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A new Andean species from central Bolivia and a key to the South American species of *Cobaea* Cav. (Polemoniaceae)

Una nueva especie de los bosques húmedos Andinos de Bolivia y un clave para las especies sudamericanos de *Cobaea* Cav. (Polemoniaceae)

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ABSTRACT

In memory to the 200 years of foundation of the state of Bolivia a new species is named *Cobaea boliviana*, it is only known from Bolivia and a relative of *Cantua buxifolia* (kantuta). Grows in the humid montane Andean forest of La Paz and Cochabamba. The genus was known in Bolivia only by the introduced *Cobaea scandens*. The species is an herbaceous vine, with compound leaves, 2–3 pairs of leaflets, terminal part modified as a tendril, blades elliptic to oblanceolate (35–) 55–105 mm, glabrous, mucronate; venation pinnate, 8–10 (–11) secondary veins per side, with a collecting nerve at the border. Inflorescences with 2 or more flowers, glabrous, subtended by two or more simple or compound bracts with bright yellow–greenish flowers. Fruit a septicidial capsule with winged seeds. According to unpublished phylogenetic results stays near to *C. campanulata* from Ecuador, differing by larger calyx lobes and filaments. Data on the distribution, ecology, phenology and conservation status are presented.

Palabras clave: Endemic vine, Montane Forest, Yungas of La Paz and Cochabamba.

RESUMEN

En el centenario de la fundación de Bolivia se nombra como *Cobaea boliviana* a una especie nueva conocida solamente de Bolivia, relacionada con la *Cantua buxifolia* (kantuta). Es originaria de los bosques montanos húmedos de los Yungas de La Paz y Cochabamba. El género antes solamente se conocía por la trepadora introducida *Cobaea scandens*. Se caracteriza por su hábito trepador herbáceo, con hojas compuestas de 2–3 pares de foliolos, el terminal modificado en zarcillos, lamina elíptica hasta oblanceolada, (35–) 55–105 mm de largo, glabra, mucronada, nervadura pinada con 8–9 (–11) nervios secundarios a cada lado, con un nervio colector en el borde, por tener inflorescencias con 2 o más flores, glabra, subtendida por 2 o más brácteas simples o compuestas, y por presentar flores grandes de color amarillo–verdoso, fruto una capsula septicida con 4 semillas aladas. Estudios morfológicos y filogenéticos la relacionan con *Cobaea campanulata*, que se diferencia por los lóbulos del cáliz y los filamentos más largos. Se presenta información de la distribución, ecología de Ecuador, fenología y estado de conservación.

Key words: Trepadora endémica, Bosque montano, Yungas, La Paz y Cochabamba.

INTRODUCTION

Cobaea Cav. is a small neotropical genus of herbaceous vines and slender lianas in the subfamily Cobaeoideae of Polemoniaceae. The genus is comprised of 19 species, most of which are rarely collected and poorly known. The genus stands out in the Polemoniaceae because it is one of the few tropical members, the

species are the only vines in the family, and because the species have a remarkable diversity of floral morphology (Prather, 1999). In addition to its scandent habit, the genus is morphologically divergent from the rest of the family in having compound leaves with the terminal leaflet modified into a tendril, septicidally dehiscent capsules, and extremely large (102–223 um) pollen grains (Prather, 1999). Because of these differences, some classifications separated the genus into a monotypic family (e.g. Dahlgren, 1980; Takhtajan, 1987), but molecular evidence squarely places the genus in the Polemoniaceae (Prather *et al*., 2000; Johnson *et al*., 2008). The sister group of *Cobaea* is *Bonplandia* Cav., a small, primarily Mexican genus of herbs or semi-shrubs perennials. Collectively, the sister group to *Bonplandia* and *Cobaea* is *Cantua* Juss. ex Lam., a modest-sized genus of South American trees and shrubs (Prather *et al*., 2000; Johnson *et al*., 2008).

The species typically occur in mesic, forested habitats such as cloud forests, mid-elevation slopes, and low-elevation rain forests (Prather, 1999), though one species is sometimes found in tropical deciduous forest (Godínez *et al*., 2001). Many of the species are narrow endemics. The species were previously known to be patchily distributed from northeastern Mexico through Central America and into Venezuela and western South America as far south as central Peru, with the exception of *Cobaea scandens* Cav., which is known to be adventive and sometimes invasive in many parts of Central America, South America, the Caribbean, and other parts of the world.

The Polemoniaceae is well-known in Bolivia because "kantuta," *Cantua buxifolia* Juss. ex Lam., is one of two national flowers. This species grows at altitudes between 3000 and 4000 m in the upper valleys and occasionally in highland areas around Lake Titicaca. Apparently, it is only known cultivated, but there are the wild *Cobaea bicolor* Lem. and *C. flexuosa* (Ruiz & Pav.) Pers. Three other Polemoniaceae, the tiny herbs *Gilia laciniata* Ruiz & Pav., *Ipomopsis gossypifera* (Gillies ex Benth.) V.E. Grant and *Microsteris gracilis* (Douglas ex Hook.) Greene are also found in this Altiplano and Puna region. In addition, *Cobaea scandens*, grows sporadically in the montane forest of the eastern slopes of the Andes in the Yungas of Dept. La Paz and is cultivated occasionally in La Paz. This widely cultivated species is thought to have been introduced to South America from eastern Mexico (Prather, 1999).

As one of us (S. Beck) was reviewing a manuscript of the Polemoniaceae for the Catálogo de las plantas vasculares de Bolivia (Jørgensen *et al*., 2014) authored by the other (L. Prather), he drew attention to three collections of *Cobaea* from Bolivia that were distinct from *C. scandens*, the only species otherwise know from Bolivia. The specimens were collected from Dept. La Paz, Prov. Sud Yungas. The specimens in question were treated as *C. lutea* in the published treatment of the Polemoniaceae in the Catálogo de las plantas vasculares de Bolivia (Prather, 2014) with the following note: "Determinación no confirmada, posiblemente se trata de una nueva especie." Molecular phylogenetic studies and further morphological examination of these specimens and additional Bolivian specimens that have been acquired have provided evidence that these Bolivian collections represent a new species of *Cobaea*, here described. We present a discussion of the morphological traits that distinguish the new species and the habitat in which the new species occurs, a key to the South American species, and the results of a phylogenetic analysis based on earlier work (Prather & Jansen, 1998). but incorporating the new taxon.

MATERIALS AND METHODS

The new species is described by analysis of ten specimens originated from the mountain forests of the eastern Andean slopes (Yungas) of La Paz and Cochabamba at altitudes (1100–2400 m. Specimens are deposited in the Herbario Nacional de Bolivia (LPB) and in the following herbaria BOLV, K, MO, RSA, US, USZ (Thiers, 2021). Field work of the collectors contributed with images data to distribution, ecology, phenology and conservation status, according to IUCN (2012) using GeoCAT for calculation of the extension of occurrence (EOO) and the area of occupation (AOO) of Bachman *et al*., (2011).

Phylogenetic studies are based by taxon sampling, DNA Amplification, and Sequencing. Leaf material was removed from several sheets with permission from MO (all from MO and US). These specimens are representative of the known distribution of *Cobaea* in Bolivia. These samples were analyzed in the context of a previous phylogenetic analysis of *Cobaea* (Prather & Jansen, 1998) with outgroups supplemented from phylogenetic analyses of *Cantua* (Monfils and Prather, 2010). Detailed results will be presented by Prather (in preparation).

TAXONOMIC TREATMENT

Cobaea boliviana Prather & S. Beck, ***sp. nov.*** (Fig. 1 y 2)

Type: BOLIVIA. **La Paz**: Prov. Sud Yungas, Huancané, ca. 11 km hacia San Isidro, 16° 22’ S, 67° 32’ W, 2300 m, 5 May. 2000, (fl, fr) *S. G. Beck* 24882 (Holotype: LPB!; Isotypes: LPB!, US!).

Similar to *Cobaea campanulata* Hemsl. (1880: 352) from which it differs in having calyx segments 6–10 mm wide (vs. 4–6 mm wide in *C. campanulata*), filaments (55–) 60–65 (–70) mm long and adnate basally to the corolla for 6–9 mm (vs. 32–50 mm long and adnate basally for 4–6 mm), anthers 9–12 mm long (vs. 4.5–5.5 mm long), and styles 65–80 mm long (vs. 41–50).

Climbing herbaceous up to 4–5 m tall. Stems abundantly branched, herbaceous, in living plants sometimes purple to violet (Fig. 2A), irregularly canaliculate when dried, reddish-brown, glabrous or puberulent to sparsely villous at nodes. Leaves alternate, compound, green; rachis (20–) 40–100 (–150) mm glabrous; leaflets 2 or 3 pairs, opposite or subopposite, terminal leaflet modified into a branched tendril, each with two claws, ocasionally subdivided again in two parts, petiolules 3–12 mm long, glabrous or slightly tomentose; blades of leaflets elliptic to oblanceolate, (35–) 55–105 (in young sterile specimen –130) mm long, 15–30 mm wide, base oblique to slightly lobed, emarginated (rarely cordate), apex acute to acuminate, mucronate, glabrous, entire margin; venation pinnate, 8–10 (–11) secondary veins per side, with an inconspicuous collecting nerve at the border of the leaflet. Inflorescences; peduncles erect, with 1–2 or more axiliar flowers, 2–5 cm long, glabrous; one pair of foliaceous bracts, fully expanded or sometimes poorly developed. Flowers: pedicels erect but nodding at apex when flowering, becoming pendulous and undulate along length in fruit, 20–29 (–35) cm long, puberulent at ápex; calyx of 5 segments united only at the very base, green, narrowly lanceolate to lanceolate, 20–30 mm long, (5–) 6–10 mm wide, membranous to chartaceous, apex acute to acuminate, abaxial surface glabrous or sparsely villous near margin, sometimes minutely puberulent near base, adaxial surface puberulent in a 0.5–2 mm wide band along margin, margin ciliate to short ciliate; corolla actinomorphic, yellow to pale green, membranous, tube campanulate, widest at apex, 25–40 (–50) mm long, 22–30 mm wide at apex; lobes broadly ovate, cup shaped, 17–23 mm long, 15–22 mm wide, much shorter than tube, apices rounded, not markedly rolled at margin, imbricate, wrinkled in bud, outer surface glabrous or sparsely villous at base and increasingly pubescent towards apex of lobes, inner surface with a dense, long-villous annulus and sometimes with sparse pubescence along veins of lobes; filaments 5, (55–) 60–65 (–70) mm long, adnate basally for 6–9 mm, slightly bent at base, slightly curved at apex, coiling after dehiscence, villous only at base; anthers yellow-greenish or yellow, positioned ventrally at anthesis, versatile, narrowly oblong to lanceolate, straight in bud, not twisted after dehiscence, 9–12 mm long, 1–2 mm wide; styles only one, (55–) 65–80 mm long, 2–3 style branches 3–9 (–10) mm long, flattened, spreading in an irregular fashion, but not merely reflexed, slightly twisted, with acute apices, papillae covering only adaxial surface; ovary with multiple ovules per locule. Fruit 37–45 mm long, 15–20 mm wide, exceeding calyx lobes by 2–3 cm, a septicidal capsule, pendulous, immature capsule bright green, mature brown to black, with 4 flat seeds overlapping, seeds (18–) 19–22 × (7–) 10–11 mm, ovate, broadly winged.

Additional specimens examined (paratypes): BOLIVIA. **La Paz**: Prov. Sud Yungas, ca. 15 km from Huancané towards San Isidro, 16°20’S, 67°31’W, 2300 m, 1 Jul. 1995, (fl), *J.R.I. Wood 9965* (K, LPB); camino Huancané - Villa Mendoza, hacia San Isidro, 16°20’38”S 67°30’04”W, 2293 m, 16 Dic. 2020, (ste.), *I. Jiménez & S. Gallegos 9420* (LPB); ibid., 16°20’28”S, 67°30’04”W, 2418 m, 13 Oct. 2024, (fl., fr.), *A.F. Fuentes et al. 24543* (LPB, MO). COCHABAMBA: Prov. Arani. Localidad El Limbo. 17°08’13”S, 65°37’49”W, 2190 m, 12 Jun. 2003, *S. Altamirano et al. 778* (BOLV, MO); El Limbo, 17°08’20” S 65°36’44” W, 2180 m, 13 Jun. 2003, (fl.), *S. Altamirano et al. 835* (BOLV, MO); Prov. Chapare, Rio Carmen Mayu, sobre la Carretera Cochabamba -Villa Tunari, 17°08’48”S, 65°44’03”W, 1680 m, 21 Jul. 2005, (fl.), *M. Atahuachi et al.846* (BOLV, LPB); Chapare, Bajo Locotal, bosque a unos 10 km de la estación San José, 17°8’42”S, 65°46’34”W, 1300 m, 30 May. 2008, *J. Terán et al. 2701* (BOLV, MO); Chapare, Sillar, kilómetro 120 de la carretera Cochabamba - Villa Tunari, 17°07'34”S, 65°41'26”W, 1021 m, 29 Jun. 2008, J. *Terán et al. 2724* (BOLV, MO, RSA); Chapare, Oeste del Parque Nacional Carrasco, 17°07’59”S, 65°04’57”W, 1810 m, 25 May. 2012, (fl.) *J. Terán et al. 5565* (BOLV?, LPB).

Distribution and Habitat: In Dept. La Paz *Cobaea boliviana* grows in the Reserva Ecológica de Apa Apa, near Chulumani, the capital of Prov. Sud Yungas (Fig. 3). From this region *C. boliviana* has been collected four times from nearby sites at about 2350 m in a wet gully near a creek. This upper montane forest is a hotspot of biodiversity as it is a rather isolated area surrounded by deforest areas, shrublands and grasslands. It still harbors a high diversity of plant species and is a popular destination for bird watchers. This area has been

studied for over 40 years (Becks collection numbers 3043–3189, at LPB from 8–9 March 1980 with the well-known ecologist Heinz Ellenberg (1913–1997), University Göttingen (Beck *et al*., 2020), and later by David N. Smith from MO, who passed away in 1991 (1945–1991).

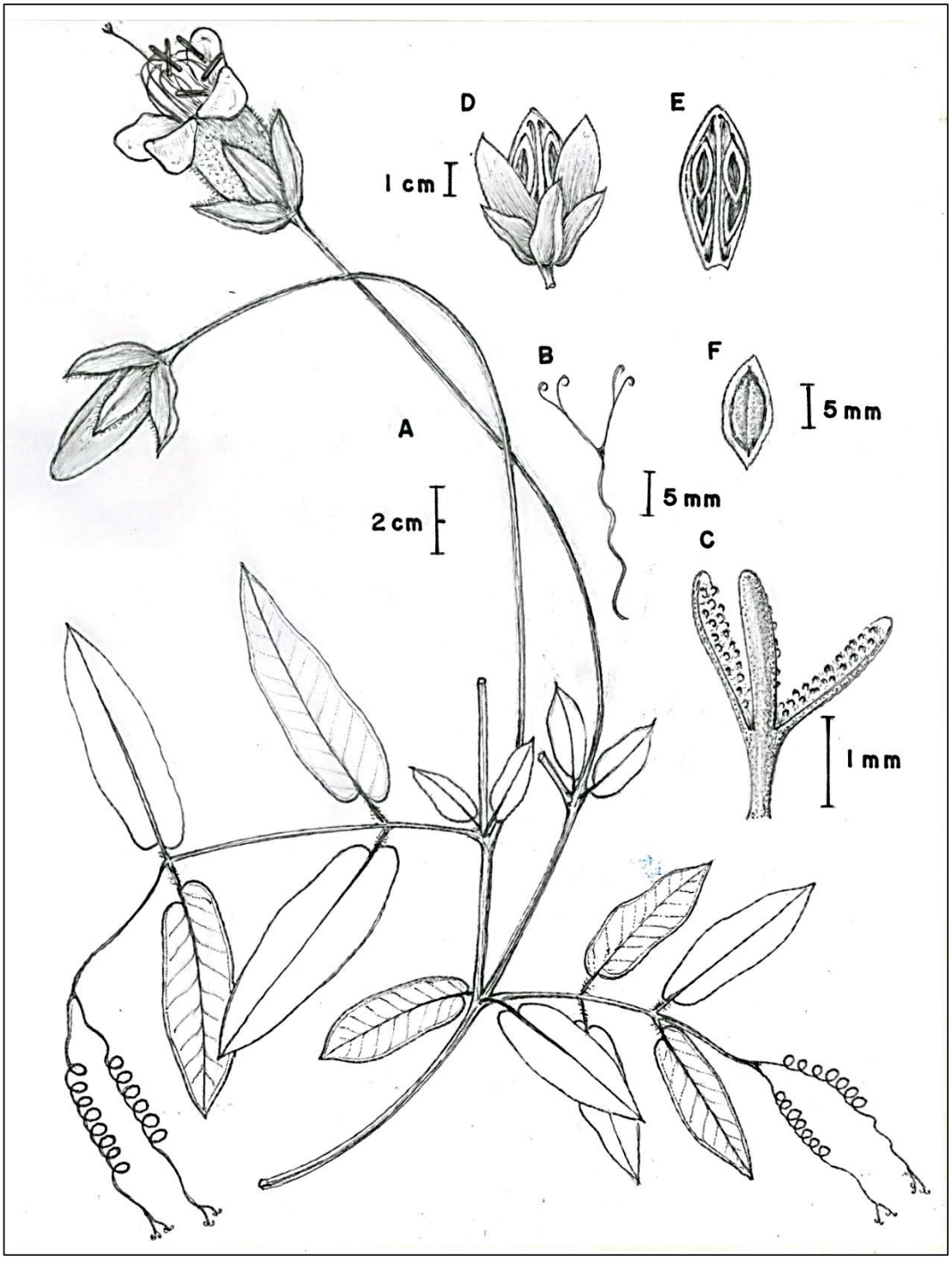

FIGURE 1. *Cobaea boliviana*, **A**. Habit with compound leaves and pair of bracts, flower, and immature fruit. **B**. Branched tendril. **C**. Stigma. **D**. Capsule. **E**. Segment of capsule with 4 seeds. **F**. Winged seed. A–C: from the Holotype *Beck 24882* (LPB), D–F: *Fuentes et al. 24543* (LPB). Drawn by Carlos Maldonado.

Recently data of vegetation, ecology, and a list of vascular plants, which includes 1.439 species in the Apa-Apa Mountain has been published with colleagues funded by the Deutsche Forschungs Gesellschaft and from Missouri Botanical Garden (Beck *et al*., 2024). We registered preliminary 151 endemics, and 80 are new species, severals still to be described, including the *Cobaea*, collected first in august 2000. The forest is composed of *Podocarpus ingensis* de Laub., *Pectinopitys harmsiana* (Pilg.) C.N. Page, nine palm species, several tree species of Lauraceae including three recently described *Ocotea* Aubl. species, (*O. comata* van der

Werff, *O. micrantha* van der Werff, *O. smithii* van der Werff), *Endlicheria chalisea* Chanderbali, *Beilschmiedia* Nees sp. and the endemic *Persea bilocularis* L.E. Kopp. Several Ericaceae are growing there, beside the epiphytic, endemic tuber wooded *Satyria boliviana* Luteyn. Four new Araceae of *Anthurium* Schott (Croat & Acebey, 2005) and some new of the about 100 fern species have been discovered from the region, as well as nearly 100 species of orchids, mostly epiphytic. Climbing species are relatively uncommon, but a scandent *Siphocampylus flagelliformis* Zahlbr., *Dioscorea* sp., eight species of the climbing genus of *Senecio* L., *Pentacalia* Cass., and two new to be described by J. Calvo (G), have been collected from the region.

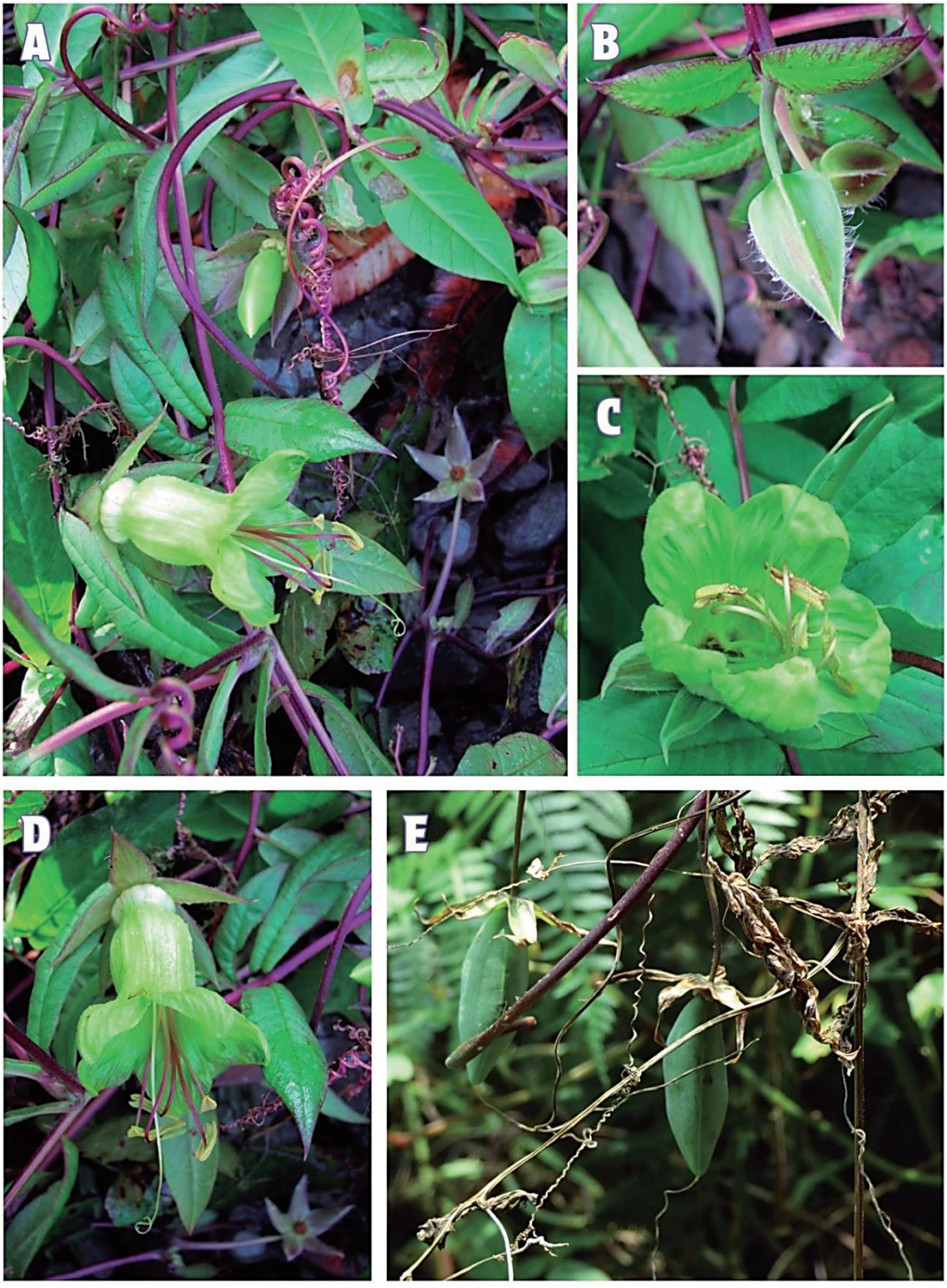

FIGURE 2. *Cobaea boliviana*. **A**. Habit with reddish stems, curled tendrils and lateral view of the flower. **B**. Flower bud with margin hairs. **C**. Front view of campanulate flower with cup shaped petals. **D**. Flower with open calyx. **E**. Pending fruits. A–D: *Teran et al. 5565*, E: *Fuentes et al. 24543*. Photos A–D by J. Terán, E by C. López.

In Dept. Cochabamba, *Cobaeae boliviana* has likewise been collected in a narrow region at the eastern end of the Parque National Carrasco where it is known from seven collections at altitudes between 1020–2190 m (Fig. 3). According to the label data of the specimens it is a rare species. In this region, the humid montane forest is composed of *Weimannia bangii* Rusby, *W. microphylla* Kunth, *Hedyosmum angustifolium* (Ruiz & Pav.) Solms, *H. racemosum* (Ruiz & Pav.) G. Don, *Alchornea pearcei* Britton ex Rusby, *Alchornea* cf. *latifolia* Sw., *Didymopanax morotoni* (Aubl.) Decne. & Planch., *Oreopanax* cf. *trollii* Harms and *Clethra scabra* Pers. The understory of the forest includes numerous ferns and species of Melastomataceae, Epiphytes are abundant. In this areas *C. boliviana* apparently also grows at lower altitudes between 1000 to 1300 m, where the forest has been partially exploited and destroyed.

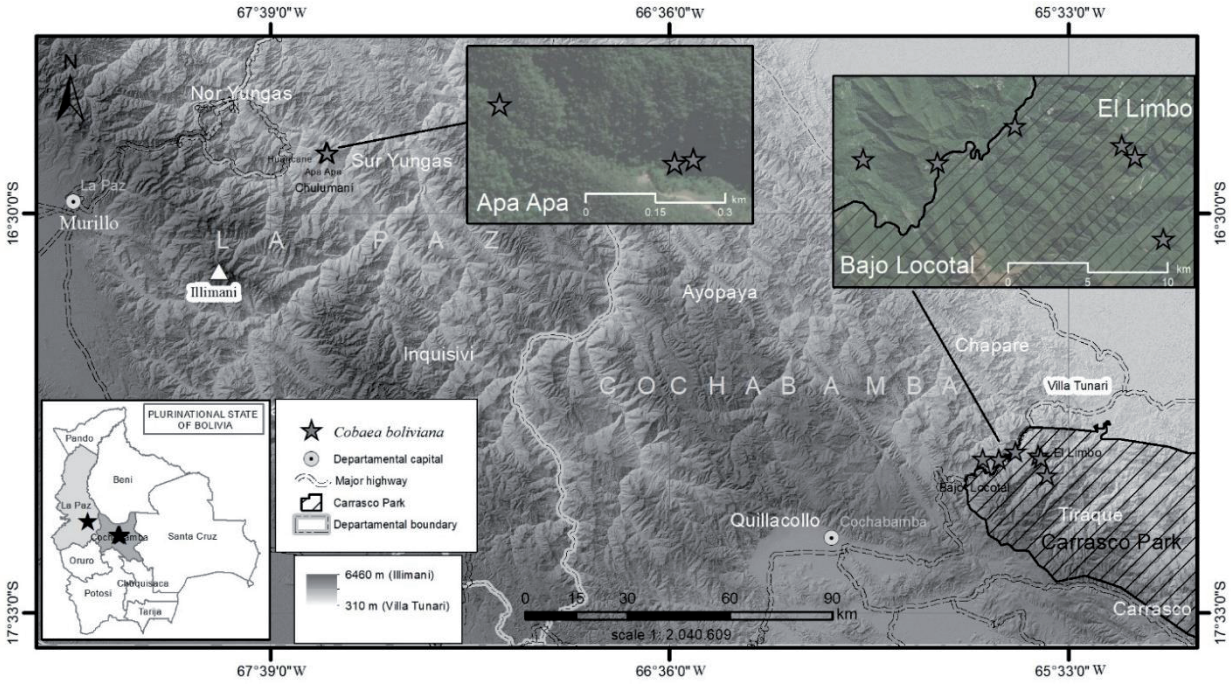

FIGURE 3. Distribution map of *Cobaea boliviana* in La Paz and Cochabamba. Elaborated by F. Zenteno.
Note: Collections cited from Prov. Arani corresponding to Prov. Tiraque according to coordinates

Phenology: *Cobaea boliviana* has been collected in flower May through August, and with immature fruits in May, June and August, mature fruits in October.

Etymology: *Cobaeae boliviana* has been found only in Bolivia and it is the only species of Cobaea that is native and endemic to the country.

Vernacular Names: No names are recorded.

Conservation status: Using the coordinates from all known collections, GeoCAT (Bachman *et al*. 2011) calculates an extent of occurrence (EOO) of 4023.4 km2 and an area of occupancy (AOO) of 32 km2, indicating the rarity of this species. The Reserva Ecológica de Apa Apa is protected by the local people because it is an important catchment for their water supply. However, construction of a small road from Huancané to Villa Mendoza - San Isidro in the valley below has brought about some disturbance that may affect the habitat of the species. Deforestation is an ongoing problem in the montane areas of the Dept. Cochabamba, but also in the Dept. La Paz, especially at lower altitudes where the terrain is less rugged. Even within the Parque National Carrasco human-mediated agricultural disturbance, mining, and logging are ongoing threats. Higher altitude habitats are less disturbed (S. Beck, pers. obs.). No local or foreign uses are known, so harvesting is apparently not a threat to the species. Based on the EOO and AOO, and its presence in at least eight localities an IUCN status (IUCN, 2012) of Endangered (EN) or Vulnerable (VU) would be appropriate. However, in the areas where it has been collected, there are currently no strong signs of deforestation or other imminent threats, and so based on the evidence available we consider the status Near Threatened (NT) as appropriate.

Phylogeny: According to preliminary results the new species belongs to section Rosenbergia, near to *Cobaea campanulata* and *C. flava* (Prather, 1999 - fig. 15).

Discussion: Species of *Cobaea* occurring in rather xeric habitats and others in mesic sites. Our species grows in a variety of habitats too, which may explicate the variety morphological. The variety of morphological differences are reflected by the new species too (see above) and also by the dilemma to differences in respect to the nearest relatives of *Cobaea flava* and *C. campanulata*. The *Cobaea* species are organized in several sections: preliminary studies suggest to include *Cobaea boliviana* in section Rosenbergia (Prather, to be confirmed).

Observation: The morphology of the species differs slightly between collections from the two different regions of its known distribution. The plants from Dept. La Paz have slightly tomentose petiolules and lanceolate calyx segments that are 26–29 mm long, while plants from Dept. Cochabamba have glabrous petiolules and narrowly ovate calyx segments that are 22–27 mm long.

key to the South American species of *Cobaea*

This key relies heavily on the key found in the monograph of the genus (Prather, 1999) but for *C. lutea* and *C. scandens* the characters are based only on South American and material are not meant to characterize morphological diversity of North American specimens, especially of the widespread and highly variable C. *lutea*. Notably, the only South American collection of *C. lutea* is *Woytkowksi 7330* (MO-2, S, UC; Prather, 1999).

1. Corolla lobes linear, several times longer than broad, longer than the corolla tube.
   2. Pedicel villous; calyx segments densely long-ciliate ..... ***C. aequatoriensis***
   2. Pedicel glabrous to puberulent, but never villous; calyx segments glabrous or sparsely ciliate . ..... ***C. penduliflora***
1. Corolla lobes orbicular, ovate, or triangular, no more than 1.5 times as long as broad, shorter than the tube
   3. Calyx segments round, apex rounded ..... ***C. scandens***
   3. Calyx segments narrowly lanceolate to lanceolate, apex acute to attenuate.
      4. Filaments becoming undulate after anthesis; stigmatic branches 2–3 mm long, their apices distinctly rounded ..... ***C. trianae***
      4. Filaments coiling after anthesis; stigmatic branches 3–10 mm long, their apices more or less acute.
         5. Filaments 55–70 mm; styles 55–80 mm.
            6. Corolla lobes 12–15 mm wide; anthers 8–9 mm long; Peru ..... ***C. lutea***
            6. Corolla lobes 15–22 mm wide; anthers 9–12 mm long; Bolivia ..... ***C. boliviana***
         5. Filaments 23–50 mm; styles 28–50 mm.
            7. Pedicels 10.5–16 cm long; corollas light yellow or white, 24–30 mm, annulus 4–6 mm above base of corolla, Peru ..... ***C. flava***
            7. Pedicels 20–28 cm long; corollas green, sometimes suffused with purple, annulus 8–14 mm above base of corolla, Ecuador ..... ***C. campanulata***

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