Polystichum yaanense (Dryopteridaceae), a Remarkable New Species from Sichuan, China

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Abstract. A new fern species, *Polystichum yaanense* Liang Zhang & Li Bing Zhang (Dryopteridaceae), is described from Bifengxia, or the Bluish Green Peak Canyon, in Ya'an Prefecture in Sichuan Province, China. The new species is morphologically unique in having yellowish green leaves, a thin but firm leaf texture, veins visible on the adaxial leaf surface, and narrowly ovate to lanceolate rachis scales. Ecologically, the new taxon grows in acidic soils, in contrast to other species in section *Haplopolystichum* Tagawa. *Polystichum yaanense* is considered to be Critically Endangered (CR), based on IUCN Red List criteria. Ten other species of *Polystichum* Roth occur in the type locality within the same canyon; all 11 species are distinguished from one another by a dichotomous key based on morphology.

Key words: China, IUCN Red List, *Polystichum*, Sichuan.

In December 2008, Hai He, a pteridologist based at the CTC Herbarium, affiliated with Chongqing Normal University, noticed images of fern species on the Internet posted by the first author (L.Z.). The images of a noteworthy species of *Polystichum* Roth (Dryopteridaceae) caught Hai He's attention and were later forwarded to the second author (L.-B.Z.), who immediately realized that it was an undescribed species. Subsequent fieldwork was conducted on 15 March 2009, and the new species is described here.

The type locality is in Bifengxia, or the Bluish Green Peak Canyon, which is located in the Ya'an Prefecture directly north of Ya'an City in Sichuan Province. The locale is a scenic area known for its well-protected vegetation and for the Giant Panda Reserve. The canyon itself is about 13 km long and is composed of two segments that form a V shape. Streams and waterfalls run perennially in the canyon. The second author (L.-B.Z.) has also identified two more localities of the new species that were collected by Wen-Pei Fang in 1930 in neighboring Hongya County, to the east in Sichuan, but no further information was available to describe the habitat.

Polystichum yaanense Liang Zhang & Li Bing Zhang, sp. nov. TYPE: China. Sichuan: Ya'an Prefecture, Yucheng Distr., Bifengxia Town, Bifeng Village, Bifengxia, 30°4′17.51″N, 102°59′48.74″E, 950 m, 15 Mar. 2009, sandstone substrate, in acidic soil, *L.-B. Zhang, Y. Wang & L. Zhang 4745* (holotype, CDBI; isotypes, CDBI, MO, SAUF). Figures 1, 2.

Species insignis lamina foliari luteolo-viridi textura tenui sed dura, venis adaxialiter visibilibus atque squamis rhachidis anguste ovatis usque lanceolatis, a speciebus sectionis *Haplopolystichi* Tagawa nobis notis bene distincta.

Plants perennial, caespitose, evergreen, 8–15(–30) cm tall; rhizome short, 0.5–1 cm, ascending; scales ovate to lanceolate, chartaceous, light brown, 0.4–3.6 mm; roots dark brown when dry, to 10 cm, ca. 0.6 mm diam., sparsely to densely covered with scales. Leaves 5 to 11 per rhizome; petiole 1.5–3(–7) cm, 0.5–1.2 mm diam. at mid-portion, adaxially canalic-

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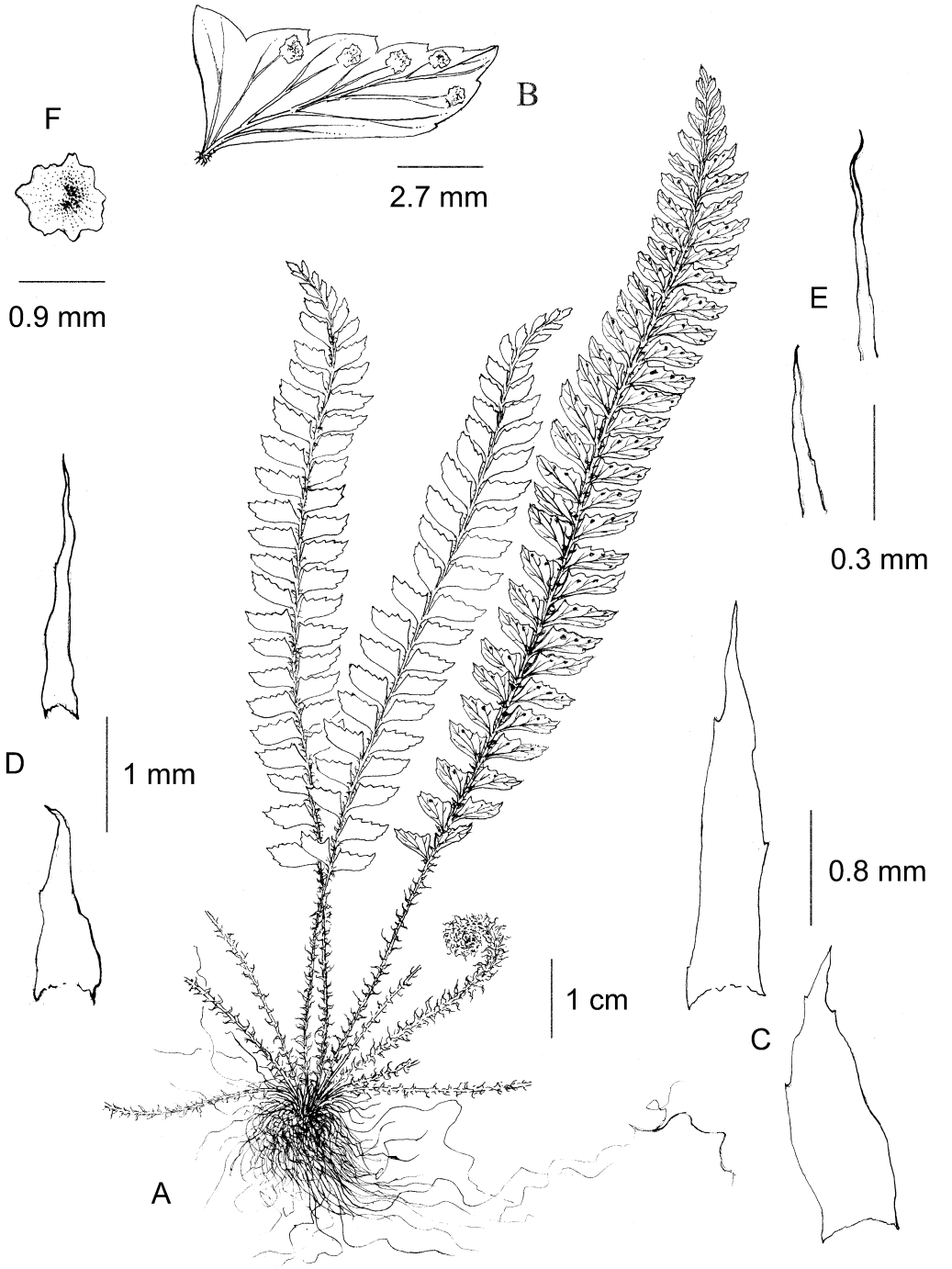

Figure 1. *Polystichum yaanense* Liang Zhang & Li Bing Zhang. —A. Plant habit. —B. Pinna. —C. Scales from base of petiole. —D. Rachis scales. —E. Narrow-type microscales. —F. Indusium. A–F taken from the holotype *L.-B. Zhang, Y. Wang & L. Zhang 4745* (CDBI).

ulate, green; basal petiole scales narrowly ovate to lanceolate (Fig. 1C), 2.7–3.4 × 0.8–1.1 mm, variable in size, thinly chartaceous and brown at mid-portion, membranous and light brown on margin, composed of multiple cell layers, margin subentire, apex acuminate or caudate, matte; distal petiole scales similar but narrower and shorter toward rachis apex, lanceolate or narrowly ovate, membranous, brown,

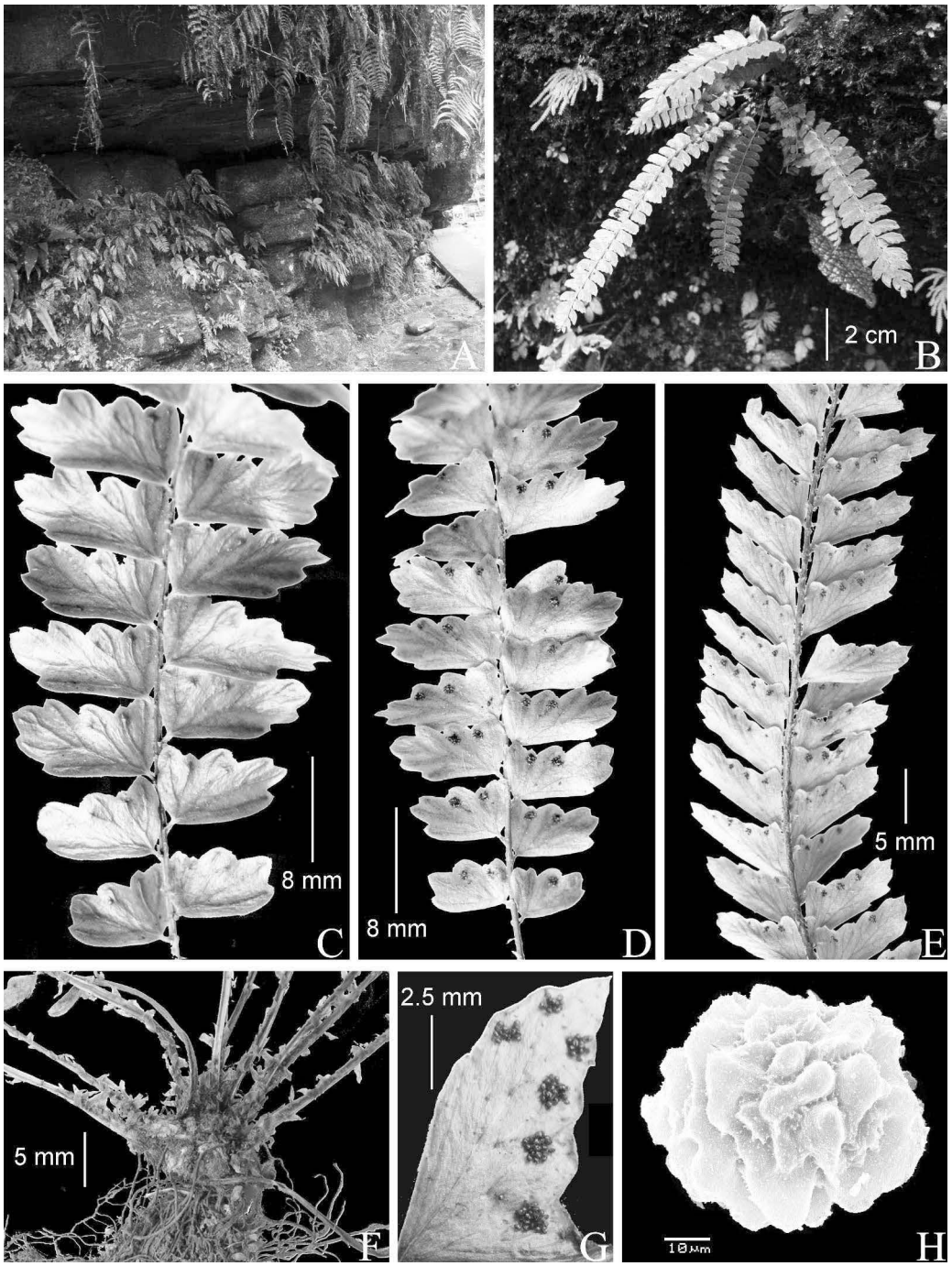

Figure 2. *Polystichum yaanense* Liang Zhang & Li Bing Zhang. —A. Habitat at the type locality in Bifengxia. —B. Plant habit. —C. Lower portion of adaxial lamina. —D. Lower portion of abaxial lamina. —E. Portion of abaxial lamina of a different plant. —F. Lower portion of plant showing petiole scales. —G. Abaxial view of pinna showing the marginal sori. —H. SEM equatorial view of spore. H taken from the holotype *L.-B. Zhang, Y. Wang & L. Zhang 4745* (CDBI).

margin subentire or slightly serrate, apex caudate, matte. Leaf lamina lanceolate, slightly contracted from the basal 4 pairs toward base, 1-pinnate, 6–12(−23) cm, 1.4–2 cm wide, apex acute and apical 4 or 5 pinna pairs contracted toward apex; rachis 0.7–1.2 mm diam. at mid-portion, without proliferous buds, adaxially sulcate; rachis scales 1.5–3.2 mm, base 0.3–1 mm wide, narrowly ovate to lanceolate, differing in size, chartaceous, light brown, margin occasionally ciliate (cilia not evident, Fig. 1D), apex caudate, matte; pinnae usually in 10 to 26 pairs, not overlapping, pointing upward, the basal 2 pairs 0.5–1.3 cm apart, ± alternate, yellowish green, oblong, the largest pinnae 8.2–10.1(−17) × 4.5–5.1(−7) mm, located at mid-lamina, shortly petiolulate; petiolules ca. 1.5 mm, coriaceous, the acroscopic base auriculate, the basiscopic base truncate, often at 90°–120° angles to rachis, pinna apex obtuse, acroscopic margin repand, serrate and without aristate spinules, abaxially scaly, adaxially lustrous and glabrous; microscales on abaxial pinna surface subulate, without dilated base (narrow-type microscales), 0.3–0.9 mm, base 0.12–0.24 mm wide, ciliate on margins (cilia not evident, Fig. 1E); venation pinnate; midrib abaxially slightly raised, adaxially flat but clearly visible; lateral veins free, usually in 3 or 4 pairs from midrib per pinna, nearly opposite, each lateral vein further dichotomous, distinct on both surfaces; sori terminal on veins of pinnae, (1)2 to 5(6) per fertile pinna (Fig. 1B), adjacent, ca. 0.9 mm from pinna margin; all pinnae on fertile lamina fertile; indusia peltate (Fig. 1F), 0.7–1.1 mm diam., membranous, brown, margin erose.

Spore morphology. The spores of *Polystichum yaanense* are round in polar view and elliptic in equatorial view. The spore size is ca. 54.2 × 62.2 μm (polar axis × equatorial axis). The ratio of the length of the polar axis to that of the equatorial axis is ca. 1.15:1. The perispore sculpture is verrucate, and the verrucae are normally more than 5 μm wide (Fig. 2H).

Distribution and ecology. *Polystichum yaanense* is described from the Ya'an Prefecture in Sichuan Province on the basis of four collections from the type locality in Bifengxia, Yucheng District. An additional two collections were discovered by the second author (L.-B.Z.) at Kew that date to 1930 from adjacent Hongya County in Sichuan, directly to the east of Ya'an City, but further details for this locale are not available. In the canyon at Bifengxia, *P. yaanense* grows in shallow acidic soils on moist and shady sandstone cliff faces at an elevation of ca. 950 m. The plants were observed 0.5–1.5 m above the ground, about 10 m away from a perennial stream. Sandstone substrate and similar habitat are not rare in western and central Sichuan, and it is thus possible that this species may occur in neighboring areas. Plants immediately associated with *P. yaanense* on these sandstone cliffs include the moss *Sphagnum* L. (Sphagnaceae); the ferns *Hicriopteris glauca* (Thunb. ex Houtt.) Ching (Gleicheniaceae), *P. acutidens* Christ (Dryopteridaceae), and *Stegnogramma cyrtomioides* (C. Chr.) Ching (Thelypteridaceae); and the lycophyte *Selaginella delicatula* (Desv. ex Poir.) Alston (Selaginellaceae).

Other plants found within 10 m of *Polystichum yaanense* include the ferns *Asplenium tripteropus* Nakai, *A. cataractarum* Blume (Aspleniaceae), *Diplazium subsinuatum* (Wall. ex Hook. & Grev.) Tagawa (Athyriaceae), *Lindsaea cultrata* (Willd.) Sw. (Lindsaeaceae), *Parathelypteris glanduligera* (Kunze) Ching (Thelypteridaceae), *Polystichum deltodon* (Baker) Diels, and *P. xiphophyllum* (Baker) Diels. Seed plant associates were *Asarum caudigerum* Hance (Aristolochiaceae), *Asystasiella neesiana* (Wall.) Lindau (Acanthaceae), *Begonia limprichtii* Irmsch. (Begoniaceae), *Dichocarpum auriculatum* (Franch.) W. T. Wang & P. G. Xiao (Ranunculaceae), *Elatostema cuspidatum* Wight (Urticaceae), *Fordiophyton faberi* Stapf (Melastomataceae), *Impatiens oxyanthera* Hook. f. (Balsaminaceae), *Loxostigma griffithii* (Wight) C. B. Clarke (Gesneriaceae), *Lysimachia paridiformis* Franch. var. *stenophylla* Franch. (Primulaceae), *Millettia dielsiana* Harms (Fabaceae), *Ophiorrhiza* L. (Rubiaceae), *Pellionia radicans* (Siebold & Zucc.) Wedd. (Urticaceae), *Rubus corchorifolius* L. f. (Rosaceae), *Saxifraga stolonifera* Curtis (Saxifragaceae), *Sinosenecio oldhamianus* (Maxim.) B. Nord. (Asteraceae), *Stachyurus chinensis* Franch. (Stachyuraceae), and *Whytockia tsiangiana* (Hand.-Mazz.) A. Weber var. *wilsonii* A. Weber (Gesneriaceae).

IUCN Red List category. Only three populations with a total of ca. 45 individuals of *Polystichum yaanense* have been found so far in Ya'an Prefecture, at the type locality in Bifengxia canyon. These populations consisted of 25, 15, and five plants, respectively, and were about 20 m, 600 m, and 600 m apart from one another. No information is available for populations in Hongya County, and the modern presence of *P. yaanense* was not confirmed at this second locality. The status of the new species is classified as Critically Endangered (CR), according to IUCN guidelines (IUCN, 2008). Although the type locality is in a protected nature reserve, hiking trails currently pass near the populations of *P. yaanense*, and the trails are heavily used in summer, which

raises significant conservation concern. This has been brought to the attention of the agency responsible for the management of Bifengxia, stressing the need to ensure the proper conservation of this habitat.

Etymology. The epithet of the new species is taken from the Chinese pinyin "yaan," for the name of the type locality in the Ya'an Prefecture in Sichuan, China, and from the Latin suffix "-ense," meaning "of origin or place."

Discussion. Morphologically, we expected *Polystichum yaanense* to share a close relationship with species in *Polystichum* sect. *Haplopolystichum* Tagawa. The new species has no bulbils on its rachis and has only free venation on the pinnae, which better corresponds to the core species group of *Polystichum* sect. *Haplopolystichum*. However, *P. yaanense* is unique within the entire *Polystichum* sect. *Haplopolystichum* s.l. (Zhang & He, 2009) in having yellowish green leaves with a thin but firm chartaceous texture, the adaxially visible veins on the pinnae, and the rachis scales that are variably narrowly ovate to lanceolate. *Polystichum* sect. *Haplopolystichum* is typically characterized by green leaves with soft chartaceous or firm coriaceous (but not firm chartaceous) texture, the adaxially indistinct venation on the pinnae, and rachis scales that are linear or lanceolate.

The verrucate perispore sculpture of *Polystichum yaanense* (Fig. 2H) is more or less similar to that of *P. excelsius* Ching & Z. Y. Liu in *Polystichum* sect. *Sphaenopolystichum* Ching ex W. M. Chu & Z. R. He (as "17, *P. xichouense*," nom. nud., Xiang, 1992: 94) and that of *P. oligocarpum* Ching ex H. S. Kung & Li Bing Zhang in *Polystichum* sect. *Metapolystichum* Tagawa (Zhang & Kung, 1994). However, the perispore sculpture of the majority of the 89 Chinese species currently known for *Polystichum* sect. *Haplopolystichum* s.l. is unknown.

The ecological preference of *Polystichum yaanense* for acidic soils distinguishes the new taxon within *Polystichum* sect. *Haplopolystichum* s.l. Other species in this section that are also documented from acidic soils include *P. balansae* Christ, *P. falcatilobum* Ching ex W. M. Chu & Z. R. He, *P. formosanum* Rosenst., *P. hancockii* (Hance) Diels, *P. hookerianum* (C. Presl) C. Chr., and *P. tripteron* (Kunze) C. Presl.

Including the new species *Polystichum yaanense*, 11 species of *Polystichum* representing five sections have now been found in the area of Bifengxia. The other 10 are *P. acutidens* Christ, *P. deltodon* (Baker) Diels, *P. falcatilobum*, *P. hecatopterum* Diels (these four in *Polystichum* sect. *Haplopolystichum*), *P. erosum* Ching & K. H. Shing (*Polystichum* sect. *Mastigopteris* Tagawa), *P. longipaleatum* Christ, *P. makinoi* (Tagawa) Tagawa (these two in *Polystichum* sect. *Metapolystichum* Tagawa), *P. altum* Ching ex Li Bing Zhang & H. S. Kung, *P. longispinosum* Ching ex Li Bing Zhang & H. S. Kung (these two in *Polystichum* sect. *Neopolystichum* Ching ex Li Bing Zhang & H. S. Kung), and *P. xiphophyllum* (Baker) Diels (*Polystichum* sect. *Xiphopolystichum* Daigobo). These species are distinguished in the following taxonomic key.

Key to Species of *Polystichum* from Bifengxia, Ya'an Prefecture, in Sichuan, China

1a. Lamina pinnate 2
2a. Rachis without bulbils 3
3a. Pinnae without long spinules on margin 4
4a. Pinnae without visible veins on adaxial lamina surface; leaf lamina chartaceous, uniformly green; rachis scales lanceolate 5
5a. Pinnae falcate-lanceolate 6
6a. Pinnae chartaceous; sori located between midrib and pinna margin. ..... *P. acutidens*
6b. Pinnae coriaceous; sori located adjacent to pinna margin ..... *P. falcatilobum*
5b. Pinnae oblong ..... *P. deltodon*
4b. Pinnae with visible veins on adaxial surface; leaf lamina thin but firmly chartaceous, yellowish green; rachis scales ovate-lanceolate .... *P. yaanense*
3b. Pinnae with long spinules on margin .... *P. hecatopterum*
2b. Rachis with a bulbil at apex ..... *P. erosum*
1b. Lamina bipinnate 7
7a. Leaf lamina chartaceous; rachis scales brown and lanceolate 8
8a. Microscales lanceolate (broad-type) 9
9a. Pinnules with long spinules on margin .... *P. longispinosum*
9b. Pinnules without long spinules on margin ... *P. altum*
8b. Microscales linear (narrow-type) 10
10a. Petiole scales concolorous; pinnules exauriculate; microscales fibrillose ..... *P. longipaleatum*
10b. Petiole scales bicolorous; pinnules auriculate; microscales linear but not fibrillose ..... *P. makinoi*
7b. Leaf lamina coriaceous; rachis scales dark brown and linear ..... *P. xiphophyllum*

Paratypes. CHINA. **Sichuan:** Hongya Co., 21 Aug. 1930, *W.-P. Fang 8480* (K, SZ); 22 Aug. 1930, *W.-P. Fang 8606* (K, SZ); Ya'an Prefecture, Yucheng Distr., Bifengxia Town, Bifeng Village, Bifengxia, 30°4′17.51″N, 102°59′48.74″E, sandstone cliffs, 0.5–1.5 m above ground, 950 m, 4 Aug. 2009, *L. Zhang 701* (CDBI, MO, SAUF), *705*, *716* (SAUF).

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