. 4F); these occur on most of the outer corolla surface and sometimes also on the calyx and pedicels.

Pollen grains are small sized (polar diameter 23.012 ± 0.846 μm), spheroidal in outline in hydrated condition, and tricolporate (Fig. 4G). The pollen surface is irregular (Fig. 4G, I). The exine ornamentation is sparsely microechinate (7.643 ± 0.802 microechini per $\mu m^2$), and the aperture membrane is granular (Fig. 4G, I).

Seeds are ovoid to reniform, compressed, 2.8 ± 0.2 mm long × 2.5 ± 0.2 mm wide (Fig. 4H). Seed coat sculpture is reticulate (Fig. 4H). The cells are polygonal with almost straight lateral walls in the seed margin, and irregular in shape with sinuate lateral walls in the center of the seed (Fig. 4H, J). All the cell walls, except for the outer periclinal walls, are papillate (Fig. 4J, K); pits are present mainly at the base of the anticlinal cell walls (Fig. 4K).


**FIGURE 2.** *Deprea* species. A–D. *D. zamorae*. A. Habit. B. Leaf pubescence. C. Flower. D. Fruits. E. *D. cyanocarpa*, flowers and fruits. F. *D. ecuatoriana*, flower. G. *D. nubicola*, flowers and fruits. H. *D. orinocensis*, flowers and fruits. I. *D. bitteriana*, flowers and fruits. J. *D. cuyacensis*, flower. Photographs. A–D, F, J by S. Leiva González; E by J. Garzón-Venegas; G by J. M. Vélez; H by J. C. Murillo; I by M. T. Cosa.

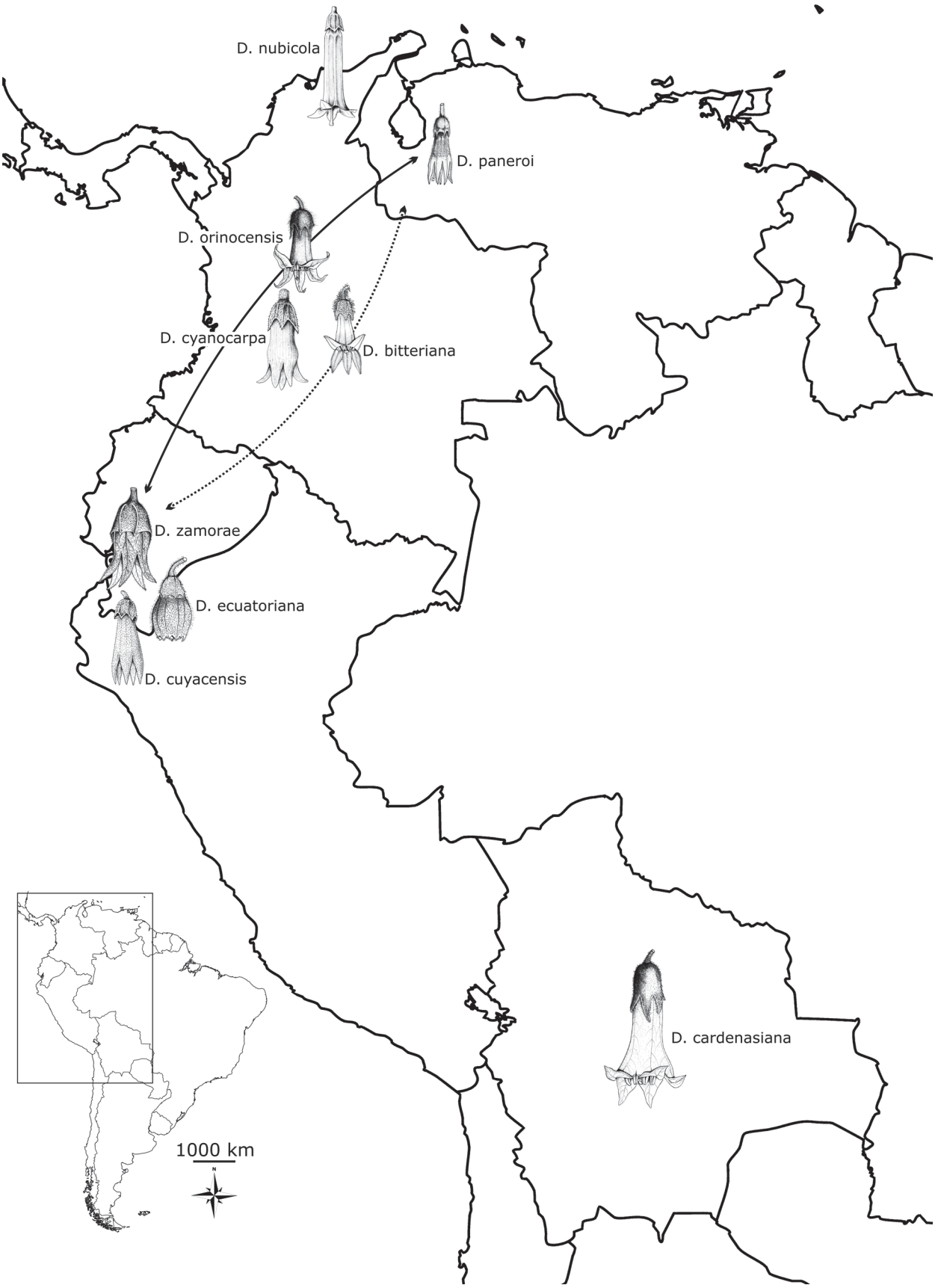


**FIGURE 3.** Schematic distribution of *Deprea* species. The flowers indicate the area of distribution of each species, except for *D. orinocensis* and *D. bitteriana*, for which the arrows indicate their distribution range. The flowers are all at the same scale.

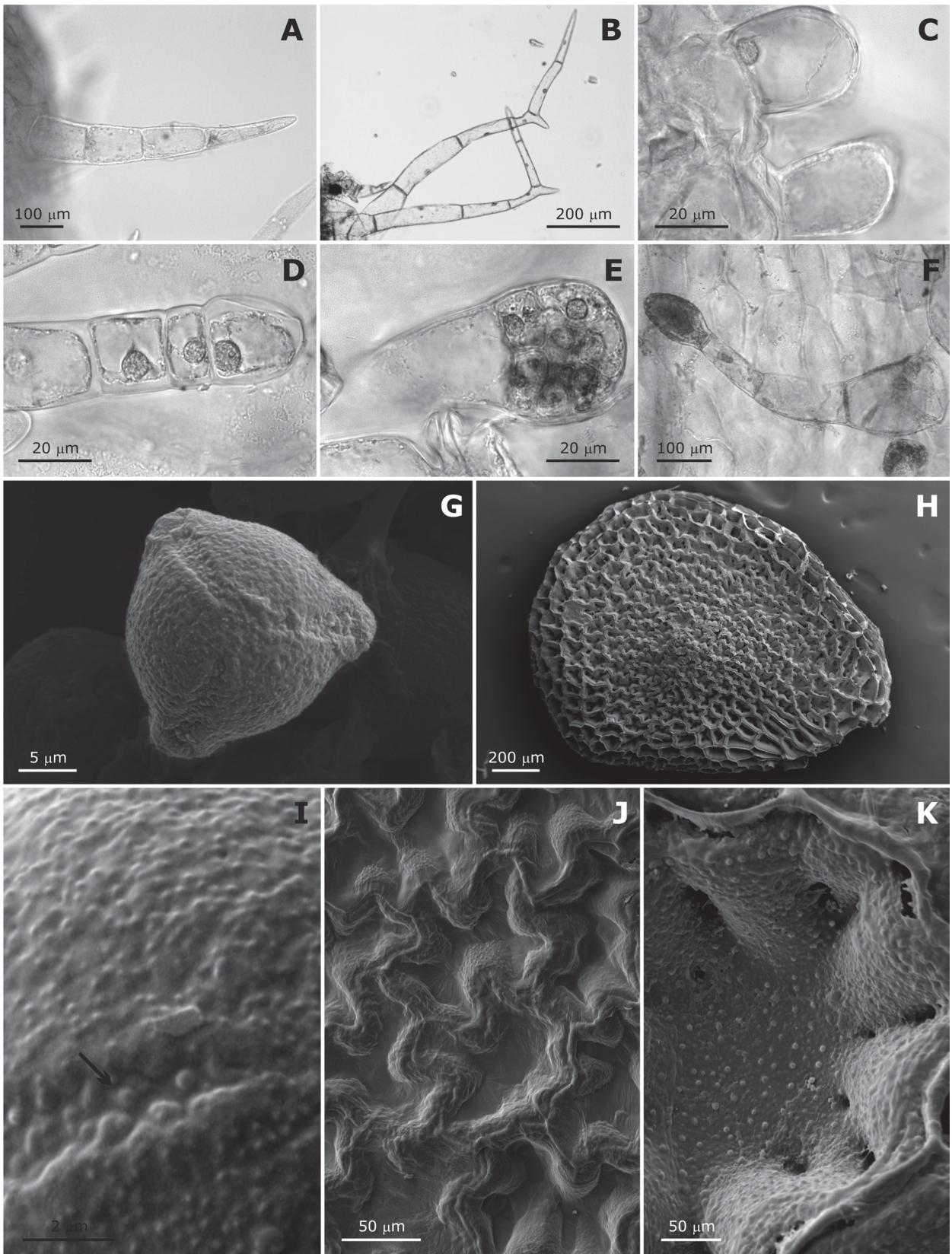


**FIGURE 4.** Trichomes, pollen and seed of *Deprea zamorae*. A–F. Trichomes. G, I. Pollen grain.H, J, K. Seed. A. Simple, non-glandular trichome with acute apex from the calyx. B. Branched eglandular trichome from the leaf surface. C. Papillae of the corolla margin. D. Simple, non-glandular trichome with obtuse apex, from the inner corolla surface. E. Glandular trichome with a multicellular head from the outer corolla surface. F. Glandular trichome with a unicellular head from the outer corolla surface. G. Pollen grain in polar view. H. Seed (treated with driaselase enzyme). I. Detail of the exine sculpture and the aperture membrane (arrow). J. Detail of the seed surface (not treated with driaselase enzyme). K. Inner surface of the seed central cells showing papillae and pits.

**Additional specimens examined:**—ECUADOR. Loja: immediately W of the pass between Loja and Zamora, 2800 m, 24 September 1967 (fl, fr), *Sparre 18939** (S). Zamora–Chinchipe: at pass between Loja and Zamora and along trail toward Zamora, 2360–2800 m, 29 July 1982 (fl, fr), *Clemants et al. 2257** (QCA, QCNE, NY); a 500 m de desvío de la ruta principal Loja–Zamora, en el límite entre Prov. Zamora–Chinchipe/ Loja, 2252 m, 79º03'22"W, 3º59'12"S, 16 July 2012 (fl, fr), *Deanna & Leiva 9* (CORD); road Loja–Zamora, km 17, 2400 m, 79º08'W, 3º59'S, 16 April 1973 (fl, fr), *Holm-Nielsen et al. 3549** (AAU, F, MO, NY, S, U); límite entre Loja–Zamora–Chinchipe, 2768–2790 m, 79º08'30,7"W, 3º59'10,4"S, 15 November 2011 (fl, fr), *Leiva et al. 5256* (HAO); Parque Nacional Podocarpus, new road Loja–Zamora, E of Cerro Yanacocha, 2550–2650 m, 79º07''W, 3º59'S, 26 November 1988 (fr), *Madsen 75571* (QCA); Parque Nacional Podocarpus, around pass on road Loja–Zamora, 2750–2950 m, 79º07'W, 3º58'S, 23 May 1988 (fl, fr), *Øllgaard et al. 74394** (QCA).

## Discussion

*Deprea zamorae* is unique in the genus by its combination of the showy purple color of young branches and leaves (Fig. 2 A, B), the corolla shape and color (Fig. 2 C), the color and shape of the fruiting calyx (Fig. 2 D), and the type of trichomes. The corolla is narrowly campanulate with the tube as long as or slightly longer than the lobes (Fig. 2 C). The orange or reddish orange accrescent calyx tightly investing the berry with minute teeth at the apex is unusual in the genus (Fig. 2 D). Branched hairs (Fig. 4 B) have been thus far known only in *D. orinocensis* (Kunth in Humboldt et al. 1818: 12) Rafinesque (1838: 57) (Sawyer & Benítez de Rojas 1998), but *D. zamorae* has some scattered branched hairs on the stems, leaves, and inner corolla surface.

*Deprea zamorae* resembles *D. cyanocarpa* J. Garzón & C.I. Orozco (2007: 220), an endemic species from Colombia, in its narrowly campanulate corolla of similar size and the purple trichomes of the calyx and corolla (Fig. 2 E). *Deprea zamorae* differs from *D. cyanocarpa* mainly by the presence of minute teeth on the calyx instead of longer calyx lobes (0.3–0.6 mm long vs. 1–2.5 mm long), the ratio of the corolla tube length to the lobe length (tube as long as or slightly longer than the lobes vs. tube two times longer than the lobes), the orientation of the fruiting pedicels (pendent vs. erect), the fruiting calyx color and shape (orange or reddish orange, urceolate, not invaginated at the base, slightly 5–10-costate and tightly enveloping the berry vs. purple, pyriform, invaginated at the base, strongly 5-costate and loosely enveloping the berry). No *Deprea* species are sympatric with *D. zamorae*. The geographically closest species is *D. cuyacensis* (N.W. Sawyer & S. Leiva in Sawyer 2001: 462) S. Leiva & Lezama (in Leiva et al. 2005: 63), from northern Peru and southern Ecuador, differing mainly by its scarce indumentum on the vegetative organs, its pale violet and funnel-shaped corolla, and its white with purple veins fruiting calyx that loosely invests the berry.

The pollen has been described as rugulate or rugulate–reticulate in most *Deprea* species, except for the scabrate pollen in *D. cuyacensis* (Sawyer 1999). However, from the images shown in that publication, the pollen surface surface appears irregular, similar to *D. zamorae,* instead of rugulate and rugulate-reticulate (cf. Hesse *et al*. 2009). The microechini (pointed ornamentations smaller than 1 µm; cf. Hesse *et al*. 2009) observed in *D. zamorae* have not been mentioned in other *Deprea* species. Since new detailed descriptions for each *Deprea* species are needed to standardize the terminology and make them comparable, a palynological analysis of the genus is in progress.

The seeds of *D. zamorae* fit the overall generic description (Barboza & Hunziker 1994; Hunziker 2001); the seed coat micromorphologycal features of *Deprea zamorae* are the first records on the subject for the genus.

**Identification Key**

Based on field observations and examinations of recent herbarium collections, we provide a new key to *Deprea* species with additional previously unpublished characters.

1. Corolla urceolate, orange, 9.5–11 mm, the lobes very short, ca. 0.6 mm long. Fruits ellipsoidal. Low shrubs ca. 0.30 m tall. Paramo. Southern Ecuador and northern Peru ..... *D. ecuatoriana* (Fig. 2F, 3)
- Corolla clearly funnel-shaped or narrowly campanulate, never orange, (7–)9–23 mm, the lobes relatively long, 1.5–8 mm long. Fruits subglobose or ovoid. Shrubs 0.5–5 m tall. Montane cloud forests in South America ..... 2
2. Corolla narrowly campanulate, purple ..... 3
- Corolla funnel-shaped, violet, lilac, yellowish cream or creamy white ..... 4
3. Calyx teeth 0.3–0.6 mm long. Corolla tube as long as or slightly longer than the lobes. Fruiting pedicels pendent, the fruiting calyx orange or reddish orange, urceolate, not invaginated at the base, slightly 5–10-costate and tightly enveloping the berry. Southern Ecuador. ..... *D. zamorae* (Fig. 2A-D, 3)
- Calyx lobes 1–2.5 mm long. Corolla tube two times longer than the lobes. Fruiting pedicels erect, the fruiting calyx purple, pyriform, invaginated at the base, strongly 5-costate and loosely enveloping the berry. West-Central Colombia..... *D. cyanocarpa* (Fig. 2E, 3)
4. Corolla creamy white, glabrous inside. Central Bolivia..... *D. cardenasiana* (Fig. 3)
- Corolla mostly to entirely violet, lilac or yellowish cream, occasionally yellowish cream with purple traces inside, pubescent inside ..... 5
5. Pedicels long, 12–20 mm. Filaments 15–20 mm, glabrous. Fruiting calyx not invaginated at the base, tightly enveloping the berry and without conspicuous ribs. Corolla lilac, the lobes 4–5 times shorter than the tube. Plants glabrescent. Northern Colombia..... *D. nubicola* (Fig. 2G, 3)
- Pedicels relatively short, less than 12 mm. Filaments 4–11 mm, pubescent. Fruiting calyx invaginated or not, loosely enveloping the berry and with 5–10 conspicuous ribs. Corolla violet or yellowish cream (exceptionally yellowish cream with purple), the lobes equal to 1.5–2.5 times shorter than the tube. Plants pubescent ..... 6
6. Plants dioecious. Filaments 2–3.1 mm. Berry whitish cream. Fruiting calyx subglobse, not invaginated. Corolla blue–violet. Northwestern Venezuela ..... *D. paneroi* (Fig. 3)
- Plants hermaphroditic. Filaments 4.6–10 mm. Berry orange or yellowish orange. Fruiting calyx pyriform, usually invaginated ..... 7
7. Corolla yellowish cream, exceptionally yellowish cream with purple, 10.5–19 mm. Branched trichomes present on leaf surfaces and margin. Andes from Venezuela to Ecuador ..... *D. orinocensis* (Fig. 2H, 3)
- Corolla entirely violet, 9–13 mm. Branched trichomes absent on leaf surfaces and margin ..... 8
8. Pedicels 4–6 mm. Calyx 2.5–3 mm. Corolla deep violet, glandular pubescent outside. Anthers 1.1–1.4 mm. Fruiting calyx greenish yellow or cream with violet apices. Andes from Venezuela to Ecuador ..... *D. bitteriana* (Fig. 2I, 3)
- Pedicels 3–12(–15) mm. Calyx 4–5 mm. Corolla pale violet, glabrous or glabrescent outside. Anthers 2–2.7 mm. Fruiting calyx white with purple veins. Northern Peru and southern Ecuador ..... *D. cuyacensis* (Fig. 2J, 3)

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