



<https://doi.org/10.11646/phytotaxa.362.3.2>

New species of *Burmeistera* (Campanulaceae: Lobelioideae) from Ecuador

ANDREA F. VALLEJO¹, ÁLVARO J. PÉREZ², DANIELA CEVALLOS² & NATHAN MUCHHALA³

¹Departamento de Mamíferos, Museo de Zoología QCAZ, Escuela de Ciencias Biológicas, Pontificia Universidad Católica del Ecuador, Apartado 17-01-2184, Quito, Ecuador; E-mail: andreavallejofv@yahoo.es

²Herbario QCA, Escuela de Ciencias Biológicas, Pontificia Universidad Católica del Ecuador, Apartado 17-01-2184, Quito, Ecuador. E-mail: ajperez@puce.edu.ec, davcevallos@puce.edu.ec

³Department of Biology, University of Missouri-St. Louis, St. Louis, Missouri 63121, U.S.A. E-mail: muchhala@umsl.edu

Abstract

Two new species of *Burmeistera* endemic to Ecuador are described and their relationship with other species are discussed. *Burmeistera pterifolia* has an extremely narrow distribution on the northwestern foothills of the Andes in the Pichincha province, and it is easily differentiated from its congeners by its pinnatilobate leaf margin and large calyx lobes. The second species, *Burmeistera draconis*, is recorded from the Zamora Chinchipe province. It is distinctive in possessing an irregularly bidentate leaf margin and cylindrical inflated fruits with short calyx lobes.

Resumen

Dos especies nuevas de *Burmeistera*, endémicas de Ecuador son descritas y sus relaciones con otras especies son discutidas. *Burmeistera pterifolia* presenta un rango de distribución muy restringido en las estribaciones noroccidentales de los Andes en Pichincha. Esta especie se diferencia fácilmente de sus congéneres por el margen pinnatilobado y los lóbulos del cáliz alargados. La segunda especie, *Burmeistera draconis*, ha sido registrada en Zamora Chinchipe. Se distingue por presentar hojas con el margen irregularmente bidentado y frutos cilíndricos con los lóbulos del cáliz cortos.

Keywords: Andes, *Burmeistera*, Campanulaceae, Ecuador, new species, taxonomy

Introduction

The genus *Burmeistera* Karsten & Triana (1854: 13) (Campanulaceae: Lobelioideae) is represented by ~ 120 species (McVaugh 1965, Muchhala & Lammers 2005, Lammers 2007, Garzón Venegas & Gonzáles 2012, Garzón Venegas *et al.* 2012, Garzón Venegas *et al.* 2013, Lagomarsino *et al.* 2015, Muchhala & Pérez 2015). It is the fourth largest genus of the Lobelioideae, after *Lobelia* Linnaeus (1753: 929) with more than 400 species, *Siphocampylus* Pohl (1831: 104) with approximately 230 species, and *Centropogon* Presl (1836: 48) with more than 220 species (Lammers 2007). *Burmeistera* is differentiated from the closely related genera *Centropogon* and *Siphocampylus* (Antonelli 2008) by its combination of usually ebracteolate pedicels, green or yellow corollas often suffused with maroon or purple, large falcate or reflexed dorsal corolla lobes, the wide open orifice of the anther tube, baccate, often inflated fruit, and oblong to fusiform seeds, much longer than broad (Lammers & Mass 1998, Lagomarsino *et al.* 2015).

The last comprehensive account of *Burmeistera* was the monograph by Wimmer (1943), and since then floristic treatments for the genus have been published for most of the countries in which it occurs, including Guatemala (Nash 1976), Costa Rica (Wilbur 1976a), Panama (Wilbur 1976b, 1981), Ecuador (Jeppesen 1981), and Peru (Stein 1987). *Burmeistera* reaches its highest diversity and endemism at mid-elevations (1500–2500 m) of the Andes of northern South America, where up to six species can co-occur at a single locality (Moreno & Muchhala 2011, Muchhala & Potts 2007). Thirty-seven species of *Burmeistera* occur in Ecuador (Jeppesen 1981, Jørgensen & León-Yáñez 1999, Lammers 2007, Muchhala & Pérez 2015), although species diversity drops sharply in the southern provinces (El Oro, Loja, Zamora Chinchipe), where only 4 species have been recorded.

The flowers of *Burmeistera* are protandrous and last about six days, with pollen shedding from the anther tube during the initial 1–2 days (the male phase). After this the stigma emerges from the anther tube and becomes receptive for the remaining days (the female phase) (Muchhala & Jarrín 2002). It is well-known that *Burmeistera* species are pollinated by bats, although one species is pollinated exclusively by hummingbirds (Muchhala 2006, Muchhala 2008). Nectar feeding bats use their sensorial system to locate flowers, and thus these flowers have evolved special features to increase attraction, including musty smells, dull colors, and nocturnal anthesis (Baker 1961), and some flowers have structures that maximize the sound reflectance from bat echolocation calls (von Helversen *et al.* 2002).

Material for the species described here was collected during surveys conducted along poorly collected areas in the south of Ecuador (Muchhala & Pérez 2015) and bat ecological research in Santa Lucia Cloud Forest Reserve. Based on the leaf margin morphology and several floral and fruit features observed in these plants we concluded that they are two species new to science. Both species are here described, illustrated and their relationships with other species discussed.

Materials and Methods

This study is based on: (1) collections and field observations of individuals found along tracks of the Tapichalaca Reserve in Zamora Chinchipe province and the Santa Lucia Cloud Forest Reserve in Pichincha province; (2) review of relevant literature as well as type images of *Burmeistera* available at JSTOR Global Plants (<http://plants.jstor.org/>) and online herbaria; and (3) examination of collections available at MO, QCA, and QCNE. The conservation status assessment is based on the IUCN (2012).

Taxonomy

Burmeistera pterifolia A. F. Vallejo, A. J. Pérez & N. Muchhala, *sp. nov.* (Fig. 1, 2)

Type:—ECUADOR. Pichincha: Cantón Quito DM, Parroquia Nanegal, Santa Lucia Cloud Forest Reserve. On ‘Loop trail’, near where it joins the principal trail, ca. 2000 m, 00°07′06.5″ N, 78°36′30.5″ W, 05 June 2016 (fl, fr), A. F. Vallejo 001 (holotype: QCA236942!, isotype MO!).

Burmeistera pterifolia differs from other species of *Burmeistera* by having lanceolate leaves with brochidodromous venation and a pinnatilobate margin, and long, narrowly triangular calyx lobes.

Freestanding herb to subshrub, ca. 1 m tall; stems 2.5–5.0 mm diam., hispidulous, pale green; latex white. Leaves alternate, distichous, chartaceous; lamina lanceolate, glabrous, apex acute, base truncate to decurrent, 55–126 × 14–33 mm, distal leaves gradually smaller than proximal leaves, adaxial leaf green with whitish color along venations and abaxial surface garnet greenish with light green venations; margin pinnatilobate; venation brochidodromous, hispidulous along the nerves at the underside, with 10 to 12 pair of secondary veins; petiole 6–11 mm long × 0.6–1.3 mm diam., hispidulous. Flowers solitary; pedicels 25–65 mm long × 0.5–1.5 mm diam., hispidulous, garnet to green, ascending at anthesis, patent in fruits, ebracteolate. Buds and flowers light green perfused with spinel pink. Hypanthium hemispherical, 5.8–6.1 mm long × 3.8–4.7 mm diam., hispidulous, with color similar to pedicels. Calyx lobes long and narrowly triangular, 13.4–15 × 2.2 mm, hispidulous, with fine reticulate venation, margin almost smooth, with 4–5 inconspicuous denticulate edges; apex acuminate to acute. Exterior of corolla light green suffused with spinel pink, this color could or not be present in the dorsal side of the flower and inside of the corolla, hispidulous, corolla base wider than hypanthium, to 6.5 mm diam., 20 mm long, corolla tube slightly curved, 13–15 mm long dorsally, narrowing from the base to the middle to 6.6–8.0 mm long; the two dorsal lobes lanceolate, falcate, 11–15 × 2–3 mm, acute at apex; the three ventral lobes distended at the base, 0.4–0.8 × 2–4 mm and narrowly triangular, acute at apex. Staminal column long, exerted to ca. 17 mm beyond dorsal lobes; filament tube 23–27 mm long × 1.0–1.3 mm diam., slightly curved, villous, light green; anther tube curved-cylindrical, 7.0 mm long × 3.0 mm diam., dorsal and ventral anthers barbate, light green suffused with purple between each anther; dorsal anthers 5.0–8.0 mm long; ventral anthers 3.0–4.6 mm long. Berries globose or ovoid, inflated with 2.0 mm thick walls, dark green when immature, light green to whitish-green when mature, 27–32 mm long × 24–27 mm diam., crowned by persistent calyx lobes; seeds elliptic, 1.0–1.2 mm.



FIGURE 1. *Burmeistera pterifolia* A.F. Vallejo, A.J. Pérez & N. Muchhala, *sp. nov.* A. Pollination by Lesser Tailless Bat (*Anoura caudifer*). B. Side view of leaves and flower in female phase. C. Close-up of flower in male phase. D. Abaxial view of leaves. E. Fruit. Photos by Andrea F. Vallejo.



FIGURE 2. Distribution map of *Burmeistera pterifolia* (circle, Santa Lucia Cloud Forest Reserve in Pichincha province) and *B. draconis* (star, Reserva Tapichalaca in Zamora Chinchipe province) in Ecuador.

Etymology:—The epithet derives from the greek *pterido* or *ptéri-s/-dos*, which means fern, and *folia* from *fylla*, which means leaves; in reference to the fern-like leaves of the species. In fact *B. pterifolia* can easily be confused with a fern when only leaves are observed.

Distribution, habitat and ecology:—*Burmeistera pterifolia* is endemic to the northwestern foothills of the Andes at the Pichincha province. Until now it is only known from the type locality, the Santa Lucia Cloud Forest Reserve (Fig. 2), an area of 800-ha managed and protected by the local community through ecotourism initiatives. It grows in cloud forest between 1870–2000 m, and is often highly abundant, with more than 40 plants in an area of 10 m². According to the Ministerio del Ambiente de Ecuador (2013) this locality lies within a much larger zone dominated by bosque siempreverde montano bajo de la cordillera occidental de los Andes (BsBn04) and bosque siempreverde montano de la cordillera occidental de los Andes (BsMn03). Flowers open at night and are pollinated by the Lesser Tailless Bat (*Anoura caudifer*) (Fig. 1A).

Phenology:—Flowers and fruits are most abundant from June to July, but fertile plants have been observed throughout the year.

Conservation status:—This species was found in Santa Lucia Cloud Forest Reserve, a privately owned 800 ha area which has been a protected since 1990s. Although the type locality is protected, there is evidence of high human disturbance related to cattle raising and agricultural activities in the surrounding areas. Currently it is impossible to assess its precise conservation status as further exploration into nearby areas is needed. Thus we propose to rank this species as Data Deficient (DD).

Discussion:—*Burmeistera pterifolia* is easily distinguishable by its lanceolate leaves with brochidodromous venation and the exceptional pinnatilobate margin, a unique feature among the Ecuadorian species, and its long, narrowly triangular calyx lobes. It is most similar to *Burmeistera truncata* Zahlbruckner (1915: 531), a species from the western foothills of Pichincha province in Ecuador and Antioquia Department in Colombia, with which it shares its lanceolate leaves, long calyx lobes and inflated fruit type, but *B. truncata* lacks the pinnatilobate leaf margin. Three other species of *Burmeistera*, all endemic to departments of Colombia, also possess pinnatifid leaves: *Burmeistera pteridioides* McVaugh (1965: 400) from Boyaca Department, *Burmeistera pinnatisecta* Luteyn (1986: 474) from Cauca

Department, and *Burmeistera multipinnatisecta* Lozano & Galeano (1986: 53) from Choco Department. All have much deeper leaf divisions which reach nearly to the midrib. The latter species is further distinguished by multipinnate (vs. unipinnate) leaves.

Additional specimens examined (paratypes):—ECUADOR. Pichincha: Cantón Quito DM, Parroquia Nanegal, Santa Lucia Cloud Forest Reserve. On ‘Loop trail’, near where it joins the principal trail, ca. 2000 m, 00°07′06.5” N, 78°36′30.5” W, 21 Jul 2014 (fl), *N. Muchhala* 522, 523 (QCA!).

Burmeistera draconis A. J. Pérez & N. Muchhala, *sp. nov.* (Fig. 2, 3)

Type:—ECUADOR. Zamora Chinchipe: Nudo de Sabanilla, east slope ca. 5 km from pass on road Yangana-Valladolid, montane rain forest, 04°30’S, 79°10’W, 2700 m, 04 April 1985 (fl,fr), *Harling G. & Andersson* L. 23645 (holotype: QCA26693!, isotype: G, MO 1290161!, NY 1185765!).

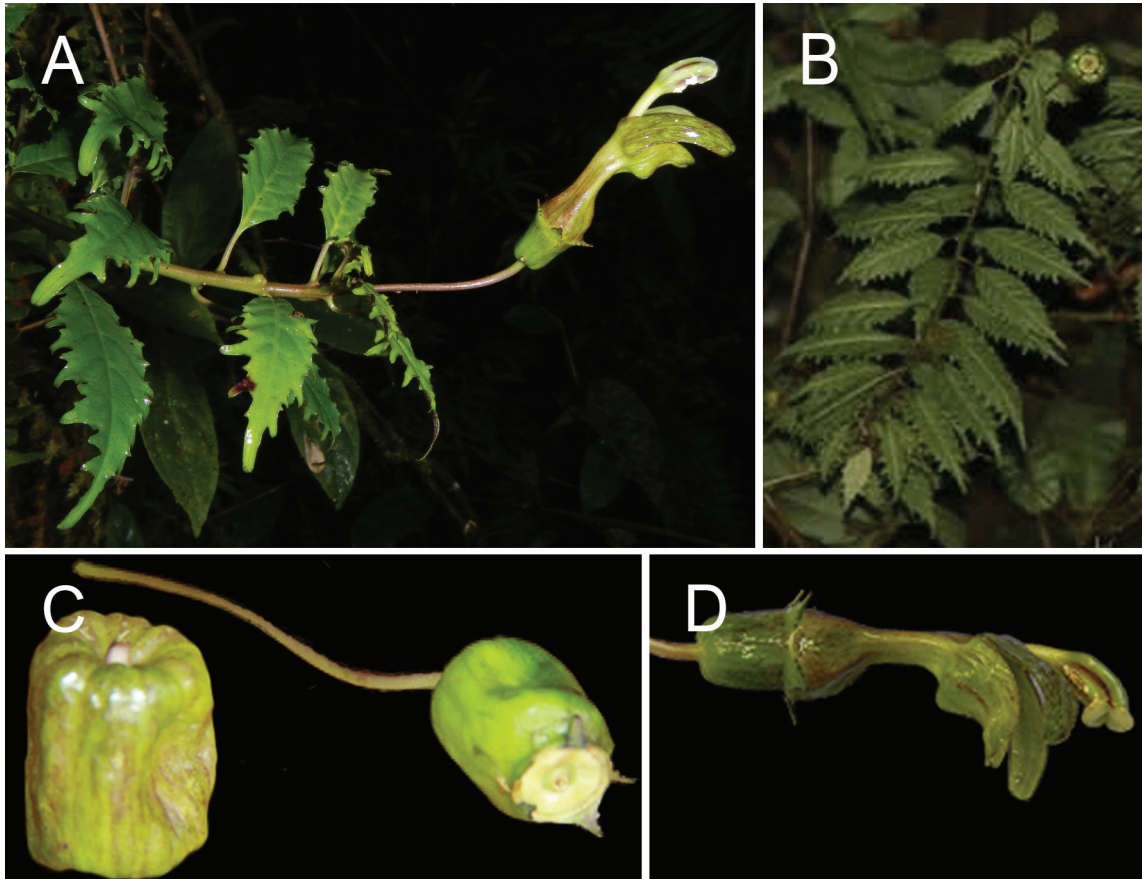


FIGURE 3. *Burmeistera draconis* A. J. Pérez & N. Muchhala, *sp. nov.* **A.** Dorso-lateral view of leaves and male flower. **B.** Abaxial view of leaves and fruit. **C.** Fruits. **D.** Female flower, lateral view. Photos by Álvaro J. Pérez.

Burmeistera draconis differs from other species of *Burmeistera* by having elliptic leaves with an irregularly toothed margin and cylindrical inflated fruits with short calyx lobes.

Freestanding shrub, 1.0–2.5 m with multiple stems, to scandent hemi-epiphytic shrub, climbing to 2–5 m; stems 8.0–15 mm diam., hispidulous, pale green; branches 2.0–5.0 mm diam., hispidulous, pale green; latex white. Leaves alternate, spirally arranged, chartaceous; lamina elliptic, glabrous, apex attenuate, base decurrent, 18–80 × 7.0–25 mm, distal leaves gradually smaller than proximal leaves, leaf surfaces pale green when fresh, olive-green when dried; margin irregularly bidentate, the larger up to 6.0 mm long, with obtuse to rounded apices; venation semi-craspedodromous, hispidulous on both sides, with 8 to 14 pair of secondary veins; petiole 5.0–20 mm long × 0.7–1.3 mm diam., hispidulous. Flowers solitary in upper leaf axils, light green suffused with maroon; pedicels 40–65 mm long × 0.6–2.0 mm diam., hispidulous, pale green, curved to sinuate and ascending at anthesis, declined in fruit, ebracteolate. Hypanthium cup-shaped, 7.1–9.5 mm long × 5.0–7.0 mm diam., glabrous, light green. Calyx lobes triangular, 3.0–5.0 × 2.0–3.0 mm, glabrous, patent to arcuate at anthesis, with fine reticulate venation, margin finely denticulate, with 4.0–5.0 teeth per side; apex acute. Corolla glabrous, 26 mm long, light green suffused with maroon externally, pale green within, corolla base slightly wider than hypanthium, corolla tube slightly curved, 15–20 mm long dorsally, narrowing

from the base to the middle to 10–13 mm long; the two dorsal lobes lanceolate, falcate, 13–17 × 3.0–5.0 mm, acute at apex; the three ventral lobes narrowly triangular, falcate, 12 × 3.0 mm, acute at apex. Staminal column long-exserted, to ca. 18 mm beyond dorsal lobes; filament tube 25–28 mm long × 1.0–1.3 mm diam., slightly curved, glabrescent, pale green; anther tube curved-cylindrical, 9.0 mm long × 4.0 mm diam., dorsal and ventral anthers barbate, pale green suffused with maroon; dorsal anthers 9.0–11 mm long; ventral anthers 6.0–7.0 mm long. Berry cylindrical, inflated with 1.0 mm thick walls, light green suffused with maroon, 29 mm long × 24 mm diam., crowned by the persistent calyx lobes; seeds elliptic, 0.8–1.0 mm.

Etymology:—The epithet is the genitive of the latin noun *draco*, which means dragon, in reference to the way the bidentate leaves arranged around long stems with distal flowers resemble the serpentine dragons of Chinese mythology.

Distribution, habitat and ecology:—*Burmeistera draconis* is endemic to the montane cloud forest of Zamora Chinchipe between 2400–2700 m (Fig. 2). According to the Ministerio del Ambiente del Ecuador (2013) this locality is within a much larger zone dominated by bosque siempreverde montano del sur de la cordillera oriental de los Andes (BsMn02). This species is sympatric with *Burmeistera zamorensis* Muchhala & Pérez (2015: 36), and associated to species such as *Centropogon comosus* Gleason (1925:13) and *Freziera neillii* Santamaria-Aguilar & Lagomarsino (2015: 92). It is likely that *B. draconis* also occurs in the adjacent Podocarpus National Park and Yacuri National Park, where similar environmental conditions and forest type are found. Flowers open at dusk and are pollinated by nectar bats (*Anoura* spp.).

Phenology:—Flowers and fruits are found from June to November, but some individuals were observed flowering throughout the year.

Conservation status:—This species was found at two localities, close to each other. One is in the Tapichalaca Reserve, a privately owned protected area of 3500 ha managed by the Jocotoco Foundation since 1998, and the other one is a collection along the road from Yangana to Valladolid. The limited collections and the need to explore other nearby areas, including the adjacent Podocarpus National Park and Yacuri National Park, prevent us to accurately assess its conservation status. Thus we proposed to rank this species as Data Deficient (DD).

Discussion:—*Burmeistera draconis* is easily recognizable by its elliptic leaves with irregularly bidentate margins and cylindrical inflated fruits with short calyx lobes. Preliminary phylogenetic studies (Muchhala, unpublished) suggest it is closely related to a group of *Burmeistera* species with inflated fruits, including *B. ramosa* Wimmer (1932: 124), *B. refracta* Wimmer (1932: 124), *B. glabrata* (Kunth 1818: 307) Hook.f. & B.D.Jacks in Jackson (1893: 361), *B. vulgaris* Wimmer (1932: 123), *B. oyacachensis* Jeppesen (1981: 40), *B. borjensis* Jeppesen (1981: 29), and *B. oblongifolia* Wimmer (1955: 108). Based on calyx lobes and other traits, it is most similar to *B. oblongifolia* (both have short triangular calyx lobes, < 5 mm), but it differs in the bidentate leaf margin (vs. callose-denticulate in *B. oblongifolia*). All other species in this group have calyx lobes > 5 mm in length. Based on leaf margin, it is most similar to *B. oyacachensis*, which has coarsely repand-lacerate margins. This species is endemic to the Napo province, and differs from *B. draconis* by its long calyx lobes (13–15 mm). In terms of leaf margin shape, all other species in this group have almost entire to shallowly repand-dentate margins.

Additional specimens examined (paratypes):—ECUADOR. Zamora Chinchipe: Cantón Palanda, Reserva Tapichalaca, on trail starting from Casa Simpson, 04°29.457'S, 79°07.579'W, 2548 m, 13 Nov 2010 (fl), *N. Muchhala* 464, 465 (QCA!); en el sendero de las Tangaras, 04°29'43"S, 79°07'55"W, 2470–2600 m, 21 Jun 2014 (fl), *A.J. Pérez et al.* 7141 (QCA!, MO!); 04°29'41.7"S, 79°07'53"W, 2496 m, 05 Ago 2015 (fl, fr), *A.J. Pérez et al.* 9117 (COLG!, QCA!, MO!).

Acknowledgments

The authors thank the Fundación de Conservación Jocotoco for logistical support and access to the Reserva Tapichalaca, as well as the staff of the Santa Lucia Cloud Forest Reserve, and D. Proaño, D. Serrano, G. Gilbert, N. Zapata, W. Santillán for assistance in the field. Fieldwork was approved by the Ministry of the Environment of Ecuador (005-14-IC-FLO-DNB/MA, 006-IC-FAU/FLO-DPZCH/MA, 005-2016-IC-FAU-DPAP-MA). Financial assistance was provided by the National Geographic Society (Grant # 8722-09), the Pontificia Universidad Católica del Ecuador through the project “Fortalecimiento de la colección del Herbario QCA mediante inventarios botánicos en áreas de vacío de información florística” (K 13056), Ecobecas (EcoCiencia), and the Secretaría de Educación Superior, Ciencia, Tecnología e Innovación de la República del Ecuador (SENESCYT, Arca de Noé Initiative; S. R. Ron and O. Torres-Carvajal Principal Investigators). We thanks to the editor and two anonymous reviewers for their comments.

References

- Antonelli, A. (2008) Higher level phylogeny and evolutionary trends in Campanulaceae subfam. Lobelioideae: Molecular signal overshadows morphology. *Molecular Phylogenetics and Evolution* 46: 1–18.
<https://doi.org/10.1016/j.ympev.2007.06.015>
- Baker, H.G. (1961) The adaptation of flowering plants to nocturnal and crepuscular pollinators. *The Quarterly Review of Biology* 36: 64–73.
<https://doi.org/10.1086/403276>
- Garzón Venegas, J. & Gonzalez, F. (2012) Five new species and three new records of *Burmeistera* (Campanulaceae-Lobelioideae) from Colombia. *Caldasia* 34: 309–324.
- Garzón Venegas, J., González, F. & Puerta, J.M.V. (2012) *Burmeistera minutiflora* (Campanulaceae-Lobelioideae), a new species from the high Andes of Antioquia (Colombia) with the smallest flowers in the genus. *Anales del Jardín Botánico de Madrid* 69: 243–246.
<https://doi.org/10.3989/ajbm.2320>
- Garzón Venegas, J., Puerta, J.M.V. & González, F. (2013) Three new species of *Burmeistera* (Campanulaceae-Lobelioideae) from Colombia. *Brittonia* 65: 119–127.
<https://doi.org/10.1007/s12228-012-9259-8>
- Gleason, H.A. (1925) Studies on the Flora of Northern South America. *Bulletin of the Torrey Botanical Club* 52 (1): 1–20.
<https://doi.org/10.2307/2479939>
- Harling, G. & Andersson, L. (Eds.) (1973) *Flora of Ecuador*, No 14. Swedish Natural Science Research Council, Stockholm, pp. 9–170.
- IUCN (2012) *The IUCN red list of threatened species*, version 2012.1. IUCN Red List Unit, Cambridge U.K. Available from: <http://www.iucnredlist.org/> (accessed 2 February 2017)
- Jackson, B.D. (1893) *Index kewensis*. Clarendon Press, Oxford.
- Jeppesen, S. (1981) Lobeliaceae. In: Harling, G. & Andersson, L. (Eds.) *Flora of Ecuador*, No 14. Swedish Natural Science Research Council, Stockholm, pp. 9–170.
- Jørgensen, P.M. & León-Yáñez, S. (1999) *Catálogo de Plantas Vasculares del Ecuador*. Missouri Botanical Garden, San Louis, 1181 pp.
- Karsten, G.K.W.H. & Triana, J.J. (1854) *Nuevos Jeneros i Especies de plantas para la flora neo-granadina*. Imprenta del Neo-Granadino, Bogotá, pp. 13–14.
- Kunth, C.S. (1818) *Nova Genera et Species Pantarum*. A La Libreirie Grecque-Latine-Allemende, Paris, 456 pp.
- Lammers, T.G. (2007) *World Checklist and Bibliography of Campanulaceae*. Royal Botanical Garden, Kew, 685 pp.
- Lammers, T.G. & Mass P.J.M. (1998) First report of the genus *Burmeistera* (Campanulaceae) from Honduras. *Sida* 18: 363–364.
- Linnaeus, C. (1753) *Species Plantarum* 2. Laurentii Salvius, Stockholm, 1200 pp.
- Lagamarsino, L.P., Santamaría Aguilar, D. & Muchhala, N. (2015) Two new species of *Burmeistera* (Campanulaceae: Lobelioideae) from the Cordillera de Talamanca of Costa Rica and Panama, with a Key to the Central American Species. *Systematic Botany* 40: 914–921.
<https://doi.org/10.1600/036364415X689339>
- Lozano, C.G. & Galeano, G.G. (1986) Una nueva especie de *Burmeistera* (Campanulaceae) de Colombia. *Caldasia* 15: 53–56.
- Luteyn, J.L. (1986) A new *Burmeistera* (Campanulaceae: Lobelioideae) from western Colombia. *Systematic botany* 11: 474–476.
<https://doi.org/10.2307/2419084>
- McVaugh, R. (1965) South American Lobelioideae new to science. *Annals of the Missouri Botanical Garden* 52: 399–409.
<https://doi.org/10.2307/2394802>
- Ministerio del Ambiente del Ecuador (2013) *Sistema de Clasificación de los Ecosistemas del Ecuador Continental*. Subsecretaría de Patrimonio Natural, Quito, 232 pp.
- Moreno, M.P. & Muchhala, N. (2011) Campanulaceae. In: Valencia, R., Pitman, N., León-Yáñez, S. & Jørgensen, P.M. (Eds.) *Libro Rojo de las Plantas Endémicas del Ecuador, Segunda Edición*. Herbario QCA, Pontificia Universidad Católica del Ecuador, Quito, pp. 252–269.
- Muchhala, N. (2006) The pollination biology of *Burmeistera* (Campanulaceae): Specialization and syndromes. *American Journal of Botany* 93: 1081–1098
<https://doi.org/10.3732/ajb.93.8.1081>
- Muchhala, N. (2008) Functional significance of interspecific variation in *Burmeistera* flower morphology: Evidence from nectar bat captures. *Biotropica* 40: 332–337.
<https://doi.org/10.1111/j.1744-7429.2007.00381.x>
- Muchhala, N. & Lammers, T.G. (2005) A new species of *Burmeistera* (Campanulaceae: Lobelioideae) from Ecuador. *Novon* 15: 176–179.

- Muchhala, N. & Potts, M.D. (2007) Character displacement among bat-pollinated flowers of the genus *Burmeistera*: Analysis of mechanism, process and pattern. *Proceedings of the Royal Society of London B*. 274: 2731–2737.
<https://doi.org/10.1098/rspb.2007.0670>
- Muchhala, N. & Pérez, A.J. (2015) *Burmeistera zamorensis* (Campanulaceae, Lobelioideae), a New Species from Southern Ecuador. *Novon* 24: 36–38.
<https://doi.org/10.3417/2014009>
- Pohl, J.E. (1831) *Siphocampylus*. In: Pohl, J.E. (Ed.) *Plantarum Brasiliae icones et descriptiones hactenus ineditae*, vol. 2. Vienna, pp.
- Presl, C. B. (1836) *Prodromus Monographiae Lobeliacearum*. Prague, 52 pp.
- Santamaría-Aguilar, D. & Lagomarsino, L.P. (2015) Cuatro nuevas especies y un nuevo registro de *Freziera* (Pentaphragaceae) de Ecuador y Perú. *Journal of the Botanical Research Institute of Texas* 9: 89–102.
- Stein, B.A. (1987) Synopsis of the genus *Burmeistera* (Campanulaceae: Lobelioideae) in Peru. *Annals of the Missouri Botanical Garden* 74: 494–496.
<https://doi.org/10.2307/2399316>
- von Helversen, D., Holderied, M.W. & von Helversen, O. (2002) Echoes of bat-pollinated bell-shaped flowers: conspicuous for nectar-feeding bats? *The Journal of Experimental Biology* 206: 1025–1034.
<https://doi.org/10.1242/jeb.00203>
- Wilbur, R.L. (1976a) A synopsis of the Costa Rican species of *Burmeistera* (Campanulaceae: Lobelioideae). *Bulletin of the Torrey Botanical Club* 102: 225–231.
<https://doi.org/10.2307/2484138>
- Wilbur, R.L. (1976b) Campanulaceae. Flora of Panama: part IX. Family 183. *Annals of the Missouri Botanical Garden* 63: 593–655.
- Wilbur, R.L. (1981) Additional Panamanian species of *Burmeistera* (Campanulaceae: Lobelioideae). *Annals of the Missouri Botanical Garden* 68: 167–171.
<https://doi.org/10.2307/2398819>
- Wimmer, F.E. (1932) *Burmeistera*. Eine umstrittene Pflanzengattung und ihre Arten. *Repertorium Specierum Novarum Regni Vegetabilis* 30. Dahlem, Berlin, pp. 123–126.
- Wimmer, F.E. (1955) Lobeliacearum species Novae Austro-Americanae. *Brittonia* 8: 107–111.
<https://doi.org/10.2307/2804853>
- Zahlbruckner, A. (1915) Neue Arten und Formen der Lobelioideen. In: Fedde, F. (Ed.) *Repertorium Specierum Novarum Regni Vegetabilis* 13. Dahlem, Berlin, pp. 528–537.