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# NORDIC JOURNAL OF BOTANY

## Research

### *Petrocodon vietnamensis* sp. nov. (Gesneriaceae) from karst caves in northern Vietnam

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Nordic Journal of Botany  
2021: e02996

doi: 10.1111/njb.02996

Subject Editor: John Parnell  
Editor-in-Chief: Torbjörn Tyler  
Accepted 23 December 2020  
Published 14 April 2021

*Petrocodon vietnamensis*, a new species from karst cave in north Vietnam is described and illustrated. It is morphologically close to *P. bonii*, but can be distinguished from the latter by having a green, 3–6 cm long peduncle; green, ca 5 mm long calyx lobes; narrow infundibuliform, a 1.1–1.2 cm long corolla tube; ovate abaxial lip lobes; pink to white, 9.5–10.5 mm long filaments; lateral staminodes adnate to ca 12 mm above the corolla base; densely white glandular-puberulent pistil; a pink to white, 5.5–7.5 mm long style; a white stigma, and a 2–3 cm long capsule. Information on ecology, phenology, preliminary conservation assessment of the new species and a key for the taxonomic identification of *Petrocodon* species in Vietnam are also provided.

Keywords: cave-dwelling, Didymocarpoideae, Flora of Vietnam, limestone flora, taxonomy

## Introduction

The genus *Petrocodon* Hance (Gesneriaceae) comprises at least 44 species and one variety (Wen et al. 2020, Xin et al. 2020a). It is mainly distributed in the limestone regions of southern and southwestern China, but also extending to adjacent countries such as Vietnam and Thailand (Möller and Clark 2013, Möller et al. 2016). As the diversity center of this genus, China has 42 species and one variety recorded (Möller 2019, Wen et al. 2019, 2020), followed by Vietnam with only three species, namely *P. bonii* (Pellegr.) Mich. Möller & A. Weber, *P. coccineus* (C.Y. Wu ex H.W. Li) Yin Z. Wang, *P. hispidus* (W.T. Wang) A. Weber & Mich. Möller, and Thailand with only two species, *P. flavus* D.J. Middleton & Sangvir. and *P. bonii* (Pellegrin 1926, Li 1982, Burt 2001, Weber et al. 2011, Middleton et al. 2015).

During a joint botanical survey for karst cave-dwelling plant diversity in northern Vietnam in late October 2016, an unknown lithophytic *Petrocodon* species with numerous purple flowers was found at the Kho Muong cave, Thanh Son commune,



Ba Thuoc district, Thanh Hoa province. More recently, in late October 2019, we also found it at the Doi cave, Ngoc Son commune, Lac Son district, Hoa Binh province, north Vietnam. We took photographs and collected voucher specimens and materials (seedling and seed) of the species which were then introduced and cultivated in the conservation nursery at the Gesneriad Conservation Center of China. Over the past three years, the living plants in both the Gesneriad Conservation Center of China and the type locality were continuously monitored for further observation. After consulting the protologues, type specimens, relevant literature and herbarium specimens of the known *Petrocodon* species (Wang 1990, Wang et al. 1998, Li and Wang 2005, Phuong 2005, Wei et al. 2010, Middleton et al. 2015), it was confirmed that the species is new to science. The new species increases number of *Petrocodon* species in Vietnam to four. Its description, illustration, information on ecology, phenology, preliminary conservation assessment of the new species, comparison with its morphologically similar species and a key for the taxonomic identification of *Petrocodon* species in Vietnam are also provided.

## Material and methods

The studied specimens are deposited in herbaria IBK and VNMN. The macromorphological features were observed based on the specimen sheets and notes in both the field

and the conservation nursery at the Gesneriad Conservation Center of China, while micromorphological observations were analysed and photographed using an optical microscope. The morphological characters of studied specimens were compared with the protologue and type specimens of previously described *Petrocodon* species, and were reviewed on the basis of specialized literature and herbarium specimens deposited in relevant herbaria.

The description of the new species follows the terminology used by Harris and Harris (2001). Assessment of conservation status of the new species was made according to the categories and criteria of IUCN (2019).

## Taxonomic treatment

*Petrocodon vietnamensis* Z.B.Xin, T.V.Do & F.Wen, sp. nov. (Fig. 1, 2)

**Type:** Vietnam, Thanh Hoa province, Ba Thuoc district, Thanh Son commune, Kho Muong cave, 3 Nov 2019, 20°29'19"N, 105°8'46"E, 375 m a.s.l., flowering, F. Wen, T.V. Do, S. Maciejewski & Z.B. Xin, VMN-CN 1248 (holotype: VNMN; isotypes: IBK!, VNMN!).

### *Etymology*

The specific epithet is derived from the type locality/country, Vietnam/Việt Nam.

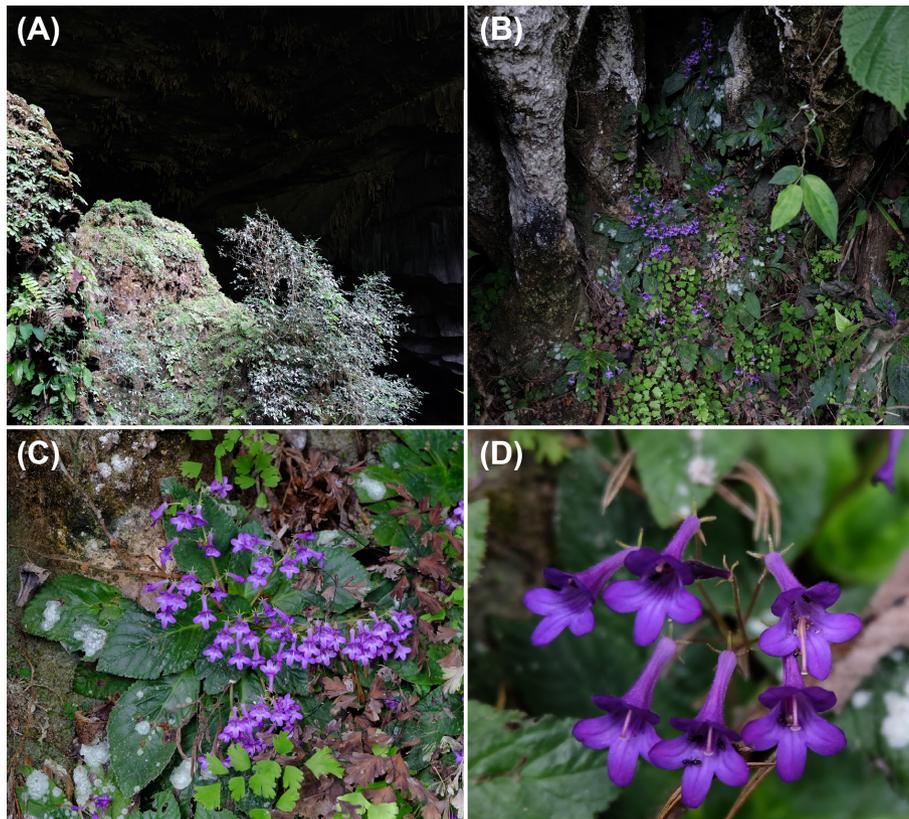


Figure 1. *Petrocodon vietnamensis* sp. nov. (A–B) habitat in Kho Muong cave, (C) plant in bloom, (D) cyme (Photographs by F. Wen).

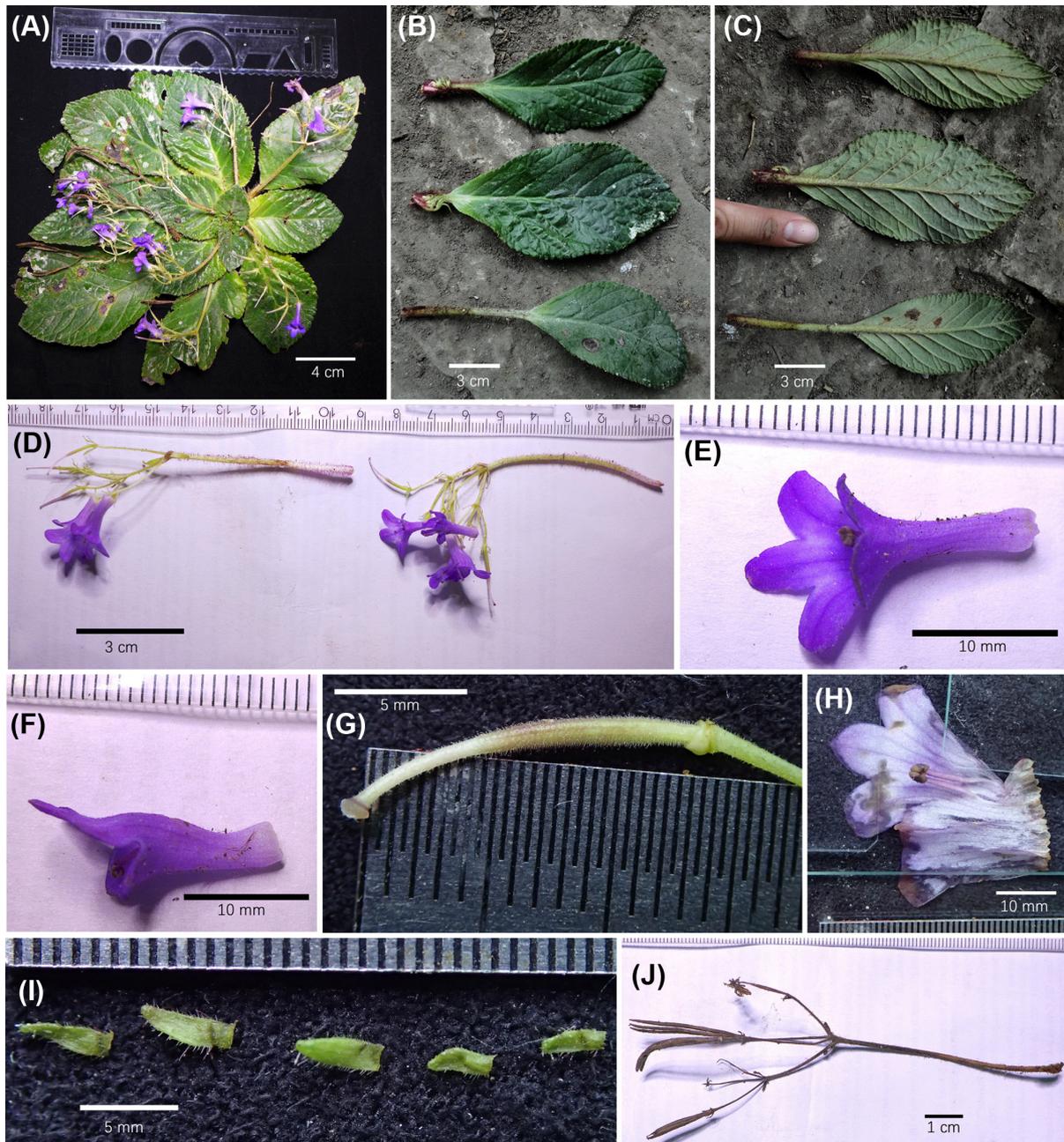


Figure 2. *Petrocodon vietnamensis* sp. nov. (A) plant in bloom, (B) adaxial surfaces of leaf blades and petioles, (C) abaxial surfaces of leaf blades and petioles, (D) cymes, (E) top view of corolla, (F) lateral view of corolla, (G) pistil, (H) opened corolla, (I) calyx lobes (two adaxial surfaces on the left; three abaxial surfaces on the right), (J) mature infructescence (Photographs by F. Wen).

**Description**

Perennial herb, lithophytic, stemless. Rhizome subterete, very short, ca 1 cm long, 3–5 mm in diameter. Leaves 12–18, all basal; leaf blades nearly coriaceous, green to dark green, commonly zygomorphic, occasionally slightly asymmetric, broadly lanceolate, elliptic-rhombic to nearly elliptic, 6.0–15.0 × 4.5–8.0 cm, acute at apex, attenuate at base, with margin obviously numerous-serrate, adaxially slightly bul-late to bullate, with appressed pubescence; nerves 7–9 on each side, adaxially sunken, abaxially prominent, densely

ferruginous and erect-pubescent along abaxial main vein and lateral veins; petiole 2.0–7.5 cm long, almost absent in young leaves, 3.5 mm in diameter, densely reddish-ferruginous, erect villous and pubescent. Cymes 3–9, 1–2-branched, 8–12-flowered; peduncle 3–6 cm long, ca 2 mm in diameter, green, densely ferruginous-villous and pubescent; bracts 2, opposite, lanceolate, 6–7 × 1–2 mm, with entire margin, adaxially brown-pubescent, abaxially glabrous; bracteoles 2, opposite, linear, 5.0 × 0.8 mm, adaxially puberulent, abaxially glabrous; pedicel 6–10 mm long, 0.5–0.7 mm in

Table 1. Morphological comparison of *Petrocodon vietnamensis* and *P. bonii*.

Characters	<i>P. vietnamensis</i>	<i>P. bonii</i>
Peduncle	green, 3–6 cm long	reddish brown, 8–15 cm long
Calyx lobe	green, ca 5 mm long	reddish brown, ca 3 mm long
Corolla tube	narrow infundibuliform, 11–12 mm long	tubaeform, 5.0–6.5 mm long
Abaxial lip lobe	ovate	nearly equilateral triangular
Filament	pink to white, 9.5–10.5 mm long	yellow, ca 4.5 mm long
Lateral staminode	ca 12 mm above the corolla base	ca 5 mm above the corolla base
Disc	the highest point ca 0.7 mm	the highest point ca 1 mm
Pistil	densely white glandular-puberulent	densely red glandular-puberulent
Style	pink to white, 5.5–7.5 mm long	yellow, ca 3 mm long
Stigma	white	yellow
Capsule	2–3 cm long	4.5 cm long

diameter, glandular-puberulent. Calyx 5-parted to the base; lobes oblong to subulate, ca 5 mm long, 1.5 mm wide, abaxially sparsely pubescent, adaxially glabrous. Corolla bilabiate,

purple, 1.6–1.8 cm long, outside sparsely glandular-puberulent, inside glabrous; tube narrow infundibuliform, 1.1–1.2 cm long, 2.8–3.2 mm in diameter at the middle, slightly



Figure 3. *Petrocodon bonii* (A) habitat in Mat Son Mountain (type locality, Vietnam), (B) plant in bloom, (C) frontal view of corolla, (D) lateral view of corolla, (E) top view of corolla, (F) opened corolla, (G) calyx lobes, (H) pistil (Photographs by F. Wen)

constricted at 3.5–3.8 mm above the base of the corolla, slightly inflated at base; adaxial lip 3.2–3.5 mm long, 2-partite nearly to base, its lobes broadly oblong to nearly rounded, rounded at apex; abaxial lip 5–6 mm long, 3-partite nearly to the base, its lobes oblong, obtuse to rounded at apex. Stamens 2, adnate to 6–7 mm above the base of the corolla tube; filaments straight, slightly geniculate at the base, pink to white, 9.5–10.5 mm long, sparsely glandular-puberulent; anthers elliptical, dark brown, 3.0–3.5 mm long, 1.5–2.0 mm in diameter. Staminodes 3, glabrous, translucent, lateral ones 3.0–3.5 mm long, adnate to 1.2 cm above the base of corolla tube, median one 1.2 mm long, adnate to ca 1 mm above the base of the corolla tube. Disc glabrous, asymmetric, the highest side 0.7 mm high, the lowest side 0.2 mm high, with entire margin. Pistil 1.4–1.6 cm long; ovary cylindrical, 8.5 mm long, densely white glandular-puberulent; style pink to white, 5.5–7.5 mm long, its indumentum same as the ovary; stigmas discoid, white, small, 1.2 mm in diameter. Capsule linear, 2–3 cm long, glabrescent, with valvular dehiscence.

#### Phenology

Flowering occurs from the middle of October to November, and fruiting from December to January.

#### Distribution and ecology

*Petrocodon vietnamensis* is hitherto only known from two localities in northern Vietnam, i.e. Kho Muong cave, Thanh Son commune, Ba Thuoc district, Thanh Hoa province and Doi cave, Ngọc Sơn commune, Lạc Sơn district, Hòa Bình province. It grows on shaded and moist rock surface at the

entrance of the karst limestone caves. The caves are located in subtropical broad-leaved evergreen monsoon forest with sufficient seasonal run-off water.

#### Conservation status

The type population of this new taxon in Thanh Hoa province consists of ca 1200 mature individuals, none of them are in protected areas but rather at a scenic spot. Another population of this new taxon in Hòa Bình province consisted of about 500 mature individuals, all growing on the cliffs at the entrance to a cave near farmland, where they are easily disturbed by human activities. Thus, following the IUCN Red List Categories and Criteria (IUCN 2019), the new species is temporarily assessed as endangered [EN C1].

#### Notes

The morphologically congener of this new taxon, *Petrocodon bonii*, was firstly deemed a member of *Didymocarpus* Wall., as *D. bonii* Pellegr., it was then transferred to the monotypic *Calcareoboaea* C.Y. Wu ex H.W. Li of the time as *C. bonii* (Pellegr.) B.L. Burt (Li 1982, Burt 2001). Ten years later, with *Calcareoboaea* C.Y. Wu ex H.W. Li incorporated into *Petrocodon*, *C. bonii* and *C. coccinea* C.Y. Wu ex H.W. Li were transferred to *Petrocodon* as *P. bonii* and *P. coccineus* (Wang et al. 2011, Weber et al. 2011). The vegetative characters of these two species are so much alike that it is hard to distinguish between them if not in flower. Fortunately, we can easily distinguish them from each other by their reproductive organs, especially in cymes and corolla. Morphological comparison of *P. vietnamensis* and *P. bonii* are summarized in Table 1.



Figure 4. All species of *Petrocodon* known from Vietnam. (A) *P. bonii*, (B) *P. coccineus*, (C) *P. hispidus*, (D) *P. vietnamensis* sp. nov. (Photographs by F. Wen).

The new species is morphologically close to *Petrocodon bonii* (Fig. 3), but can be distinguished by its green peduncle, 3–6 cm long (versus reddish-brown, 8–15 cm long), calyx lobes green, ca 5 mm long (versus reddish-brown, ca 3 mm long), corolla tube narrow infundibuliform, 1.1–1.2 cm long (versus tubaeform, 5.0–6.5 mm long), abaxial lip lobe ovate (versus nearly equilateral triangle), filament pink to white, 9.5–10.5 mm long (versus yellow, 4.5 mm long), lateral staminode adnate to ca 12 mm above the corolla base (versus ca 5 mm above the corolla base), pistil densely white glandular-puberulent (versus densely red glandular-puberulent), style pink to white, 5.5–7.5 mm long (versus yellow, ca 3 mm long), stigma white (versus yellow) and capsule 2–3 cm long (versus 4.5 cm long).

#### Key to all species of *Petrocodon* in Vietnam (Fig. 4)

- 1 Leaf blades margin serrate or denate.....2  
– Leaf blades margin entire.....*P. hispidus*
- 2 Adaxial lip 2-lobed; abaxial lip 3-lobed.....3  
– Adaxial lip 4-lobed; abaxial lip undivided.....  
.....*P. coccineus*
- 3 Corolla tube 11–12 mm long; filament 9.5–10.5 mm long.....*P. vietnamensis*  
– Corolla tube 5.0–6.5 mm long; filament 4.5 mm long...  
.....*P. bonii*

#### Additional examined specimens

*Petrocodon vietnamensis* (paratypes), Vietnam, Hoa Binh province: Lac Son district, Ngoc Son commune, Doi cave, 20°25'35"N, 105°18'23"E, alt. 248 m a.s.l., 31 Oct 2019, flowering, F. Wen, T.V. Do & Z.B. Xin, VMN-CN 1214 (paratypes: IBK!, VNMN!); Thanh Hoa province: Ba Thuoc district, Thanh Son commune, Kho Muong cave, 20°29'10"N, 105°8'30"E, alt. 340 m a.s.l., 25 Oct 2016, flowering, Y.G. Wei, T.V. Do & F. Wen, WYG16102502 (IBK!, VNMN!).

*Petrocodon bonii* (Pellegr.) A. Weber & Mich. Möller, Vietnam, Tonkin occidental, Mat Son, 29 Oct 1892, Bon H.F., #5730 (type: P!); Thanh Hoa province: Thanh Hoa city, Mat Son mountain, 19°47'39"N, 105°46'44"E, alt. 165 m a.s.l., 22 Oct 2017, Y.G. Wei, T.V. Do & F. Wen, VMN-CN 937 (VNMN!).

**Acknowledgements** – We would like to thank the staffs of Pu Luong Nature Reserve (Thanh Hoa province) and Ngoc Son-Ngo Luong Nature Reserve (Hoa Binh province) for the assistance during fieldwork, and the curators of the following herbaria: HN, HNU, IBK, IBSC, K, KUN, NIMM, P, VNM and VNMN for making collections available to us. We are grateful to Winston J. Goresky, from Canada, for editing the manuscript and checking the errors of grammar and vocabulary. The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

**Funding** – This study was financially supported by the Vietnam National Foundation for Science and Technology Development

(NAFOSTED) (106.03-2019.308), the Foundation of Guangxi key Laboratory of Plant Conservation and Restoration Ecology in Karst Terrain (19-050-6; 19-185-7), the Guangxi Natural Science Foundation (2017GXNSFAA198006; 2020GXNSFBA297049), the National Natural Science Foundation (31860047), Basal Research Fund of GXIB (Guizhiye20009), Guilin Science and Technology Foundation (20180107-6), 21st Talent project of 'Ten-Hundred-Thousand' in Guangxi, the Key Science and Technology Research & Development Project of Guangxi (Guike AB16380053; Guike AD20159091).

#### Author contributions

Zi-Bing Xin and Truong Van Do contributed equally to this publication. **Zi-Bing Xin**: Investigation (equal); Methodology (equal); Writing – original draft (lead); Writing – review and editing (lead). **Truong Van Do**: Investigation (equal); Methodology (equal); Resources (equal); Writing – review and editing (lead). **Long-Fei Fu**: Methodology (equal); Writing – review and editing (equal). **Zhang-Jie Huang**: Methodology (equal); Writing – review and editing (equal). **Stephen Maciejewski**: Investigation (equal); Methodology (equal); Writing – review and editing (equal). **Fang Wen**: Funding acquisition (equal); Investigation (equal); Methodology (equal); Project administration (equal); Resources (equal); Writing – original draft (equal); Writing – review and editing (equal).

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