Polystichum quangbinhense sp. nov. (subg. Haplopolystichum; Dryopteridaceae),
the southernmost cave species of Polystichum from central Vietnam

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A new fern species, Polystichum quangbinhense, a member of P. subg. Haplopolystichum (Dryopteridaceae), is described and illustrated from Quang Binh Province in central Vietnam. It is the southernmost cave species of the genus discovered so far. Polystichum quangbinhense is most similar to P. obliquum in having oblong pinnae, but the two can be distinguished from each other by the morphology of pinna margins. Polystichum quangbinhense was found inside a karst cave at an elevation of 120 m with humid and shady conditions and is currently known from two populations occurring at two sides of the Doi Cave (So Dua Cave), Quang Binh Province, central Vietnam, and is classified as Critically Endangered (CR) following IUCN Red List criteria.

Key words: Quang Binh, karst cave, Polystichum quangbinhense, Vietnam

Introduction
The Southeast Asian country Vietnam is rich in plant diversity including fern diversity (Phan, 2011). This diversity is still underexplored. In 2013 our fieldwork led to addition of 11 species of Polystichum Roth (1800: 31; Dryopteridaceae) alone to the fern flora of Vietnam (Lu et al. 2014a, b). Our 2014 fieldwork continued to add new discoveries to the fern flora of Vietnam (Zhang et al. 2015a, b). Here we describe the first cave fern of Polystichum for the country from central Vietnam. It is also the southernmost cave species of the genus found so far.

Description
Polystichum quangbinhense Li Bing Zhang, N.T.Lu & Liang Zhang, sp. nov. (Figs. 1 & 2)
Diagnosis:—Polystichum quangbinhense is most similar to P. obliquum (D.Don, 1825: 3) T.Moore (1858: 87), but the former has rounded pinna apices and an indistinct auricle at the acroscopic pinna base, while the latter has acute pinna apices and a distinct auricle at the acroscopic pinna base.

Type:—VIETNAM. Quang Binh Province: Bo Trach District, Son Trach Commune, Phong Nha Ke Bang National Park, Doi Cave (So Dua Cave), 17°31'18''N, 106°17'04''E, cave entrance, 120 m, 31 October 2014, Li Bing Zhang, Liang Zhang & Ngan Thi Lu 7213 (holotype VNMN!; isotypes CDBI!, MO!, VNMN!).

Plants perennial, evergreen, 10–35 cm tall. Rhizomes ascending, 1.0–1.5 cm long, ca. 0.5 mm in diam. Leaves in tufts, 4–16 per rhizome. Petioles 4–13 cm long, 0.8–1.2 mm in diam., basal portions densely covered with scales, scales lanceolate to ovate-lanceolate, 0.3–0.7 mm, membranous, long-acuminate, with slightly ciliate margins. Laminae oblong-lanceolate, 1–pinnate, 14–22 × 2.0–4.4 cm, apices acute to acuminate, basalmost 2–4 pairs narrower toward base, yellowish green when dried; rachises 0.6–1.0 mm in diam., scales linear, long-lanceolate to ovate-lanceolate, brown, 0.8–1.3 mm long, 0.4–0.6 mm wide at base, margins sparsely toothed, apices long-caudate. Pinnae 13–20 pairs, with auricles deltoid, sharp and pointing upward, dimidiate to oblong, 1.2–2.2 × 0.2–0.6 cm, basalmost 2–4 pairs slightly smaller, nearly 2/3 as long as middle ones,
0.6–0.7 cm apart, middle pairs 0.6–0.7 cm apart, all pinnae papery, alternate, margins shallowly crenulated, apices acute to obtuse, base cuneate and asymmetric, acroscopic side much broader, short-petiolate (petioles 0.4–0.8 mm long), abaxially with sparse lanceolate and light brown microscales, ca. 0.2–0.3 mm long, 0.1–0.2 mm wide at base; adaxially glabrous; venation abaxially visible, adaxially somewhat obscure, lateral veins free, single or forked. Lower 3–7 pairs of pinnae sterile; sori terminal on lateral veins of fertile pinnae, (1–)4–6(–8) on acroscopic side of fertile pinnae, 1–3(–4) on distal basiscopic side of fertile pinnae, 0.8–1.2 mm in diam., closer to pinna margins than to midrib (centers of sori 0.5–1.1 mm from pinna margins, 0.8–3.8 mm from midrib), centers ca. 0.5–2.1 mm apart from one another; indusia peltate.

**FIGURE 1.** *Polystichum quangbinhense* Li Bing Zhang, N.T.Lu & Liang Zhang.—A. Outside view of So Dua Cave in Quang Binh, Vietnam.—B. Inside view of So Dua Cave.—C, D. Habit.—E, F. Abaxial and adaxial lamina surfaces.—G. Lower portion of plant.—H. Portion of abaxial lamina bearing sori.—J. Lower portion of lamina with portion of stipe.—K. Fiddlehead.
FIGURE 2. Polystichum quangbinhense Li Bing Zhang, N.T.Lu & Liang Zhang.—A. Habit.—B. Portion of rachis with pinnae.—C. Leaf apex.—D. Portion of rachis showing pinnae.—E, F. Petiole scales.—G, H. Rachis scales.

Geographical distribution:—Polystichum quangbinhense is only known from the two cave entrances in Son Trach Commune in Quang Binh Province, central Vietnam. Our extensive fieldwork in central Vietnam in 2014 did not find additional occurrences for the species. Like other cave endemics discovered in southern China (e.g., Zhang & He 2008), this new species is possibly endemic to Doi Cave.

Ecology:—Polystichum quangbinhense grows inside a karst cave with humid and shady conditions at an elevation of 120 m.
IUCN Red List category:—Only one population is known from each side of the Doi Cave (So Dua Cave). The status of the new species clearly should be classified as CR—Critically Endangered category based on current information and following IUCN (the International Union for Conservation of Nature and Natural Resources) guidelines (IUCN 2015).

Etymology:—The species epithet is based on the Vietnamese spelling, quangbinh, the name of a province in central Vietnam, the type locality of the species.

Additional Specimens Examined:—VIETNAM. Quang Binh Province: Bo Trach District, Son Trach Commune, Phong Nha Ke Bang National Park, Doi Cave (So Dua Cave) other entrance, 17°31’07.52”N, 106°17’03.67”E, 120 m, 3 November 2014, Li Bing Zhang, Liang Zhang & Ngan Thi Lu 7278 (CDBI!, MO!, VNMN!).

Discussion:—Polystichum quangbinhense is also similar to P. tiandengense H. He & Li Bing Zhang (in press) in having oblong pinnae with rounded pinna apex, but the former has pinnae shallowly crenulated on margins, whereas the latter has pinnae toothed on margins.

Cave endemics of Polystichum are broadly distributed in southern China (e.g., Wang & Wang 2001, Zhang & He 2009, 2010, 2011, 2012, He & Zhang 2010, 2011, 2012, in press, Zhang et al. 2010, Luo & Zhang 2012, Han et al. 2016, Li et al. 2016). However, P. quangbinhense is the first cave species discovered from Vietnam. The locality of P. quangbinhense is ca. 600 km (linear distance) away from that of the southernmost cave species of Polystichum described from China, P. tiandengense. In fact, P. quangbinhense is the southernmost cave species of the genus found so far, raising some questions: What are its relationships with other cave species of the genus in southern China? Did cave species of Polystichum in Vietnam and southern China evolve in a similar way, e.g., from cave or non-cave ancestors? The discovery of P. quangbinhense is thus significant in study of cave speciation of the genus.

Notably, Polystichum quangbinhense is also found to grow at an elevation of 120 m, the lowest elevation among the cave species of the genus found so far. In addition, it is the only cave species of the genus growing in a tropical climate, although the microhabitats of P. quangbinhense inside a limestone cave are similar to those of cave species growing in southern China.

Acknowledgments
The research was partially supported by a grant from National Natural Science Foundation of China (Grant# (#31400196) to L.-Z., a grant from Chengdu Institute of Biology, Chinese Academy of Sciences and a grant from the National Natural Science Foundation of China (#31628002) to L.-B.Z., and the CAS-TWAS President’s Fellowship to N.T.L. We thank Dinh Huy Tri and Vo Van Tri for providing information about the locality of the new species, an anonymous reviewer for helpful comments, and the curators of the herbaria CDBI, MO, and VNMN for providing access to material in their care.

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