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Pan B, Wen F, Zhao B, et al. *Primulina beiliuensis* B. Pan & S. X. Huang, a new species of Gesneriaceae from limestone areas in Guangxi, China [J]. *Guihaia*, 2013, 33 (5): 591–598

广西石灰岩地区苦苣苔科植物一新种——北流报春苣苔

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摘要: 报道了广西石灰岩地区苦苣苔科报春苣苔属 (*Primulina* Hance) 1 新种——北流报春苣苔 (*P. beiliuensis* B. Pan & S. X. Huang)。该新种在形态上与黄花牛耳朵 [*P. lutea* (Yan Liu & Y. G. Wei) Mich. Möller & A. Weber] 较近, 但叶宽卵形, 叶基部近心形, 叶缘具浅钝齿或呈浅波状齿, 花冠紫色, 花冠、花序梗、花梗、苞片及花萼均被紫色短柔毛而区别与后者; 分子生物学证据表明, 在系统发育上与桂林小花苣苔 [*P. repanda* var. *guilinensis* (W. T. Wang) Mich. Möller & A. Weber] 近缘, 但两者在形态学上相差较远。

关键词: 报春苣苔属; 北流报春苣苔; 广西; 苦苣苔科; 石灰岩植物区系; 新种

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Primulina beiliuensis B. Pan & S. X. Huang, a new species of Gesneriaceae from limestone areas in Guangxi, China

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Abstract: A new species of Gesneriaceae, *Primulina beiliuensis* B. Pan & S. X. Huang from limestone areas in Guangxi, China, is described and illustrated here. The new species is morphologically similar to *P. lutea* (Yan Liu & Y. G. Wei) Mich. Möller & A. Weber, but easily differs from the latter in its leaf blades broadly ovate, base nearly cordate, margin shallowly obtuse-dentate or shallowly undulate-serrate, corolla purple, corolla, peduncle, bracts and calyx lobes outsides, and pedicel with purple pubescence. Molecular evidences hint that it is systematically similar to *P. repanda* var. *guilinensis* (W. T. Wang) Mich. Möller & A. Weber, but the morphologies of two relatives are obviously different.

Key words: *Primulina*; *P. beiliuensis*; Guangxi; Gesneriaceae; limestone flora; new species

报春苣苔属 (*Primulina* Hance) (苦苣苔科) 主要分布于我国华南、西南至越南北部山地。广西是该属植物的分布中心, 近年来越来越多该属的新分类群被鉴定、发现和发表, 使其目前已成为拥有至少 140 个种和 9 个变种的中大小的属。作者于

2008 年自广西北流市采集到一种未知的报春苣苔属植物, 在对这种植物进行长期的野外定点观测与生物学性状调查之后, 我们发现该物种在已公开发表的涉及苦苣苔科植物的文献与专著中 (王文采, 1990; Wang *et al.*, 1998; 李振宇等, 2004; 韦

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毅刚等, 2010; Wen *et al.*, 2012a, b) 均未被提及与记载, 是一未被描述和发表的新分类群。

1 材料与方法

在野外收集该新种新鲜的叶片材料, 用硅胶干燥法保存备用 (Chase *et al.*, 1991), 采集回实验室后采用改进 CTAB 法提取硅胶干燥叶的 DNA (王化坤等, 2006)。核糖体 DNA 中的内转录间隔区 (ITS) 与叶绿体 DNA (cpDNA) 非编码区 *trnL-F* 片段的扩增与 Taberlet *et al.* (1991)、Doyle JJ & Doyle JL (1990) 以及 White *et al.* (1990) 所用的方法一致。本新物种的 ITS 与 *trnL-F* 片段在 Genbank 登记的序列分别为 JN644337 和 JN644340, 详见表 1。

对该新种的 ITS 与 *trnL-F* 片段在 NCBI 数据库 (<http://blast.ncbi.nlm.nih.gov/>) 中进行 BLAST 搜索, 同时依据形态学的证据, 该新种显然应该置入报春苣苔属 (Wang *et al.*, 2011; Weber *et al.*, 2011)。为阐明该新种的系统分类地位, 基于近期发表的相关论文 (李家美等, 2007; Möller *et al.*, 2011; Weber *et al.*, 2011), 我们选择的内类群为报春苣苔属的 22 个种 (含本新种) 与来自与双片苣苔属 (*Didymostigma* W. T. Wang) 的 1 个种和新定义的石山苣苔属 (*Petrocodon* Hance) 的 12 个种, 按照王文采系统, 这些种分别被置于原来的石山苣苔属、细筒苣苔属 (*Lagarosolen* W. T. Wang)、朱红苣苔属 (*Calcareoboea* C. Y. Wu ex H. W. Li) 和长蒴苣苔属 (*Didymocarpus* Wall.); 外类群为滇桂蛛毛苣苔 (*Ornithoboea wildeana* Craib) 和锈色蛛毛苣苔 [*Paraboea rufescens* (Franch.) Burt]. 上述物种的 ITS 与 *trnL-F* 片段序列数据来自于 GenBank (表 1)。

DNA 序列比对用 CLUSTAL W ver. 1. 83 (Thompson *et al.*, 1997) 和 MEGA 4. 0 (Tamura *et al.*, 2007) 软件完成, 并在 BioEdit 5. 0. 9. 1 软件上经过手工适当调整, 以减少缺失或插入。ITS 与 *trnL-F* 片段的边界根据 GenBank 中已有的近缘类群序列确定。

为评价 ITS 和 *trnL-F* 间的一致性, 在 PAUP * 4. 0b10 (Swofford, 2003) 上进行不一致差异性 (ILD) 检验 (Farris *et al.*, 1994)。100 次重复, 每次重复开始于 10 个任意增加而进行进化树对分重接 (TBR)。

排列好的序列数据用 PAUP * 4. 0b10 软件基于最大简约法进行分析。最大简约法分析中, 空缺被当作缺

失, 特征相同加权, 用每步增加一棵树的方法, 任意重复 1 000 次进行启发式搜索, TBR 支长交换, 得到的系统树分支的可靠性评价使用自展分析 (Bootstrap), 1 000 次重复取样, 100 次随机序列加入。

2 结果与分析

2. 1 新种北流报春苣苔的系统位置分析

ILD 测试结果显示 P 值 = 0. 162, 表明两组数据是一致的, 即可以联合两组数据进行分析。ITS 和 *trnL-F* 联合数据有 1 559 个位点, 其中 517 个 (33. 16%) 是变化位点, 289 个 (18. 54%) 是有效信息位点。最大简约法分析得出 1 棵最简约树, 树长为 1 089, 一致性指数 0. 6685, 保持性指数 0. 7324。

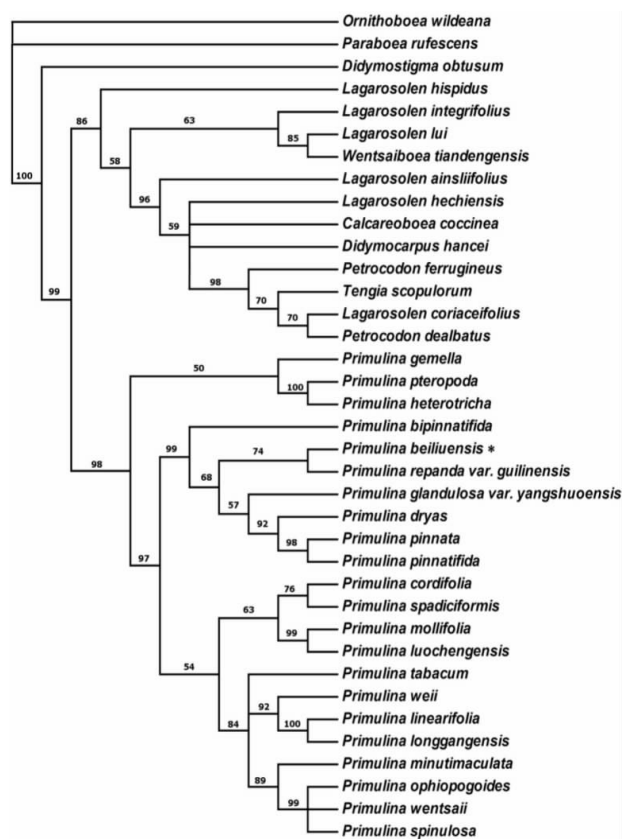


图 1 基于 ITS 和 *trnL-F* 联合序列数据的严格一致树分支上的数字为严格一致树的支持率。* 为新种北流报春苣苔。

Fig. 1 Strict consensus tree based on a maximum-parsimony (MP) analysis of combined ITS and *trnL-F* data. Numbers above and below the branches indicate bootstrap values > 50% by MP analysis. * Indicates the new species, *Primulina beiliuensis*.

MP 树显示外类群为滇桂蛛毛苣苔和锈色蛛毛苣苔。新种北流报春苣苔和桂林小花苣苔聚成支持率为 74% 的单系分支 (图 1)。

表 1 物种名称 (源自新旧分类系统)、凭证标本号及所使用的 ITS 与 *trnL-F* 序列
Table 1 Species names from former and present taxonomy, voucher numbers and accession numbers of ITS and *trnL-F* sequences used in this study

种名 (Weber 和 Möller 分类系统) Species (Weber & Möller' s taxonomy)	种名 (王文采分类系统) Species (W. T. Wang' s taxonomy)	凭证标本号 Voucher number	<i>trnL-F</i>	ITS
<i>Primulina gemella</i> (D. Wood) Yin Z. Wang	<i>Chirita gemella</i> D. Wood		FJ501523	FJ501345
<i>Primulina repanda</i> var. <i>guilinensis</i> (W. T. Wang) Mich. Möller & A. Weber	<i>Chiritopsis repanda</i> var. <i>guilinensis</i> W. T. Wang		AJ492292	FJ501351
<i>Primulina glandulosa</i> var. <i>yangshuoensis</i> (F. Wen, Yue Wang & Q. X. Zhang) Mich. Möller & A. Weber	<i>Chiritopsis glandulosa</i> var. <i>yangshuoensis</i> F. Wen, Yue Wang & Q. X. Zhang		HQ632948	HQ633045
<i>Primulina dryas</i> (Dunn) Mich. Möller & A. Weber	<i>Chirita sinensis</i> Lindl.		FJ501524	FJ501348
<i>Primulina pinnata</i> (W. T. Wang) Y. Z. Wang	<i>Chirita pinnata</i> W. T. Wang		FJ501526	FJ501349
<i>Primulina pinnatifida</i> (Hand. -Mazz.) Y. Z. Wang	<i>Chirita pinnatifida</i> (Hand. -Mazz.) Burt		FJ501527	FJ501350
<i>Primulina longgangensis</i> (W. T. Wang) Y. Z. Wang	<i>Chirita longgangensis</i> W. T. Wang		AJ492290	FJ501347
<i>Primulina tabacum</i> Hance	<i>Primulina tabacum</i> Hance		AJ492300	FJ501352
<i>Primulina spadiciformis</i> (W. T. Wang) Mich. Möller & A. Weber	<i>Chirita spadiciformis</i> W. T. Wang		AJ492291	FJ501346
<i>Primulina luochengensis</i> (Yan Liu & W. B. Xu) Mich. Möller & A. Weber	<i>Wentsaiboea luochengensis</i> Yan Liu & W. B. Xu		HQ632949	HQ633046
<i>Primulina beiliuensis</i> B. Pan & S. X. Huang*		Bo Pan 0121		
<i>Paraboea rufescens</i> (Franchet) B. L. Burt	<i>Paraboea rufescens</i> (Franch.) Burt.		DQ872825	DQ865196
<i>Ornithoboea wildeana</i> Craib;	<i>Ornithoboea wildeana</i> Craib		DQ872824	DQ865197
<i>Primulina heterotricha</i> (Merr.) Y. Z. Wang	<i>Chirita heterotricha</i> Merr.		DQ872816	DQ872826
<i>Primulina pteropoda</i> (W. T. Wang) Y. Z. Wang	<i>Chirita pteropoda</i> W. T. Wang		DQ872817	DQ872827
<i>Primulina bipinnatifida</i> (W. T. Wang) Y. Z. Wang	<i>Chiritopsis bipinnatifida</i> W. T. Wang		DQ872806	DQ872842
<i>Primulina cordifolia</i> (D. Fang & W. T. Wang) Y. Z. Wang	<i>Chiritopsis cordifolia</i> D. Fang & W. T. Wang		DQ872803	DQ872845
<i>Primulina minutimaculata</i> (D. Fang & W. T. Wang) Y. Z. Wang	<i>Chirita minutimaculata</i> D. Fang & W. T. Wang		DQ872815	DQ872828
<i>Primulina ophiopogoides</i> (D. Fang & W. T. Wang) Y. Z. Wang	<i>Chirita ophiopogoides</i> D. Fang & W. T. Wang		DQ872814	DQ872829
<i>Primulina wentsaii</i> (D. Fang & L. Zeng) Y. Z. Wang	<i>Chirita wentsaii</i> D. Fang & L. Zeng		DQ872812	DQ872831
<i>Primulina spinulosa</i> (D. Fang & W. T. Wang) Y. Z. Wang	<i>Chirita spinulosa</i> D. Fang & W. T. Wang		DQ872813	DQ872830
<i>Primulina mollifolia</i> (D. Fang & W. T. Wang) Y. Z. Wang	<i>Chiritopsis mollifolia</i> D. Fang & W. T. Wang		DQ872802	DQ872847
<i>Primulina weii</i> Mich. Möller & A. Weber	<i>Chirita mollifolia</i> D. Fang & Y. G. Wei		DQ872811	DQ872832
<i>Primulina linearifolia</i> (W. T. Wang) Y. Z. Wang	<i>Chirita linearifolia</i> W. T. Wang		DQ872810	DQ872834
<i>Petrocodon integrifolius</i> (D. Fang & L. Zeng) A. Weber & Mich. Möller	<i>Lagarosolen integrifolius</i> D. Fang & L. Zeng		HQ633037	HQ632940
<i>Petrocodon lui</i> (Yan Liu & W. B. Xu) A. Weber & Mich. Möller	<i>Lagarosolen lui</i> Yan Liu & W. B. Xu		HQ633035	HQ632938
<i>Petrocodon tiandengensis</i> (Yan Liu & B. Pan) A. Weber & Mich. Möller	<i>Wentsaiboea tiandengensis</i> Yan Liu & B. Pan		HQ633042	HQ632945
<i>Petrocodon hispidus</i> (W. T. Wang) A. Weber & Mich. Möller	<i>Lagarosolen hispidus</i> W. T. Wang		HQ633036	HQ632939
<i>Petrocodon hechiensis</i> (Y. G. Wei, Yan Liu & F. Wen) Y. G. Wei & Mich. Möller	<i>Lagarosolen hechiensis</i> Y. G. Wei, Yan Liu & F. Wen		HQ633039	HQ632942
<i>Petrocodon coccineus</i> (C. Y. Wu ex H. W. Li) Y. Z. Wang	<i>Calcareoboea coccinea</i> C. Y. Wu ex H. W. Li		FJ501341	FJ501516
<i>Petrocodon ainsliifolius</i> sp. nov.	<i>Lagarosolen ainsliifolius</i> sp. nov.		HQ633038	HQ632941
<i>Petrocodon hancei</i> (Hemsl.) A. Weber & Mich. Möller	<i>Didymocarpus hancei</i> Hemsl.		HQ633041	HQ632944
<i>Petrocodon ferrugineus</i> Y. G. Wei	<i>Petrocodon ferrugineus</i> Y. G. Wei		HQ633043	HQ632946
<i>Petrocodon coriaceifolius</i> (Y. G. Wei) Y. G. Wei & Mich. Möller	<i>Lagarosolen coriaceifolium</i> Y. G. Wei		HQ633040	HQ632943
<i>Petrocodon dealbatus</i> Hance	<i>Petrocodon dealbatus</i> Hance		GU350636	GU350668
<i>Petrocodon scopulorum</i> (Chun) Y. Z. Wang	<i>Tengia scopulorum</i> Chun		HQ633044	HQ632947
<i>Didymostigma obtusum</i> (C. B. Clarke) W. T. Wang	<i>Didymostigma obtusum</i> (C. B. Clarke) W. T. Wang		HQ632971	HQ632875

2. 2 新种北流报春苣苔的分类处理

北流报春苣苔 新种 图 2, 图 3

Primulina beiliuensis B. Pan & S. X. Huang,

sp. nov. Fig. 2, Fig. 3.

It is morphologically similar to *P. lutea* (Yan Liu & Y. G. Wei) Mich. Möller & A. Weber, but easily

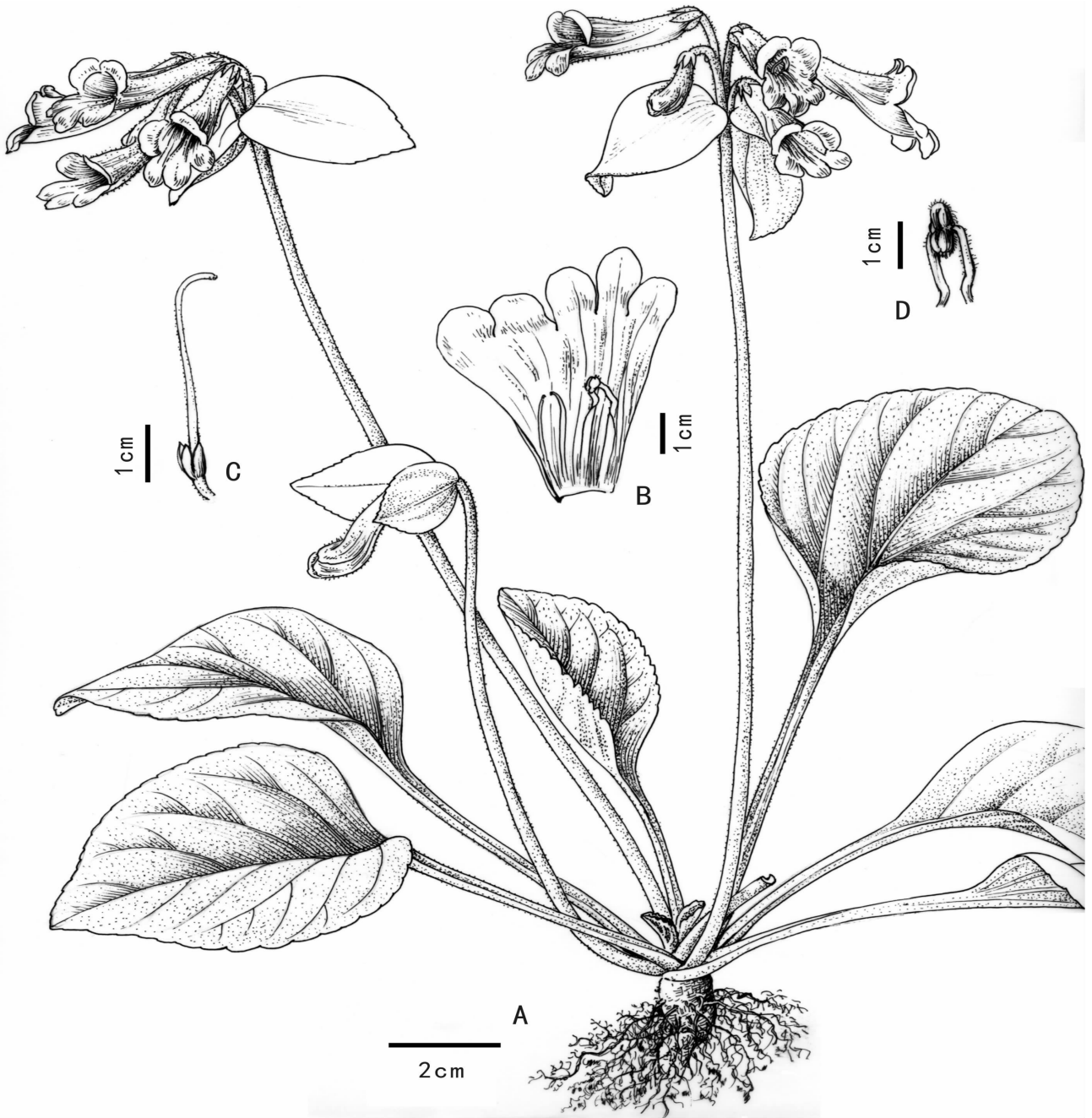


图 2 北流报春苣苔 (新种) A. 开花植株; B. 花冠展开, 示雄蕊与退化雄蕊; C. 雌蕊; D. 雄蕊。(林文宏 绘图)

Fig. 2 *Primulina beiliuensis* B. Pan & S. X. Huang, sp. nov. A. Plant with flowers; B. Opened corolla with stamens and staminodes; C. Pistil; D. Stamens. (Drawn by LIN Wen-Hong)

differs the latter in its leaf blades broadly ovate to nearly cordate, margin shallowly obtuse-dentate or shallowly undulate-serrate, corolla purple, corolla, peduncle, bracts and calyx lobes outsides, and pedicel with purple pubescence.

Perennial herbs. Rhizome 3–5 cm long, 1–1.5 cm in diameter. Leaves 4–8, all basal; petiole compressed, 2.5–6 cm long, 2–6 mm in diameter; leaf blade fleshy, broadly ovate to nearly cordate, (4.5–9) cm × (4.5–7.5) cm, apex sub-

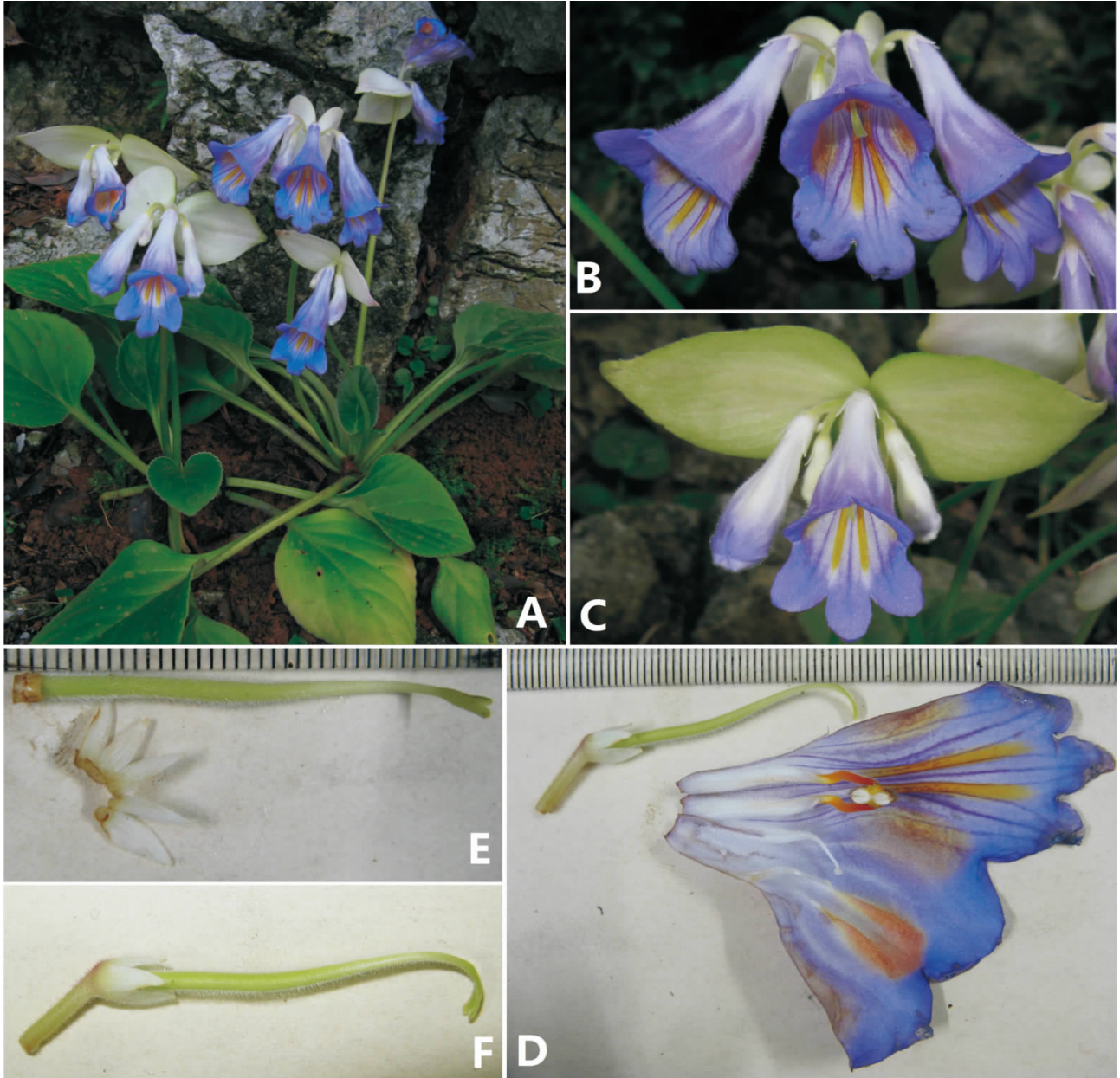


图 3 北流报春苣苔 (新种) A. 开花植株; B. 花序; C. 花朵与苞片; D. 花冠展开, 示雄蕊与退化雄蕊; E. 萼片展开与雌蕊; F. 雌蕊与柱头。
Fig. 3 *Primulina beiliuensis* B. Pan & S. X. Huang, sp. nov. A. Plant with flowers; B. Cyme; C. Flowers and bracts; D. Opened corolla with stamens and staminodes; E. Opened calyx lobes and pistil; F. Pistil and stigma.

acute, base broadly cuneate or cordate, margin shallowly obtuse-dentate or shallowly undulate-serrate, both surfaces with appressed pubescence, lateral veins 3–4 on each side. Cymes axillary, ca. 4, no branched, 10–22 cm tall, (1–) 2–4 (5) on one cyme; peduncle 9–17 cm long, slender, purple-pubescent; bracts 2, big, opposite, ovate, broadly ovate or rounded-ovate, (3.5–4.5) cm × (2.5–3) cm, margin shallowly obtuse-dentate or shallowly undulate-serrate, outside densely purple-pubescent, inside white-pubescent; pedicel 2–3 cm long,

densely purple-pubescent. Calyx 5-parted to the base, lobes laciniate, (4.5–6) mm × (0.2–2) mm, outside purple-pubescent, inside pubescent. Corolla purple, inside with six dark purple and two yellow stripes, 3–4 cm long, outside purple-pubescent, inside sparsely pubescent; tube thick infundibuliform, 2–3 cm long, ca. 1.5 cm in diameter at orifice; limb distinctly 2-lipped, adaxial lip 2-lobed, lobes rounded, ca. 9 mm long, abaxial 3-lobed, lateral ones ovate, central one oblong, ca. 1 cm long. Stamens 2, adnate to ca. 7 mm above the base of the co-

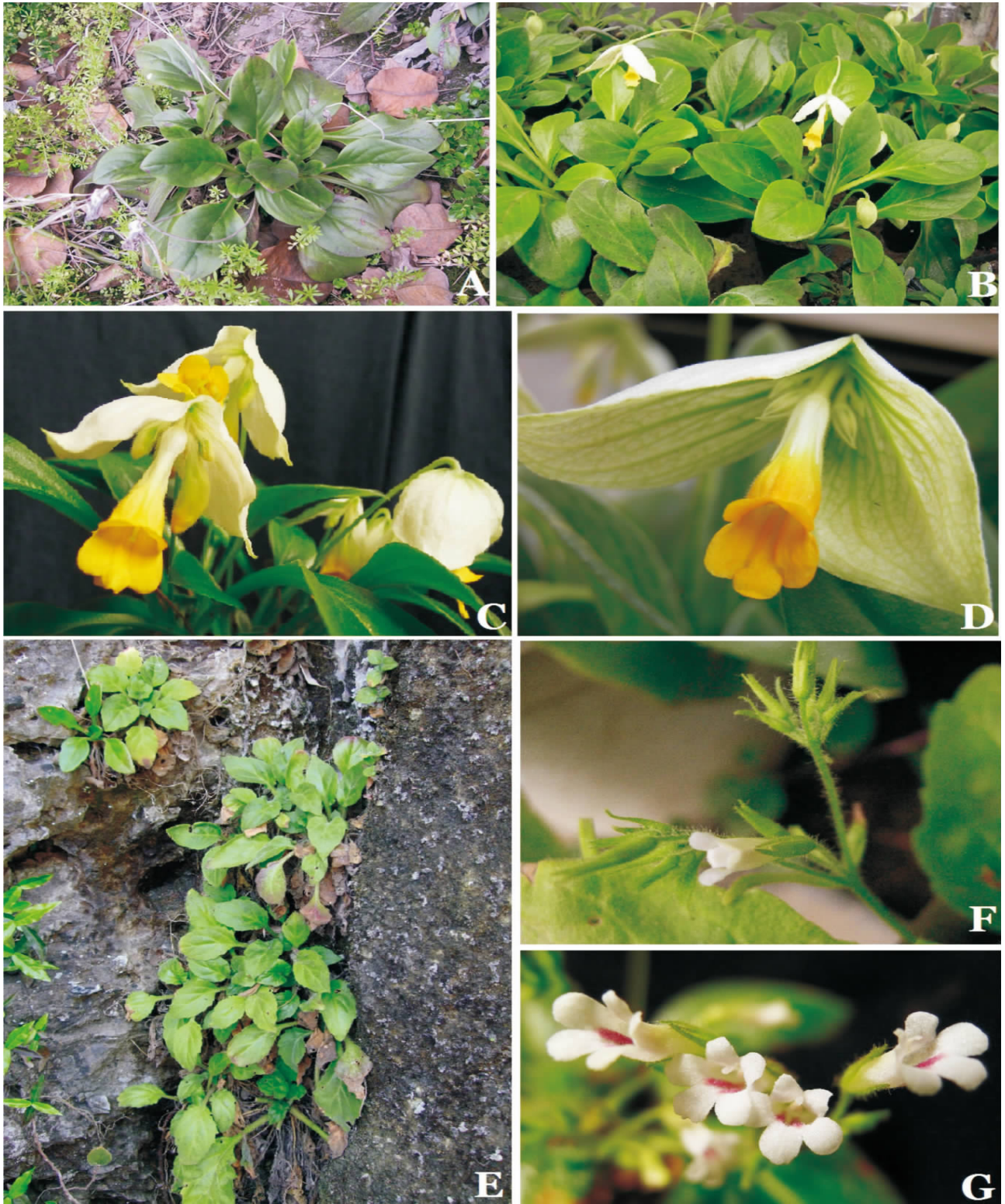


图 4 北流报春苣苔形态学上的近缘种 (A-D. 黄花牛耳朵) 与其系统发育上的近缘种 (E-G. 桂林小花苣苔) A. 野外植株; B. 开花植株; C. 花序与花; D. 花朵与苞片正面观; E. 野外植株; F. 花序与苞片; G. 花朵正面观。

Fig. 4 Two relatives of *Primulina beiliuensis* the morphological relative (A-D. *P. lutea*) and the systematic relative (E-G. *P. repanda* var. *guilinensis*) A. Plants in the field; B. Plants with flowers; C. Cymes and flowers; D. The frontal view of flower and bracts; E. Plants in the wild; F. Cyme and bracts; G. The frontal view of flowers.

rolla tube; filaments geniculate from the middle, orange, 6–8 mm long, with sparsely short glandulous

hairs. Anthers elliptical, ca. 5mm long, back densely white lanate; staminodes 3, lateral ones adnate

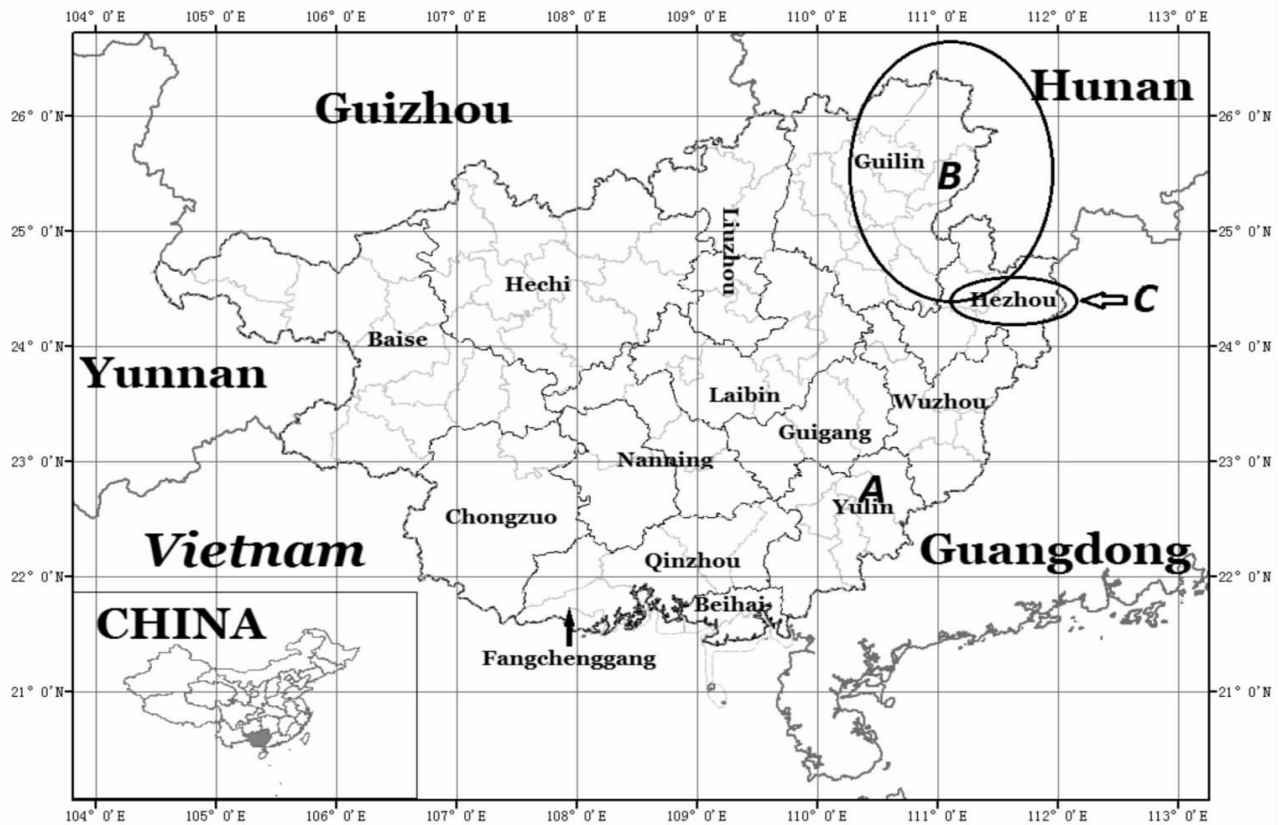


图 5 北流报春苣苔及其近缘种的分布地图 A. 已知的唯一一个北流报春苣苔分布地点; B. 椭圆区域为桂林小花苣苔的分布区域; C. 椭圆区域为黄花牛耳朵的分布区域。
 Fig. 5 Distributed map of *Primulina beiliuensis* and its two relatives A. Only known distributed locality of *P. beiliuensis*; B. Distributed region (elliptical area) of *P. repanda* var. *guilinensis*; C. Distributed region (elliptical area) of *P. lutea*.

表 2 新种北流报春苣苔与其形态学上的近缘种黄花牛耳朵的区别特征比较

Table 2 Detailed comparison between *Primulina beiliuensis* sp. nov. and its morphological relative, *P. lutea*

特征 Character	北流报春苣苔 <i>P. beiliuensis</i>	黄花牛耳朵 <i>P. lutea</i>
Leaf blade shape	broadly ovate to nearly cordate	ovate or narrowly ovate
Leaf blade margin	shallowly obtuse-dentate or shallowly undulate-serrate	entire
Indumentum of peduncle	purple-pubescent	densely appressed pubescence
Indumentum of outside of bracts, corolla and calyx lobes	Sparsely purple-pubescent	densely appressed pubescence
Indumentum of pedicel	densely purple-pubescent	densely short glandulous hairs and pubescence
Bracts margin	shallowly obtuse-dentate or shallowly undulate-serrate	entire
Corolla collar	purple	yellow
Corolla tube shape	thick infundibuliform	narrow infundibuliform
Staminodes	3	2
Flowering time	April to May	June to July

ca. 8 mm above the base of the corolla tube, ca. 6 mm long, apex capitate, the central one adnate to the

base of corolla tube, ca. 5 mm long. Disc annular, ca. 2 mm high. Pistil 2. 5—3. 2 cm long; ovary 8—10 mm long, pubescent, style with sparsely short glandulous hairs and pubescence; stigma obtrapeziform, 2-parted. Capsule no seen. Flowering from April to May.

China (中国), Guangxi (广西), Beiliu City (北流市), near suburb (城郊), on the moist tufa and moss, or crevices of limestone rock on hill (生于石灰岩山体的潮湿钙华表面上和苔藓丛或岩石缝隙中), rare (罕见), only one population with no more than 200 individuals (仅 1 个居群, 数量不超过 200 株), about 175 m, April 20, 2008, 标本号: 盘波 Bo Pan 0121 (holotype: IBK; isotype: IBK).

3 结论与讨论

3. 1 形态学上的近缘种

本种在营养器官与生殖器官等形态学特征上近

似于黄花牛耳朵,但基于 ITS 与 *trnL-F* 片段的联合分析,即从分子生物学的角度上观察则与桂林小花苣苔近缘。本新种与黄花牛耳朵在一些特征上可以显著区别,如叶宽卵形,叶基部近心形,叶缘与苞片边缘均具浅钝齿或呈浅波状齿,花冠紫色,苞片、花冠、花序梗、花梗、苞片及花萼均被紫色短柔毛,花期 4~5 月等(表 1);尽管在系统发育上(分子证据)标明该种与桂林小花苣苔存在比较近缘的关系,但两者在形态学上相差较远,很容易区分(图 4)。

3. 2 形态学与分子生物学证据上近缘种表现之差

该新种,北流报春苣苔在形态学上的相似种与分子生物学证据上表现的近缘种,从形态学的角度看相差较远。从三者的分布地点(图 5)上看,桂林小花苣苔主要分布在广西的北部桂林地区一带,北达湖南省(张贵志等,2012),南则达贺州市(韦毅刚等,2010),黄花牛耳朵则主要分布在贺州(刘演等,2004)和广东省的西部少数地区(王炳谋,私人通信,2012),两者的分布区域有少数重叠。但北流报春苣苔仅局限分布在玉林市地区北流一带。三者的地带性分布呈阶梯状。联合形态学与分子生物学的相关性,同时考虑其地带性分布,三者可能有一个共同的祖先,分布在共同的连成一片的石灰岩区域。由于石灰岩地质构造的特殊性,使其极易产生隔离而独特的微环境,这也与前人的认识相同——在我国华南石灰岩岩溶地区,大多数报春苣苔属植物分布区域均十分狭小,不少种只分布在一个或少数石灰山上。这充分说明在岩溶地区,岩溶山地及其山体丘陵中间的酸性土壤的阻断作用所产生的隔离现象对报春苣苔属物种形成起了相当大的作用(Li & Wang, 2007; 李振宇等,2004)。在漫长的地质历史时期中为了适应不同的、剧烈变化的生态生境破碎,促进了三个不同物种的形成与分化。

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