

Petrocodon ionophyllus, a new species of Gesneriaceae from the limestone areas of South China

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Abstract: A new species, *Petrocodon ionophyllus* F.Wen, S.Li & B.Pan, from the limestone area of Southwestern Guangxi, South China is described here. Based on the population information and threatened situation, the current existence status of this species is assessed as ‘Endangered’.

Keywords: Endemic, Limestone Flora, New Taxa, *Petrocodon integrifolius*, Southwestern Guangxi.

Introduction

Since 2011, our understanding of generic limits in Chinese Gesneriaceae has improved considerably following the integration of additional morphological and molecular data (Möller *et al.*, 2016; Möller, 2019). In particular, a number of monotypic and small genera that were considered endemic to or mainly existing in China have been merged. The new classification in Gesneriaceae is based heavily on molecular-phylogenetic results, with a morphological character or a suite of characters used to support the new taxonomic boundaries. This has also provided a more suitable framework for further research of new Gesneriaceae taxa (Wen *et al.*, 2011; Weber *et al.*, 2011, 2013; Möller *et al.*, 2011, 2014; Möller, 2019; Wen *et al.*, 2019), for example some new genera, *Billolivia* D.J.Middleton (Middleton *et al.*, 2014), *Chayamaritia* D.J.Middleton & Mich.Möller (Middleton *et al.*, 2015a), *Litostigma* Y.G.Wei,

F.Wen & Mich.Möller (Wei *et al.*, 2010a), *Rachumia* D.J.Middleton & C.Puglisi (Middleton *et al.*, 2018), *Tribounia* D.J.Middleton (Middleton & Möller, 2012), and many new species, *viz.* *Oreocharis duyunensis* Z.Y.Li, X.G.Xiang & Z.Y.Guo (Guo *et al.*, 2018), *Paraboea dushanensis* W.B.Xu & M.Q.Han, *P. sinovietnamica* W.B.Xu & J.Guo and *P. xiangguiensis* W.B.Xu & B.Pan (Xu *et al.*, 2017), *Petrocodon tongziensis* R.B.Zhang & F.Wen (Zhang *et al.*, 2019), *Primulina anisocymosa* F.Wen, Xin Hong & Z.J.Qiu (Hong *et al.*, 2019), were confirmed and published in recent years.

The authors have undertaken more than 20 expeditions in karst and non-karst landforms of South and Southwest China and collected a number of Gesneriaceae specimens, including many unknown species since 2013. During this fieldwork, the authors made observations and carried out biological investigations particularly on those unknown taxa, and introduced living material to the nursery and the common garden of the Gesneriad Conservation Centre of China (GCCC) for further study and display.

Living plants of a species of Gesneriaceae with a single flower were observed in the field in Jingxi city, Guangxi, in 2010. Because of some corolla characters (*e.g.*, corolla purple and zygomorphic; tube cylindrical and not swollen, much longer than limb; limb lobes subequal with acute apex) hinted that it should belong to *Petrocodon* Hance (in previous *Lagarosolen* W.T.Wang) (Wang, 1984; Wang *et al.*, 1990, 1998; Weber *et al.*, 2011). The

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plants were tentatively considered as a possible ecotype of *Petrocodon integrifolius* (D.Fang & L.Zeng) A.Weber & Mich.Möller (Fang *et al.*, 1993; Li & Wang, 2004; Wei *et al.*, 2010b) because of their similarities in habit. After several years of field investigations, the authors collected further flowering specimens of this species. We carefully observed the morphology of those plants that were introduced and cultivated in the nursery and common garden of GCCC over the following years and confirmed that it can be clearly distinguished from *Petrocodon integrifolius*. Detailed analysis of morphology, types and other authentic specimens of related species of *Petrocodon* housed in various herbaria (E, GH, HN, IBK, K, KUN, MO, PE, PH, US and VNMN) and relevant literature (Wang *et al.*, 1990, 1998; Li & Wang, 2005; Wei, 2006, 2007; Wei *et al.*, 2010b; Wen *et al.*, 2012; Chen *et al.*, 2014; Jiang *et al.*, 2011; Hong *et al.*, 2014; Xu *et al.*, 2014; Li & Wang, 2015; Middleton *et al.*, 2015b; Yu *et al.*, 2015; Guo *et al.*, 2016; Lu *et al.*, 2017b; Cen *et al.*, 2017; Zhang *et al.*, 2018; Li *et al.*, 2019; Su *et al.*, 2019 a & b; Zhang *et al.*, 2019) revealed it to be a new a taxon, which is described and illustrated here.

***Petrocodon ionophyllus* F.Wen, S.Li & B.Pan, sp. nov.** Figs. 1 & 2

Petrocodon ionophyllus can easily be distinguished from other species of *Petrocodon* by its purplish green to purplish brown leaf blades. Additionally, it closely resembles *P. integrifolius* in having ovate or broadly ovate leaf blades and purple corolla with a long tube and narrowly triangular limb lobes, but differs from it in having 3–5 flowers per cyme (*vs.* 8–10[–12]), calyx lobes narrowly lanceolate to linear-lanceolate (*vs.* triangular), position of upper corolla lobes close together to nearly parallel (*vs.* spreading, positioned at over 80° angle) and stamens eglandular puberulent (*vs.* puberulent and glandular puberulent).

Type: CHINA, Guangxi Zhuangzu Autonomous Region, Jingxi City, Sanhe town, growing in crevices of rocks and cliff on limestone hills, in evergreen broad-leaved forests, rare, 780 m, 08.04.2013, flowering, Bo Pan *et al.* BP P0783 (holo IBK!; iso IBK!, KUN!).

Perennial herbs forming acaulescent rosettes. Rhizomes subterete, 0.5–1.2 cm long, 0.2–0.4 cm in diam. Leaves 4–8, clustered at apex of rhizome, opposite; petioles terete, 12–15 × 1.5–2 mm, dark green with a slightly pale purplish shading, densely pubescent; leaf blade purplish green to purplish brown, chartaceous when dried, often almost symmetrical, ovate or broadly ovate, 3.2–6.4 × 2.8–4.8 cm, broadly cuneate at base, obtuse to acute at apex, margins entire, abaxial surface sparsely strigose, adaxial surface pubescent; lateral veins 2–4 on each side of midrib, slightly prominent abaxially, slightly sunken adaxially. Cymes 1–2, rarely 4, usually 1-branched with 3–5 flowers; peduncles 5–9 cm long, 1.2–1.5 mm in diam., densely pubescent to pilose, green with a purplish shading; bracts 2, lanceolate, 6–10 × 1.5–1.8 mm, apex acuminate, margins entire, abaxially white puberulous, adaxially glabrous, usually caducous; pedicels 4.8–7 mm long, densely puberulent, white. Calyx 5-parted to the base; lobes narrowly lanceolate to linear-lanceolate, 6–8 mm long, *c.* 1 mm wide, abaxially puberulent, white, adaxially glabrous, brownish. Corolla purple, white puberulent outside, 2.5–3.2 cm long; tube infundibuliform, 1.6–1.8 cm long, *c.* 3 mm in diam. at middle, glabrous inside; orifice *c.* 5 mm in diam.; limb 2-lipped, adaxial lip 2-lobed, lobes *c.* 5 mm long, *c.* 4 mm in diam. at base, narrowly triangular; abaxial lip 3-lobed, lobes 6–8 mm long, *c.* 4.2 mm in diam. at base, narrowly triangular to narrowly lanceolate, apex attenuate-acuminate, three pale purple longitudinal stripes and puberulent-hairs along the abaxial lip lobes. Stamens 2, deflected to one side (left or right) at the throat of corolla but included, adnate at *c.* 9 mm above the corolla tube base; filaments *c.* 10 mm long, straight, eglandular puberulent; anthers fused by their entire adaxial surfaces, reniform, white, *c.* 2 mm long, glabrous. Staminodes 3, lateral ones adnate to corolla tube *c.* 7 mm above the base, 9–10 mm long; the central one adnate to corolla tube *c.* 5 mm above the base, *c.* 1.1 mm long, all glabrous. Ovary 5.5–6 mm long, 0.7–0.9 mm in diam., densely white puberulent; style 6.5–7 mm long, deflected to the other side

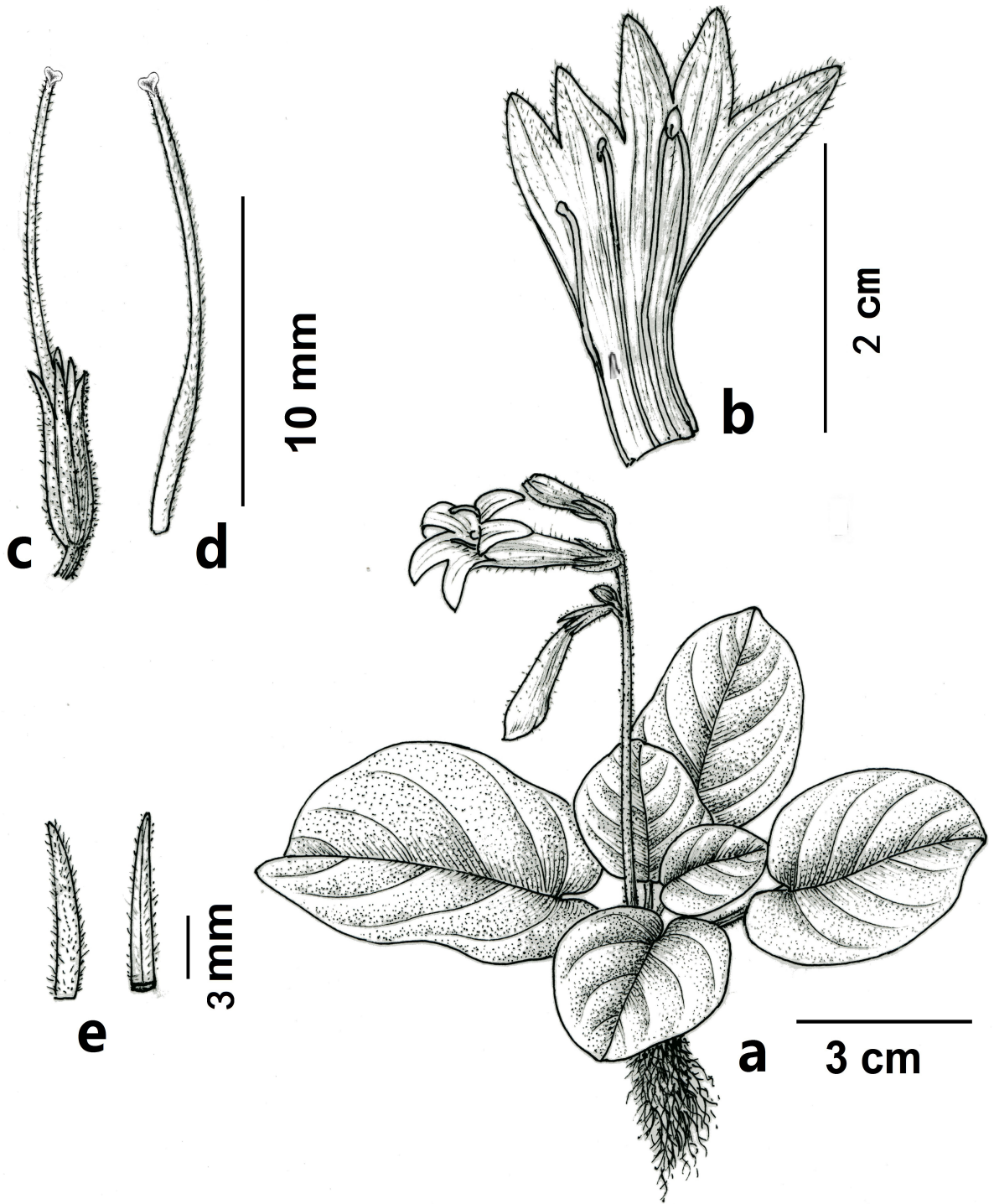


Fig. 1. *Petrocodon ionophyllus* F.Wen, S.Li & B.Pan: **a.** Flowering plant; **b.** Opened corolla with stamens and staminodes; **c.** Pistil with calyx; **d.** Pistil without calyx; **e.** Bracts (left: abaxial surface; right: adaxial surface) (drawn by Lin Wen-Hong).



Fig. 2. *Petrocodon ionophyllus* F.Wen, S.Li & B.Pan: **a.** Habitat; **b.** Flowering plant in natural habitat; **c.** Lateral view of cyme, inflorescence with open flowers, buds and bracts; **d.** Flower and anthers near corolla; **e.** Lateral view of corolla; **f.** Top view of corolla; **g.** Front view of open flower and enantiostyly, deflection of style (stigma immature) and anthers; **h.** Stigma mature; **i.** Indumentum of abaxial surfaces of bracts and calyx lobes; **j.** Dehiscent capsules and seeds (photos by Wen Fang).

away from stamens, densely white glandular-puberulent; disc annular, *c.* 1 mm in high, margins entire; stigma bilobed, lobes ovate, *c.* 0.6 mm long. Capsules linear, straight, 1.4–1.7 cm long, glabrous, 4-valved. Seeds spindle shaped, *c.* 0.3 mm long, without hair-like appendages, brown to brownish black.

Flowering & fruiting: Flowering from April to May and fruiting from June to August.

Habitat: *Petrocodon ionophyllus* is found growing mostly in crevices and on moist surfaces of limestone rock at elevation range of 740–780 m in an evergreen broad-leaved forest on a limestone hill.

Etymology: The characteristic purplish green to purplish brown leaves of this species are unusual in the genus and distinguishes it from other *Petrocodon*

species. Thus, the specific epithet, “*ionophyllus*” is chosen, derived from the Greek “*ion-*” (meaning violet-coloured) and “*-phyllus*” (leaves), referring to its purple-hued leaves.

Distribution: *Petrocodon ionophyllus* is only found in Jingxi city, China. The type locality is close to the border between China and Vietnam, hence the distribution of this species might extend into Vietnam.

Conservation status: Currently, only one location with three sub-populations of this new species are known in the wild, with a total of 200 mature individuals on three limestone mountains in Sanhe Town. The mountains do not belong to any of the protected areas or natural reserves, so this population is very vulnerable to local timber

Table 1. Morphological comparison of *Petrocodon ionophyllus* (see Fig. 4) and *P. integrifolius*

Characters	<i>P. ionophyllus</i> F.Wen, S.Li & B.Pan	<i>P. integrifolius</i> (D.Fang & L.Zeng) A.Weber & Mich.Möller
Leaf blade colour	Purplish green to purplish brown	Pale green to green
Leaf blade shape	Ovate or broadly ovate	Ovate to orbicular
Leaf blade base	Broadly cuneate at base	Obviously cordate, sometimes cuneate
Leaf blade indumentum	Sparsely strigose on adaxial surface, pubescent on abaxial surface	Appressed pubescent on both surfaces
Leaf blade apex	Acute to obtuse, no rounded	Obtuse to rounded
Number of flowers per cyme	3–5	8–10 (or more)
Bracts shape	Lanceolate	Oblong to lanceolate
Calyx lobe shape	Narrowly lanceolate to linear-lanceolate	Triangular
Stamens	Eglandular puberulent	Puberulent and glandular puberulent
Ovary	Densely white puberulent	Spreading glandular puberulent

harvesting, road construction and other detrimental factors. Because only one location (with <250 mature plants) has been found so far, we recommend that this species should be provisionally treated as Endangered (EN) under category D for very small or restricted population (IUCN, 2019).

However, this status could be reassessed in the future fieldwork.

Notes: The expanded genus *Petrocodon* and the many new published species resulted in a genus with various flower shapes, stamen numbers and

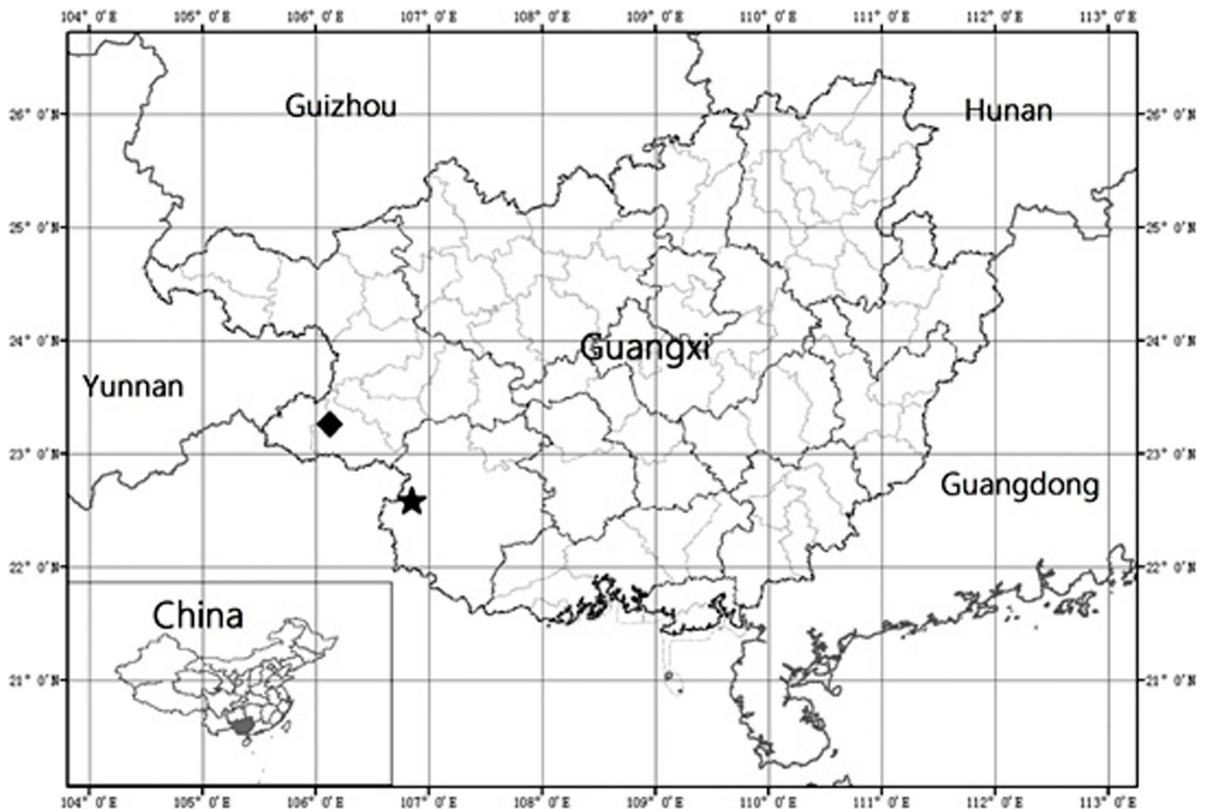


Fig. 3. Distribution of *Petrocodon ionophyllus* F.Wen, S.Li & B.Pan (◆) and its morphologically similar species, *P. integrifolius* (D.Fang & L.Zeng) A.Weber & Mich.Möller (*).

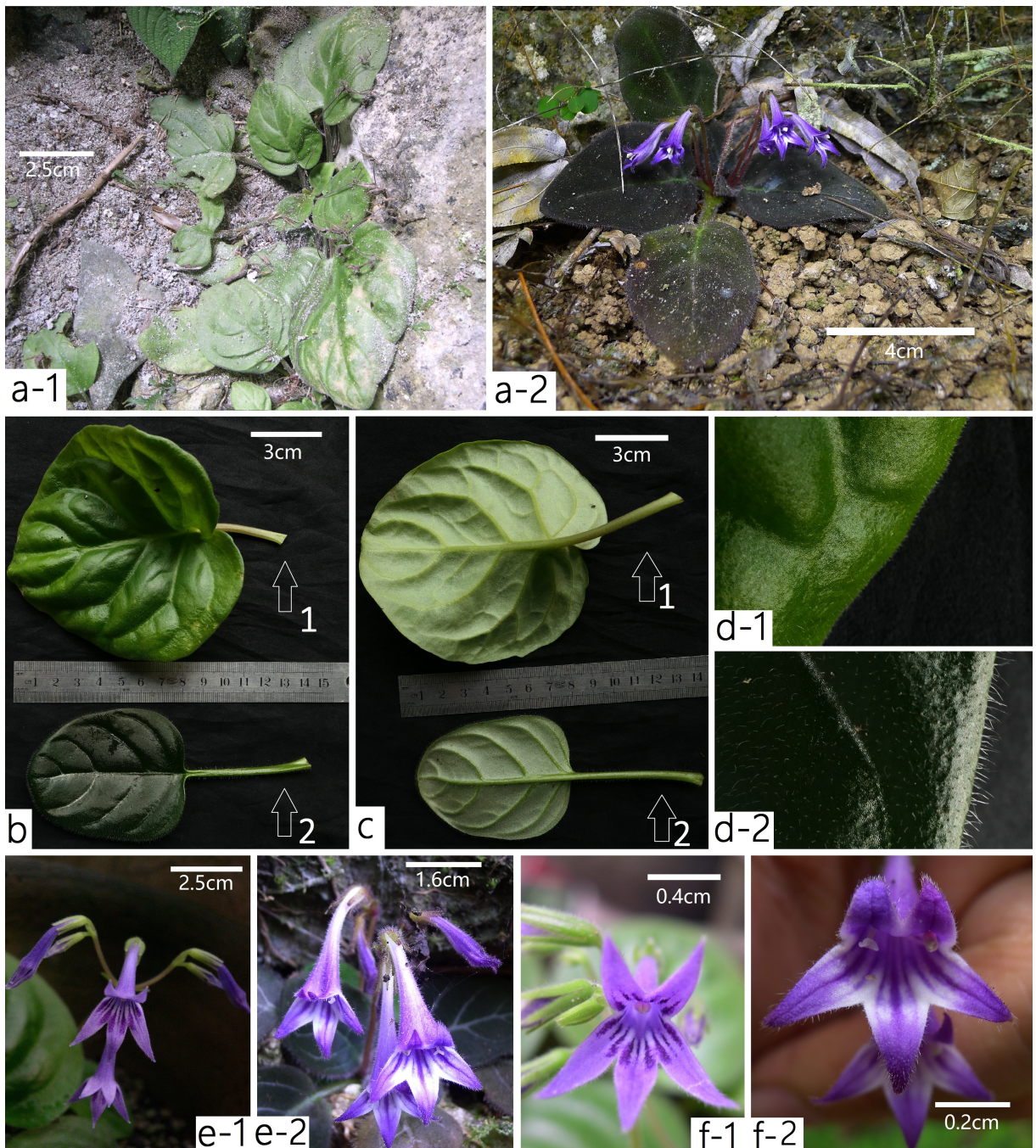


Fig. 4. Morphology comparison between *Petrocodon ionophyllus* F.Wen, S.Li & B.Pan and *P. integrifolius* (D.Fang & L.Zeng) A.Weber & Mich.Möller: (a. Habitat; b., c., d., e. After common garden experiment). 1. *Petrocodon integrifolius*; 2. *P. ionophyllus*: a. Habitat; b. Adaxial view of leaves; c. Abaxial view of leaves; d. Indumentum of leaf margins; e. Inflorescences; f. Frontal view of corollas (photos by Wen Fang).

colours (Weber *et al.*, 2011; Lu *et al.*, 2017a). The genus currently harbours almost 40 species and has its distribution centre in the mountainous area of southwestern and southern China (Wen *et al.*, 2019, 2014 onw.). Only four species have been found distributed outside China, namely *Petrocodon*

coccineus (C.Y.Wu ex H.W.Li) Yin.Z.Wang and *P. hispidus* (W.T.Wang) A.Weber & Mich.Möller (both distributed in China and Vietnam), *P. bonii* (Pellegr.) Mich.Möller & A.Weber (distributed in Laos, Thailand and Vietnam, not in China) and *P. flavus* D.J.Middleton & Sangvir (endemic to

Thailand) (Burtt, 2001; Phuong, 2006; Weber *et al.*, 2011; Middleton *et al.*, 2015b).

The morphological variation between *Petrocodon* species is rather diverse, yet we identified this species mistakenly as *P. integrifolius* when this plant was discovered because of their morphological similarities. The new species, *P. ionophyllus*, occurs in Jingxi City of Guangxi and grows on the surfaces and in crevices of limestone rocks under forests up to an altitude of about 750 meters. However, *P. integrifolius* is distributed in Longzhou County of Guangxi, and only grows in deep caves at altitudes between 200 to 530 meters (Fig. 3). In their native habitat, the new species grows significantly smaller than *P. integrifolius*, the texture of the leaves is hard, chartaceous to nearly leathery, and the hairs on the leaves are rough. The leaves of *P. integrifolius* are thin like paper, and pubescent. Living plants from the type localities of both species, Longzhou and Jingxi, were introduced to the greenhouses of GCCC. The differences observed in the field between these species were found to be consistent even after 4 years of cultivation. In *P. ionophyllus*, exhibit reciprocal enantiostyly where the style is deflected to one side and the stamen to the other, which is perhaps to reduce autogamy (Jesson & Barrett, 2002, 2003) (Table 1, Fig. 4).

This is similar to the mirror-image flowers described in *Paraboea rufescens* (Franch.) Burtt (Gao *et al.*, 2006). Further, the florescence of the two species are different; the flowering period of *Petrocodon ionophyllus* is from April to May, whereas *P. integrifolius* begins to bloom from June onwards.

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