Passiflora unipetala, a New Bat-pollinated Species of *Passiflora* supersect. *Tacsonia* (Passifloraceae)

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ABSTRACT. *Passiflora unipetala* P. Jørg., Muchhala & J. M. MacDougal (Passifloraceae) is described from two cloud forest remnants in Pichincha, Ecuador, and is assigned to the Andean endemic *Passiflora* L. supersect. *Tacsonia* (Juss.) Feuillet & J. M. MacDougal. This new species with yellowish green flowers is distinguished from all other passionflowers by having only one petal. It is pollinated by bats, which is rare in *Passiflora*.

Key words: Bat pollination, Ecuador, IUCN Red List, *Passiflora* supersect. *Tacsonia*, Passifloraceae.

Described within *Passiflora* L. (Passifloraceae), the new species was discovered and first collected by Muchhala in May 2009 while he studied the ecology of flower-visiting bats in Ecuador, and then collected and documented again by him at a different locality in June 2010. The type was collected in June 2009 from the same plant that Muchhala had observed earlier that year. Jørgensen and Ulloa returned again to the type locality in June 2011 and April 2012 to collect more flowering material if possible, but a landslide had destroyed the plant or clone.

This new species in *Passiflora* has only a single petal. This notable character-state has never before been recorded in the genus or even within the family. The petal is large, situated in the uppermost part of the horizontally presented flower, and is well-developed enough to shield the pollen and stigmas from rain. The species is placed in *Passiflora* supersect. *Tacsonia* (Juss.) Feuillet & J. M. MacDougal based on the large verticillate bracts, large flowers with an elongate floral tube longer than the sepals, very reduced corona, pollen with three primary opercula, foveate testa, and 3-lobed serrate leaves with petiolar glands.

Passiflora unipetala P. Jørg., Muchhala & J. M. MacDougal, sp. nov. TYPE: Ecuador. Pichincha: Bellavista Cloud Forest Reserve, next to Research Center entrance, Tandayapa–Mindo rd., turnoff toward Nanegalito, 2350 m, 00°00′47″S, 78°41′12″W, 24 June 2009, *P. M. Jørgensen & C. Ulloa 2486* (holotype, MO; isotypes, QCA, QCNE). Figures 1, 2.

Haec species *Passiflorae ampullaceae* (Mast.) Harms similis, sed ab ea petalo unico, bracteis ovato-ellipticis luteoviridibus, stipulis linearibus integris atque fructu costato triangulari-ellipsoideo differt.

Liana to 6 m; stem cylindrical, drying dark brown with light brown stripes, shoot apex cernuous; internodes 6.8–13.4 cm; indument pale brown translucent, sparingly pubescent, trichomes curly. Stipules linear, 8–10 × 0.8–1 mm, early deciduous, particularly pubescent toward the apex, upper 1/3 pinkish; petioles 2.2–2.9 cm, canaliculate adaxially, pubescent; glands 4 to 6(to 8) adaxially, scattered or occasionally 1 pair and the rest scattered, very reduced in size and possibly nonfunctional, pubescent; leaves trilobed (8–)10–16 cm wide; lobes narrowly ovate, acute; margin serrate, central lobe 8–12.6 × 2.6–4.1 cm, lateral lobes 6–9 × 1.7–2.6 cm; lamina matte to slightly lustrous above, dark green, primary nerves impressed, secondary nerves slightly raised in a depression, and tertiary nerves raised, pubescent only on principal nerves toward the base, trichomes white; undersurface lighter green, densely pubescent, trichomes white translucent along all nerves, surface between nerves glabrous, all nerves prominently raised. Flowers axillary, solitary, horizontal, light yellowish green, with no human-

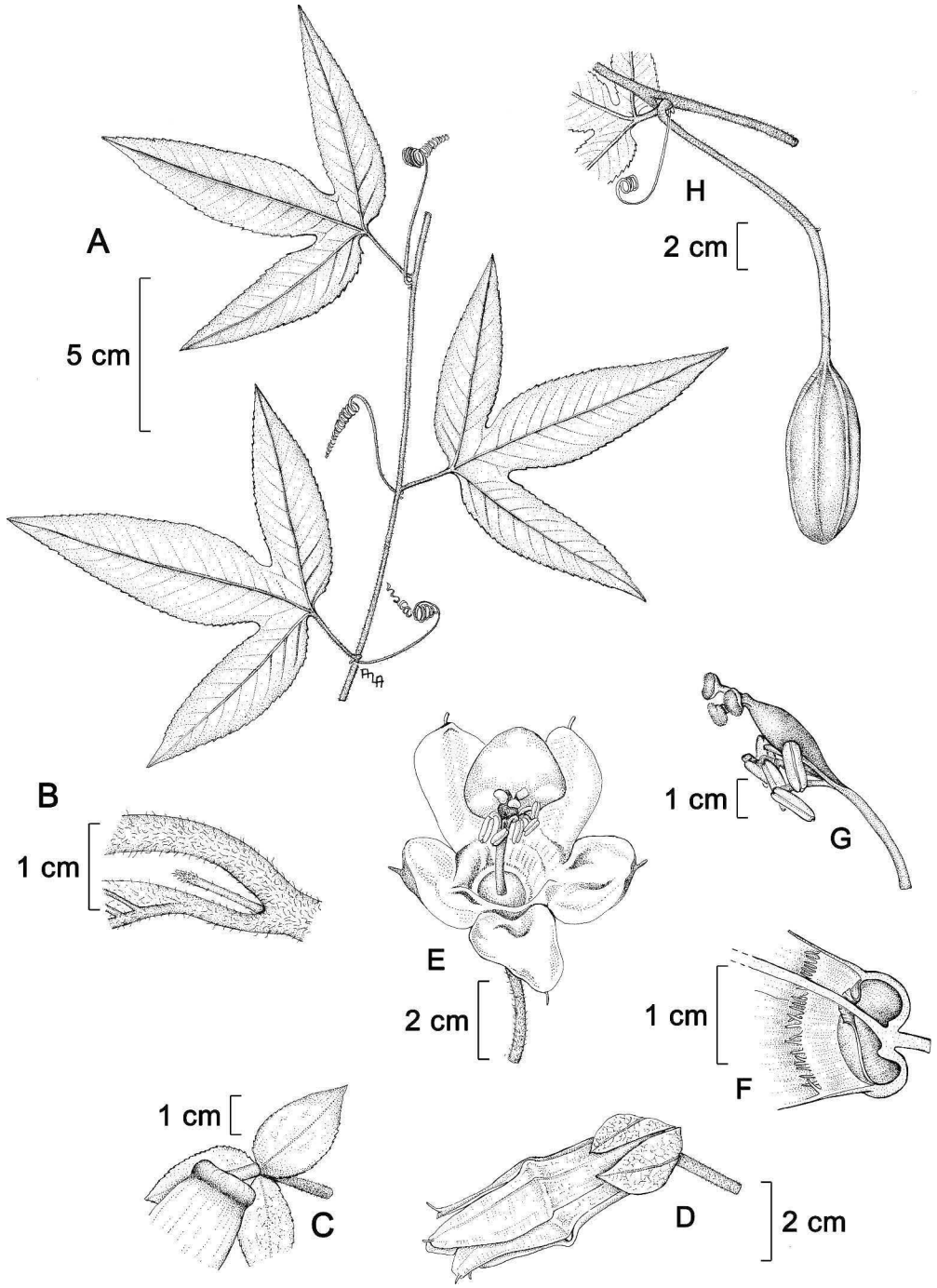

Figure 1. *Passiflora unipetala* P. Jørg., Muchhala & J. M. MacDougal. —A. Habit of leaves, pre-reproductive shoot. —B. Detail of node, showing stipule. —C. Bracts near base of flower at articulation of peduncle. —D. Side view of flower closed after anthesis. —E. Flower, front view; note single petal and dimples at base of lower sepals. —F. Flower, longitudinal section at base of floral tube showing nectary chamber and hypanthium, row of coronal filaments, and operculum membrane near base of eccentric curved androgynophore. —G. Gynoecium and androecium at end of androgynophore. —H. Fruit, habit. A–D, F–G, drawn from the holotype, including photographs of same (*P. M. Jørgensen & C. Ulloa 2486*, MO); E, drawn from photographs of the paratype (*N. Muchhala 303*, MO); and H from photographs of the paratype (*N. Muchhala 450*, QCA).

Figure 2. *Passiflora unipetala* P. Jørg., Muchhala & J. M. MacDougal. —A. Flower and bud in situ, oblique side view. —B, C. The bat, *Anoura fistulata* Muchhala, Mena-Valenzuela & Albuja, feeding at flower during a clinging-type visit. Note thumb-claw and contact of anthers on back of bat. Photos taken by Muchhala at the type locality in Bellavista Cloud Forest Reserve, Pichincha, Ecuador.

detectable odor; peduncles 10.7–13 cm, including portion distal to articulation, no significant elongation in fruit, slightly pubescent, stout and thick, sometimes flushed reddish; bracts 3.3 × 1.5 cm, free, located at articulation 0.9–1.1 cm from hypanthial base, ovate to elliptic, acute, yellow to yellowish green, margins denticulate, teeth occasionally glandular, reticulate venation visible; hypanthium (floral tube) 3.4 cm long, 2 cm wide at apex, 1.2 cm at base, light green to light yellowish green outside, whitish inside; sepals 5 in number, 3–3.4 × 1.7–2 cm, ovate, ridged to folded transversely at base, conspicuously keeled, acute, light yellowish green, aging to a slight reddish or pink flush adaxially as flower closes, aristate subterminally, awn 4–4.5 mm; petal 1, 3.4 × 2(–2.6) cm, ovate, obtuse, light yellowish green; outer corona absent, reduced to a mere irregular ridge at the base of the petals where the outer corona is typically located in tacsonias, inner corona placed ca. 5 mm above base of hypanthium, consisting of ca. 1 mm filiform projections toward the apex of the flower; operculum flat, curved toward apex of flower clasping the androgynophore, margin irregularly denticulate; androgynophore 4 cm, slightly curved, eccentric, white; androecium zygomorphic, presenting pollen downward, free filaments 0.9–1.4 cm, white; anthers yellow; pollen grains subspherical, 46–52 μm diam., coarsely reticulate, with wavy muri, zonocolpate, geminicolpate with 3 pairs of colpi, each pair anastomosing at the poles, forming 3 pseudopercula, secondary opercula absent, 47,110 ± 7622 SE pollen grains per flower; ovary ellipsoid, green, hexagonal to obtusely 6-ridged in cross section, glabrous; styles cream; stigmas light green. Fruit 8.5–9 cm, including 1 cm stipe, 3.3–3.5 cm diam., ellipsoid, 3-ribbed and somewhat triangular in cross section, turning yellowish orange at maturity; seeds 8.7 × 5.1 mm, the testa shallowly foveate near the center of each face.

Distribution. *Passiflora unipetala* is endemic to cloud forests of the northwestern slopes of the Andes of Ecuador. It has been collected at elevations from 1950 to 2350 in two private reserves: Bellavista Cloud Forest Reserve and Bosque Protector Rio Guajalito.

IUCN Red List category. *Passiflora unipetala* is only known from two individuals at two localities about 30 km apart, and the type individual perished in a landslide between 2009 and 2011. The species conforms to IUCN (2001) criteria B, C, and D as Critically Endangered (CR). However, the western slopes of Pichincha at ca. 2000 m elevation are still relatively well preserved, and the two localities are both within privately protected areas.

Ecology and phenology. *Passiflora unipetala* is pollinated by glossophagine bats (Fig. 2); its pollen has been found on the fur of *Anoura caudifer* Geoffroy, *A. geoffroyi* Gray, and *A. fistulata* Muchhala, Mena-Valenzuela & Albuja, in both of the collection sites, as well as at El Pahuma Orchid Reserve at 2000 m (Muchhala & Jarrin-V., 2002; Muchhala et al., 2005). It apparently presents a steady-state (year-long) flowering schedule, as bats have been captured with its pollen throughout the year (including February, March, April, June, July, September, October, and December; Muchhala, unpublished data). During flower visits, bats have been observed to either continue hovering while visiting the flowers in less than a second (supplemental video available from Muchhala), or to briefly cling to the hypanthium with their thumb-claws (e.g., Fig. 2B).

Etymology. The specific epithet refers to the presence of a single petal, reflecting the evolutionary loss of four of five petals, a characteristic unique to this species among the family.

Relationships. *Passiflora unipetala* clearly falls in *Passiflora* supersect. *Tacsonia*, and would key to *P. ampullacea* (Mast.) Harms or *P. coactilis* (Mast.) Killip in the *Flora of Ecuador* (Holm-Nielsen et al., 1988), although it differs from both in only having a single petal (vs. five). *Passiflora unipetala* is quite similar to *P. ampullacea* in its flower color and shape, and might be closely related, but differs by the stipules that have an entire margin (vs. denticulate margin), and by the ribbed, subtriangular fruit (vs. nonribbed and terete in cross section). It differs from the pink-flowered *P. coactilis* by the deeply lobed leaves, free bracts, stout peduncles that hold the yellowish green flowers horizontally, gullet-shaped hypanthium, and ribbed fruits.

Another group of species to consider for relationships and placement of the new species is *Passiflora* sect. *Rathea* (H. Karst.) Harms in *Passiflora* supersect. *Tacsonia*. The species *P. andina* Killip, *P. harlingii* Holm-Niels., and *P. colombiana* L. K. Escobar all have yellowish green to orange or salmon-colored pendent gullet-shaped flowers, a corona series on the inner floral tube wall (occasionally missing), and deeply trilobed leaves. The characteristics that separate them from *P. unipetala* are the five petals inserted below the fused sepals and the fact that the stipules are all linear lanceolate, occasionally serrate, but never linear aciculate.

A logical placement of *Passiflora unipetala* would be near *P. ampullacea* or within *Passiflora* sect. *Rathea*. Both of those taxa share with the new species

the characteristic of cernuous growing-shoot apices, a derived character-state in *Passiflora* supersect. *Tacsonia*. Convergence and reductions could easily be in play here, so the phylogenetic position of *P. unipetala* within *Passiflora* supersect. *Tacsonia* will have to await more detailed analysis. In any case, it appears that this bat-pollinated species has been derived from hummingbird-pollinated relatives in *Passiflora* supersect. *Tacsonia*.

The well-developed single petal is unique. There are a few species of fundamentally apetalous *Passiflora* that occasionally have flowers with only one (or more) small, poorly developed petals, e.g., *P. apetala* Killip, but those petals appear vestigial and only a few millimeters in size. Members of *Passiflora* supersect. *Cieca* (Medik.) J. M. MacDougal & Feuillet have similarly lost all of their petals, although in a few of the species it is occasionally possible to find anomalous single flowers on a plant with one or two petals (MacDougal, 1992; Porter-Utley, 2003).

Passiflora unipetala exhibits a number of characteristics known to be associated with a syndrome of chiropterophily (Faegri & van der Pijl, 1979; von Helverson, 1993), including nocturnal anthesis, a wide flower opening with a gullet- or funnel-shaped floral tube, and a light greenish or yellowish green floral color. However, it lacks the musky or skunky odor typical to bat-flowers; in fact, no odor could be detected. The flower has a particularly undulating surface at its mouth created by folds and indentations in the sepals, including unusual dish-shaped pockets or dimples inside at the base of the sepals (see Fig. 1E). The function of this sculpturing could be to give the flower more physical strength to support the nectar-seeking bat and maintain the mouth of the flower open and accessible. Alternatively, the folds and shapes may have acoustic properties that help the bats to locate the flower, as has been shown recently for other bat-pollinated flowers (e.g., von Helversen & von Helversen, 1999; Simon et al., 2011). *Passiflora* sect. *Rathea* (mentioned above as a possible relative of the new species) also has species with unusual gullet-shaped to somewhat tubular flowers with conspicuous folds and dimples near the mouth, formed by the petals in that case, but their pollinators are unknown. Such dimples are not found in *P. ampullacea*, which after a full night of observation was found to be visited by hummingbirds in the early morning (Escobar, pers. comm.).

With *Passiflora unipetala*, there are now eight out of ca. 575 species of *Passiflora* with flowers known to be bat-pollinated: *P. mucronata* Lam. (Sazima & Sazima, 1978, 1987; Varassin et al., 2001), *P. contracta* Vitta, *P. ovalis* Vell. ex M. Roem. (as *Tetrastylis ovalis* (Vell.) Killip; Buzato & Franco, 1992), an unpublished species in *Passiflora* supersect. *Laurifolia* (Killip ex Cervi) Feuillet & J. M. MacDougal from Venezuela (Vanderplank, 1996), *P. penduliflora* Bertero ex DC. (Kay, 2001), *P. silvestris* Vell. (as *P. galbana* Mast.; Varassin et al., 2001), and *P. trisecta* Mast. (Muchhala, pers. obs.). In addition there are nine species with flowers that appear bat-adapted, although actual pollinator observations are lacking: *P. macropoda* Killip, *P. weberbaueri* Harms, *P. peduncularis* Cav. (Ulmer & MacDougal, 2004), *P. recurva* Mast. (Machado & Vogel, 2004), *P. setacea* DC., *P. hatschbachii* Cervi, *P. andina* Killip, *P. harlingii* Holm-Niels., and *P. colombiana*.

Paratypes. ECUADOR. **Pichincha:** Reserva Bellavista, 30 m from research station on rt. side of rd. to lodge, 2350 m, 00°00′47″S, 078°41′12″W, 30 May 2009, *N. Muchhala 303* (MO); Reserva Rio Guajalito, beginning of Cascadas trail, 1949 m, 00°14′45″S, 078°48′08″W, 24 June 2010, *N. Muchhala 450* (QCA-208301, QCA-7007687).

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