



## Two new species of *Billolivia* (Gesneriaceae) with yellow flowers from Vietnam

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### Abstract

*Billolivia citrina* and *B. yenhoeae* are described as new species of Gesneriaceae from Central Vietnam. They are the first taxa of the genus known to have yellow corolla lobes. A key to all eleven species of the genus is given.

**Key words:** *Billolivia*, Gesneriaceae, new species, Vietnam, yellow flowers

### Introduction

*Billolivia* (Middleton *et al.* 2014a: 255) of the Gesneriaceae is a Vietnam-endemic genus described recently with *B. vietnamensis* D.J.Middleton & Luu in Middleton *et al.* (2014a: 261) from the lowland Binh Phước Province of southern Vietnam and four other species from the Central Highlands of Vietnam: *B. longipetiolata* D.J.Middleton & Luu in Middleton *et al.* (2014a: 256), *B. minutiflora* D.J.Middleton & H.J.Atkins in Middleton *et al.* (2014a: 258), *B. poilanei* D.J.Middleton & H.J.Atkins in Middleton *et al.* (2014a: 260), and *B. violacea* D.J.Middleton & H.J.Atkins in Middleton *et al.* (2014a: 262). In the same year, *B. moelleri* D.J. Middleton in Middleton *et al.* (2014b: 189) was found from southern Central Vietnam. In 2015, two additional species, namely *B. kyi* Luu & G.Tran in Luu *et al.* (2015: 362) and *B. tichii* Luu, Q.D.Nguyen & N.L.Vu in Vũ *et al.* (2015: 190), from the Central Highlands, were described. The ninth and northernmost species of the genus, i.e. *B. cadamensis* Q.D. Nguyen, N.L. Vu & Luu in Nguyen *et al.* (2016: 493), was discovered from Cà Đam Mountain, Quảng Ngãi Province, Central Vietnam, where *B. middletonii* N.S.Lý (2017: 89) was collected. As the protologues of both species match each other and *B. cadamensis* was earlier validly published, according to Article 11 of the International Code of Nomenclature for algae, fungi, and plants (McNeil *et al.* 2012), the name *B. cadamensis* has priority and thus *B. middletonii* is reduced to its synonym.

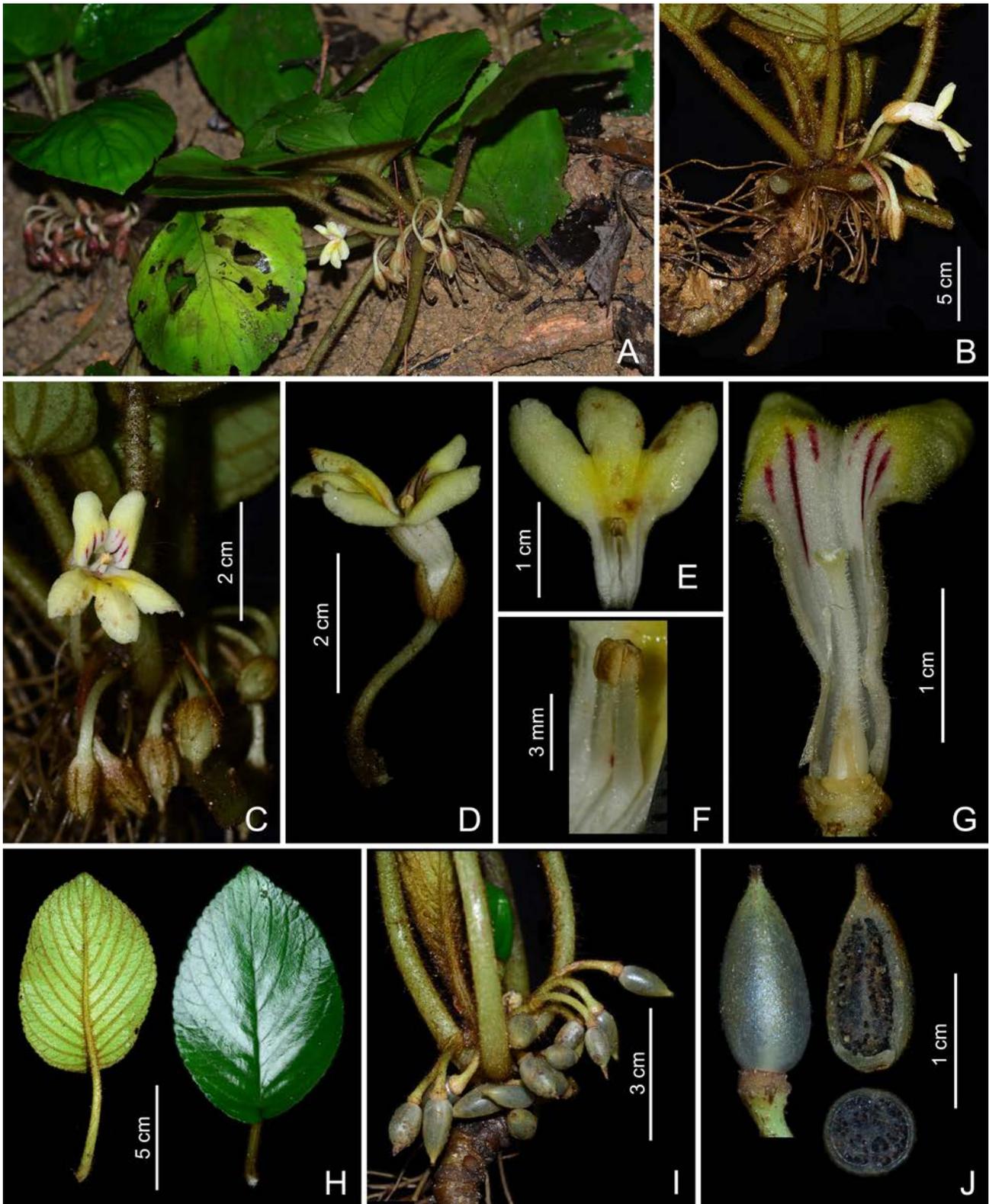
We describe here two additional new species. They are different from *B. poilanei* in having coarsely dentate laminae, narrower calyx lobes and from all other known *Billolivia* in having yellow corolla lobes.

### Taxonomy

***Billolivia citrina* Luu, H.Đ.Trần et N.L.Vu, sp. nov.** (Fig. 1)

*Billolivia citrina* is similar to *B. yenhoeae* in having yellow flowers but differs in having ovate leaves, much shorter inflorescences, smaller flowers, citrus yellow corolla lobes, slightly curved filaments and apically hairy ovary. It is also close to *B. cadamensis* in having overall habit, leaf indumentum, flower shape, and purple lines on the base of lobes but differs in having ovate leaf laminae, densely pubescent bracts, greenish white calyx, and yellow corolla lobes.

**Type:**—VIETNAM. Phú Yên Province: Sông Hinh District, Mt. Hòn Đền, approximate coordinates 12°53'52"N and 108°48'40"E, at ca. 600 m elevation, 20 January 2017, Trần Hữu Đăng, Nguyễn Trần Quốc Trung, Nguyễn Quốc Đạt, Vũ Ngọc Long NF-BOL-PY 002 (holotype SGN!, isotypes SGN!, PHH!, HNU!, VNMN!).



**FIGURE 1.** *Billolivia citrina*. A. Habit. B. Stem and inflorescence. C. Flower and fruits. D. Flower, side view. E. Lower lip of corolla. F. Stamens. G. Upper lip of corolla and gynoeceium. H. Leaf, abaxial and adaxial laminas. I. Inflorescences. J. Fruit, cross and longitudinal sections. *Photo: Trần Hữu Đăng.*

Terrestrial herb to 20 cm tall; stems rhizomatous, creeping and then erect, sparsely pubescent with brown multicellular uniseriate hairs to 3 mm long. Leaves alternate; petioles 3–9 cm long, densely pubescent with brown multicellular uniseriate hairs to 3 mm long; lamina ovate, slightly asymmetric, 9–14 cm long, 5.0–9.0 cm wide, base round, apex subacute, margin coarsely dentate, 8–10 secondary veins on each side of midrib, adaxial lamina dark green, glabrous,

margin densely ciliate, abaxial lamina pale green, with dense brown appressed hairs to 2 mm long. Inflorescences axillary, 3–9-flowered; peduncle white, to 8 mm long, densely pubescent; ray white, to 1 mm long, densely pubescent; bracts lanceolate to narrowly triangular, to  $9 \times 3$  mm, abaxially densely pubescent, apex acute, margins ciliate; pedicels white, 2–2.5 cm long, distally sparsely pubescent, basally densely pubescent. Calyx of 5 lobes almost divided to base, greenish white, outside densely long brown pubescent, inside glabrous; lobes triangular, to 8 mm long, to 3 mm wide at base, apex acute, with ciliate margins. Corolla 26–28 mm long, composed of a narrow tube which slightly flares towards an oblique mouth and a 2-lipped limb with lobes recurved; tube 14 mm long, white, outside pubescent, inside glabrous; throat white, with shortly stalked to sessile glands and purple lines on the base of lobes; upper lip 2-lobed, lobes  $6\text{--}7 \times 12\text{--}13$  mm, ovate; lower lip 3-lobed, lateral lobes elliptic,  $5\text{--}6 \times 10\text{--}11$  mm, lower lobe slightly obovate,  $7\text{--}8 \times 5.5\text{--}6$  mm; all lobes citrus yellow, outside sparsely pubescent with multicellular uniseriate hairs, inside with shortly stalked glands. Stamens inserted at 6–7 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, 5-lobed at apex, 1 mm high. Ovary 3–3.5 mm long, 2 mm in diameter, with dense stalked glands on apical 1/3; style 7–8 mm long, densely covered with glandular hairs; stigma slightly lobed, ciliate. Fruits ovoid, greenish cream,  $14\text{--}16 \times 6\text{--}8$  mm, mostly brown puberulent, basally glabrous, translucent when ripe; seeds many, ovoid,  $0.15 \times 0.2$  mm, black.

**Distribution, habitat, and phenology:**—Found on moist gulleys in montane moist evergreen closed forest at around 600 m in elevation, Mt. Hòn Đen, Sông Hinh District, Phú Yên Province, Vietnam. Flowering and fruiting were seen in December and January.

**Etymology:**—The epithet refers the citrus yellow colour of its corolla lobes.

**Vietnamese name:**—Luu hoa vàng chanh.

**Proposed IUCN conservation status:**—*Billolivia citrina* has been known only from the type location, where it is not commonly encountered. Our surveys in the province over the last several years have not found additional populations of the species. This new species appears to have a restricted distribution confined to forests of Song Hinh District with a total area of <400 km<sup>2</sup> where deforestation for agricultural expansion is occurring. The species, therefore, should be considered for listing in the Endangered category, EN B2a&b(i&ii) (IUCN 2012).

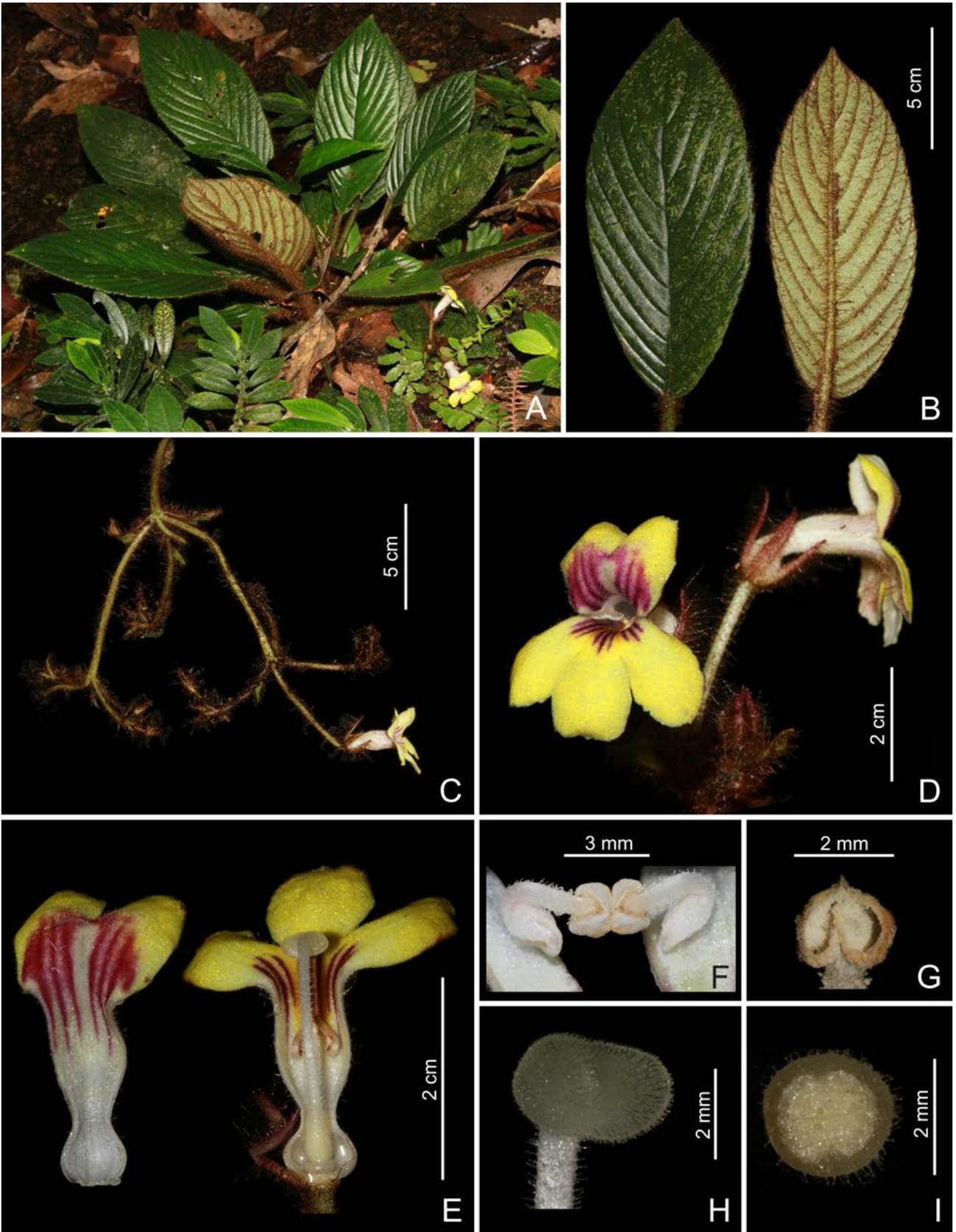
**Notes:**—*Billolivia citrina* is similar to *B. yenhoe* in having yellow corolla lobes but differs in many characters: ovate leaves, much shorter peduncles, smaller flowers, citrus yellow corolla lobes, slightly curved filaments, and apically hairy ovaries. *Billolivia citrina* is also morphologically close to *B. cadamensis* in having short stems, glabrous adaxial laminae, hairs mainly on abaxial midribs and veins, calyces divided into 5 lobes to base, shape of corolla and lobes, corolla throat with purple lines on the base of lobes and white glandular puberulent filaments with a red dot in the middle. The later species, however, has elliptic leaf laminae, glabrous bracts, brownish red calyces, and white corolla lobes. The purple lines in the corolla of *B. citrina* recall those of *B. cadamensis*, *B. tichii*, *B. vietnamensis*, and *B. moelleri* but these species have white and/or purple corolla lobes.

### ***Billolivia yenhoe* Luu, sp. nov.** (Fig. 2)

*Billolivia yenhoe* is unique in the genus in having stolons and up to 52 cm long peduncles. It is most similar to *B. citrina* in having yellow flowers but differs in having obovate leaves, much longer peduncles, bright yellow corolla lobes, strongly S-curved filaments, and fully hairy ovaries.

**Type:**—VIETNAM. Khánh Hòa Province: Khánh Vĩnh District, Sơn Thái Commune, approximate coordinates 12°13'01"N and 108°44'50"E, at 1,061 m elevation, 01 November 2013, *Luu Hồng Trường KH 0941* (holotype SGN!; isotypes SGN!).

Terrestrial herb to 20 cm tall, stoloniferous; stems to 10 cm, internodes congested; stolons up to 60 cm long, densely pubescent. Leaves alternate; petioles 4–9 cm long, densely pubescent with brown multicellular uniseriate hairs to 4 mm long; lamina obovate to oblanceolate, slightly asymmetric, 13–20 cm long, 6–7 cm wide, base round to cuneate, apex subacute to acute, margin coarsely dentate, 8–10 of secondary veins on each side of midrib, adaxial lamina dark green, with sparse erect brown hairs to 3 mm long when young, glabrous when mature, margin densely ciliate, abaxial lamina pale green, with dense erect brown hairs to 5 mm long on midrib and venation, glabrous on lamina between veins. Inflorescences axillary, thyse, to 15-flowered; peduncle light green, 10–52 cm long, densely pubescent; ray white to light green, to 15 cm long, pubescent; bracts oblong to oblanceolate, light green, to  $3.5 \times 1$  cm, apex acute, abaxially densely pubescent, with ciliate margins; pedicels white, 4–5.5 cm long, pubescent. Calyx of 5 lobes almost divided to base, white to light green, outside densely brown long pubescent, inside glabrous; lobes narrowly triangular, to 12 mm long, to 2 mm wide at base, apex acute, with ciliate margins. Corolla 28–34 mm long, composed of a narrow tube and a 2-lipped limb with lobes recurved; tube 18–21 mm long, white, contracted below the middle, then slightly



**FIGURE 2.** *Billolivia yenhoe*. A. Habit. B. Leaf, adaxial and abaxial laminae. C. Inflorescence. D. Flowers, front and side views. E. Longisection of corolla showing the gynoecium. F. Stamens. G. Open anthers. H. Stigma. I. Cross section of ovary. Photo: Lưu Hồng Trường.

flaring towards mouth, outside pubescent, inside glabrous; throat yellow, glabrous and with purple lines; upper lip 2-lobed, lobes 1.3–1.5 × 9–11 mm, ovate; lower lip 3-lobed, lobes slightly obovate, 12–14 × 8–9 mm; all lobes bright yellow, with purple lines at base, outside sparsely pubescent with multicellular uniseriate hairs to 5 mm, inside with shortly stalked glands. Stamens inserted at the middle of the corolla tube; filaments 6–7 mm long, strongly S-curved, white, with sparse glandular hairs on upper half. Disc bowl-shaped, obscurely 5-lobed, 1.5 mm high. Ovary 5–5.5 mm long, 2.5 mm in diameter, fully covered with dense stalked glands; style 13–14 mm long, densely covered with glandular hairs; stigma 2-lobed, ciliate. Fruits ovoid, around 10 × 0.6 mm, brown hairy, translucent violet and with persistent style.

**Additional specimens examined (paratypes):**—VIETNAM. Khánh Hòa Province: Khánh Vĩnh District, Sơn Thái Commune, approximate coordinates 12°13'01"N and 108°44'50"E, at 1,040 m elevation, 12 November 2016, *Luu Hồng Trường, Nguyễn Quốc Đạt & Nguyễn Trần Quốc Trung NF-BOL-KH 036* (SGN!); 26 November 2016, *Phạm Hữu Nhân & Luu Hồng Trường PHN12-01* (SGN!, PHH!, HNU!, VNMN!).

**Distribution, habitat and phenology:**—Growing in scattered clumps on moist gulleys in montane moist evergreen closed forest at around 1,060 m elevation, Sơn Thái Commune, Khánh Vĩnh District, Khánh Hòa Province, Vietnam. Flowering was seen in November to January.

**Etymology:**—The species is named after the first author's beloved wife Lương Thị Yên Hòa for her invaluable support for his interest in botany.

**Vietnamese name:**—Luu hoa Yên Hòa.

**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 less than 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 a really rare species distributed in a forest where human impacts, including illegal logging, are common. This species, therefore, should be considered for listing in the Critically Endangered category, CR B2a&b(i,ii&iii) (IUCN 2012).

**Notes:**—*Billolivia yenhoeae* is the first taxon in the genus known to have vegetative propagation by stolons, which may form colonies in separated gulleys. It grows with an undescribed *Billolivia* with distinguishably hairy leaves, which will be the subject for another paper. *Billolivia yenhoeae* has the longest peduncles in the genus. Its yellow flowers recall those in *B. citrina* but *B. yenhoeae* is distinct in having obovate to oblanceolate leaves, much longer peduncles, larger flowers, bright yellow corolla lobes, S-curved filaments, and fully hairy ovaries.

### Key to all known species of *Billolivia*

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 .....8
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* (syn. *B. middletonii*)
- Corolla lobes red, without purple lines in tube and onto lobes ..... *B. kyi*
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*
- Leaf lamina obovate to oblanceolate; peduncle 10–52 cm long; corolla lobes bright yellow; fruits translucent violet when ripe ..... *B. yenhoeae*
7. 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*
8. Corolla throat with purple lines in tube and onto lobes .....9
- Corolla throat without purple lines in tube and onto lobes .....10
9. Calyx lobes 3.5–4 mm wide; corolla tube about 15 mm long ..... *B. moelleri*
- Calyx lobes 1.5–2 mm wide; corolla tube 20–22 mm long ..... *B. tichii*
10. 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*
- 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*

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