Taiwania 69(2): 178–184, **2024**
DOI: 10.6165/tai.2024.69.178

A new lithophilous species of Gesneriaceae, *Primulina jinyu*, from the limestone area of Hubei Province, China

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(Manuscript received 22 March 2024; Accepted 6 May 2024; Online published 15 May 2024)

ABSTRACT: *Primulina jinyu* F.Wen, L.Ding & X.C.Ke, a new species of Gesneriaceae from the limestone area of Hubei, Central China, is described and illustrated. This new species is morphologically similar to *P. chizhouensis* Xin Hong, S.B.Zhou & F.Wen, but it can be easily distinguished from the latter by several characteristics, such as the indumentum of leaf blades, and the shape of bracts, the colour and indumentum of corolla, and the number and indumentum of staminodes, etc. The conservation status of *P. jinyu* can be considered as Critically Endangered [CR B2a+B2b(v)].

KEY WORDS: *Chirita*, Flora of Hubei, limestone flora, new taxon, *Primulina chizhouensis*, taxonomy.

INTRODUCTION

Since 2011, taxonomic revisions of the Gesneriaceae in China have become progressively more refined. Based on morphological and molecular evidence, several monotypic genera, oligotypic genera, and small genera that were originally considered endemic to or primarily found in China have been merged. The original *Chirita* Buch.-Ham.ex D.Don has been split into different genera (with Sect. *Microchirita* and Sect. *Liebigia* being elevated to genus level); almost all species of the original Sect. *Chirita* have been incorporated into the *Henckelia* Spreng.; almost all species from the original Sect. *Gibbosaccus*, along with two species from the *Wentsaiboea* D.Fang & D.H.Qin, and all species of *Chiritopsis* W.T.Wang were merged into *Primulina* Hance. This current classification system adequately interprets the intergeneric relationships and evolutionary connections among China's Gesneriaceae (Möller and Clark, 2013). It also provides a suitable framework for Chinese botanists to conduct in-depth studies on new taxonomic groups within Gesneriaceae (Wang *et al*., 2011; Weber *et al*., 2011). In the broad sense, *Primulina* Hance (1883), expanding from its original monotypic basis by incorporating species from various groups and genera mentioned above, has become the genus with the largest number of species within the Gesneriaceae family in China. At present, there are at least 240 species (including infraspecific taxa) that have been formally described, with no fewer than 220 species found in China (of which at least 215 are endemic to China) (Möller *et al.*, 2016; Deng *et al*., 2024; GRC, 2024; POWP, 2024), reflecting the rich species diversity and morphological diversity of the *Primulina*.

Since 2010, building on previous research, the author has continuously conducted specialized field surveys and research on Gesneriaceae plants in karst and non-karst terrains in China, collecting many plant specimens of *Primulina*, including many poorly known taxa. Based on continuous fieldwork, we conducted long-term field monitoring and biological trait investigations on these doubtful species of Gesneriaceae, combined with their introduction and cultivation under controlled environmental conditions in greenhouses at the Gesneriad Conservation Center of China (GCCC). After several years of field observations, we believe that a unknown species of *Primulina* s.l. distributed in Hubei province, China, has not appeared or been recorded in any domestic or international monographs (Wang and Pan, 1990; Wang *et al*., 1998; Li and Wang, 2005; Wei *et al*., 2010) or recently published literature in the last several decades on *Primulina* s.l. of Gesneriaceae (e. g. Li *et al*., 2023; Li and Pan, 2023; Tong *et al*., 2023; Xu *et al*., 2023a,b; Yang *et al*., 2023; Zhou *et al*., 2023; Chen *et al*., 2024a,b; Deng *et al*., 2024), and is an undescribed new taxonomic group of Gesneriaceae.

Based on the biological characteristics of this new species, especially the relatively uncommon trait of a swollen ventral part of the corolla within *Primulina*, combined with its resemblance to the traditional Chinese ornamental fish, the Goldfish, and the overall pale-yellow color with a light purplish-red halo of the corolla, it is thus named *P. jinyu*.

MATERIAL AND METHODS

Field surveys were carried out in the karst region of Yangxin County of Hubei in China from 2019 to 2022. The descriptions and illustrations presented here are based

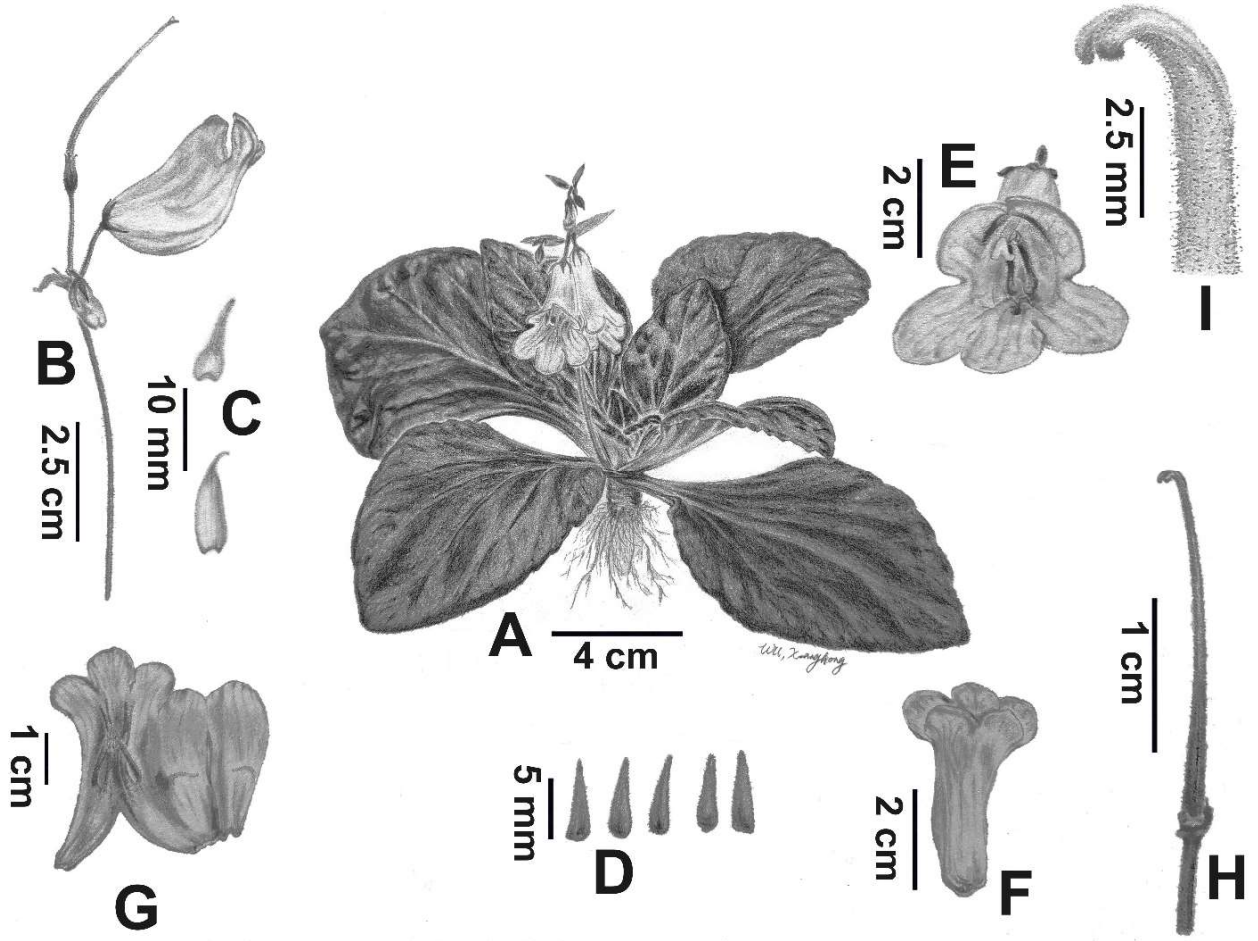

Fig 1. ***Primulina jinyu*** F.Wen, L.Ding & X.C.Ke **A.** Habit. **B.** Cyme. **C.** Abaxial (upper) and adaxial (below) surfaces of bracts. **D.** The abaxial surfaces of calyx segments. **E.** The frontal view of corolla. **F.** The top view of corolla. **G.** Opened corolla. **H.** Pistil and disc without calyx segments. **I.** Stigma and some part of style (Drawing by Xiang-Hong Wu).

on an analysis of the habits and characteristics of wild populations in field surveys and the type specimens stored in IBK. Comparisons of diagnostic characteristics were based on living plants from China. Observing the living plants introduced and cultivated in the nurseries of the NGGRB and the GCCC, we can diagnose whether their characteristics will change due to changes in the growing environment. After examination of the specimens stored in related Herbaria (HITBC, IBK, KUN, PE) and digital specimens online, especially type specimens from E, HN, K, P, VMN, such as: Chinese Virtual Herbarium (http://www.cvh.ac.cn/) in China and Global Plants on JSTOR (https://plants.jstor.org/) and consulting the related taxonomic publications of *Primulina* from the adjacent regions (Wang *et al*., 1990, 1998; Wei *et al.*, 2010; Wei, 2018). The terminology follows Wang *et al.* (1998). The specific epithets and the authors' names align with the International Plant Names Index, making sure there are no repetitions. (IPNI, 2024, continuously updated). The preliminary conservation assessments followed the Guidelines for Using the IUCN Red List Categories and Criteria Version 15 (IUCN, 2022).

TAXONOMIC TREATMENT

Primulina jinyu F.Wen, L.Ding & X.C.Ke, ***sp. nov.***

金魚報春苣苔 Figs 1-3

***Type*:** China. Hubei Province. Huangshi City, Yangxin County, Paishi Town, Chenshan village, on moist limestone rock surfaces in a limestone gorge, 29.684°N, 115.039°E, alt. ca. 214 m, 09 May 2019, *KXC190509-01* (Holotype: IBK!; Isotype: IBK!).

***Diagnosis*:** It differs from *Primulina chizhouensis* Xin Hong, S.B.Zhou & F.Wen in leaf blade adaxially and abaxially short puberulent, glabrescent when mature; bracts lanceolate to broadly lanceolate or oblong-ovate; pedicel puberulent and glandular puberulent; corolla pale yellowish with a light purplish-red halo, outside sparsely puberulent and glandular puberulent; anthers glabrous; staminodes 3, glandular puberulent; mature capsule persistent withered style 1.2–1.6 cm long.

***Description*:** Perennial herb, acaulescent. **Rhizome** unapparent compressed, rounded to cylindrical, 0.8–1.5 cm long, 0.8–1.2 cm in diameter, internodes inconspicuous,

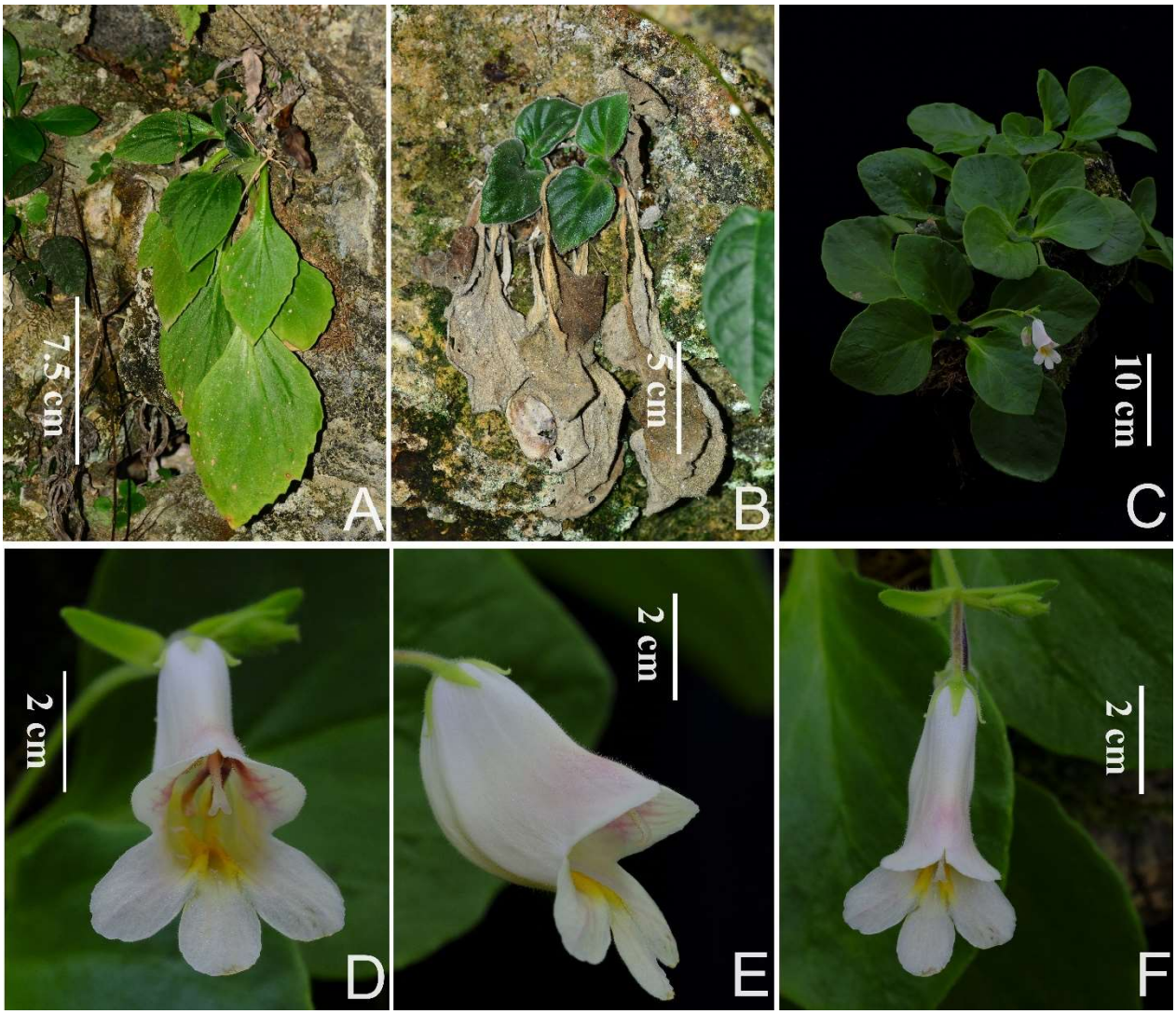

Fig 2. Photographs of ***Primulina jinyu*** F.Wen, L.Ding & X.C.Ke **A.** Habit in summer. **B.** Habit in winter. **C.** The cultivated plants in nursery. **D.** The frontal view of corolla. **E.** The lateral view of the corolla. **F.** The top view of the corolla (Photoed by Fang Wen).

glabrous; roots fibrous, lacking of taproot. **Leaves** basal, ca. 6, opposite, basal or clustered on the top of rhizome. **Petioles** glabrous, cross section shallowly "v"-shaped, 1.5–4.5 × 0.5–0.8 cm. **Leaf blades** rhombic, broadly rhombic, oblong-rhombic, occasionally elliptic or oblong, slightly asymmetric but not falcate, 10–20 × 5–10 cm, thick herbaceous and slightly fleshy, adaxially and abaxially extremely short puberulent, glabrescent when mature, base cuneate, margin undulate, sometimes shallowly serrate, rarely entire, apex acute; lateral veins ca. 3 on each side of midrib, adaxially impressed, abaxially conspicuously prominent. **Compact dormancy buds** with 2–4 villous cataphylls, leaf blades greyish-green, nearly orbicular, 1.0–2 × 0.7–1.5 cm, formed in winter. **Cymes** 2–4, axillary, (1 or) 2–5-flowered, rarely more. **Peduncle** 4.0–7.5 cm long, covered sparsely vertical puberulent hairs; bracts 2, free, opposite, pale green to pale yellowish green, lanceolate to broadly lanceolate or oblong-ovate, 3.0–3.5 × 0.8–1.2 cm, outside pubescent, inside nearly glabrous, margin entire, apex acute, usually withered when in full-blossom period but persistent. **Pedicel** brownish purple, 1.2–2 cm long, puberulent and glandular puberulent. **Calyx** 5-sect from base; segments equal, green, lanceolate-linear, 3–3.5 × 0.5–0.8 cm, outside puberulent and glandular puberulent, inside sparsely puberulent, margin entire, apex acute. **Corolla** pale yellowish with a light purplish-red halo, 3.5–4.5 cm long, outside sparsely extremely puberulent and glandular puberulent, inside nearly glabrous; tube broadly tubular, ventral surface longitudinally constricted, forming clearly carinate, 2.9–3.2 cm long, orifice ca. 2.0 cm in diameter; limb distinctly 2-lipped, adaxial lip 2-partite to the base, lobes slightly oblique, semi-ovate, adaxial surfaces with red shading, adaxial lobes 0.9–1.1 × ca. 1.2 cm; abaxial lip 3-partite to middle or slightly over middle, abaxial surfaces of all lobces adaxial

Fig 3. Photographs of ***Primulina jinyu*** F.Wen, L.Ding & X.C.Ke **A.** Cyme. **B.** The abaxial (upper) and adaxial (below) surfaces of bracts. **C.** Calyx segments. **D.** Pistil without calyx segments. **E.** Opened corolla. **F.** The top view of the anthers. G. The lateral view of anther. **H.** The dried infructescence. **I.** Dried bracts. **J.** seeds. (Photoed by Fang Wen).

surfaces with slight red shading, lateral lobes obliquely ovate, 5–8 × 9–10.5 mm, the central one oblong, 8–10 × 7–9 mm. **Stamens** 2, anterior, adnate to corolla tube 1.8–2.0 cm above the base; filaments reddish purple to reddish, geniculate at base, ca. 1.1 cm long, glandular-puberulent and the head of glandular-puberulent black; **anthers** fused by their entire adaxial surfaces, oblong-nephroid, 3–3.5 × 1.3–1.5 mm, glabrous. **Staminodes** 3, pale yellow, linear and usually curving to be near semi-ring, apex capitate, glandular puberulent same as filaments, 6–8 mm long, adnate to corolla 1.1–1.2 cm above base; the central one usually inconspicuous, nearly invisible, only 0.5 mm long, translucent, punctate, adnate to the base of corolla tube. **Disc** wax white to wax pale yellow, annular, margin sinuate, glabrous, 0.8–1.0 mm high. **Pistil** 2.5–3.0 cm long; ovary cylindrical, 1.2–1.5 cm long, 1.2–1.7 mm in diameter; **style** white, 10–12 mm long, 0.8–1.0 mm in diameter, sparsely puberulent and glandular puberulent; **ovary** green with longitudinal pale brown stripes, densely puberulent and glandular puberulent. **Stigma** translucent to white, cuneate, apex retuse, 2.5–3.0 mm long. **Capsule** linear, straight, 3.2–4.0 cm long after excluding the length of the end persistent sere style 1.2–1.6 cm long, densely vertical pubescent when mature. **Seeds** numerous, oval, yellowish brown, umbilici black, 0.40–0.45 × 0.15–0.2 mm, inappendiculate.

***Phenology*:** Flowering is from the middle of May to June, and the fruiting is from July to August.

***Etymology*:** The specific epithet, "*jinyu*", of this new species originates from the traditional Chinese ornamental fish, the Goldfish, and "*jinyu*" is the Mandarin pronunciation of Goldfish. This type of ornamental fish usually has a round, swollen abdomen, which somewhat resembles the swollen corolla tube of this new species; additionally, the flower color ranges from yellow with light purplish-red to light yellow-green tinges, complementing the Goldfish's variable colors. Moreover, the character "金" (Jin) in Goldfish also carries the meaning of the color yellow in Chinese. Therefore, the pinyin "*jinyu*" of the Goldfish is used directly as the specific epithet, functioning as a noun.

***Distribution, habitat and preliminary conservation status*:** Currently, the only known population of this species is one, concentrated in the type locality in Huangshi city, Hubei. Since it is concentrated on the limestone cliff walls within a scenic area, and there are no suitable living environments around for this species, it is clearly estimated that the number of mature adults is about 150 individuals. The distribution is located next to the limestone mountain forest road, which makes the survival of this species easily affected by human activities such as road construction. In the past few years, due to multiple renovations and expansions of the scenic area roads, over 60% of the cliffs on which they depend have been destroyed, and the number of mature individuals within the population has decreased from more than 300 (based on a 2017 on-site count) to less than 70 individuals (observed in 2022). Therefore, according to the IUCN endangered level assessment criteria (IUCN, 2012), it is temporarily assessed as "Critically Endangered (CR B2a+B2b(v))." This endangered status may change based on future more in-depth investigations and detailed assessments.

***Notes*:** Before this species was discovered, there were 21 species of *Primulina* that produced purely yellow flowers or primarily yellow-colored flowers. Among them, the *Chiritopsis*-like small-flowered *Primulina* species include the following: *P.* cerina F.Wen, Yi Huang & W.C.Chou, *P. confertiflora* (W.T.Wang) Mich.Möller & A.Weber, *P. cordifolia* (D.Fang & W.T.Wang) Yin Z.Wang, *P. danxiaensis* (W.B.Liao, S.S.Lin & R.J.Shen) W.B.Liao & K.F.Chung, *P. lepingensis* Z.L.Ning & M.Kang, *P. repanda* (W.T.Wang) Yin Z.Wang and *P. xiuningensis* (X.L.Liu & X.H.Guo) Mich.Möller & A.Weber. The flowers of this type of plant are relatively small, with the corolla length often only about 1 cm or shorter. Most of them are beige to light yellow, and in some cases, they can even become a near-white cream color. This type often has longitudinally different colored stripes in the corolla throat, that is, the nectar guides. For example, in *P. cordifolia*, there are two deep orange-yellow to orange-red nectar guides at the lower part of the corolla throat.

Another type is the large-flowered *Chirita*-like taxa, which often has larger flowers with a corolla length usually exceeding 2 cm. The following are some examples: *P. albicalyx* B.Pan & Li H.Yang, *P. alutacea* F.Wen, B.Pan & B.M.Wang, *P. heterochroa* F.Wen & B.D.Lai, *P. jiangyongensis* X.L.Yu & Ming Li, *P. leprosa* (Yan Liu & W.B.Xu) W.B.Xu & K.F.Chung, *P. liangwaniae* B.M.Wang & Y.H.Tong, *P. lutea* (Yan Liu & Y.G.Wei) Mich.Möller & A.Weber, *P. lutescens* B.Pan & H.S.Ma, *P. moi* F.Wen & Y.G.Wei, *P. pteropoda* (W.T.Wang) Yan Liu, *P. versicolor* F.Wen, B.Pan & B.M.Wang, *P. zixingensis* Li H.Yang & B.Pan. Among these species, pure bright yellow and light yellow are not common, only *P. alutacea*, *P. lutea*, and *P. pteropoda* have them; the remaining species with yellow flowers can be divided into two groups: one with corolla in a mix of yellow and other colors or derivative shades of yellow, like *P. heterochroa*, *P. lutescens*; and the other with corollas in yellow but featuring various deep reddish-brown, purplish-red stripes, and spots, including *P. albicalyx*, *P. jiangyongensis*, *P. leprosa*, *P. liangwaniae*, *P. moi*, *P. versicolor*, *P. zixingensis*.

There are three species of yellow-flowered *Primulina* whose corolla size falls between the aforementioned *Chiritopsis*-like and *Chirita*-like types. Their corolla tubes are more or less laterally compressed. They are *Primulina hochiensis* (C.C.Huang & X.X.Chen) Mich.Möller & A.Weber var. *ochroleuca* F.Wen, Y.Z.Ge & Z.B.Xin, *P. malipoensis* Li H.Yang & M.Kang, and *P. yandongensis* Ying Qin & Yan Liu.

Table 1. Comparison of ***Primulina jinyu*** F.Wen, D.Li & X.C.Ke *sp. nov*. and ***P. chizhouensis*** Hong Xin, S.B.Zhou & F.Wen.

characters	*P. jinyu*	*P. chizhouensis*
Leaf		
petiole indumentum	glabrous	densely strigose
blade shape	rhombic, broadly rhombic, oblong-rhombic, occasionally elliptic or oblong, slightly asymmetric but not falcate, apex acute	ovate to oblong, 4–14 × 3–10 cm, asymmetric
blade indumentum	adaxially and abaxially short puberulent, glabrescent when mature	densely villous on both surfaces
blade margin	undulate, sometimes shallowly serrate, rarely entire	with crenations from the middle to the apex
Bracts		
shape	lanceolate to broadly lanceolate or oblong-ovate	ovate
size	3.0–3.5 × 0.8–1.2 cm	0.4–0.6(–1.1) × 0.3–0.5 cm
Pedicel indumentum	puberulent and glandular puberulent	villous
Calyx		
size	3–3.5 × 0.5–0.8 cm	0.6–1 × 0.2–0.3 cm
shape	lanceolate-linear	narrowly linear
indumentum	outside puberulent and glandular puberulent, inside sparsely puberulent	outside densely villous, inside glabrous
Corolla		
color	pale yellowish with a light purplish-red halo	purple
indumentum	outside sparsely puberulent and glandular puberulent	pubescent from base to orifice
tube shape	broadly tubular, ventral surface longitudinally constricted, forming clearly carinate	cylindrical
Stamens		
insertion position	adnate to corolla tube 1.8–2.0 cm above the base	adnate to corolla tube ca. 1.5 cm above the base
anthers indumentum	glabrous	bearded on the back.
Staminodes		
number	3	2
indumentum	two lateral ones glandular puberulent; the central one glabrous	glabrous
insertion position	two lateral ones adnate to corolla 1.1–1.2 cm above base	adnate to corolla tube ca. 8 mm above the base
Pistil	ovary green with longitudinal pale brown stripes. Stigma translucent to white, cuneate, apex retuse, 2.5–3.0 mm long	Pistil ca. 3 cm long; ovary linear, ca. 1.5 × 0.2 cm, style, 1.5–1.8 cm long; stigma bipartite, lobes narrowly lanceolate, 0.1–0.2 mm long
style indumentum	sparsely puberulent and glandular puberulent	pubescent
ovary indumentum	densely puberulent and glandular puberulent	pubescent
Mature capsule	persistent withered style 1.2–1.6 cm long	lacking of persistent sere style

From the distribution of the aforementioned species, 17 are found in South China, only 2 in Hunan Province in Central China (*P. jiangyongensis* and *P. zixingensis*), and 2 in East China's Jiangxi, Anhui, and Zhejiang, which are *P. lepingensis* and *P. xiuningensis* respectively. The discovery of this new species in Hubei Province, outside the aforementioned regions in the Central China, introduces another yellow-flowered species to the region, expanding the distribution area of yellow-flowered *Primulina* species to include Hubei.

The *Primulina* species distributed in East China have a characteristic feature: the above-ground parts that grow vigorously during the spring and summer seasons gradually wither and dry up in autumn, eventually forming dormant buds in winter to survive the colder temperatures compared to South China. This is observed in species like *P. xiziae* F.Wen, Yue Wang & G.J.Hua (Li *et al*., 2012), *P. chizhouensis* Xin Hong, S.B.Zhou & F.Wen (Hong *et al*., 2012), *P. lepingensis*, *P. xiuningensis*, etc. *P. jinyu* also forms dormant buds in winter, and its distribution latitude is similar to that of the species in East China that form dormant buds, also forming winter buds to survive the wet and cold winter. Excluding the characteristic of color, in terms of plant morphology and flowers, this new species is closer to *P. chizhouensis* and is distinctly different from the large-flowered yellow species of *Primulina* mainly distributed in South and Central South China. Detailed differences between it and *P. chizhouenis* are provided in Table 1.

Other specimen examined: *Primulina chizhouensis*: CHINA. Anhui Province: Chizhou city, Tangxi village, growing in the entrance of a limestone cave, elevation ca. 200 m, 8 June 2008 (fl.), S.B.Zhou & Xin Hong 0806001 (holotype ANU!, isotype IBK!).

ACKNOWLEDGMENTS

We would like to thank the Key Science & Technological Research and Development Project of Guangxi (Guike ZY21195050), the Capacity-building Project of SBR of CAS (KFJ-BRP-017-68), the Foundation of Guangxi Key Laboratory of Plant Conservation Restoration Ecology in Karst Terrain (22-

035-26) and the Basic Research Fund of Guangxi Academy of Sciences (grant no. CQZ-C-1901) financially supported this study. We also would like to thank Stephen Maciejewski, of the Gesneriad Society, and Michael LoFurno, Associate Professor, Temple University, for their editorial assistance.

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