



Two new species of *Primula* (Primulaceae) from Yunnan, China

Bin YANG^{1,2,3,#}, Ji-Dong YA^{4,5,#}, Wei ZHANG⁶, Yu SONG⁷, Wen WANG⁸, Zheng-Min ZHU⁸, Jiang-Hai HE⁸, Yun-Jun ZUO^{1,2,3,*}, Yun-Hong TAN^{1,2,3,*}

1. Southeast Asia Biodiversity Research Institute, Chinese Academy of Sciences & Center for Integrative Conservation, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Mengla, Yunnan 666303, China. **2.** Yunnan International Joint Laboratory of Southeast Asia Biodiversity Conservation & Yunnan Key Laboratory for Conservation of Tropical Rainforests and Asian Elephants, Menglun, Mengla, Yunnan, 666303, China. **3.** Center of Conservation Biology, Core Botanical Gardens, Chinese Academy of Sciences, Mengla, Yunnan 666303, China. **4.** Germplasm Bank of Wild Species, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, Yunnan 650201, China. **5.** Academy of Biodiversity, Southwest Forestry University, Kunming, 650224, Yunnan, China. **6.** Key Laboratory of Economic Plants and Biotechnology, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, Yunnan, 650201, China. **7.** Key Laboratory of Ecology of Rare and Endangered Species and Environmental Protection (Ministry of Education), Guangxi Normal University, Guilin, Guangxi, 541004, China. **8.** Management and Conservation Bureau of Yunnan Huangliangshan National Nature Reserve, Luchun 662599, China. # These authors contributed equally to this work. *Corresponding authors' emails: YJZ: zuoyunjuan@xrbg.ac.cn; YHT: tyh@xrbg.org.cn

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ABSTRACT: *Primula sugongii* J.D.Ya, Bin Yang & Y.H.Tan and *P. zhengyii* Bin Yang & Y.H.Tan, two new species of Primulaceae from Yunlong County and Luchun County, Yunnan Province, China, are described based on morphological characters and phylogenetic evidence, and colour plates of these two species are also provided. The molecular phylogenetic analysis using the nuclear ribosomal internal transcribed spacer (nrITS) and chloroplast genome, *Primula sugongii* was nested within the clade with most members of sect. *Obconicolisteri*, for *Primula zhengyii*, the phylogenetic position and its affiliation is somewhat controversial. Based on the comprehensive morphological evidence, they are affiliated to *Primula* sect. *Obconicolisteri* Balf. f. *Primula sugongii* is morphologically similar to *P. barbicalyx* C.H.Wright in having short and pilose scapes and calyx, but it can be easily distinguished by its longer corolla tube and corolla exannulate at throat, and series of other characters of the leaf blade. *Primula zhengyii* is morphologically similar to *P. zhui* Y.H.Tan & Bin Yang and *P. intanoensis* T. Yamaz., but clearly differs from *P. zhui* by its shorter corolla tube and smaller flowers size and differs from *P. intanoensis* by its distylous flowers and several other characters of leaf blade.

KEY WORDS: *Primula barbicalyx*, *Primula intanoensis*, *Primula sugongii*, *Primula zhengyii*, *Primula zhui*, Section *Obconicolisteri*.

INTRODUCTION

The genus *Primula* L. is the largest in Primulaceae (Hu and Kelso, 1996; Richards, 2003). Consisting of more than 500 species, it is mainly distributed in the alpine region of the North Temperate Zone. There are more than 300 species of 24 sections in China, mostly distributed in western Sichuan, eastern Xizang, and northwestern Yunnan (Hu, 1990a, 1998; Hu and Kelso, 1996; Richards, 2003).

The mode of dehiscence of capsule is of taxonomic significance in infrageneric classification in *Primula* (Smith and Fletcher, 1946; Hu, 1990b; Richards, 2003; Rankin, 2019). The traditional uniquely morphological character of *Primula* sect. *Carolinella* (Hemsl.) Pax is its calyptrate capsules that might have evolved more than once in *Primula* (Richards, 2003; Yan et al., 2010; Liu et al., 2015; Xu et al., 2016). The calyptrate capsules of *P.* sect. *Carolinella* are very different from the operculate, and it is not operculate but rather dehisce by irregular calyptra (Pax and Knuth, 1905; Xu et al., 2016). Rankin (2019) made a further detailed explanation and illustration of the two terms. Capsules of *Primula ambita*, *P. obconica*, and other species of section *Obconicolisteri* Balf. f. are operculate (Rankin, 2019). In this case, several

species such as *Primula larsenii* C.M.Hu (Hu, 1990b), which is conspecific with *P. intanoensis* T. Yamaz. (Yamazaki, 1988; Hu, 1999), *P. calyprata* X.Gong & R.C.Fang (Gong and Fang, 2003), *P. hunanensis* G.Hao, C.M.Hu & X.L.Yu (Yu et al., 2015), *P. zhui* Y.H.Tan & Bin Yang (Yang et al., 2017) that appear to belong in section *Obconicolisteri* rather than in section *Carolinella* (Rankin, 2019). However, as previously revealed by molecular studies, species of sect. *Carolinella* were divided into four separate clades (Liu et al., 2015; Xu et al., 2016). *Primula calyprata* was differentiated as an independent lineage (Xu et al., 2016), or sister to the clade of section *Obconicolisteri* (Liu et al., 2015), so its taxonomic position requires further investigation. *Primula hunanensis* together with *P. wangii*, *P. undulifolia*, *P. kweichouensis* and *P. kwangtungensis*, formed a clade became the sister to the majority members of subgen. *Auganthus* (Xu et al., 2016), whereas some species (i.e. *P. kweichouensis* and *P. kwangtungensis*) have ever been placed in sect. *Obconicolisteri* (Smith and Fletcher, 1946).

Section *Obconicolisteri* is one of 38 sections traditionally recognized in *Primula* (Richards, 2003). It comprises ca. 15 species (Hu and Kelso, 1996; Fang, 1998; Richards, 2003; Zhong et al., 2019; Averyanov et al., 2020; Ma et al., 2021) of which 11 are endemic to



China, mainly occurring in Yunnan and Sichuan provinces (Richards, 2003; Zhong *et al.*, 2019; Ma *et al.*, 2021). The species of this section can be distinguished by a set of morphological characters: leaf blades rounded, entire to shallowly lobed, usually hairy and heart shaped at the base with long stalk, calyx cup shaped, capsule globose to top shaped which widest at the flattened top and is enclosed in the tube of the calyx, the dehiscence is irregular and the wall crumbles at maturity (Smith and Fletcher, 1946; Richards, 2003), which only in a ring around the lid, and is quite distinct from that in the sect. *Petiolares*, the operculum usually remaining attached at one side (Rankin, 2019).

In recent six years, there are more than 20 new species of *Primula* have been described in China (Li *et al.*, 2017, 2023; Xu *et al.*, 2017a, 2017b, 2019, 2022a, 2022b; Yang *et al.*, 2017; Ju *et al.*, 2018, 2021; Yuan *et al.*, 2018; Wu *et al.*, 2019, 2023; Sun *et al.*, 2020; Zhang *et al.*, 2020a, 2022, 2023; Ma *et al.*, 2021; Wang *et al.*, 2022, 2023; Wei *et al.*, 2022), and there are new members still to be discovered. During our recent field expedition to survey plant diversity in Yunnan province, two unknown species, which are affiliated to *Primula* sect. *Obconicolisteri* and with cup-shaped calyces and globose and irregular operculate capsules, were discovered. Some individuals collected from Yunlong County were then introduced to the greenhouse of Kunming Institute of Botany for cultivation and flowered in December 2020. Based on a detailed examination of the morphological and anatomical characteristics of our material and closely related species (Hu and Kelso, 1996; Richard, 2003), we concluded that the two species collected in Yunnan belong to two species new to science, which are hereby described.

MATERIALS AND METHODS

Morphological descriptions were based on living collections and dried specimens. Related species were chosen for morphological comparisons and phylogenetic results (Liu *et al.*, 2015; Xu *et al.*, 2016; Zhong *et al.*, 2019), with the morphological features of these species culled from specimens and descriptions in previous studies (Smith and Fletcher, 1946; Hu and Kelso, 1996; Hu, 1999; Richards, 2003). Voucher specimens have been deposited in the herbarium of the Xishuangbanna Tropical Botanical Garden (HITBC) and Kunming Institute of Botany (KUN), Chinese Academy of Sciences.

To assess the phylogenetic position and interspecific relationship of the two new species, we sampled the nuclear ribosomal internal transcribed spacer (nrITS) and chloroplast genome were used for phylogenetic analyses. Sixteen samples of *Primula* were newly sampled for phylogenetic analyses, including two samples for both *P. sugongii* and *P. zhengyi* (Table S1). Other sequences of *Primula* were obtained from NCBI GenBank and species of *Androsace* were chosen as the outgroup. 103

accessions of the nrITS representing 76 taxa and 117 plastomes of 94 taxa were obtained. Voucher information and GenBank accession numbers for all sequences are listed in Table S1.

Genomic DNA were extracted from silica gel-dried materials. Library construction, Illumina NovaSeq sequencing, raw data cleaning and quality control were performed at Shanghai Personalbio Technology Co., Ltd. (China). The plastid genomes and nuclear ribosomal DNA were assembled by GetOrganelle v1.6.2e (Jin *et al.*, 2020) using high-quality Illumina sequencing reads. The plastomes were annotated using the online program Geseq (Tillich *et al.*, 2017) with *P. obconica* (NC_046415.1) and *P. oreodoxa* (NC_050848.1) as references. Annotations were then manually adjusted in Geneious v.9.1.7 (Keasey *et al.*, 2012). The plastid protein coding sequences were extracted from the plastomes using Phylosuite (Zhang *et al.*, 2020b). The coding regions of 75 plastid genes were aligned with MAFFT v.7.450 (Katoh and Standley, 2013) implemented in Geneious v9.1.7 and concatenated to create a supermatrix.

We performed maximum likelihood analyses for plastid protein-coding regions and nrDNA, respectively, using RAxML v8.2.12 (Stamatakis, 2014) under the GTRGAMMA model. Support for nodes was evaluated with 1000 bootstrap replicates. We used jModelTest v2.1.10 (Darriba *et al.*, 2012) to estimate the best-fit nucleotide substitution models, according to the corrected Akaike information criterion (AICc). We also inferred phylogenetic trees using Bayesian inference implemented in MrBayes v3.2.7 (Ronquist *et al.*, 2012). Two independent runs and four chains using a Markov chain Monte Carlo algorithm were run for four million generations, with every 100 generations sampled and a burn-in rate of 25%. The phylogenetic trees were visualized and edited in FigTree v1.4.3 (Rambaut, 2012).

RESULTS AND DISCUSSION

Morphological analyses

Measurements and morphological character assessments revealed that the two new species shared a set of morphological characters of *Primula* sect. *Obconicolisteri*. They have cup-shaped calyces, globose and irregular operculate capsules, elliptic leaf blades with rounded apex and cordate base. *Primula sugongii* is similar to *P. barbicalyx*, but can be easily distinguished by its longer corolla tube and corolla exannulate at throat (Table 1); *Primula zhengyi* is morphologically similar to *P. zhui* and *P. intanoensis* in terms of the ovate-elliptic leaves, umbel inflorescence and tawny pilose petioles; but it can be distinguished from *P. zhui* by its shorter corolla tube and smaller corolla size; and from *P. intanoensis* by its distylous and pink flowers, smaller calyx, larger corolla size and longer style (Table 2).



Phylogenetic analyses

The aligned nrITS regions of 119 samples of Primulaceae is 723 bp, including 466 polymorphism sites. 75 aligned plastid protein-coding regions were concatenated into a supermatrix with a length of 67,808 bp, including 14132 polymorphism sites. The best-fit substitution model selected for the ITS matrix is GTR+I+G and TVM+I+G for plastid supermatrix. The phylogenetic relationships revealed by Bayesian Inference and maximum likelihood analyses based on the nrITS and chloroplast genome dataset is shown in Fig. 1 and Fig. 2, respectively.

Based on the phylogenetic analyses of the Bayesian inference from the nrITS sequences (Fig. 1), the two new species together with 3 species of sect. *Obconicolisteri*, including *P. boconica*, *P. rubifolia*, *P. barbicalyx*, and *P. chapaensis* of sect. *Carolinella* and *P. zhui*, form a strongly supported monophyletic clade (Fig. 1, clade I: BI_{PP} = 1, BS = 94%). Morphologically, this clade can be distinguished by the umbel or abbreviated raceme, most of the species (except *Primula sugongii*) have papery or submembranous leaf blades when dry, and a set of morphological characters of sect. *Obconicolisteri*. The other clade of sect. *Obconicolisteri* (Fig. 1, clade II) with one species, *P. oreodoxa* is nested with species of sect. *Monocarpiaeae*.

However, the plastid phylogeny with an extensively sampling of sect. *Obconicolisteri* reveals a different evolutionary scenario of the genus *Primula* (Fig. 2). Three clades of sect. *Obconicolisteri* have been detected, including the major clade (Fig. 2, clade I: BI_{PP} = 1, BS = 100%), which is comprised of *P. ambita*, *P. obconica*, *P. sinolisteri*, *P. rubifolia*, *P. asarifolia*, *P. vilmoriniana*, *P. barbicalyx*, and the new species *P. sugongii*; *P. densa* clade (Fig. 2, clade II: BI_{PP} = 1, BS = 100%); and *P. oreodoxa*-*P. dumicola* clade (Fig. 2, clade III: BI_{PP} = 1, BS = 100%), which is forming a sister relationship to the clade with species of sect. *Monocarpica*. The new species *P. zhengyi* has been shown as basal to the group of *P. oreodoxa*-*P. dumicola* clade and the clade with species of sect. *Monocarpiaeae* (BI_{PP} = 1, BS = 96%) (Fig. 2).

The non-monophly of sect. *Carolinella* shown in this study is consistent with previous phylogenetic analyses (Yan *et al.*, 2010; Liu *et al.*, 2015; Xu *et al.*, 2016). All the sampled species of sect. *Carolinella* are divided into four clades (Fig. 1: clades A, B, C, D). *Primula chapaensis* (Fig. 1, clade A) and *P. calyprata* is differentiated as an independent clade (Fig. 1, clade B), respectively, and the latter share a sister relationship to the clade with most species of which belong to sect. *Monocarpiaeae*, sect. *Malvacea*, and sect. *Cortusoides* etc.. The specially puzzling systematic position of *P. chapaensis* (Fig. 2, clade A) and *P. calyprata* (Fig. 2, clade C) are also found in the chloroplast genome analyses. *P. wangii*, *P. kweichouensis* and *P. kwangtungensis* are together forming a clade (Fig. 1, clade C; Fig. 2, clade B). Among the original three

species of sect. *Carolinella*, i.e. *Primula partschiana*, *P. rugosa*, *P. carolinehenryae* (= *P. henryi*), the former two sampled species was confirmed forming a clade (Fig. 1, clade D), and the third species is the type species of sect. *Carolinella*, the phylogenetic relationship among them remains unclear. So based on the phylogenetic analysis of our results and formerly studies (Liu *et al.*, 2015; Xu *et al.*, 2016), whether these three species included were the real members of sect. *Carolinella* still needs further study. Morphologically, these three species can be distinguished from other clades of sect. *Carolinella* (Fig 1; clades A, B and C) by the abbreviated raceme and subleathery leaf blades when dry, but in contrast, species of clade A have thin papery leaf blades when dry, clade B has superimposed umbel and thick-papyraceous leaf blades when dry, species of clade C have umbel inflorescences. Additionally, ovary and capsula of these three species were narrowed toward apex into a beak, capsula slightly longer than calyx (*P. rugosa* unknown) (Smith and Fletcher, 1946; Hu and Kelso, 1996).

Based on our phylogenetic analyses of nrITS and chloroplast genome dataset, *Primula sugongii* was nested within the clade with most members of sect. *Obconicolisteri*, it is appropriate to affiliate *P. sugongii* to sect. *Obconicolisteri*; for *Primula zhengyi*, although the phylogenetic position and its affiliation is somewhat controversial, *P. zhengyi* has thinly papery leaf blades when dry and a set of morphological characters of sect. *Obconicolisteri*, so based on the comprehensive morphological evidence, our current placement affiliating it to sect. *Obconicolisteri* is only a temporary measure.

TAXONOMIC TREATMENT

Primula sugongii J.D.Ya, Bin Yang & Y.H.Tan, sp. nov.

素功报春 Fig. 3 & Fig. S1

Type: CHINA. Yunnan Province, Yunlong County, Minjian Township, 25°40'35.47"N, 98°56'9.45"E, terrestrial perennial herbs on stone cliff under evergreen broadleaf forests, elev. 2061 m, introduced to and cultivated at the greenhouse of Kunming Institute of Botany, Chinese Academy of Sciences, 17 December 2020, J.D.Ya BC201231 (holotype: HITBC[0082349]; isotype: KUN).

Diagnosis: *Primula sugongii* is similar to *P. barbicalyx* C.H.Wright, but can be easily distinguished by its corolla tube 1.6–1.8 cm (vs. 0.9–1.1 cm) long, 4–5.5 times (vs. 2–2.5 times) as long as the calyx, and corolla exannulate (vs. annulate) at throat; leaf blade thick papery or thinly leathery (vs. thinly papery or membranous) when dry (Table 1).

Description: Perennial herb, 5–10 cm, efarinose, with a short, comparatively stout rhizome and numerous fibrous roots. **Leaves** forming a spreading rosette, petiole 3.5–5.5 cm long, with densely pink or stained white pilose, leaf blade elliptic to oblong, 1.6–2.6 × 2.0–4.2 cm, rounded at the apex, sometimes emarginate, cordate at the

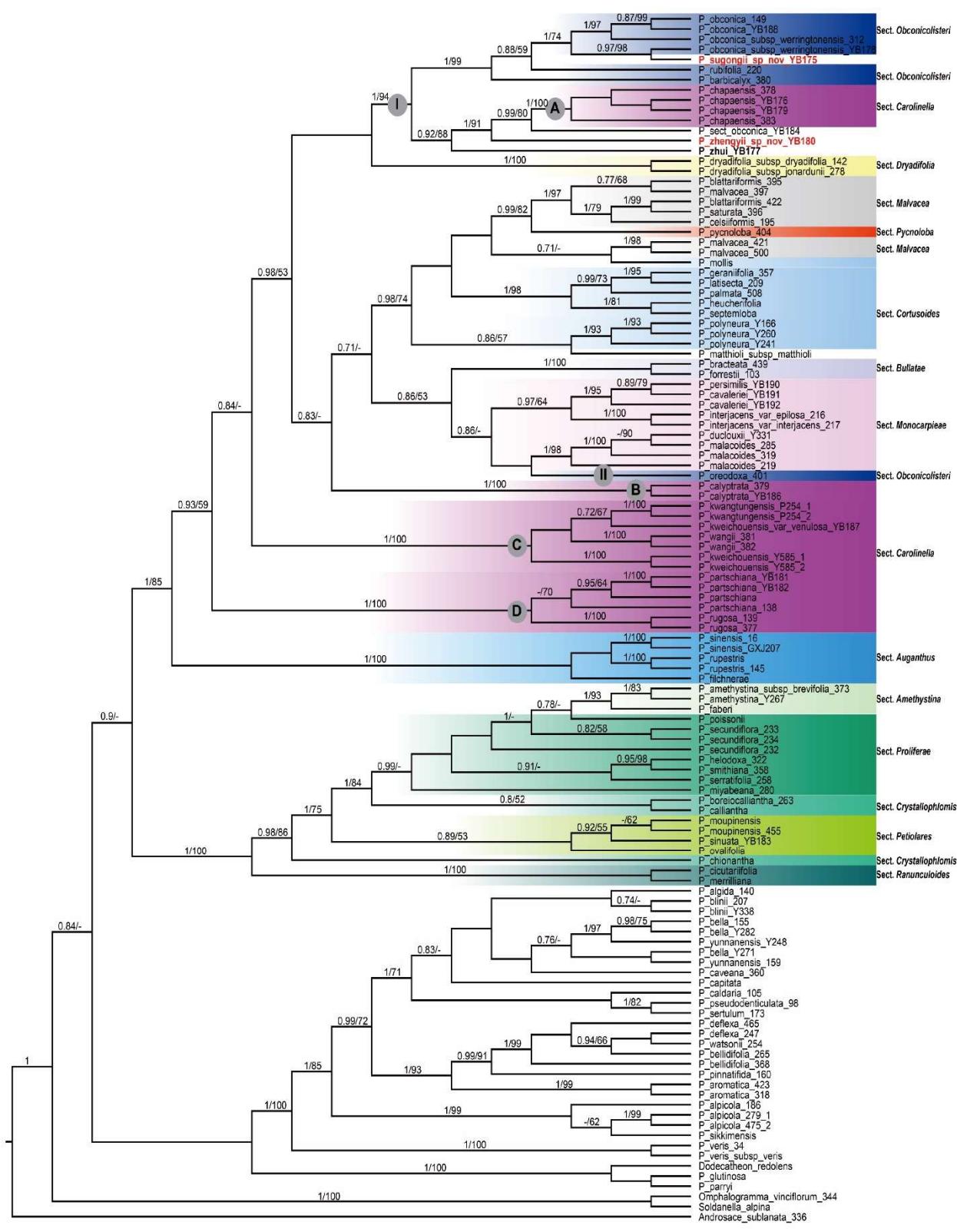


Fig.1. Maximum likelihood (ML) and Bayesian Inference were used to reconstruct a phylogenetic tree based on nuclear ribosomal ITS region of Primulaceae. Posterior probabilities ($B_{PP} \geq 0.7$) and bootstrap percentades ($\geq 50\%$) are shown above the branches.

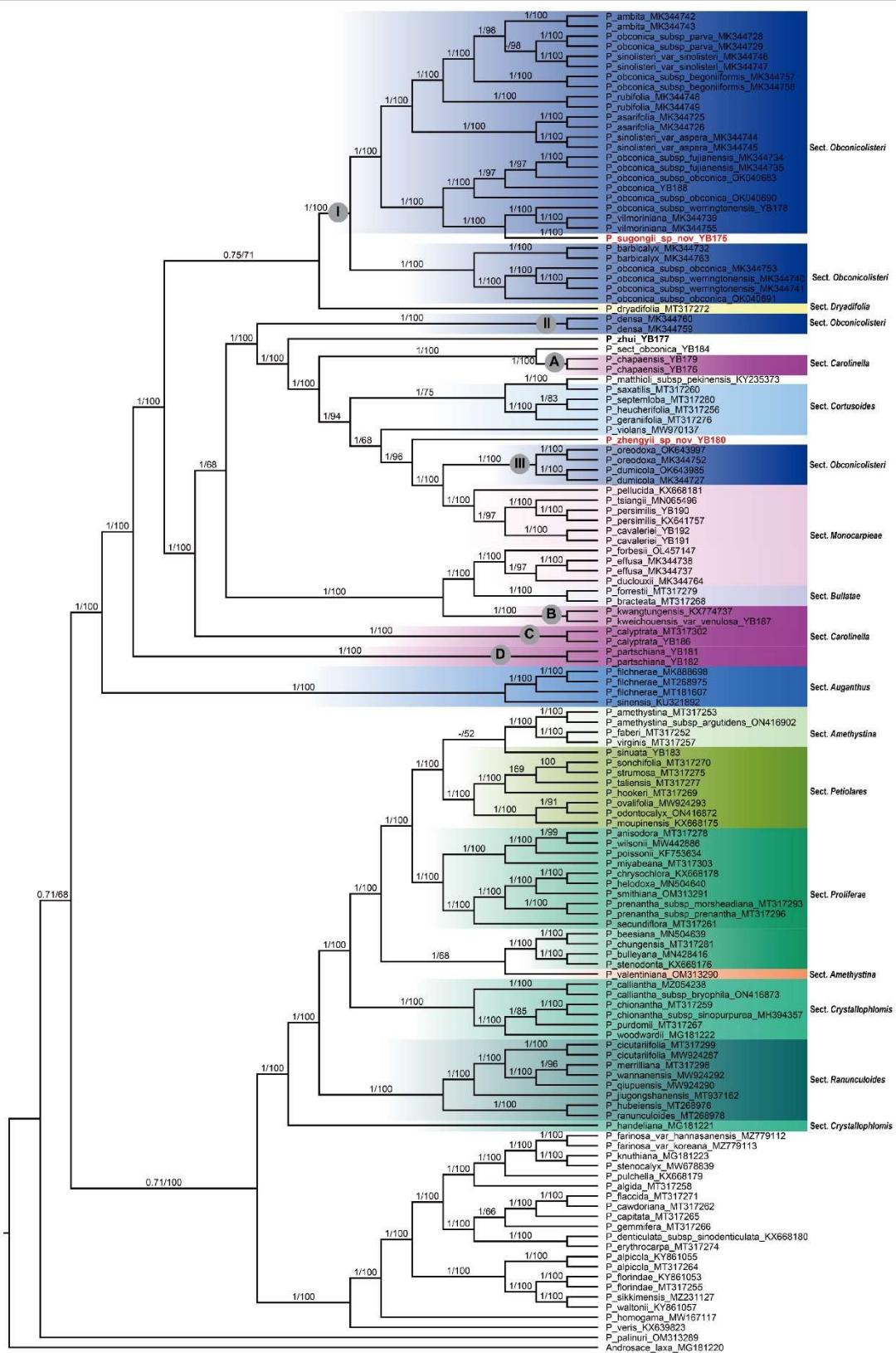


Fig.2. Maximum likelihood (ML) and Bayesian Inference were used to reconstruct a phylogenetic tree based on 75 plastid coding genes of Primulaceae. Posterior probabilities ($\text{Bi}_{\text{PP}} \geq 0.7$) and bootstrap percentages ($\geq 50\%$) are shown above the branches.

**Table 1.** Morphological comparison between *Primula sugongii* and *Primula barbicalyx*.

Characters	<i>Primula sugongii</i>	<i>Primula barbicalyx</i>
Leaf blade	elliptic to oblong, thick papery or thinly leathery when dry	ovate-elliptic to oblong, thick papery or thinly leathery when dry
Indumentum of leaf blade	adaxially puberulent, abaxially pubescent, distinctly pilose along the nerves and margin	adaxially pubescent or becoming glabrescent, abaxially sparsely pilose along veins
Pedicels	2.0–2.7 cm	0.5–2.0 cm
Calyx	4–5 mm, narrowly campanulate; lobes triangular	4–7 mm, broadly campanulate, lobes triangular to ovate-triangular
Corolla	pink, exannulate, 1.5–1.6 cm in diameter	rose to nearly white, annulate, 1.0–1.5 cm in diameter
Corolla tube	1.6–1.8 cm, 4–4.5 times as long as the calyx	0.9–1.1 cm, 2–2.5 times as long as the calyx
Style & Stamens	Pin flowers: stamens ca. 5 mm above base of corolla tube, style 1.5–1.6 cm; Thrum flowers: stamens inserted 2–2.5 mm near throat of corolla tube, style ca. 4 mm	Pin flowers: stamens ca. 3 mm above base of corolla tube, style 8–9 mm; Thrum flowers: stamens inserted ca. 3 mm near throat of corolla tube, style ca. 3–4 mm

base, sometimes oblique, slightly undulate or repand at the margins, thick papery or thinly leathery when dry, adaxially puberulent and sparsely pilose, abaxially pubescent, distinctly pilose along the nerves and margin; lateral nerves 4–6 pairs, raised and prominent abaxially. **Scape** 1.5–1.6 cm, shorter than the leaves, densely covered by pink or stained white pilose, carrying an umbel of 3–5 flowers. **Bracts** 4–5 × 1–1.5 mm, linear, densely pilose. **Pedicels** 2.0–2.7 cm, covered by pink or stained white pilose and puberulous. **Flowers** distylous. **Calyx** 4–5 mm, narrowly campanulate, outer surface with stained white pilose and puberulous, inner surface puberulent, split to one third, lobes triangular, 1.5–2 × 1–1.5 mm. **Corolla** pink, with greenish yellow eyes, exannulate, puberulous at throat, limb 1.5–1.6 cm in diam., lobes obovate, apex emarginate, corolla tube 1.6–1.8 cm, 4–4.5 times as long as the calyx, sparsely puberulous and puberulent; **Pin flowers:** stamens ca. 5 mm above base of corolla tube, style 1.5–1.6 cm; **Thrum flowers:** stamens inserted 2–2.5 mm near throat of corolla tube, style ca. 4 mm. **Ovary** globose. **Capsule** obovate, included in the calyx, c. 3 mm in diameter, dehiscing by irregularly edged operculum at maturity, remaining attached at one side.

Phenology: *Primula sugongii* flowering from December to January of the next year in the greenhouse, fruiting from March to April.

Etymology: The species epithet *sugongii* honors Prof. Su-Gong Wu from the Kunming Institute of Botany, Chinese Academy of Sciences, who worked on plant taxonomy and made great contributions to flora of China.

Distribution and habitat: *Primula sugongii* is endemic to the West of Yunnan, Southwest China, only known from its type locality, growing on the rocky cliff, at altitudes of 2000–2400 m (Fig. 5).

Preliminary conservation status: This species is only known from a single locality in the west of Yunnan. Due to insufficient field investigation, the natural distribution of this species in the wild is not clear. The species was temporarily assessed as Data Deficient (DD) according to the IUCN Red List Categories (IUCN Standards and Petitions Committee, 2022). Further field surveys in the west of Yunnan may provide more information on its distribution.

Notes: The leaf blade of *Primula barbicalyx* is thinly papery or submembranous when dry, abaxially sparsely pilose along veins, whereas *P. sugongii* is thick papery or thinly leathery when dry, abaxially pubescent, distinctly pilose along the nerves and margin (see Table 1). *P. barbicalyx* grows on limestone crags at 2900m at Mengtze in Southeast Yunnan, China of its type locality (Smith and Fletcher, 1946), while the *P. sugongii* is located in West of Yunnan (Fig. 5).

Primula zhengyii Bin Yang & Y.H. Tan, *sp. nov.*

征镒报春 Fig. 4 & Fig. S2

Type: CHINA. Yunnan Province, Luchun County, Qimaba village, Huanglianshan National Nature Reserve, 22°52'38" N, 102°18'29" E, elev. 1612 m, moist and rocky places along streams, 5 April 2020, B. Yang, Y. Song & K. J. Li T0471 (holotype: HITBC [0037946], isotypes: HITBC [0037943, 0037944, 0037945]).

Diagnosis: *Primula zhengyii* is morphologically similar to *P. zhui* Y.H. Tan & Bin Yang and *P. intanoensis* T. Yamaz. with ovate-elliptic leaves, umbel inflorescence and tawny pilose petioles, but clearly differs from the former by its shorter corolla tube (0.5–0.8 cm vs. 1.4–1.6 cm) and smaller corolla size (1.1–1.2 cm vs. 1.6–1.8 cm) and the latter by its distylous (vs. homostylous) and pink (vs. white) flowers, smaller calyx (3–4 mm vs. 4–5(–7) mm), larger corolla size (1.1–1.2 cm vs. 0.8–1.0 cm) and longer style of thrum flowers (3–4 mm vs. 2.3 mm) and pin flowers (5–6 mm vs. 2.3 mm) (Table 2).

Description: Perennial herb, 8–20 cm tall, efarinose, with a short rhizome and numerous fibrous roots. **Leaves** forming a spreading rosette; petiole 2.5–10.5 cm long, stained white or tawny pilose to puberulous; leaf blade ovate-elliptic to elliptic, 3.5–9.0 × 2.5–6.0 cm, rounded at apex, cordate and sometimes oblique at base, slightly sinuate or irregularly dentate along margins, thinly papery when dry, adaxially puberulent, abaxially sparsely puberulent to glabrous, sparsely pilose to puberulous along the mid-veins; lateral veins 4–6 pairs, raised and prominent, sparsely puberulent to glabrous. **Scape** slender, 6.5–15 cm tall, slightly longer than the leaves, sparsely pilose to puberulous, carrying an umbel or

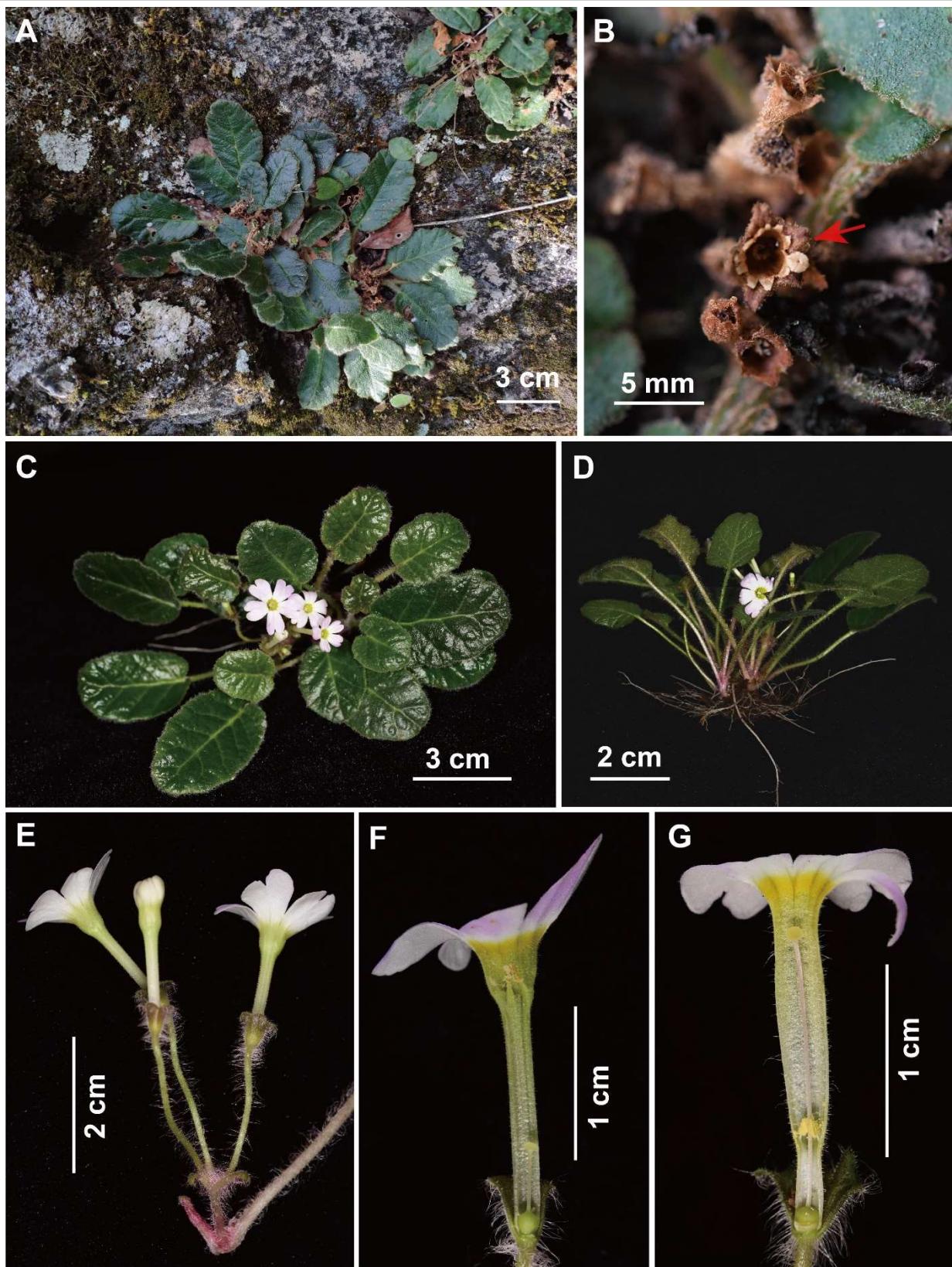


Fig. 3. *Primula sugongii* J.D.Ya, Bin Yang & Y.H.Tan. **A.** Habitat; **B.** Infructescence, showing the irregularly dehiscent capsule with edged operculum (red arrow); **C.** Flowering plant in anterior view; **D.** Flowering plant in side view; **E.** Inflorescens of thrum flowers; **F.** Dissected thrum flower, showing stamens and style; **G.** Dissected pin flower, showing stamens and style. (Photos by J.-D. Ya)

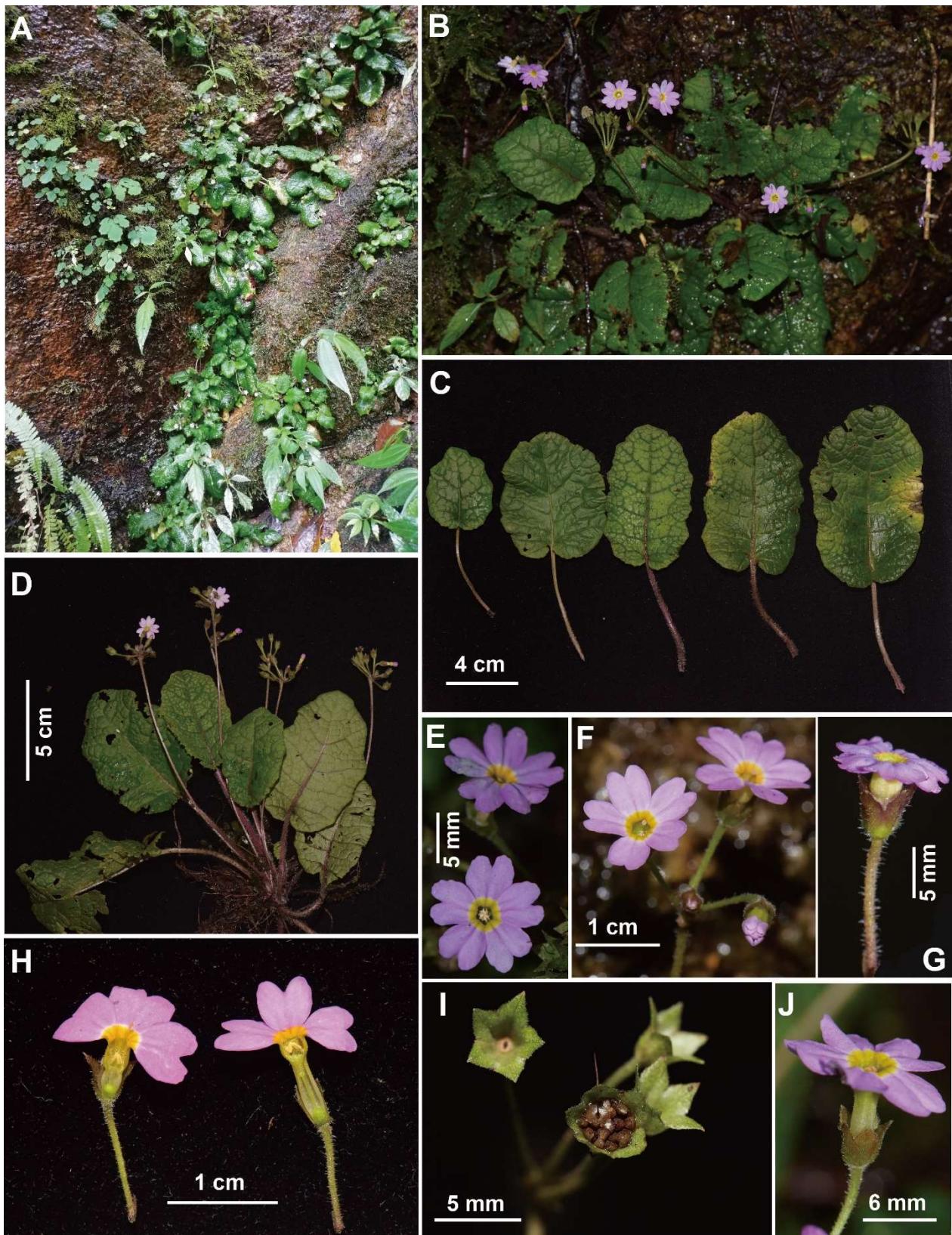
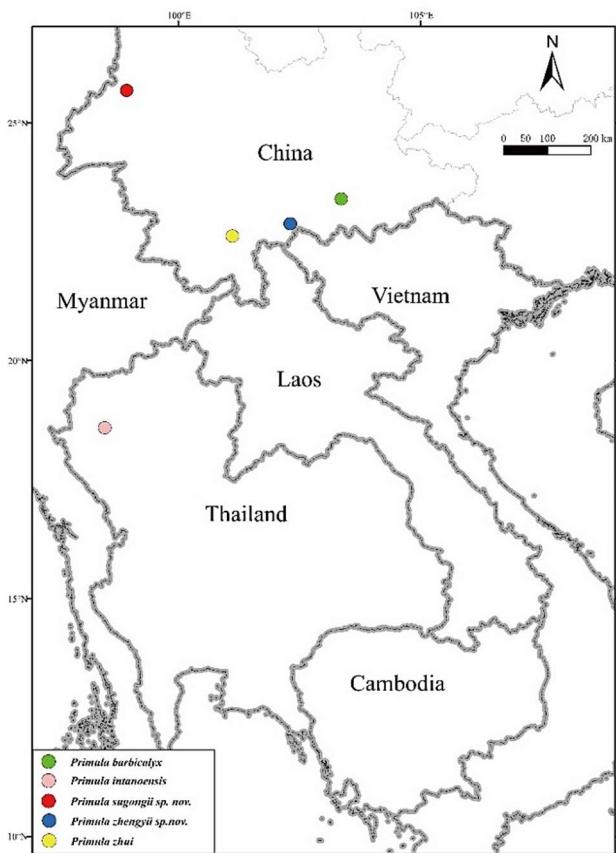


Fig. 4. *Primula zhengyi* Bin Yang & Y.H.Tan: **A.** Habitat; **B.** Habit; **C.** Leaves; **D.** Flowering plant; **E.** Thrum flowers in anterior view; **F.** Pin flowers in anterior view; **G.** Pin flowers in side view; **H.** Dissected pin (left) and thrum (right) flowers, showing stamens and styles; **I.** Infructescence, showing the mature capsule; **J.** Thrum flowers in side view. (Photos: A-H, J by B. Yang, I by Si-Ke Shen).

**Table 2.** Morphological comparison of *Primula zhengyii*, *Primula zhui* and *Primula intanoensis*.

Characters	<i>Primula zhengyii</i>	<i>Primula zhui</i>	<i>Primula intanoensis</i>
Leaf blade	ovate-elliptic to elliptic	ovate-elliptic to ovate-oblong	ovate-elliptic to suborbicular
Indumentum of leaf blade	adaxially puberulent, abaxially sparsely puberulent to glabrous, sparsely pilose to puberulous along the mid-veins	adaxially aparsley pubescent, abaxially pubescent, distinctly pilose and with sparse short glandular hairs along the nerves	adaxially softly pubescent, abaxially makedly pilose along the nerves
Flower	heterostylous	heterostylous	homostylous
Calyx	3–4 mm, campanulate	ca. 6–8 mm, narrowly proculiform or campanulate	4–5 (ad 7 mm in fruit) mm, campanulate
Corolla	pink, annulate, 1.1–1.2 cm in diameter	white to pink, exannulate, pubescent at throat, 1.6–1.8 cm in diameter	white, annulate, 0.8–1.0 cm in diameter
Corolla tube	5–8 mm, 1.5–2 times as long as the calyx	1.4–1.6 cm, 2–2.5 times as long as the calyx	5–6 mm, 1–1.5 times as long as the calyx
Style & Stamens	Pin flowers: stamens at middle of corolla tube, inserted ca. 2.5 mm above base of corolla tube, style 5–6 mm; Thrum flowers: stamens inserted near throat of corolla tube, 5–6 mm above base of corolla tube, style 3–4 mm	Pin flowers: with stamens 5 mm above base of corolla tube, style ca. 1.2 cm; Thrum flowers: stamens inserted 1.3 cm near throat of corolla tube, style ca. 2.5–3 mm	stamens inserted near middle of corolla tube 2.5–3mm; style ca. 2.3 mm, reaching the level of the stamens

**Fig. 5.** Type localities of *Primula sugongii*, *P. zhengyii* and its related species of *P. barbicalyx*, *P. intanoensis* and *P. zhui*.

abbreviated raceme of 3–12 flowers. **Bracts** 2–5 mm, subulate, sparsely puberulous. **Pedicels** 8–15 mm, puberulous to puberulent. **Flowers** distylos; **Calyx** 3–4 mm, campanulate, sub-prominently 5-veined, puberulous to puberulent on the outside, split nearly to one third with triangular lobes that are ca. 1 mm long. **Corolla** pink, annulate, throat brownish yellow; limb 1.1–1.2 cm in diameter; lobes obovate, emarginate at apex, corolla tube

greenish cream, sparsely puberulent on outside; **Pin flowers:** corolla tube ca. 5 mm, 1.5 times as long as the calyx, stamens at middle of corolla tube, inserted ca 2.5 mm above base of corolla tube, style 5–6 mm, elongate nearly to throat or slightly exserted; **Thrum flowers:** corolla tube 7–8 mm, 2.0 times as long as the calyx, stamens inserted near throat of corolla tube, 5–6 mm above base of corolla tube, style 3–4 mm, elongate to middle of corolla tube. **Ovary** sub-globose. **Capsule** obovate, included in the calyx, c. 3 mm in diameter, dehiscing by irregularly edged operculum, remaining attached at one side; seeds chestnut brown, angular, c. 0.5 mm in diameter.

Distribution and habitat: *Primula zhengyii* is known only from two very close localities in Huanglianshan national nature reserve of Luchun County, in Southeast Yunnan Province, Southwest China. It usually grows in moist and rocky places along streams, at altitudes of 1600–1850 m (Fig. 5).

Phenology: Flowering from March to April, fruiting unknown.

Etymology: This species is named after Prof. Zheng-Yi Wu (= C.Y. Wu), the famous botanist of Kunming Institute of Botany, Chinese Academy of Sciences, in honor of his great contributions to plant taxonomy and floristics in China.

Preliminary conservation status: At present, there are only two known distribution sites for this species, both of which are in the national nature reserve and the habitats are well preserved. Therefore, the new species is assigned a preliminary status of Least Concern (LC) according to the IUCN Red List Categories (IUCN Standards and Petitions Committee, 2022). However, since very few details exist about its natural distribution, a detailed investigation of the same habitats may identify more populations and individuals of this species.

Additional specimens examined: CHINA. Yunnan Province, Luchun County, Qimaba village, Huanglianshan National Nature Reserve, 22°52'30"N, 102°18'37"E, elev.1834 m, moist and



rocky places along streams, 5 April 2020, B. Yang, Y. Song & K.J. Li T0470 (Paratypes: HITBC [0037937, 0037938, 0037939, 0037940, 0037941, 0037942]).

Notes: The new species most resembles *Primula zhui* and *P. intanoensis* on morphology, however, *P. zhengyii* can be clearly distinguished from the latter two species by series of characteristics of flowers. In addition to the differences in flowers, the new species have several other characters that differ from *P. intanoensis*, especially the indumentum of the leaf blade (see Table 2). *P. zhui* is endemic to South Yunnan, Southwest China, which grows in the understory of subtropical evergreen broadleaf forests, at an elevation 1300–1500 m (Yang et al., 2017). *P. intanoensis* was restricted into Thailand, it grows on rather moist humus rich ground in mossy forest at an elevation 1900–2590m, in Doi Inthanon National Park in Chaingmai(Yamazaki, 1988) (Fig. 5).

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