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Primulina arcuata, a new species of *Primulina* (Gesneriaceae) from the Danxia Landform in Jiangxi, China

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ABSTRACT: Based on morphological observations and comparisons, a new species of *Primulina* (Gesneriaceae), *P. arcuata* G.L.Xu & L.Ding, is described and illustrated. This new species resembles *P. jiulianshanensis* in leaf blade shape, but differs from the latter by corolla tube curved-tubular (*vs.* funnelform); calyx lobes oblong (*vs.* lanceolate); peduncle, pedicel, both surfaces of bracts, both surfaces of bracteoles and abaxial surface of calyx lobes covered with glandular-puberulent hairs (*vs.* with eglandular-puberulent hairs). A detailed description, photographs, distribution information and a provisional conservation status assessment are provided.

KEY WORDS: Flora of Jiangxi, IUCN, Morphology, *Primulina jiulianshanensis*, Taxonomy, Xiaowudang Scenic Spot.

INTRODUCTION

Primulina Hance (1883), established 140 years ago, was originally a monotypic genus with *P. tabacum* Hance, only known from the Lianjiang River basin in northern Guangdong, China. The second species of this genus, *P. guangxiensis* Yan Liu & W.B.Xu, was published in 2011 based only on morphological characteristics. *Primulina* has been redifined since 2011 (Wang *et al.*, 2011; Weber *et al.*, 2011) based on morphological characteristics; most species of *Chirita* sect. *Gibbosaccus* Clarke, two species of *Wentsaiboea* D.Fang & D.H.Qin (2004) and *Chiritopsis* W.T.Wang (1981) were integrated into the genus, *Primulina* (Wang *et al.*, 2011; Weber *et al.*, 2011; Zhou *et al.*, 2016). Since then, many new taxa of this genus have been published and reported, and as of December 2022, more than 240 species (including infraspecies, the same below) have been discovered and published, of which 224 species are distributed in China. This genus is now the largest genus of Gesneriaceae in China (POWO, 2022).

Among the known species worldwide, more than 170 are endemic to Karst areas in southern to southwestern China and northern Vietnam (Wei, 2018; Xu *et al.*, 2020a). Karst and Danxia Landforms often exhibit unique biodiversity, vegetation types, and flora (Yu *et al.*, 2019). The chemical characteristics of Danxia soil generate a range of edaphic habitats, which possibly play an essential role in the diversification and evolution of *Primulina* (Hao *et al.*, 2015). However, the diversity of *Primulina* in the Danxia Landform has not been well understood so far (Yu *et al.*, 2019), compared with South China and Southwest China, these are not particularly rich areas for species of Gesneriaceae. Currently, there are 42 species of 14 genera of Gesneriaceae in Jiangxi Province, including 14 species of *Primulina* (Peng *et al.*, 2021; Xu *et al.*, 2023). Among them, four species of *Primulina* are only distributed in Danxia Landform, which are *P. suichuanensis* X.L.Yu & J.J.Zhou (Zhou *et al.*, 2016), *P. inflata* Li H.Yang & M.Z.Xu (Xu *et al.*, 2020b), *P. jiulianshanensis* F.Wen & G.L.Xu (Xu *et al.*, 2023), and *P. danxiaensis* (W.B.Liao, S.S.Lin & R.J.Shen) W.B.Liao & K.F.Chung (Shen *et al.*, 2010; Xu *et al.*, 2012).

In March 2020, we found a rare *Primulina* population on a Danxia Landform cliff in Xiaowudang Scenic Spot, Longnan City, Jiangxi Province. At first glance, the morphology of this species is similar to that of the recently published species *P. jiulianshanensis*. Regarding vegetative organs, both leaves are oblong–elliptic to broadly–ovate with villous and glandular hairs. Both of them are distributed in the Danxia Landform. However, this species' characteristics of reproductive organs, such as corolla size, corolla tube, calyx lobes, staminodes, and indumentum, are significantly different. We carefully observed this wild population for three years and found their morphology stable. The relevant literature was consulted, and all available specimens of *Primulina* were used and compared (*viz.,* those stored in the following herbaria: e.g., ANU, HITBC, IBK, IBSC, KUN, PE) (Wei *et al.*, 2010, 2022; Lu *et al.*, 2013; Wen *et al.*, 2015; Li *et*

Table 1. Morphological comparison of ***Primulina arcuata*** and ***P. jiulianshanensis***.

Characters	***P. arcuata*** sp. nov.	***P. jiulianshanensis***
Bracts and bracteoles		
Indumentum	Both surfaces of bracts and bracteoles covered glandular-puberulent hairs	Both surface of bracts and bracteoles with no glandular-puberulent hairs
Size	Bracts 1.5–5 ×0.5–1 mm, bracteole 1–2 × ca. 0.5 mm,	Bracts 2–9 × 1–2 mm, bracteoles 2–5 × 1–1.5 mm
Calyx lobes		
Shape and size	Oblong, 4–6 × 1–2 mm	Lanceolate, 8–11 × ca. 2 mm
Indumentum	Abaxial surface glandular-puberulent and villous	Abaxial surface puberulent and villous
Corolla tube	Curved-tubular, mouth 0.7–0.9 cm in diam.	Funnelform, mouth 1.3–1.6 cm in diam.
Peduncle and pedicle	Densely villous and glandular-puberulent	Densely villous
Staminodes		
Size	Lateral staminodes 1–3 mm long,	Lateral staminodes ca. 6 mm
Position	Lateral staminodes adnate to 17–20 mm above the corolla tube base, middle staminodes adnate to 9–16 mm above the corolla tube base	Lateral staminodes adnate to ca. 14 mm above the corolla tube base, middle staminodes adnate to 5–6 mm above the corolla tube base
Filaments length	4–6 mm	8–11 mm

al., 2017; Wei, 2018; Liu *et al.*, 2020; Qin *et al.*, 2020; Xin *et al.*, 2021). *Primulina* material from recent fieldwork by the authors in South and Southwest China was also examined by the authors. This species is morphologically distinguishable from any known *Primulina* species, so we describe it as new.

MATERALS AND METHODS

Ten living plants at the flowering stage were randomly selected for morphological observation in the field. The sizes of petioles, leaves, inflorescences, capsules, and flowers were measured, and the flower organs were dissected. The indumentum characters were studied under Olympus-ML31 dissecting microscopes (Guangzhou, China) and Olympus-CX33 Optical microscope (Nanjing, China), and the Nikon D750 camera (Tokyo, Japan) was used to take photos and record. We described this presumed new species using the terminology of Wang *et al.* (1990, 1998).

TAXONOMIC TREATMENT

Primulina arcuata G.L.Xu & L.Ding, ***sp. nov.***

弧冠报春苣苔 Figs. 1–3

Type: China. Jiangxi Province: Longnan City, Wudang Town (Xiaowudang Scenic Spot). Growing on moist rock surfaces of Danxia Landform, elevation ca. 730 m, 26°21'47.26"N, 115°25'40.85"E, 7 April 2023, Xu Guo–Liang, *JLSXGL–20230407* (holotype: IBK!, isotypes: KUN!),

Diagnosis: This new species differs from *Primulina jiulianshanensis* (Fig. 4) in corolla tube curved-tubular (*vs.* funnelform); calyx lobes oblong, 4–6 × 1–2 mm (*vs.* lanceolate, 8–11 × ca. 2 mm); lateral staminodes 1–3 mm long (*vs.* ca. 6 mm long), central staminodes adnate 9–16 mm above corolla tube base (*vs.* 5–6 mm above corolla tube base); peduncle, pedicel, both surfaces of bracts and bracteoles, abaxial surface of calyx lobes covered with glandular-puberulent hairs (*vs.* with eglandular-puberulent hairs). The detailed morphological comparison of *P. arcuata* and *P. jiulianshanensis* in Table 1.

Description: Perennial herb. Stem terete, 0.8–1.5 cm long, 0.7–1.2 cm in diameter. Leaves basal, 3–9, opposite; petiole compressed, densely villous and glandular-puberulent, 0.8–3 × 0.4–0.5 cm. Leaf blade oblong-elliptic to broadly-ovate, herbaceous, 3.5–8 × 2–6 cm, adaxial green to dark green, densely white to light red villous and glandular-puberulent; abaxial pale green; densely white villous and glandular-puberulent, base narrowly to broadly-cuneate or rounded, margin irregularly obtuse-serrate, apex obtuse to nearly rounded; lateral veins 3–4 on each side of the midrib, adaxially inconspicuous, abaxially prominent. Cymes 2–5, axillary, 2–8 flowered; peduncle and pedicle green to light red, densely white to light red villous and glandular-puberulent; peduncle 3–7 cm long, 1–2 mm in diam., pedicle 3–10 mm long, 0.5–1.5 mm in diam., Bracts 3, green to light red, lanceolate, adaxially densely white to light red villous and glandular-puberulent, abaxially sparsely white puberulent and glandular-puberulent, margin entire, apex acute, ciliate and glandular-puberulent, lateral ones opposite, 2–5 × ca. 1 mm, central one smaller, 1.5–3 × ca. 0.5 mm; bracteoles 3, 1–2 × ca. 0.5 mm, shape, color and indumentum same as bracts. Calyx 5-parted from the base; segments equal, calyx lobes oblong, 4–6 × 1–2 mm; outside green to light red, densely white to light red villous and glandular-puberulent; inside pale green, sparsely white puberulent and glandular-puberulent; margin entire but each side of calyx lobes with 4–6 purplish brown crenate at the apex. Corolla light blue, bluish purple or reddish purple throat with two dark purple stripes respectively between each pair of abaxial lip lobes, a dark purple lump on the upper throat of the corolla tube inside and upper lip lobes, ovate; outside densely covered with short glandular-puberulent, inside sparsely glandular-puberulent; corolla tube curved-tubular, 2.5–3.5 cm long, mouth 7–9 mm in diam., base

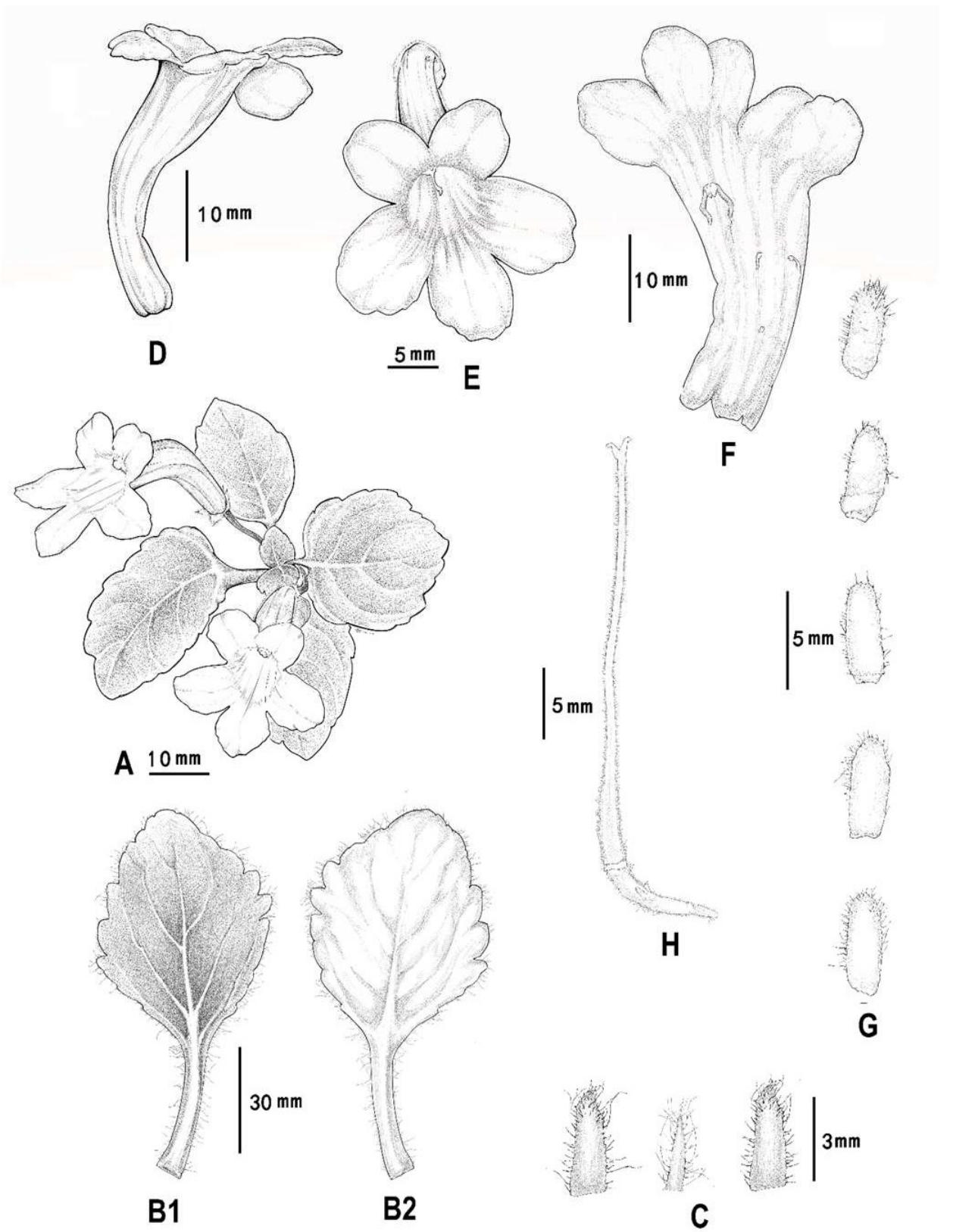

Fig. 1. ***Primulina arcuata*** sp. nov. **A.** habit, **B1.** adaxial leaf surface, **B2.** abaxial leaf surface, **C.** bracks, **D.** flower in side view, **E.** flower in front view, **F.** opened corolla, showing stamens and staminodes, **G.** calyx lobes, **H.** pistil. Di Hu drew them based on wild individuals collected from the type locality.

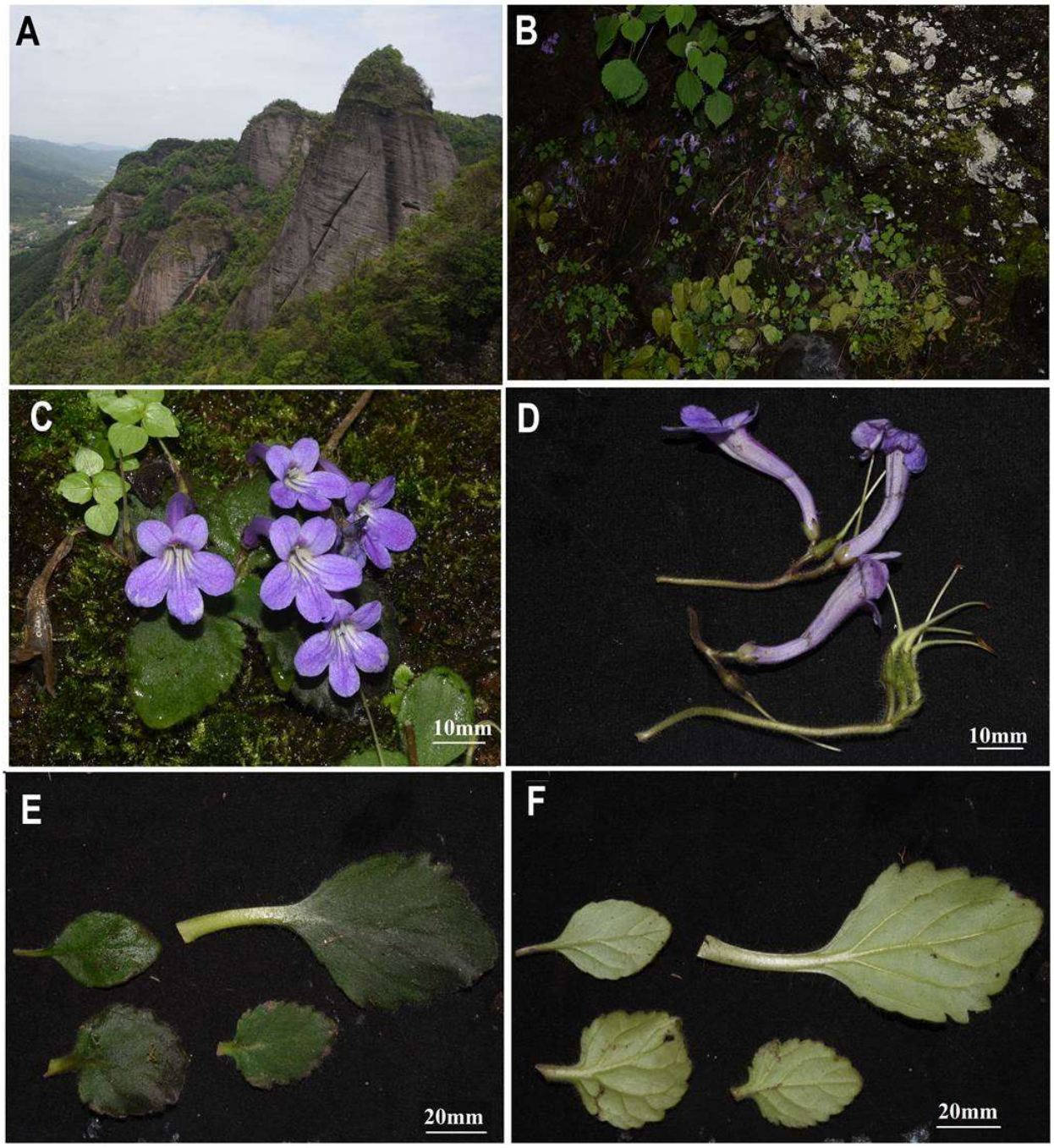

Fig. 2. ***Primulina arcuata*** sp. nov. **A.** habitat **B.** population. **C.** habit, **D.** inflorescence, **E.** adaxial leaf surface, **F.** abaxial leaf surface

3–6 mm in diam. Limb distinctly 2-lipped, adaxial lip 2-parted, lobes nearly equal, broadly obovate to semicircular, 6–9 × 7–10 mm; abaxial lip 3-parted, lobes elliptical to oblong, 7–10 × 6–8 mm. Stamens 2, adnate to ca. 2 cm above the corolla base; anthers pale yellowish, reniform, densely villous and glandular-puberulent, fused by entire adaxial surfaces; filaments linear, 4–6 mm long, yellowish, geniculate near the base, sparsely glandular-puberulent. Staminodes 3, translucent to white, lateral ones 1–3 mm long, sparsely glandular-puberulent, linear, adnate to 1.7–2.0 cm above the corolla tube base; the middle one 0.5–1 mm long, adnate to 9–16 mm above the corolla tube base. Disc yellowish green, annular, margin erose, ca. 0.5 mm high. Pistil 2.9–3.3 cm long; ovary pale green, ovoid oblong, 5–7 mm long, 1–2 mm in diam., densely villous and glandular-puberulent; style white, 2.2–2.6 cm long, ca. 0.5 mm in diam., sparsely puberulent and glandular-puberulent. Stigma acute triangle, 2-parted at apex, lobes ca. 2 mm long. Capsule linear, curved, 2–3 cm long, parietal placenta, densely villous and glandular-puberulent.

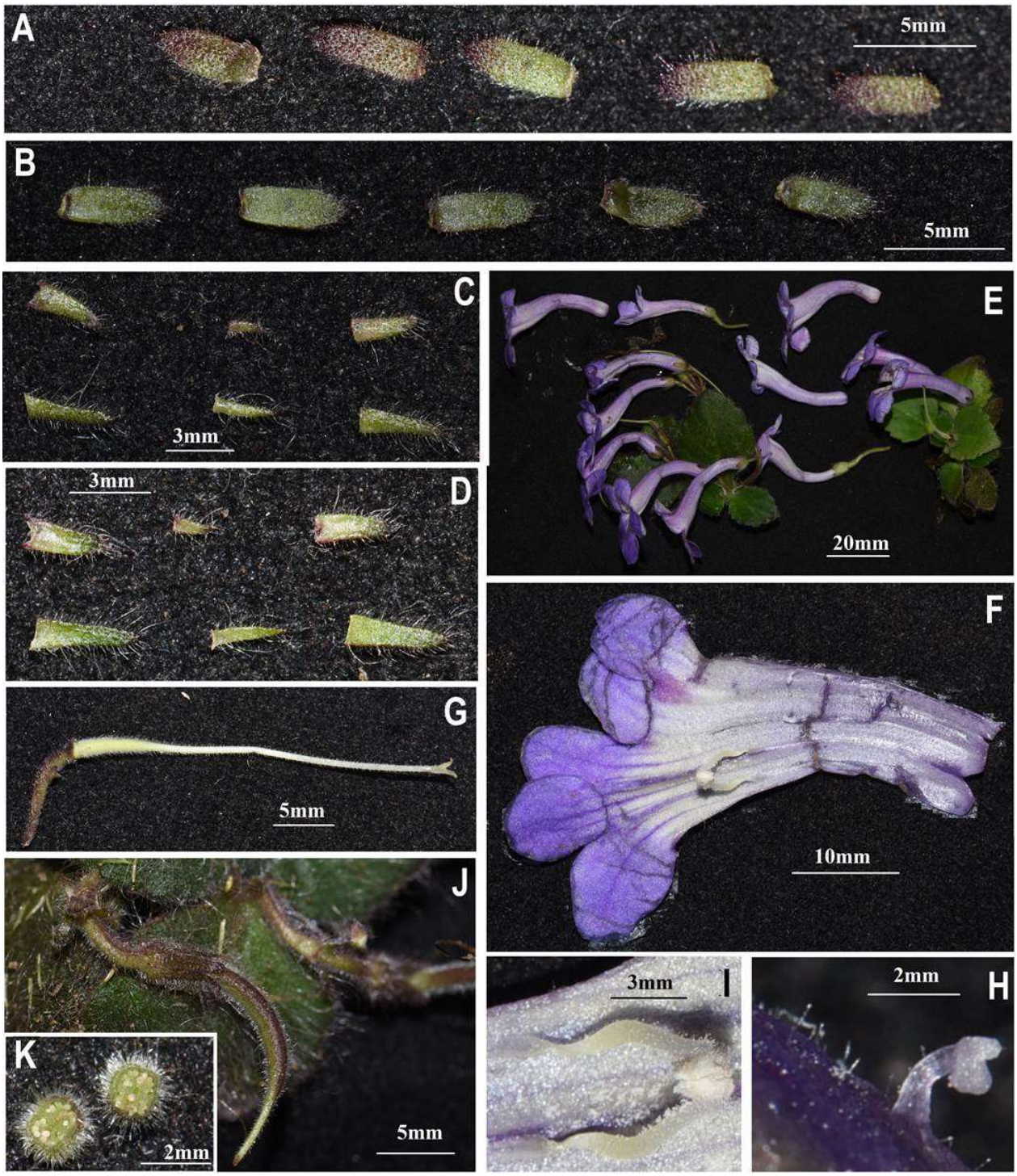

Fig. 3. ***Primulina arcuata*** sp. nov. **A.** adaxial surface of calyx lobes, **B.** abaxial surface of calyx lobes, **C.** adaxial surface of bracts, **D.** abaxial surface of bracts, **E.** corolla tube in side view, **F.** opened corolla, showing stamens and staminodes, **G.** pistil, **H.** one of lateral staminodes, **I.** stamens and anthers, **J.** immature capsules, **K.** transverse section of capsule.

Distribution and habitat: *Primulina arcuata* is only known from its type locality, Xiaowudang Mountain Scenic Spot, Wudang Town, Longnan City, Jiangxi Province, at 500–800 m a.s.l. It grows on moist rock surfaces of the Danxia Landform. This new species is mainly accompanied by *Euphorbia hylonoma* Hand.-Mazz., *Asplenium tripteropus* Nakai, *Oreocharis auricula* (S. Moore) C.B. Clarke, *Selaginella tamariscina* (P. Beauv.) Spring, and other common species on the Danxia Landform.

Phenology: Flowering from March to April, fruiting from April to August.

Etymology: The specific epithet is derived from the curved corolla tube of this new species.

Vernacular name: 弧冠报春苣苔 (Chinese name); Hú Guàn Bào Chūn Jù Tái (Chinese pronunciation).

Provisional conservation status: Currently, only one population of ca. 800 mature individuals of the new species is known in the type locality, Xiaowudang Scenic Spot, Longnan City, Jiangxi Province, China. The population is susceptible to tourist disturbance despite the locality being supervised by the Scenic Spot management committee. All individuals are clustered in a narrow region at the Xiaowudang Scenic Spot. The known AOO of the new species is about 25 m^2 (=0.000025 km^2), and the estimated suitable habitat is about 20 km^2. Thus, considering the small number of individuals and the vulnerability of this population, it should be temporarily assessed as Near Threatened (NT), following the IUCN Red List Categories and Criteria (IUCN Standards and petitions committee 2022).

Note: The type locality of *Primulina arcuata* and *P. jiulianshanensis* are both in Longnan City and distributed in the Danxia Landform area. They can be distinguished at a glance by their macroscopic difference of corolla tubes and calyx lobes. We know the genus *Primulina* is species-rich. However, in contrast to its high species diversity, the morphological variation of *Primulina* is relatively limited compared to other genera (Möller *et al.*, 2016). The flower morphology is relatively monotonous, and most species possess a straight infundibuliform corolla. They are only differentiated by size (e.g., corolla lobes size, tube length, and width) and coloration (Yang *et al.*, 2017). The morphology of curved corolla tubes in *Primulina* is particularly rare (Yang *et al.*, 2017; Peng *et al.*, 2020). So far, *P. arcuata* is the only species of *Primulina* with a curved corolla tube found in the Danxia Landform.

Additional specimens examined **(paratypes):** **CHINA.** Jiangxi Province: Longnan City, Wudang Town (Xiaowudang Scenic Spot), 545 m, 20 April 2022, *Xu Guo-Liang*, *XWDXGL-20220420* (IBK).

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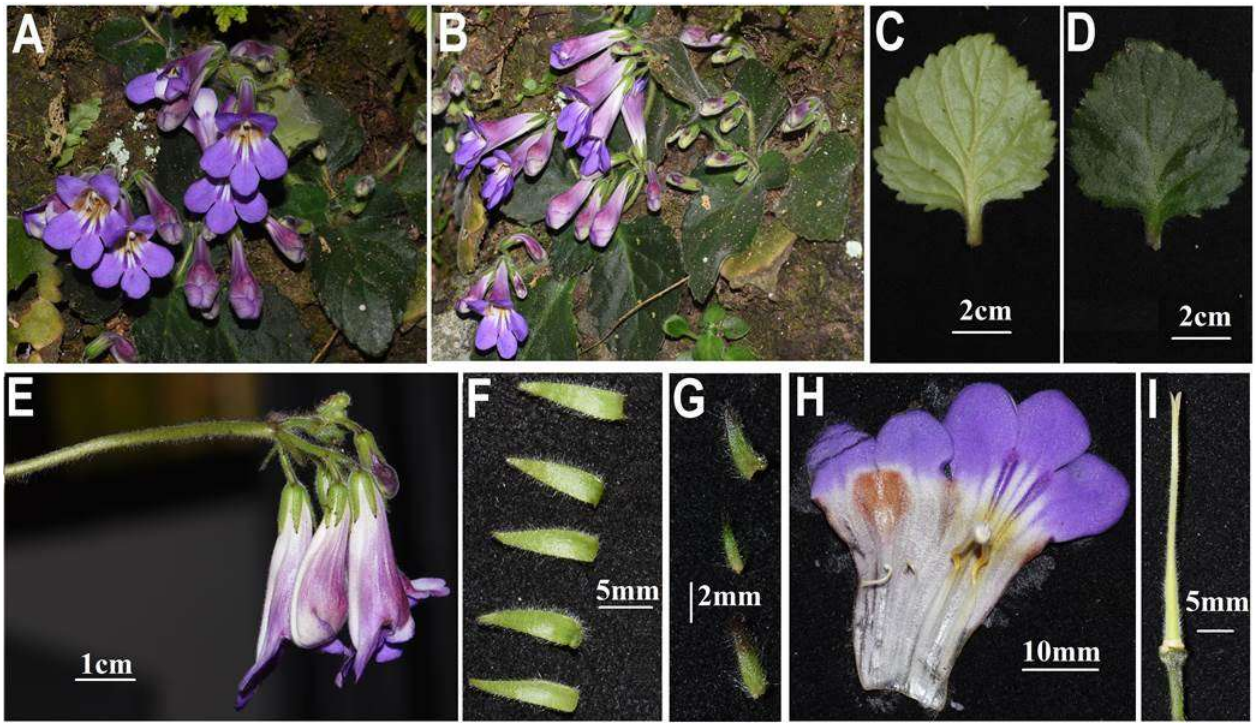

Fig. 4. *Primulina jiulianshanensis*. A. habit in front view, **B.** habit in side view, **C.** abaxial surface of the leaf blade, **D.** adaxial surface of the leaf blade, **E.** inflorescence, **F.** calyx lobes, **G.** bracks, **H.** opened corolla, **I.** pistil