

## *Primulina jianghuaensis* sp. nov. (Gesneriaceae) from a limestone cave in southern Hunan, China

Xiu-Zhen Cai, Ren-Yuan Yi, Lei Zhou, Ren-Ping Kuang and Ke-Ming Liu

X.-Z. Cai, R.-Y. Yi, L. Zhou, R.-P. Kuang and K.-M. Liu (*lkming8@yahoo.com.cn*), Dept of Botany, College of Life Sciences, Hunan Normal Univ., CN-410081 Changsha, PR China.

A new species of Gesneriaceae, *Primulina jianghuaensis* K. M. Liu & X. Z. Cai, from a limestone cave in Hunan Province, China, is identified and described. Its seed and pollen grain morphology are described. The new species is morphologically closely related to *P. lingchuanensis* (= *Chiritopsis lingchuanensis*) and *P. danxiaensis* (= *Chiritopsis danxiaensis*), but it can be distinguished by its 12–25 (–30) leaves, ovate or broad ovate leaf blade, subcordate, truncate or slightly decurrent leaf base, undulate leaf margin, 5–20 cymes, and 2–3 staminodes.

The southern Hunan Province adjoins Guangxi Zhuangzu Autonomous Region, which resides in the heart of an immense limestone terrain stretching (Xu 1995). Gesneriaceae show an extreme abundance and diversity in these limestone regions in China. As limestone caves and crevices are fragile micro-habitats which are highly vulnerable to the increasing economic activities in this region (Clements et al. 2006), their effective conservation depends on urgent and accurate biodiversity updates.

The genus *Chiritopsis* in China once consisted of 14 species and 3 varieties (Wang et al. 1998, Liu et al. 2006, Wen et al. 2008, Xu and Gao 2009, Pan et al. 2010, Shen et al. 2010, Wu et al. 2011). However, it was revised by Wang et al. (2011), Weber et al. (2011) and Möller et al. (2011) by molecular phylogenetic approaches. *Chiritopsis*, *Wentsaiboaea* (excluding *W. tiandengensis*) and all species of *Chirita* sect. *Gibbosaccus* were then transferred to the originally monotypic genus *Primulina*.

In April 2011, two of the authors encountered an interesting plant of Gesneriaceae when collecting plants of *Impatiens* during a field work in limestone areas in the southern Hunan Province, China. Because no flowers were observed at that time, we went twice to collect flowers and fruits during June to August 2012, and collected specimens and took photographs. After carefully consulting national floras and other relevant literature, as well as herbarium specimens and carrying out comparisons with similar taxa, it became clear that the plants represent a new species of *Primulina*, which is described here.

***Primulina jianghuaensis* K. M. Liu & X. Z. Cai sp. nov. (Fig. 1–2)**

*Species Primulinae lingchuanensi* Yan Liu & Y. G. Wei affinis, a qua lamina ovatis vel lato-ovatis, basi subcordatis vel truncatis,

*nervis lateralibus utrinsecus 3–5, staminodiis 2–3 bene differt. Haec species foliorum formae etiam P. danxiaensi* W. B. Liao, S. S. Lin & R. J. Shen similis, a qua foliis 12–25, margine elobatis, petiolis complanatis, corolla alba, staminodiis 2–3 differt.

**Type:** China. Jianghua County, Hunan Province, growing in the entrance of a limestone cave on the northern hillside, at 397 m a.s.l., 24°51'21.05"N, 111°42'58.22"E, 23 Jul 2012 (flowering and fruiting), K. M. Liu and X. Z. Cai 31269 (holotype: HNNU, isotypes: HNNU) (Supplementary material Appendix A1).

### Etymology

The specific epithet is derived from the type locality, Jianghua County, Hunan Province.

### Description

Perennial, stemless herb. Rhizomes subterete, 5–10 mm long, 2–5 mm in diameter. Leaves 12–25 (–30), all basal, petiolate, carnosely papery when dry; petiole flattened, 2–11 cm long, 1–2 mm wide, puberulent; leaf blades ovate or broadly ovate, 3–7 cm long, 2.0–5.5 mm wide, pubescent on both surfaces, obtuse or subacute at apex, subcordate at base, truncate or slightly decurrent, sometimes inequilateral, with undulate margin; lateral veins 3–5 on each side of midrib, their adaxial side flat, white, puberulent to pilose, prominent on the abaxial side, abaxially more densely puberulent along veins. Cymes 5–20, axillary, 1–2-branched, with 3–9 or more flowers; peduncle slender, 8–20 cm long, ca 1 mm in diameter, densely white pubescent to pilose. Bracts 2, opposite, narrowly ovate, ca 9 × 4 mm, both surfaces densely white puberulent, with entire margin; bractlets lanceolate, ca 5 × 2 mm, white puberulent on both surfaces, with entire

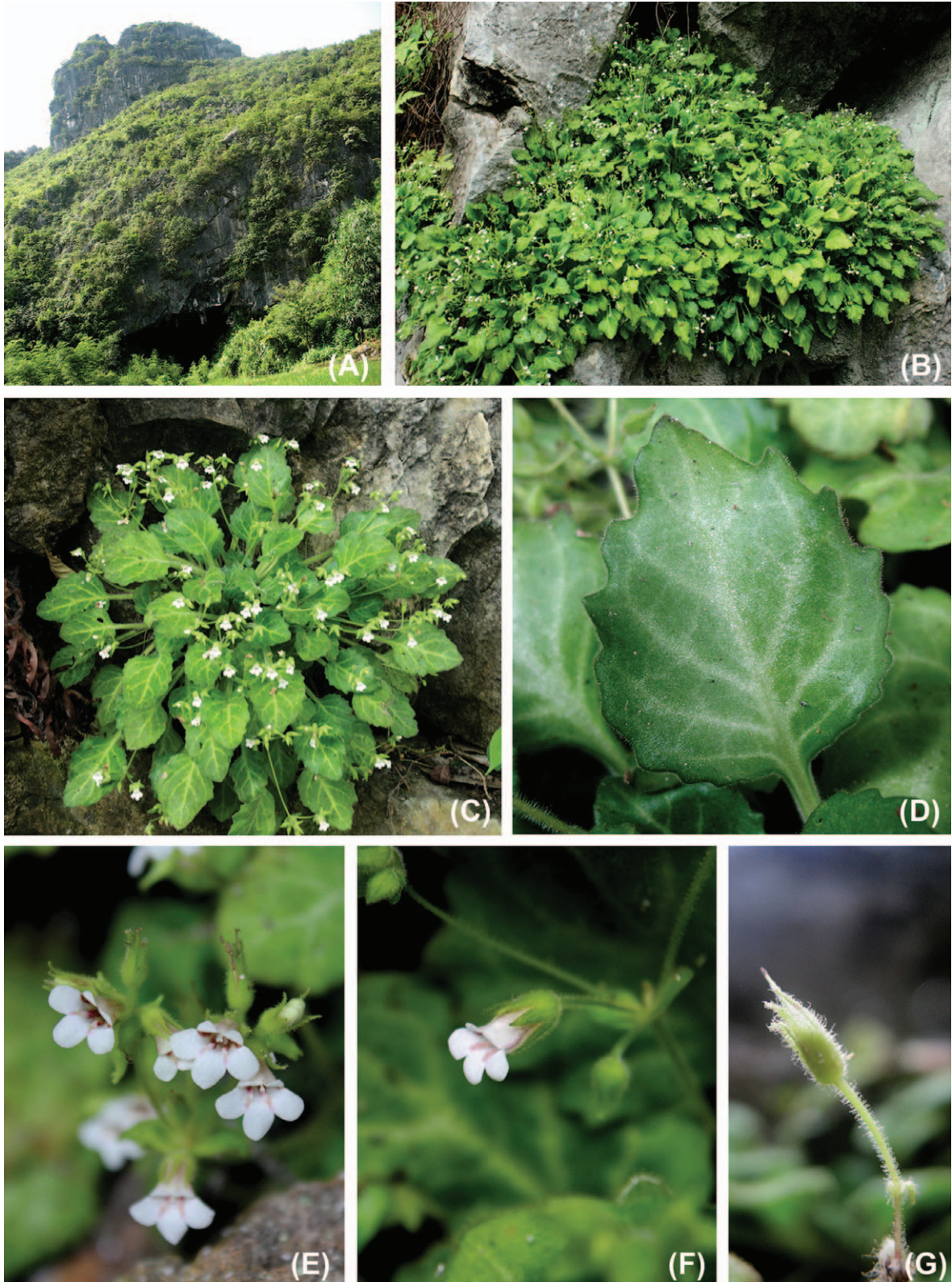


Figure 1. Habitat and morphology of *Primulina jianghuaensis* sp. nov. (A) type locality, (B) habitat, (C) mature plant, (D) adaxial leaf blade surface, (E) inflorescence, (F) lateral view of flower, (G) young fruit. Photo by Xiu-Zhen Cai.

margin. Pedicel fine, 6–18 cm long, white puberulent. Calyx 5-lobed, dissected to near base with lobes narrowly ovate to lanceolate, ca  $7.0 \times 1.5$  mm, acute at apex, white puberulent outside, sparsely white puberulent inside, with entire

margin, persistent. Corolla white, 9–12 mm long, white puberulent to pilose outside, sparsely white puberulent inside; tube 6–7 mm long, ca 4.5 mm in diameter at the mouth, ca 2 mm in diameter at the base, with 2 conspicu-

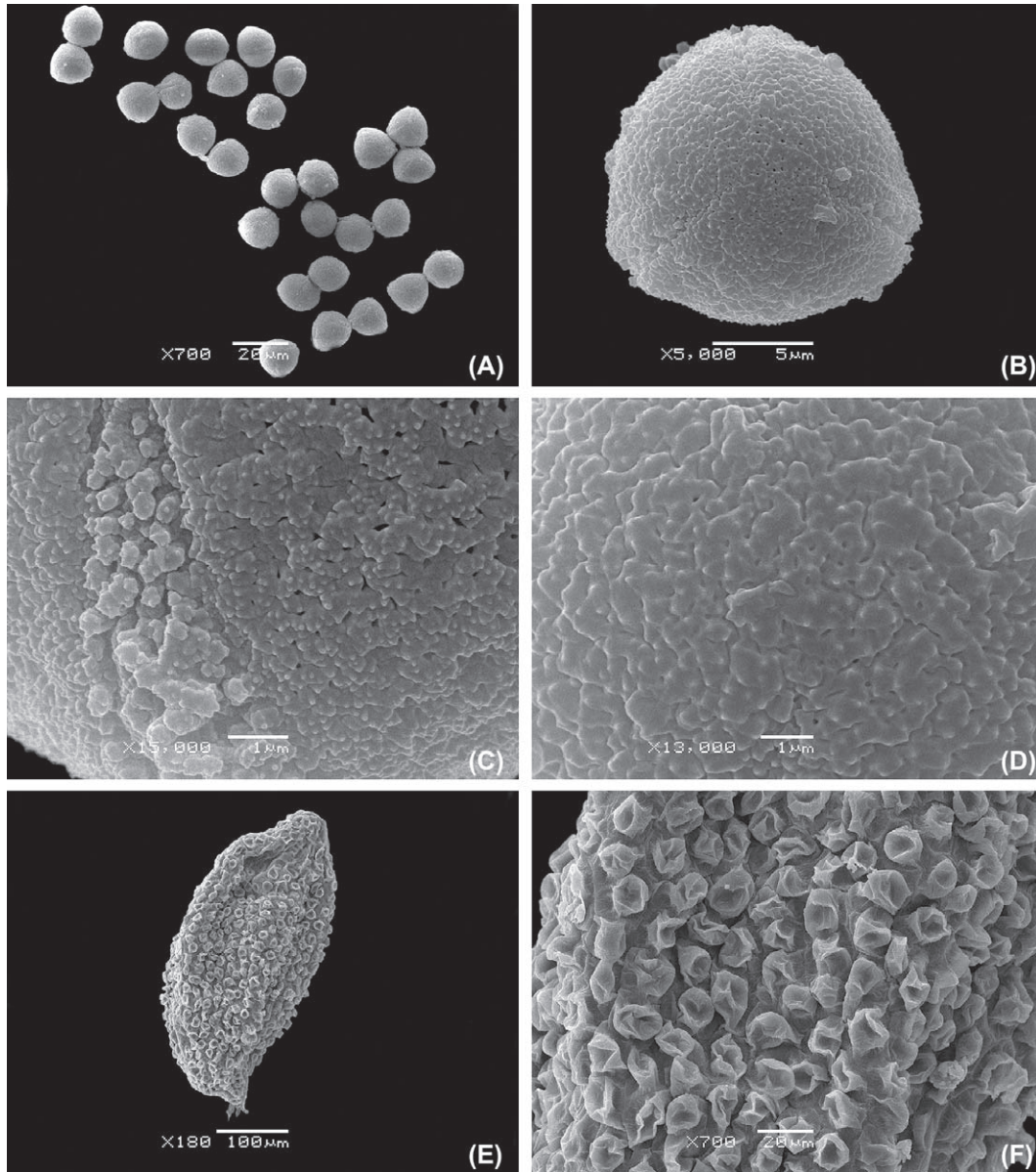


Figure 2. Scanning electron microscope (SEM) photos of pollen and seed of *Primulina jianghuaensis* sp. nov. (A)–(D): pollen, (A) whole view (showing the shape of pollen grains), (B) polar view (showing 3-colpate), (C) colpate in partial view, (D) polar view showing exine ornamentation, (E)–(F) seed and testa, (E) overview, (F) testa surface. Voucher specimen: Ke-Ming Liu and Xiu-Zhen Cai 31269.

ous dark red strips inside the tube. Corolla limb distinctly 2-lipped; adaxial lip 2-lobed, with lobes oblong, ca  $1.0 \times 1.8$  mm; abaxial lip 3-lobed, with obovate lobes, ca  $3-4 \times 3.0$  mm. Stamens 2, included, adnate to 1.5 mm above the corolla tube base; filaments narrowly linear, ca 4–5 mm long, geniculate near the middle, sparsely puberulent; anthers ca 2 mm long, dorsifixed, longitudinal; connective puberulent; staminodes 2–3, adnate to ca 1 mm above the adaxial side of the corolla tube base, ca 1–2 mm long, glabrous, capitate at apex. Disc annular, ca 0.4 mm high, with repand margin, glabrous. Pistil ca 9 mm long; ovary narrowly ovoid, 4 mm long, ca 1 mm in diameter, pilose; placentas 2, parietal; style 5–7 mm long, white puberulent, persistent; stigma 1, ca 0.5 mm long, with apex 2-lobed, glabrous, persistent. Capsule narrowly ovoid, straight, slightly shorter than calyx, ca

5–6 mm long, ca 3 mm in diameter, pilose inside. Seeds numerous, ellipsoid or subellipsoid, yellow–brown, ca 0.3 mm long, ca 0.2 mm in diameter.

#### **Phenology**

The plants have been observed to flower from June to August and fruit from July to September.

#### **Vernacular name**

China: jianghuabaochunjutai.

#### **Distribution and habitat**

*Primulina jianghuaensis* is only found in four places in Jianghua County, southern Hunan Province: Shizi hill, Chuanyan cave, Luotuo hill and Dashi hill. It grows on moist,

Table 1. Morphological comparison of *Primulina jianghuaensis* sp. nov., *P. lingchuanensis* and *P. danxiaensis*.

Characters	<i>P. jianghuaensis</i>	<i>P. lingchuanensis</i>	<i>P. danxiaensis</i>
Number of leaves	12–25 (–30)	10–20	4–7
Leaf blade	Ovate or broad-ovate	Narrowly ovate, ovate or subelliptic	Ovate to broad-ovate or nearly orbicular
Leaf apex	Obtuse or subacute	Obtuse or rounded	Rounded to obtuse
Leaf base	Subcordate, truncate or slightly decurrent	Attenuate to petiole or broadly cuneate	Cordate, sometimes curled such that two sides overlap
Leaf margin	Undulate	Repand, with some repand obtuse teeth	Nearly palmately lobed, lobes in 4–8 pairs, each broadly ovate
Lateral veins	Conspicuous, 3–5 pairs, white on adaxial side	Inconspicuous, 2–3 pairs	Conspicuous, 5–7 pairs
Petioles	Flat	Flat	Terete
Cymes	5–20	3–10	1–3
Number of flowers	3–9-flowered or more	2–12-flowered	2–5-flowered
Bracts	Narrowly ovate, margin entire	Lanceolate, margin entire	Oblanceolate to lanceolate, supra denticulate
Sepals	Ovate to lanceolate	Lanceolate-linear	Lanceolate to linear
Corolla colour	White	White	Yellowish
Filaments	Sparsely puberulent	Pubescent	Glabrous
Staminodes	2–3	3	2
Style	Puberulent	Densely pubescent	Glabrous, sparsely puberulent at base
Flowering time	Jun–Aug	Jun–Sep	May–Jun
Fruiting time	Jul–Sep	Jul–Oct	Jun–July
Habitat	Moist, shady surface of rocks near the entrance of a limestone cave	Rocky crevices at the entrance of a limestone cave	Shaded cliffs or rocks in red sandstone hills

shady surface of rocks near the entrance of limestone caves on the northern hills, at altitudes between 380–420 m a.s.l. The main companion species are the ferns *Selaginella uncinata* (Desv.) Spring (Selaginellaceae), *Pieris cretica* var. *neriosa* (Thunb.) Ching et S. H. Wu (Pteridaceae), *Adiantum capillus-veneris* (L.) Hook. (Adiantaceae), *Cheilanthes mexicana* (Fe'e) N. Punetha & Kholia (Sinopteridaceae) and the seed plants *Tirpitzia sinensis* (Hemsl.) Hallier (Linaceae), *Pilea cavaleriei* Lévl. (Urticaceae), *Elatostema involucratum* Franch. et Savat. (Urticaceae), *Begonia grandis* Dry. (Begoniaceae), and *Fallopia multiflora* (Thunb.) Haraldson (Polygonaceae).

#### Conservation status

At present, a total of four sites are known. Each population of *P. jianghuaensis* is comprised of 200–300 mature individuals. The total population of this new species is small; it is estimated that mature individuals of the new species are no more than 1200. Therefore, we propose that *P. jianghuaensis* should be considered as 'Endangered' (EN) according to the IUCN red list categories and criteria (IUCN 2012) and China species red list (Wang and Xie 2004). Additional ecological and biological studies should be undertaken to ensure effective conservation measures.

#### Similar species

*Primulina jianghuaensis* resembles *P. lingchuanensis* (= *Chiritopsis lingchuanensis*) in its entire bract margins, white corolla, style with hairs and preference for limestone caves, but the latter can be distinguished by its narrowly ovate, ovate or subelliptic leaf blade, attenuate to petiole or broadly cuneate leaf base, repand leaf margin, inconspicuous lateral veins, and 3 staminodes. *Primulina jianghuaensis* is

also similar to *P. danxiaensis* (= *Chiritopsis danxiaensis*) in leaf shape and conspicuous lateral veins, but the latter differs by having 4–7 leaves, cordate leaf base, nearly palmately lobed leaf margin, 5–7 pairs of lateral veins, denticulate supra bracts, 1–3 cymes, yellowish corolla, and 2 staminodes. The characteristic features and differences among these related taxa are summarized in Table 1.

#### Palynology

A pollen sample of *P. jianghuaensis* was examined under SEM. Pollen grains were found to be single, mostly sub-plate or subspheroidal (Fig. 2A), tricolpate, and 3-lobed circular in polar view (Fig. 2B). Its size is  $13.5 \times 14.7 \mu\text{m}$  (P  $\times$  E). The germinal furrow is slightly sunken, with irregular granules (Fig. 2C). Polar surface ornamentation is finely rugulose, with few perforations (Fig. 2D).

#### Seed micro-morphology

Seeds of *P. jianghuaensis* are numerous and so minute that they can hardly be separated under magnifying glass. In general, seeds of this species are ellipsoid or subellipsoid in shape, yellow–brown in color, and  $0.32\text{--}0.38 \times 0.18\text{--}0.22 \text{ mm}$  in size (Fig. 2E). The seed coat surface is rough with irregular granular ornamentation. The granular epidermal cells are ca  $10\text{--}14 \mu\text{m}$  long, with apex foveate (Fig. 2F).

**Acknowledgements** – The authors are grateful to Prof. Wen-Bo Liao of Sun Yat-sen Univ. and Prof. Yan Liu of Guangxi Inst. of Botany, the Chinese Academy of Sciences for assistance in the course of preparing this paper. Financial support for this work was provided by Specialized Research Fund for the Doctoral Program of Higher Education (SRFDP, no. 20104306120008) and Hunan Provincial Construct Program of the Key Discipline in Ecology (0713).

## References

- Clements, R. et al. 2006. Limestone karsts of southeast Asia: imperiled arks of biodiversity. – *Bio Science* 56: 733–742.
- IUCN 2012. IUCN red list categories and criteria, ver. 4.0. – IUCN Species Survival Commission.
- Liu, Y. et al. 2006. *Chiritopsis lingchuanensis* Yan Liu & Y. G. Wei, a new species of Gesneriaceae from Guangxi, China. – *Acta Phytotax. Sin.* 44: 340–344.
- Möller, M. et al. 2011. A molecular phylogenetic assessment of the advanced Asiatic and Malesian didymocarpoid Gesneriaceae with focus on non-monophyletic and monotypic genera. – *Plant Syst. Evol.* 292: 223–248.
- Pan, B. et al. 2010. *Chiritopsis longzhouensis*, a new species of Gesneriaceae from Limestone areas in Guangxi, China. – *Taiwania* 55: 370–372.
- Shen, R. J. et al. 2010. *Chiritopsis danxiaensis* sp. nov. (Gesneriaceae) from Mount Danxiashan, south China. – *Nord. J. Bot.* 28: 1–5.
- Wang, S. and Xie, Y. 2004. China species red list. – Higher Education Press.
- Wang, W. T. et al. 1998. *Chiritopsis* W. T. Wang. – In: Wu, C. Y. and Raven, P. H. (eds), *Flora of China* 18. Science Press, Miss. Bot. Gard. Press, pp. 345–348.
- Wang, Y. Z. et al. 2011. Phylogenetic reconstruction of *Chirita* and allies (Gesneriaceae) with taxonomic treatments. – *J. Syst. Evol.* 49: 50–64.
- Weber, A. et al. 2011. Molecular systematics and remodelling of *Chirita* and associated genera (Gesneriaceae). – *Taxon* 60: 767–790.
- Wen, F. et al. 2008. A new variety of *Chiritopsis* (Gesneriaceae) from Guangxi, China – *Chiritopsis glandulosa* var. *yangshuoensis*. – *Guihaia* 28: 290–291.
- Wu, W. H. et al. 2011. *Chiritopsis hezhouensis* (Gesneriaceae) from karst caves in Guangxi, China. – *Taiwania* 56: 132–137.
- Xu, Z. R. 1995. A study of the vegetation and floristic affinity of the limestone forests in southern and southwestern China. – *Ann. Miss. Bot. Gard.* 82: 570–580.
- Xu, W. B. and Gao, H. S. 2009. *Chiritopsis jingxiensis*, a new species of Gesneriaceae from a Karst Cave in Guangxi, China. – *Novon* 19: 559–561.

Supplementary material (Appendix NJB00260 at <[www.oikosoffice.lu.se/appendix](http://www.oikosoffice.lu.se/appendix)>). Appendix A1.