Woodsia guizhouensis (Woodsiaceae), a New Species from a Limestone Area in Guizhou, China

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Woodsia guizhouensis (Woodsiaceae), a New Species from a Limestone Area in Guizhou, China

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Abstract. A new pteridophyte species, *Woodsia guizhouensis* P. S. Wang, Q. Luo & Li Bing Zhang (Woodsiaceae), is described and illustrated from higher elevational areas in Guizhou, China. It is morphologically most similar to *W. andersonii* (Bedd.) Christ and *W. rosthorniana* Diels. *Woodsia guizhouensis* is only 3–8 cm tall, its rhizome scales are light brown with sparsely fimbriate margins, its pinnae are short-petiolulate, and its pinna bases are cordate or sometimes rounded. The perispore sculpture of *W. guizhouensis* pollen is cristate, with numerous acanthoid projections and a few irregular perforations. *Woodsia guizhouensis* is only known from four localities in western Guizhou and is considered to be Endangered (EN), based on IUCN Red List criteria.

Key words: China, Guizhou, IUCN Red List, *Woodsia*, Woodsiaceae.

The fern genus *Woodsia* R. Br. is one of ca. 15 genera recognized by Smith et al. (2006) in the family Woodsiaceae s.l., although recent molecular study has supported the recognition of a monotypic Woodsiaceae s. str. (Schuettpelz & Pryer, 2008). *Woodsia* s. str. (excluding *Cheilanthopsis* Hieron. and *Protowoodsia* Ching) contains more than 30 species, occurring in Asia, Europe, and North America. There are 21 species in China, 19 of which were documented in the Chinese-language *Flora of China* (Wu, 1999) and two from earlier works, with *W. kangdingensis* H. S. Kung, Li Bing Zhang & X. S. Guo from Sichuan (Kung et al., 1995) and *W. okamotoi* Tagawa from Taiwan (Tagawa, 1938; DeVol, 1994).

In the last three years, four independent field trips were made (August 2007, 2009; September 2008, 2009) to southwestern Guizhou Province in China. During each of these trips, an unknown species of *Woodsia* was collected from western Guizhou. Field observations, morphological work, and palynological studies confirm that the taxon validated herein is an undescribed species, thus representing the 22nd species of *Woodsia* reported for China.

Woodsia guizhouensis P. S. Wang, Q. Luo & Li Bing Zhang, sp. nov. TYPE: China. Guizhou: Bijie City, Yangjiawang, Gonglongping Forestry Center, among crevices on wet limestone cliff, 27°12.92′N, 104°59.52′E, 1670 m, 21 Sep. 2008, *Q. Luo 08301* (holotype, CDBI; isotypes, BJ, MO). Figures 1, 2.

Species *Woodsiae rosthornianae* Diels affinis, a qua statura minore 3–8 cm alta, paleis rhizomatis dilute brunneis margine sparsim fimbriatis atque pinnis lateralibus petiolulatis basi saepe leviter cordatis vel interdum rotundatis differt.

Plants perennial, deciduous, caespitose, 3–8 cm tall; rhizome short, erect, with a cluster of persistent petiole bases; sparsely scaled; rhizome scales light brown, membranous, ca. 2.5 × 0.1–0.6 mm, linear to lanceolate, sparsely fimbriate; adventitious roots dark brown when dry, to 12 cm, ca. 0.3 mm diam. Leaves deciduous, 5 to 10 per rhizome; grayish green when dried; petioles straw-colored, not articulate, 0.5–2.2 cm, 0.4–0.6 mm diam., adaxially canaliculate and green; basal petiole scales narrowly lanceolate, 1.2–4 × 0.1–0.8 mm, membranous, multicellular, light brown, fimbriate, matte; distal petiole scales narrowly lanceolate, 1.2–3.5 × 0.1–0.7 mm, membranous, multicellular, light brown, sparsely fimbriate, matte; leaf lamina narrowly elliptic, slightly contracted toward lamina base, 1-pinnate, 2–6 × 0.8–2 cm, apex obtuse; rachis 0.2–0.5 mm diam. at mid-point, adaxially sulcate, with no proliferous bulbils; rachis

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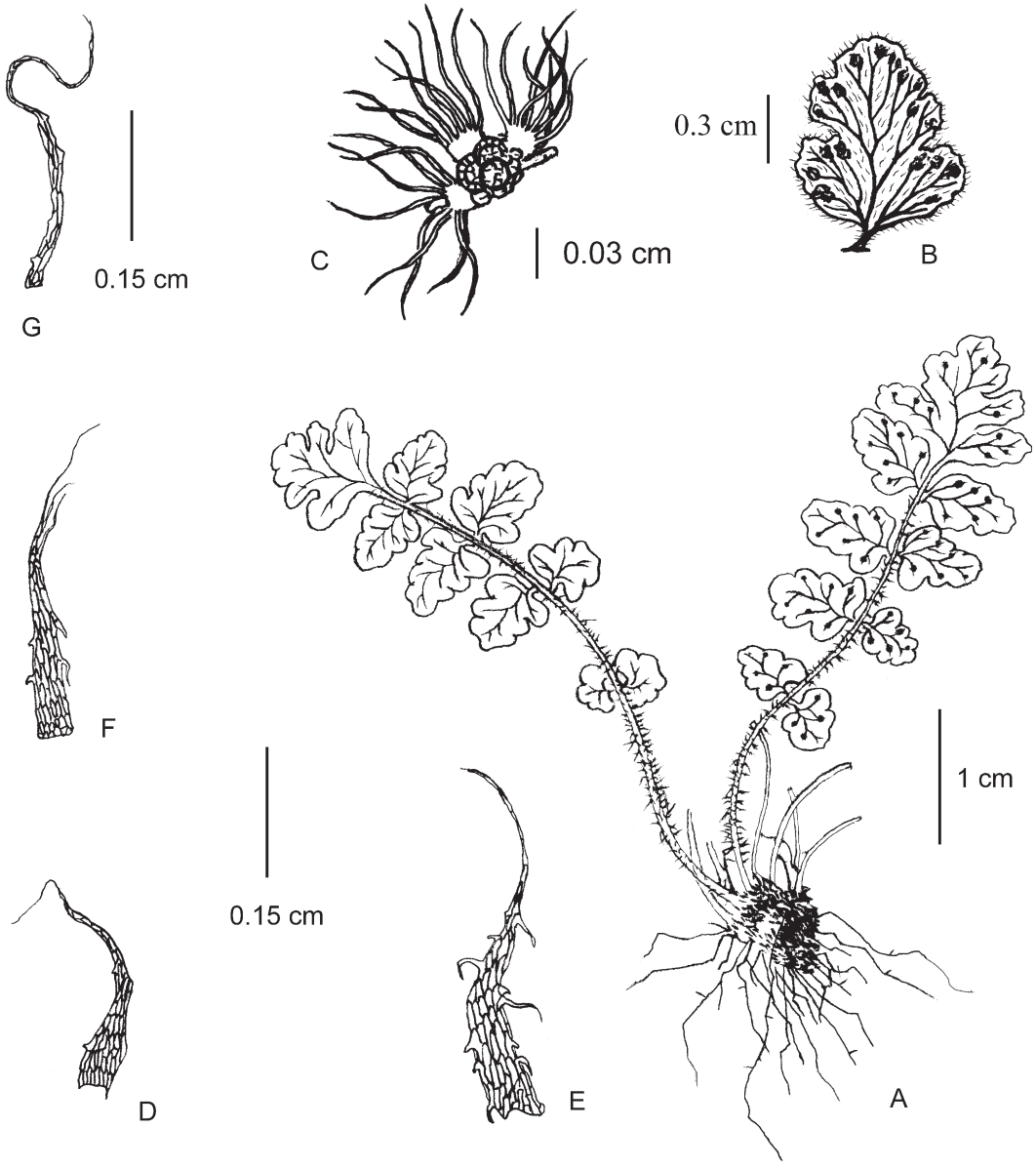

Figure 1. *Woodsia guizhouensis* P. S. Wang, Q. Luo & Li Bing Zhang. —A. Habit. —B. Pinna. —C. Sporangia surrounded by indusial lobes fimbriate at apices. —D. Scale from rhizome. —E. Scale from petiole base. —F. Scale from middle of petiole. —G. Rachis scale. Drawn from the isotype *Q. Luo 08301* (MO).

scales similar to distal petiole scales; pinnae in 3 to 8 pairs, herbaceous, lower pinnae ovate, 4–8 × ca. 3–6 mm, briefly petiolulate to 1 mm, base often shallowly cordate or sometimes rounded, apex obtuse or rounded; middle pinnae longer than lower pinnae but otherwise similar, ovate to oblong, 4–10 × 3–7 mm; terminal pinnae nearly an equilateral triangle, 0.8–1.2 cm, apex obtuse or rounded, with 3 pairs of lobes; lobes of pinnae 3 to 4 pairs, obtusely deltoid, nearly entire to crenate on margins; both surfaces of pinnae densely pubescent, trichomes yellowish clear, 0.53–0.69 mm × 14–22 μm; lamina with veins free, in 4 to 5 pairs from midrib. Sori round, dorsal or subterminal on veinlets, 1 to 4 per pinna segment; indusia shallowly cupulate, inferior, contracted to a jar-like shape when dry, 1–1.2 mm diam., membranous, brown, often 3-lobed, apices of lobes with multicellular trichomes 1.2–1.36 mm × 11–15 μm. Sporangia dehiscing into 4 to 5 portions when mature, each portion ca. 0.45 mm; annuli with 18 to 20

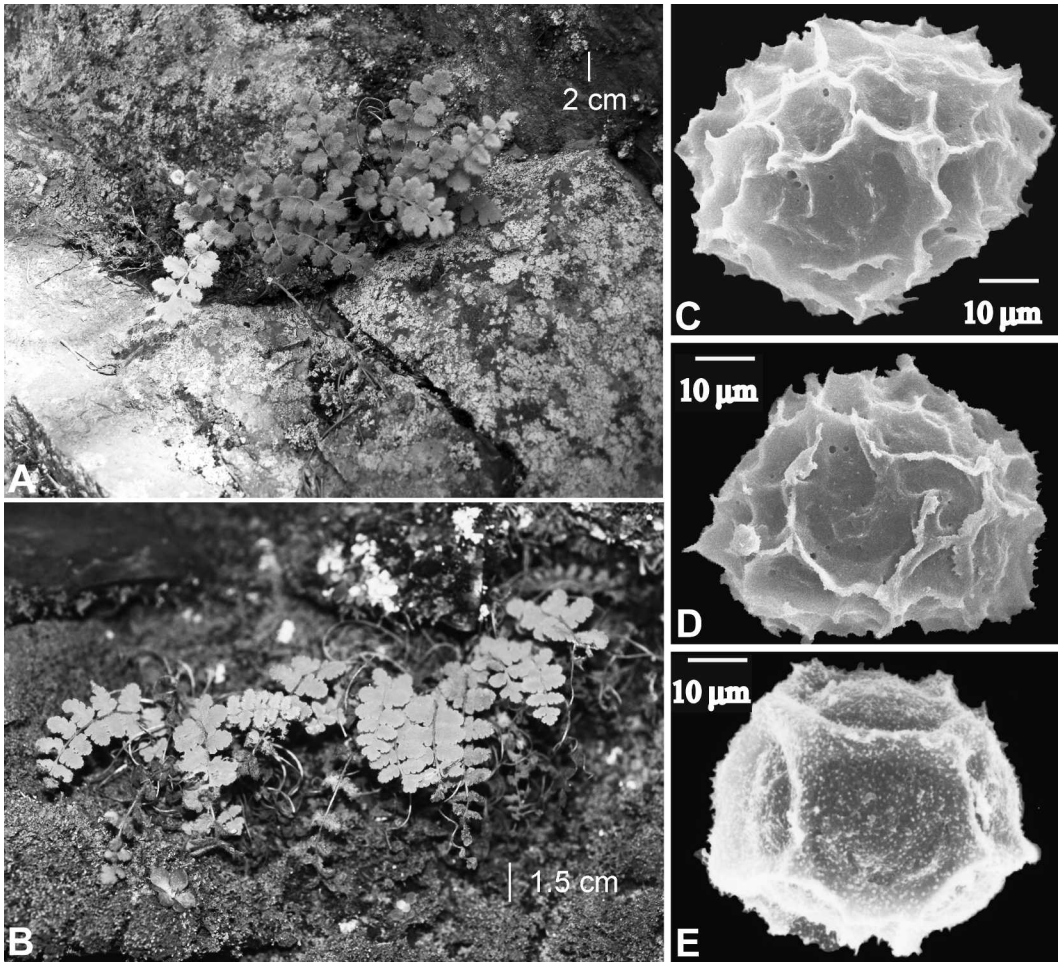

Figure 2. *Woodsia guizhouensis* P. S. Wang, Q. Luo & Li Bing Zhang. —A. Plant habit at the type locality outside Bijie City, northwestern Guizhou. —B. Plant habit in Pu'an County, western Guizhou. —C. Polar view of spore of *W. guizhouensis* under SEM. —D. Equatorial view of spore of *W. guizhouensis* under SEM. Both C and D taken from the isotype *Q. Luo 08301* (MO). —E. Polar view of spore of *W. rosthorniana* under SEM taken from *F.-K. Zhao 20562* (PE).

thickened cells; spores oblong, light brown, with cristate perispore sculpturing.

Spore morphology. Spores of *Woodsia guizhouensis* are bilateral, elliptic in polar view, and semi-orbicular in equatorial view. The spore size is ca. 40(37–44) × 57(47–67) μm (polar × equatorial axes). The ratio of the lengths of polar and equatorial axes is ca. 0.7:1. The perispore sculpturing is cristate, with numerous bent acanthoid projections and a few irregular perforations (Fig. 2C, D). Such cristate perispore ornamentation is common among Chinese species of *Woodsia* (Dai & Wang, 2007).

Distribution, habitat, and ecology. *Woodsia guizhouensis* was found in two nearby cities and one county in western Guizhou, from the environs of Bijie City and Liupanshui City, as well as Pu'an County. It is possible that this species also occurs in adjacent areas in western and northwestern Guizhou, famous for its mountainous habitats. This species may possibly be found in adjacent northeastern Yunnan. *Woodsia guizhouensis* grows in wet and shady limestone crevices or cliffs under broad-leaved forests. It has been seen in four different localities; three of these are more than 90 km apart from each other. Populations of *W. guizhouensis* are distributed in elevations from 1650 to 2300 m.

IUCN Red List category. Only four populations of *Woodsia guizhouensis* were observed, among locales in two different cities and one county, with a combined estimate of ca. 30 individuals noted among all populations seen. The new species should be

classified as Endangered or EN, according to IUCN (2008) Red List criteria. Although the habitat of *W. guizhouensis* in Liupanshui City for one paratype collection lies inside Yushe National Park and thus is well protected, detailed investigation for the population size and biology of the species is needed to best assess its vulnerability. The three remaining habitats in Bijie City, Liupanshui City, and Pu'an County, respectively, are not protected, which raises concerns about the conservation status of *W. guizhouensis*.

Etymology. The epithet of *Woodsia guizhouensis* is taken from the Chinese pinyin word "guizhou," for the name of the province in southwestern China, and from the Latin suffix "–ensis," meaning "of origin or place."

Discussion. The new species *Woodsia guizhouensis* is morphologically most similar to *W. rosthorniana* Diels, but *W. guizhouensis* is smaller, only 3–8 cm tall; its rhizome scales are light brown with sparsely fimbriate margins; its pinnae are short-petiolulate, to 1 mm; and its pinna bases are cordate or sometimes rounded. In contrast, *W. rosthorniana* is larger, 7–25 cm tall; its rhizome scales are brown with entire margins; its pinnae are sessile; and its pinna bases are obtuse or rounded (Wu, 1999). *Woodsia rosthorniana* can be found in scattered locations to the west and north in Chongqing, Gansu, Hebei, Liaoning, Shaanxi, and Sichuan, and to the southwest in Yunnan Province, but the taxon has not been collected in Guizhou (Ching & Wu, 1983; Wu, 1999).

Palynologically, the spores of *Woodsia guizhouensis* and *W. rosthorniana* differ. The perispore sculpture of *W. guizhouensis* is cristate, with numerous acanthoid projections and a few irregular perforations (Fig. 2C, D), while that of *W. rosthorniana* is granulate, with only a few cristae and numerous spinules (Fig. 2E; see also Dai & Wang, 2007). The equatorial axis of spores in *W. guizhouensis* is 57 μm on average, whereas in *W. rosthorniana* it is shorter, ca. 49 μm. *Woodsia guizhouensis* is also similar to *W. andersonii* (Bedd.) Christ, but the new species has briefly petiolulate pinnae (to 1 mm; Fig. 1A, B) and larger spores (ca. 40 × 57 μm), while *W. andersonii* has sessile pinnae, although it is similar to *W. guizhouensis* in its ovate shape (Wu, 1999) and smaller spores (ca. 35 × 47 μm; Dai & Wang, 2007). *Woodsia andersonii* is distributed in Gansu, Shaanxi, Sichuan, Tibet, and Yunnan in addition to the type locality, Sikkim (Wu, 1999). *Woodsia guizhouensis* is further similar to *W. okamotoi* Tagawa from Taiwan (Tagawa, 1938; DeVol, 1994) in its small leaf size. However, *W. okamotoi* has a darker (castaneous) rachis and petiole (vs. stramineous or straw-colored in *W. guizhouensis*). Its abaxial leaf surfaces have more densely distributed scales. *Woodsia okamotoi* occurs at much higher elevations (2800–3700 m), while *W. guizhouensis* was collected at elevations of 1650–2300 m.

Woodsia guizhouensis is the second species in the genus noted in Guizhou. The other is *W. polystichoides* D. C. Eaton (Wang & Wang, 2001), the most widespread species of *Woodsia* in China, which is distributed throughout northern, southwestern, central, and eastern locales, with the exception of Fujian. *Woodsia polystichoides* is also reported from Taiwan as well as Korea, Japan, and the Russian Far East (Wu, 1999). The occurrence of *W. polystichoides* in Guizhou was only recently discovered (Wang, 1992) from northeastern to northwestern mountainous terrains (Wang & Wang, 2001). Both *W. guizhouensis* and *W. polystichoides* have rhizome scales with fimbriate margins, a character state that distinguishes them from *W. rosthorniana* (see above). In comparison with *W. polystichoides*, *W. guizhouensis* is a smaller fern, only 3–8 cm tall, its rhizome scales are light brown, its petioles are not articulate, and it has three to eight pairs of ovate to oblong pinnae, while *W. polystichoides* is 10–30 cm tall, its rhizome scales are darker and brown, its petioles are articulate above the base, and it has 16 to 30 pairs of lanceolate pinnae (Wu, 1999). The perispore sculpture of *W. polystichoides* is also cristate (alate in Dai & Wang, 2007), but only with approximately four straight cristae on each spore as opposed to numerous bent cristae in *W. guizhouensis* (Fig. 2C, D).

Key to Morphologically Similar and/or Sympatric Species of *Woodsia guizhouensis* in China

1a. Petioles articulate above the base ... *W. polystichoides*
1b. Petioles not articulate above the base 2
2a. Pinnae petiolulate to 1 mm ..... *W. guizhouensis*
2b. Pinnae sessile 3
3a. Petiole and rachis of leaf frond castaneous or brown ..... *W. okamotoi*
3b. Petiole and rachis of leaf frond stramineous or straw-colored 4
4a. Pinnae ovate, pinnatifid, not or only slightly contracted toward lamina base; trichomes under sori separate ..... *W. andersonii*
4b. Pinnae elliptic, pinnatipartite, contracted toward lamina base; trichomes under sori fused at bases ..... *W. rosthorniana*

Paratypes. CHINA. **Guizhou:** Liupanshui City, Yushe National Park, 1700 m, 14 Aug. 2009, *J.-H. Zhao & N.-W. Zhao 508* (GZTM); Liupanshui City, from Shuicheng to Yushe, 1910 m, 19 Sep. 2009, *N.-W. Zhao s.n.* (Herbarium Pei-Shan Wang [Guizhou Institute of Biology]); Pu'an, betw. Digua Town & Erdaoqiao, 25°68.83′N, 104°95.99′E, 1650 m, 9 Aug. 2007, *L. Zhang & H. He 316* (CTC, MO).

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