



## Two new species of *Billolivia* (Gesneriaceae) from the Langbiang Plateau, Vietnam

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### Abstract

Two new species of the recently established genus *Billolivia* (Gesneriaceae) are described from the Langbiang Plateau in the Central Highlands of Vietnam, namely *B. noanii* and *B. trucii*. Their conservation status is assessed. These findings increase the total number of *Billolivia* species to be 13. A key to all known species of the genus is given.

**Keywords:** *Billolivia*, Gesneriaceae, Langbiang Plateau, new species, Vietnam

### Introduction

The Vietnam-endemic genus *Billolivia* (Gesneriaceae) was established with five species in Middleton *et al.* (2014a: 255) and since then seven additional species have been described (Luu *et al.* 2015; Luu *et al.* 2018; Lý 2017; Middleton *et al.* 2014b; Nguyen *et al.* 2016; Vũ *et al.* 2015). Of these, *B. middletonii* N.S.Lý (2017: 89) was reduced to a synonym of *B. cadamensis* Q.D.Nguyen, N.L.Vu & Luu (2016: 493). Our on-going research on the genus has resulted in the collection of more new taxa. In this paper, we describe two additional new species, increasing the total number of species reported for the genus to 13.

### Taxonomy

#### *Billolivia noanii* Luu, N.L.Vu & H.N.Pham, *sp. nov.* (Fig. 1)

*Billolivia noanii* is morphologically similar to *B. cadamensis* Q.D.Nguyen, N.L.Vu & Luu in Nguyen *et al.* (2016: 493) in having adaxially glabrous laminas with hairs mainly on abaxial midrib and venation, short, brownish pink and sparsely pubescent peduncle, and white corolla with purple lines on the base of lobes but differs in having obovate to oblanceolate leaves, to 8-flowered inflorescences, ovate bracts, calyx with a tube and to 3 mm wide calyx lobes, larger flowers and mostly glabrous ovary.

**Type:**—VIETNAM. Langbiang Plateau: Ninh Thuận Province, Phước Bình National Park, Mt. Gia Rích, approximate coordinates 12°06'01"N and 108°42'22"E, at 1,580 m elevation, 3 November 2016, Phạm Hữu Nhân *et al.* NF-BOL-PB001 (holotype SGN!, isotypes SGN!, VNMN!).

Terrestrial herb to 35 cm tall; stems to 15 cm. Leaves alternate; petioles 5–10 cm long, pubescent with brown multicellular uniseriate hairs to 3 mm long; lamina obovate to oblanceolate, slightly asymmetric, 15–24 cm long, 7–10 cm wide, base round to obtuse, apex subacute to acute, margin coarsely dentate, ciliate, 12–16 of secondary veins on each side of midrib, adaxial lamina dark green, glabrous, abaxial lamina purple when young, pale green when mature, with appressed brown hairs to 3 mm long mainly on midrib and venation. Inflorescences axillary, thyrses, to 8-flowered; peduncle brownish red, 5–7 mm long, densely pubescent; rachises brownish red, to 4 mm long, pubescent; bracts ovate, brownish red, to 3.5 × 2.5 cm, apex acute, abaxially sparsely pubescent, with ciliate margins; pedicels

brownish red, 2.5–3.3 cm long, very sparsely pubescent. Calyx brownish red, ovoid, 11–15 mm long, 5–6 mm wide at widest portion, composed of a flaring tube and  $5 \pm$  equal lobes, densely long brown pubescent outside, glabrous inside; tube 4–7 mm long, 5–6 mm wide at mouth; lobes triangular, 7–8 mm long, to 3 mm wide at base, apex acute, with ciliate margins. Corolla 25–30 mm long, composed of a narrow tube and a 2-lipped limb; tube 20–25 mm long, white, contracted below the middle, then slightly flaring towards mouth, outside pubescent, inside with shortly stalked to sessile glands; throat white with yellow patch on lower lip; upper lip 2-lobed, lobes  $7-9 \times 7-8$  mm; lower lip 3-lobed, lobes  $10-12 \times 10-12$  mm; all lobes orbicular to obovate, white, with purple lines on the base, outside sparsely pubescent with multicellular uniseriate hairs, inside with shortly stalked glands. Stamens inserted at 15–17 mm from corolla base; filaments slightly curved, 7–8 mm long, white with a red dot in the middle, sparsely glandular puberulent. Disc bowl-shaped, slightly lobed, 3 mm high. Ovary 5–6.5 mm long, 3–3.5 mm in diameter, mostly glabrous with dense stalked glands at apex; style 10–13 mm long, densely covered with glandular hairs; stigma 2-lobed, ciliate. Fruits unknown.

**Distribution, habitat, and phenology:**—Found on wet soils along streams in submontane moist evergreen closed forest at around 1,600 m in elevation, Mt. Gia Rích, Phước Bình National Park, Ninh Thuận Province, Langbiang Plateau, Vietnam. Flowering and fruiting were seen in December and January.

**Etymology:**—The species is named after the second author's wife Nguyễn Thị Kiều Noan for her support for his botanical work.

**Vietnamese name:**—Luu hoa Noan.

**Proposed IUCN conservation status:**—*Billolivia noanii* is only known from the type location. Our surveys in the adjacent areas have not found additional populations of the species. This new species appears to have a restricted distribution confined to forests of Mt. Gia Rích with a total area of  $<400$  km<sup>2</sup>. The species, therefore, should be considered for listing in the Endangered category, EN B2a&b(i&ii) (IUCN 2012).

**Notes:**—*Billolivia noanii* is morphologically closest to *B. cadamensis* as both species have the following characteristics in common: adaxially glabrous laminae, hairs mainly on abaxial midrib and venation, short, brownish pink and sparsely pubescent peduncle, bracts with pubescence on outer surface and ciliate margins, brownish red calyx, white corolla with purple lines on the base of lobes and white filaments with a red dot in the middle. However, the latter is different in having elliptic leaves, 2–4 flowers per thyrse, narrower bracts ( $6-10 \times 2-3$  mm), 3.5–4 mm wide calyx lobes free to base, smaller corollas (20–26 mm long), shorter disc (2 mm) with pronounced 5-lobes, mostly hairy ovary with glabrous basal 1/4 and shorter style (7–8 mm long).

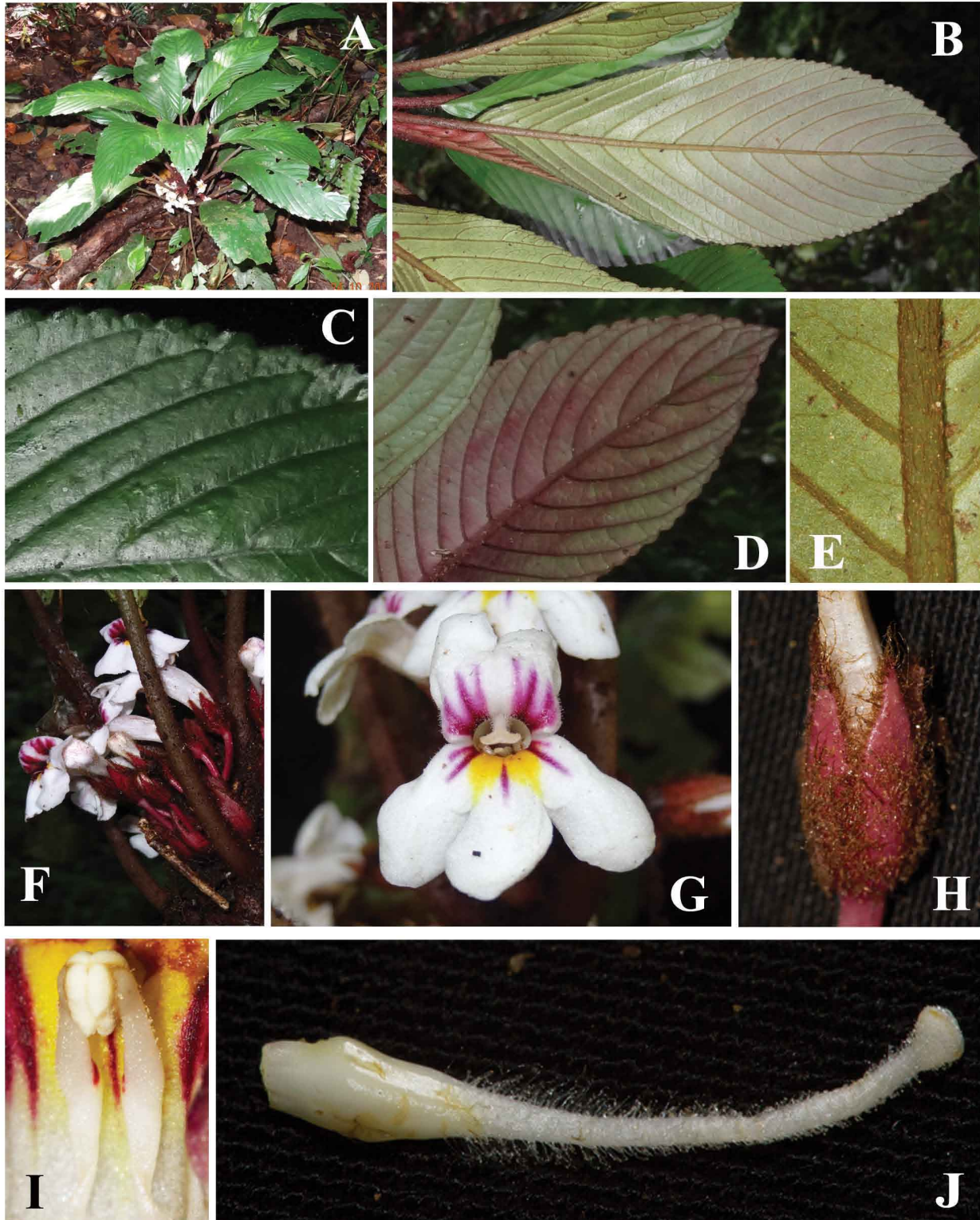
***Billolivia trucii*** Luu & Q.D.Nguyen, *sp. nov.* (Fig. 2)

*Billolivia trucii* is similar to *B. yenhoeae* Luu in Luu et al. (2018: 229) in having stolons but differs in having adaxially hairy, conspicuously dentate and thin leaves, white corolla lobes with dark violet lines, slightly curved filaments with greenish patch in the middle and a green stigma.

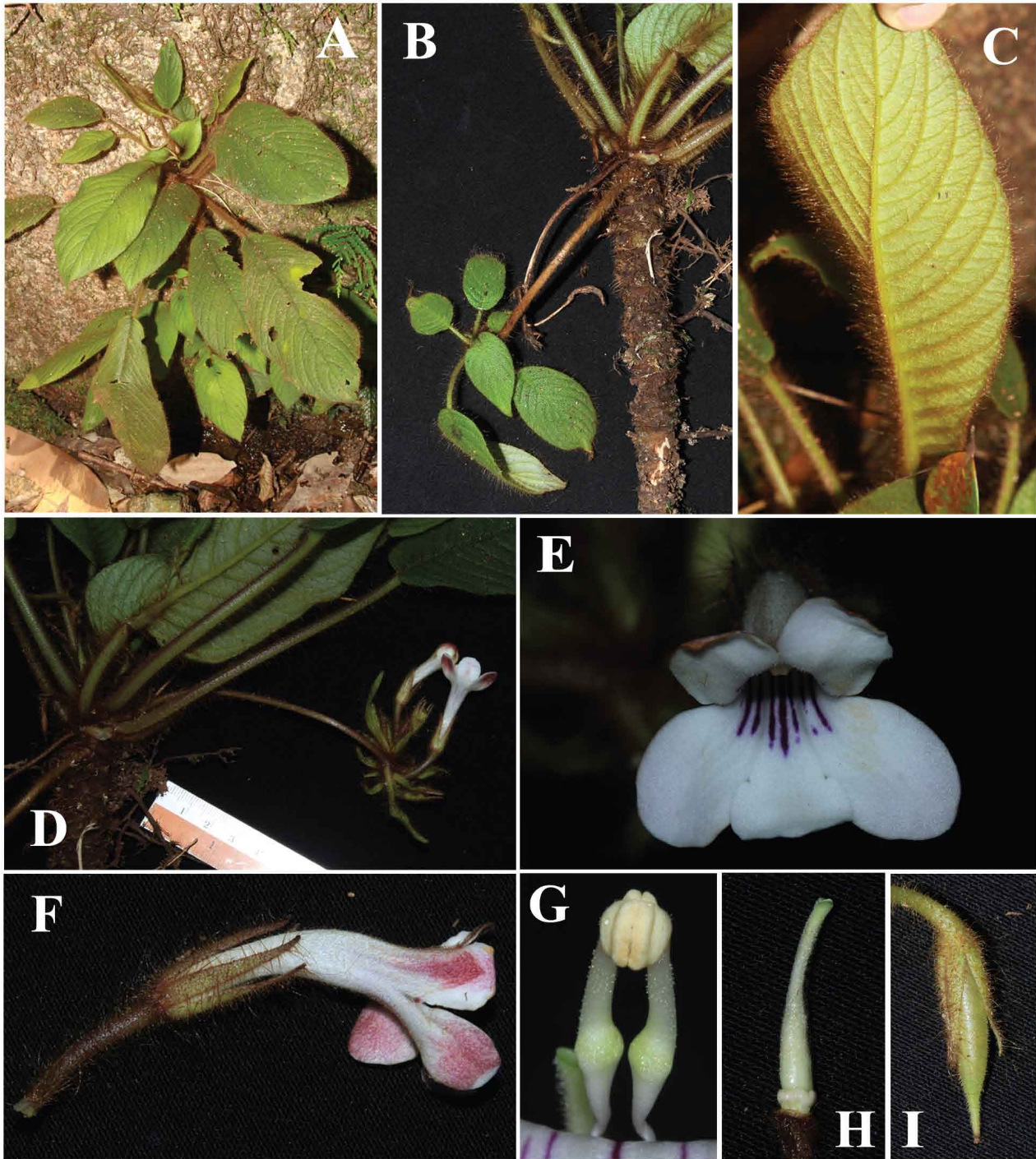
**Type:**—VIETNAM. Langbiang Plateau: Khánh Hòa Province, Khánh Vĩnh District, Sơn Thái Commune, approximate coordinates  $12^{\circ}13'01''$ N and  $108^{\circ}44'50''$ E, at 1,040 m elevation, 13 November 2016, Luu Hồng Trường et al. NF-BOL-KH 037 (holotype SGN).

Terrestrial herb to 20 cm tall, stoloniferous; stems to 10 cm high, 1 cm in diameter, internodes congested; stolons up to 10 cm long, densely pubescent. Leaves alternate; petioles 4–11 cm long, densely pubescent with erect brown multicellular uniseriate hairs to 4 mm long; lamina ovate to oblanceolate, thin, 5–18 cm long, 3–9 cm wide, base round to slightly cordate, apex acute, margin entire or minutely dentate, 8–15 secondary veins on each side of midrib, adaxial lamina green, with dense erect brown hairs to 4 mm long, margin densely ciliate, abaxial lamina pale green, with dense erect brown hairs to 5 mm long. Inflorescences axillary, thyrse, to 8-flowered; peduncle light green, to 10 cm long, densely pubescent with erect brown multicellular uniseriate hairs to 3 mm long; ray white to light green, to 22 cm long, pubescent with erect brown hairs to 2 mm long; bracts oblong to narrowly lanceolate, light green, to  $0.5 \times 3$  cm, apex obtuse, abaxially densely pubescent, with ciliate margins; pedicels greenish to brownish, 1.5–2.3 cm long, pubescent. Calyx of 5 lobes almost divided to base, light brown to light green, outside densely brown long pubescent, inside glabrous; lobes narrowly triangular, to 13 mm long, to 2 mm wide at base, apex acute, with ciliate margins. Corolla 3.2–3.8 cm long, composed of a narrow tube and a 2-lipped limb with lobes recurved; tube 2.3–2.5 cm long, curved, white, slightly flaring towards mouth, outside pubescent, inside glabrous; throat white, with dark violet lines and covered with dense stalked glands; upper lip 2-lobed, lobes elliptic,  $7-8 \times 9-10$  mm; lower lip 3-lobed, lobes elliptic,  $6-7 \times 7-8$  mm; all lobes adaxially white, with dark violet lines at base and sparsely pubescent with multicellular uniseriate hairs to 4 mm, abaxially white at periphery with brownish red patch in the centre and with shortly stalked

glands. Stamens inserted at the middle of the corolla tube; fertile filaments 6–7 mm long, slightly curved, white with greenish patch in the middle, with sparse glandular hairs on upper half; staminodes 3, the medial one early caducous. Disc bowl-shaped, 5-lobed, 1.7 mm high, 2.7 mm in diameter. Ovary creamy translucent, 6–6.5 mm long, 1.7 mm in diameter, basal half glabrous, upper half covered with dense stalked glands; style creamy translucent, 8.5–9 mm long, densely covered with glandular hairs; stigma green, slightly 2-lobed, ciliate. Fruits oblong-ovoid, around  $20 \times 0.4$  mm, brown hairy on apical half, translucent light green and with persistent style and calyx.



**FIGURE 1.** *Billolivia noanii*. A. Habit. B. Leaf, abaxial lamina. C. Leaf, glabrous adaxial lamina. D. Leaf, purple abaxial young lamina. E. Hairiness on abaxial lamina. F. Inflorescence. G. Flower, front view. H. Calyx. I. Stamens. J. Pistil. Photo: Phạm Hữu Nhân, Nguyễn Quốc Đạt and Nguyễn Thế Văn.



**FIGURE 2.** *Billolivia trucii*. A. Habit. B. Stolon. C. Leaf, abaxial lamina. D. Inflorescence. E. Flower, front view. F. Flower, side view G. Stamens. H. Pistil. I. Fruit. Photo: *Luu Hồng Trường and Nguyễn Quốc Đạt*.

**Additional specimens examined (paratypes):**—VIETNAM. Langbiang Plateau: Khánh Hòa Province, Khánh Vĩnh District, Sơn Thái Commune, approximate coordinates 12°13'01"N and 108°44'50"E, at 1,060 m elevation, 25 April 2017, *Luu Hong Truong et al. NF-BOL-KH 032* (paratypes PHH!, SGN!, VNMN!).

**Distribution, habitat and phenology:**—Growing in scattered clumps on moist gulleys in montane moist evergreen closed forest at around 1,000 m elevation, Sơn Thái Commune, Khánh Vĩnh District, Khánh Hòa Province, Langbiang Plateau, Vietnam. Flowering was seen in April to May and fruiting in April to November.

**Etymology:**—The species is named after the first author's daughter Luu Thanh Trúc.

**Vietnamese name:**—Luu hoa Trúc.

**Proposed IUCN conservation status:**—The species is only known from a single population of less than 250 individuals growing in a less than 1 km<sup>2</sup> watershed of an unnamed stream, which is around 100 m away from a recently built national road. We have not found any additional populations even though we have been surveying biodiversity in the whole Khánh Hòa Province and neighbouring provinces since 2012. This is really a rare species distributed in a forest where human impacts, including illegal logging, are common. Our most recent visit to the site in June 2018 noted that the species' habitat was destroyed heavily due to landslide and less than 50 individuals were surviving. Like *B. yenhoeae*, this species should be considered for listing in the Critically Endangered category, CR B2a&b(i,ii&iii) (IUCN 2012) and it needs urgent conserving measures.

**Notes:**—*Billolivia trucii* is found sympatric with *B. yenhoeae*. They are the only two species in the genus known to have stolons. They also have oblanceolate leaves. However, the latter species differs in having adaxially glabrous, coarsely dentate and thick leaves, yellow corolla lobes, strongly S-curved filaments and a white stigma. The new taxon is the first in the genus known to have a green stigma and a greenish patch in the middle of filaments. The hairy and thin leaves in *B. trucii* look like those in *B. minutiflora* D.J.Middleton & H.J.Atkins (Middleton *et al.* 2014a: 258), *B. poilanei* D.J.Middleton & H.J.Atkins in Middleton *et al.* (2014a: 260) and *B. vietnamensis* D.J.Middleton & Luu (Middleton *et al.* 2014a: 261) but the new species is easily distinguishable from these three taxa as it has a tough stem with stolons and congested internodes, larger, ovate to oblanceolate leaves, longer peduncles and larger, oblong-ovoid fruits.

### Key to known *Billolivia* species

1. Calyx divided into 5 lobes almost to base .....2
- Calyx connate into a tube at base for at least 4 mm, margin 5-lobed.....10
2. Calyx lobes > 3.5 mm wide .....3
- Calyx lobes ≤ 3 mm wide .....5
3. Leaf margins minutely dentate or crenate, often appearing entire; calyx lobes 4.8–5.8 mm wide ..... *B. poilanei*
- Leaf margins coarsely dentate; calyx lobes <4 mm wide .....4
4. Corolla lobes white, with purple lines in tube and onto lobes .....*B. cadamensis*
- Corolla lobes red, without purple lines in tube and onto lobes..... *B. kyi* Luu & G.Tran in Luu *et al.* (2015: 362)
5. Corolla lobes yellow .....6
- Corolla lobes white .....7
6. Leaf lamina ovate; peduncle to 8 mm long; corolla lobes citrus yellow; fruits translucent when ripe.....
- .....*B. citrina* Luu, H.Đ.Trần et N.L.Vu in Luu *et al.* (2018: 227)
- Leaf lamina obovate to oblanceolate; peduncle 10–52 cm long; corolla lobes bright yellow; fruits translucent violet when ripe.....
- .....*B. yenhoeae*
7. Leaf lamina thick, adaxially glabrous ..... *B. noanii*
- Leaf lamina thin, adaxially hairy.....8
8. Stem tough with stolons; internodes congested; leaves ovate to oblanceolate; peduncles to 10 cm long; fruits oblong-ovoid.....
- .....*B. trucii*
- Stem slender without stolons; internodes not congested; leaves ovate to elliptic, peduncles ± sessile; fruits ellipsoid.....9
9. Leaf abaxially with hairs on venation and occasionally between veins; corolla 12–15 mm long; unfertilised ovary glabrous.....
- .....*B. minutiflora*
- Leaf abaxially with pubescence throughout; corolla 18–25 mm long; unfertilised ovary pubescent at apex.....*B. vietnamensis*
10. Corolla throat with purple lines in tube and onto lobes ..... 11
- Corolla throat without purple lines in tube and onto lobes .....12
11. Calyx lobes 3.5–4 mm wide; corolla tube about 15 mm long ..... *B. moelleri* D.J.Middleton in Middleton *et al.* (2014b: 189)
- Calyx lobes 1.5–2 mm wide; corolla tube 20–22 mm long ..... *B. tichii* Luu, Q.D.Nguyen & N.L.Vu in Vũ *et al.* (2015: 190)
12. Calyx fused into a tube for 7–9 mm; corolla lobe tips pink or red; leaf margins coarsely dentate; petioles 9–18 cm long.....
- .....*B. longipetiolata* D.J.Middleton & Luu in Middleton *et al.* (2014a: 256)
- Calyx fused into a tube for 4–6 mm; corolla lobe tips violet; leaf margins minutely dentate or appearing entire; petioles 6–12.5 cm long.....
- .....*B. violacea* D.J.Middleton & H.J.Atkins in Middleton *et al.* (2014a: 262)

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