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Asplenium minutifolium (Aspleniaceae), a new species from Thailand

HIRONOBU KANEMITSU[1,*], SHUICHIRO TAGANE[1], SOMRAN SUDDEE[2],
SUKID RUEANGRUEA[2] & TETSUKAZU YAHARA[1]

ABSTRACT

A new species of *Asplenium* (Aspleniaceae), *A. minutifolium* Kanem. & Tagane, from Phu Kradueng National Park, Loei Province, Northeast Thailand and Khao Yai National Park, Nakhon Nayok Province, Central Thailand, is described and illustrated. This species can be distinguished from all similar species in East and South-East Asia by its simple and small lamina (1–5 × 0.3–0.7 cm), small and entire pinnae (1–4 × 0.8–2.5 mm), reflexed pinna arrangement (>90° from the midrib) in the lower 2/3 of the lamina and a sori arrangement that is almost always arranged in a single row on the basiscopic vein.

KEYWORDS: *Asplenium*, Aspleniaceae, Pteridophyte, Fern, new species, Phu Kradueng National Park, Khao Yai National Park, Thailand.

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INTRODUCTION

The genus *Asplenium* L. (Aspleniaceae) is one of the largest genera of the Pteridophyta, comprising about 700 species. The species are widely distributed, from temperate to tropical regions (Boonkerd & Suksathan, 2009; Chang *et al*., 2013), are adapted to various environments, and are often epiphytic or epipetric (de Winter & Amoroso, 2003). In Thailand, 38 *Asplenium* species have been recorded (Boonkerd & Pollawatn, 2000; Boonkerd, 2009; Lindsay & Middleton, 2012 onwards; Lindsay *et al*., 2013).

During a botanical survey in Phu Kradueng National Park in June 2015, we discovered an unknown species of *Asplenium* in a rock crevice at the top of the mountain. The plant is characterized by very small pinnae, obscure venation and asymmetrically arranged sori. In these characters, it differs from all the known *Asplenium* species in Thailand and the surrounding regions, including Cambodia, China, Japan, Korea, Laos and Vietnam. In addition, when we examined material of *Asplenium* at the Kyoto University Museum (KYO), we also found specimens of the same species collected from Khao Yai National Park, Nakon Nayok Province, Central Thailand.

Here we describe and illustrate it as a new species, *Asplenium minutifolium* Kanem. & Tagane, based on our newly collected materials as well as the herbarium specimens at KYO. In addition to morphological examination, DNA sequences can be extremely helpful for delimiting species (Hebert & Gregory, 2005; Dick & Webb, 2012). We sequenced the plastid region *rbcL* following the recommendation of the CBOL Plant Working Group (2009).

MATERIALS AND METHODS

Morphological observations

We compared the specimen collected from Phu Kradueng National Park with dried specimens in the herbaria BK, BKF, KYO and TNS and with digitized specimen images available on the web pages of JSTOR Global Plants (http://plants.jstor.org/). We compared the morphology of *Asplenium minutifolium* with that of all similar species in the region using taxonomic literature (Iwatsuki, 1995; Lin & Viane, 2013) and the website of Ferns of Thailand, Laos and Cambodia (Lindsay & Middleton, 2012 onwards; http://rbg-web2.rbge.org.uk/thaiferns/index.htm).

[1] Center for Asian Conservation Ecology, Kyushu University, 744 Motooka, Fukuoka 819-0395, Japan.

[2] Forest Herbarium, Department of National Parks, Wildlife and Plant Conservation, Chatuchak, Bangkok 10900, Thailand.

* Corresponding author: hironobu.kanemitsu@gmail.com

DNA barcoding

DNA amplification and sequencing were performed according to published protocol (Kress *et al*., 2009).

DESCRIPTION

Asplenium minutifolium Kanem. & Tagane, **sp. nov.**

Similar to *Asplenium kiangsuense* Ching & Y.X.Jing of southern China in size and shape of lamina, but differs in having a narrower lamina (ca 0.7 cm wide in *A. minutifolium* vs. ca 1 cm wide in *A. kiangsuense*), wingless rachis (vs. 2 slightly raised lateral wings), smaller pinnae (1–4 × 0.8–2.5 mm vs. 4–5 × 4–5 mm), generally fewer sori per pinna (1–3(–4) vs. 3–5), and in the sori arrangement (usually arranged in a row vs. arranged oppositely). Also similar to *Asplenium siamense* Tagawa & K.Iwats. of North-East Thailand, but can be distinguished by its simple pinnae at the tip of lamina (vs. lamina forked several times at the tip), thicker pinnae (thickly papery vs. thinly papery), reflexed pinna arrangement in lower part (vs. divaricate around lamina), and pinnae with entire or slightly undulate margins (vs. shallowly lobed (lobes to ca 1mm long)). (Table 1).— Type: Thailand. Loei Province, Phu Kradueng National Park, Lom Sak Cliff, alt. 1292 m, 16°51′37.44″N, 101°43′40.1″E, 12 June 2015, *Kanemitsu et al. T4736* (holotype **BKF!**, isotype **TNS!**). Figs. 1–2.

Epipetric. *Rhizome* short, ascending, bearing fronds in a tuft, densely scaly at apex; scales linear, up to 2 mm long, 0.2 mm wide, blackish, clathrate, more or less membranous at margin. *Stipe* 0.4–2 cm long, dark purple, polished, flat adaxially, rounded abaxially, glabrous but scaly at base; rachis dark purple, polished, flat adaxially, rounded abaxially, wingless throughout, almost glabrous except for a few small fibrous scales near base. *Lamina* simply pinnate, oblong to oblong-lanceolate, 1–5 × 0.3–0.7 cm. *Pinnae* thickly papery, glabrous, 7–20 pairs, subsessile to shortly stalked (stalks ca 0.3 mm long), lower 2/3 pinnae reflexed against rachis (at an angle of (90–)110–120(–140)° from the midrib), subopposite or alternate up to 1.7 mm distant, sub-flabellate to trapeziform-oblong, 1–4 × 0.8–2.5 mm, base asymmetrical, truncate to cuneate on acroscopic side, cuneate to acute on basiscopic side, margin entire but slightly undulate on the upper edge; veins all free, simple or forked, not reaching the margin, obscure on both surfaces but the ends of the veins can be visible on the upper surface of pinnae (possibly as hydathodes). *Sori* 1–3(–4) per pinna, usually 1–3 sori on the acroscopic veins only (arranged in a row with their indusia opening towards the pinna apex), rarely with 1 additional sorus on the basal basiscopic vein (its indusium opening towards the upper edge of the pinna) indusia ca 1 × 0.3 mm, membranous, (sub)entire, glabrous, persistent; sporangia glabrous.

Thailand.— NORTH-EASTERN: Loei [Phu Kradueng National Park, *Kanemitsu et al. T4736* (**BKF!**, **TNS!**)]. CENTRAL: Nakhon Nayok [Khao Yai National Park, alt. 950–1050 m, 9 Oct. 1979, *Shimizu et al. T19733* (**KYO!**)].

Distribution.— Currently *Asplenium minutifolium* is known only from Phu Kradueng National Park and Khao Yai National Park.

Ecology.— In Phu Kradueng National Park, *Asplenium minutifolium* occurs in a semi-shaded and damp rock crevice that is ca 50 cm wide and 10 cm deep, on the plateau at an altitude of ca 1300 m. Associated fern and lycophyte species include *Aglaomorpha rigidula* (Sw.) Hovenkamp & S.Linds., *Goniophlebium subauriculatum* (Blume) C.Presl, *Oleandra undulata* (Willd.) Ching, *Pyrrosia lingua* (Thunb.) Farw. var. *heteractis* (Mett. ex Kuhn) Hovenkamp, and *Selaginella siamensis* Hieron. Other than the elevation, nothing is known about the ecology of this species at Khao Yai National Park.

Etymology.— The species epithet "*minutifolium*" refers to the very small lamina and pinnae of this species.

Preliminary conservation assessment.–– Critically Endangered (CR D) (IUCN 2012). Only five individuals in a single population occupying < 1 m^2 were found on the plateau of Phu Kradueng, despite an extensive search for more plants at the same site and other sites in the summit area of Phu Kradueng National Park. Moreover, in view of the fact that the plateau of Phu Kradueng has been well botanized and that there are no other specimens of this species in BK and BKF, *A. minutifolium* is likely very rare. Because of the plateau of Phu Kradueng is very popular for tourists, specific conservation

efforts are desirable to protect the population and habitat of this species. At Khao Yai National Park only a single collection is known from about 40 years ago but the lack of collections from an area otherwise well collected would also suggest very few individuals are present there.

We estimate that there are fewer than 50 individuals of this species and hence apply category D of CR for the species.

DNA Barcode.— GenBank accession No. LC147386 (*rbcL*). We sequenced material from *Kanemitsu et al. T4736*.

Table 1. Comparison of *Asplenium minutifolium* with the two most similar Asian species.

Characters	*A. minutifolium*	*A. kiangsuense**[1]	*A. siamense**[2, 3]
Ridges on rachis	Absent (flat adaxially)	Absent or with 2 slightly raised lateral ridges	Absent (flat adaxially)
Lamina size	1–5 × 0.3–0.7 cm	3–10 × ca 1 cm	3–8 × 1.2 cm
Lamina at tip	Simple	Simple	Forked several times
Pinna	Thickly papery	Papery	Thinly papery
Pinnae size	1–4 × 0.8–2.5 mm	4–5 × 4–5 mm	3–7 × 2–4 mm
Pinna arrangement in lower 2/3 part of frond	Reflexed (at an angle of (90–)110–120(–140)° from midrib)	Divaricate (at an angle of ca 90° from midrib)	Divaricate *[3](at an angle of ca 60–90(–100)° from midrib)
Pinna shape	Sub-flabellate to trapeziform-oblong	Elliptic to trapeziform-oblong	Ovate-elliptic to sub-triangular
Acroscopic edge of pinna	Entire but slightly undulate	Entire to sinuate	Shallowly lobed (lobes to ca 1 mm)
Sori per pinna	1–3 on acroscopic veins, rarely 1 on basal basiscopic vein	2 or 3 on both basiscopic and acroscopic veins	3–5 per pinna, 2–3 on acroscopic veins, 2 on basiscopic veins.
Distribution	Thailand (Phu Kradueng National Park and Khao Yai National Park)	China (Anhui, Fujian, Hunan, Jiangsu, Jiangxi, Yunnan, Zhejiang)	Thailand (North-Eastern: Loei)

*[1] from Lin & Viane (2013).

*[2] from Lindsay & Middleton (2012 onwards, http://rbg-web2.rbge.org.uk/thaiferns/).

*[3] from the specimen *Shimizu et al. T22757* (Phu Kradueng National Park, alt. 1250–1280 m, **KYO!**)

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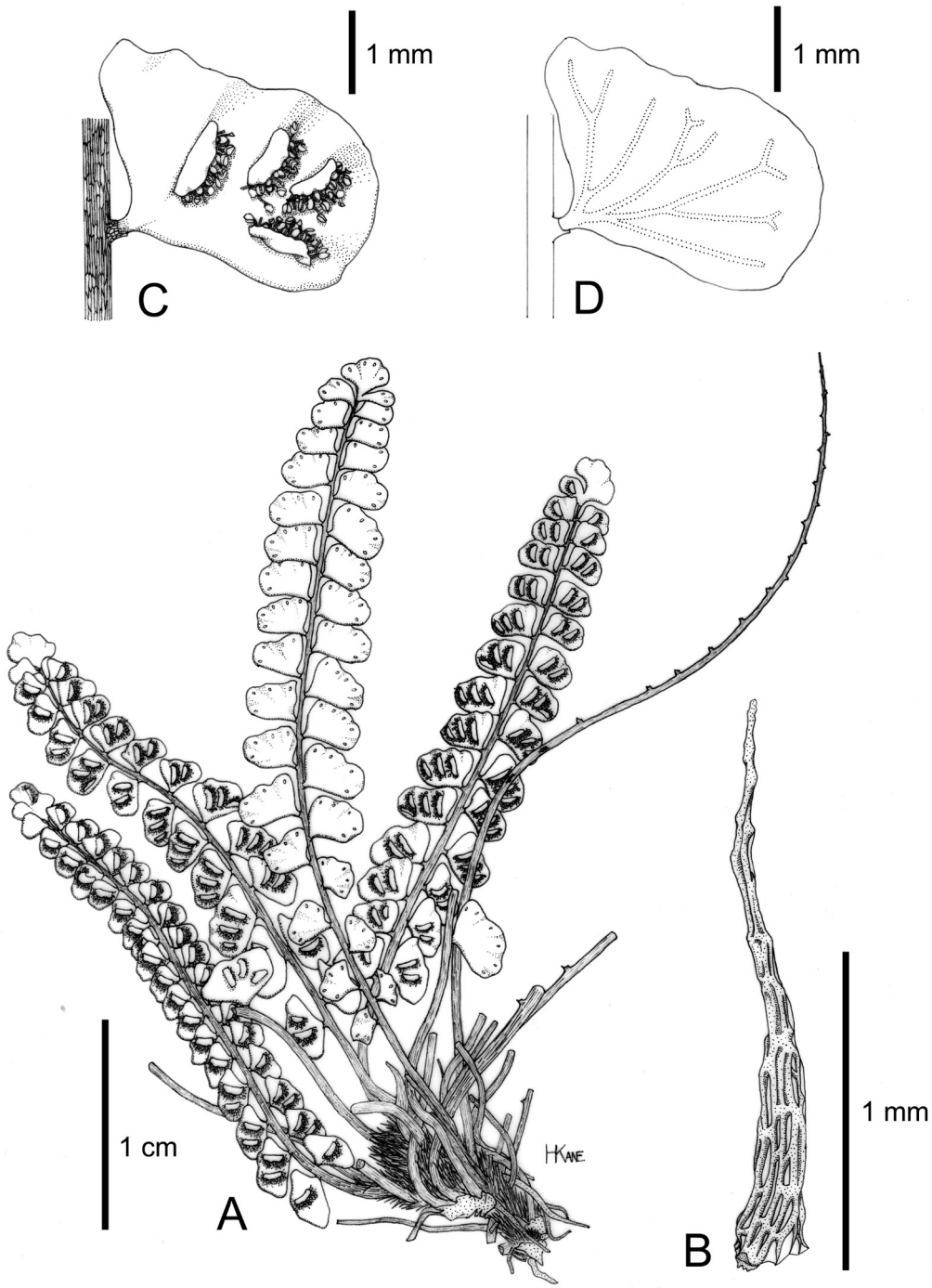

Figure 1. *Asplenium minutifolium* Kanem. & Tagane, sp. nov. A. whole plant (hydathodes are visible at the margin of pinnae on upper surface); B. a scale from rhizome; C. undersurface of pinna with four sori (three sori on acroscopic veins with their indusia opening towards the pinna apex and one sorus on the basal basiscopic vein with its indusium opening towards the upper edge of the pinna). Most pinnae have fewer sori and lack the one on the basal basiscopic vein; D. a schematic diagram of the same pinna revealing the position of the obscure veins. Drawn by H. Kanemitsu. All from *Kanemitsu et al. T4736* (TNS!)

Figure 2. *Asplenium minutifolium* Kanem. & Tagane, sp. nov. A. habit; B. portion of lamina (undersurface) showing sori; C. rhizome with scales; D. habitat.

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