

A new species of *Dryopteris* (Dryopteridaceae) from Hainan Island, China

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ABSTRACT. *Dryopteris gemmifera*, a new endemic species of Dryopteridaceae from Hainan Island, is described and illustrated. The new species is characterized by its 2-pinnatifid fronds, costae sparsely covered with narrow and flat scales, and especially by the presence of proliferous buds on the distal part of the rachis. The affinity between *Dryopteris gemmifera* and related species, *D. fuscipes* and *D. guangxiensis*, as well as the systematic position of this new species, is briefly discussed. An identification key to all eleven species of *Dryopteris* from Hainan Island is provided.

Keywords: *Dryopteris*; Hainan Island; Morphology; Spores; Taxonomy.

INTRODUCTION

Dryopteris Adans. is a large fern genus with about 225 species throughout the world. The center of diversity of the genus is in the eastern Himalayas, western China, and surrounding areas (Ching, 1938; Jermy, 1980; Fraser-Jenkins, 1986). With 127 species in China (Wu and Lu, 2000), *Dryopteris* is the second largest genus of ferns in this region. Among the Chinese species of *Dryopteris*, seven are recorded from Hainan Island: *D. cyclopeltiformis* C. Chr., *D. intergriloba* C. Chr., *D. podophylla* (Hook.) Kuntze, *D. polita* Rosenst., *D. scottii* (Bedd.) C. Chr., *D. sparsa* (D. Don) Kuntze, and *D. subtriangularis* (Hope) C. Chr. (Wu and Lu, 2000).

Since 2001 we have conducted extensive surveys to update the fern flora of Hainan, for which the last treatment was by Ching and his colleagues in 1964. During the fieldwork we not only confirmed the presence of the seven *Dryopteris* species mentioned above, but also found three more species, *D. fuscipes* C. Chr., *D. pacific* (Nakai) Tagawa, and *D. tenuicula* C. G. Matthew & Christ, new to this island (Dong et al., 2004; Dong, 2007). In addition, we collected an unknown, interesting *Dryopteris* species in 2005, growing in an almost inaccessible, well protected forest in northwestern Hainan. Our morphological study revealed that it is a new species.

MATERIALS AND METHODS

The unknown taxon was found at five different sites in the Yinggeling mountain area, during fieldwork done from

August to November 2005. A total of 18 mature fronds from five small populations were collected and deposited at IBSC.

The unknown species agreed relatively well with the description of *Dryopteris guangxiensis* S. G. Lu (Lu, 1999) from Guangxi, China. However, when searching the specimens of *D. guangxiensis* in herbaria, we found that it is only represented by its type, which unfortunately has probably been lost. During a collecting trip to its type locality, Mt. Damingshan, Guangxi, in March 2007, we found a very small population of *D. guangxiensis* and pressed three fronds as voucher specimens, which were then deposited at IBSC.

Apart from field observations, we carefully checked the morphology of voucher specimens of both species under a dissecting microscope. Spore samples were observed and photographed using a JEOL scanning electron microscope (SEM).

Taxonomic Treatment

Dryopteris gemmifera S. Y. Dong, sp. nov.—TYPE: CHINA. Hainan Island: Mt. Yinggeling, 19°02' N, 109°32' E, alt. 1,250 m, on mountain slope in primary rain forest, 11 Sep 2005, S. Y. Dong 1568 (holotype: IBSC; isotypes: IBSC). 芽孢鳞毛蕨 Figures 1, 2, 3A-C

Species affinis *D. guangxiensis* S. G. Lu, sed rhachidi gemmata, lamina ovata vel deltoideo-ovata (in *D. guangxiensis* longideltoidea), squamis rhachidis et eis costae planis (in *D. guangxiensis* bullata), sporis minoribus (39-40 μ m longis et 26-30 μ m latis in *D. gemmifera*, sed 60-74 μ m longis et 41-45 μ m latis in *D. guangxiensis*) differt.

Terrestrial, herb 36-45(60) cm high. Rhizomes short,

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erect, 1.5-1.8 cm in diameter, with copious scales at apex; scales narrowly lanceolate, blackish, entire at the margin but with several short hair-like branches at base, 3-6(8) mm long and ca. 0.5 mm wide. Fronds tufted; stipes slender, 1-1.5 mm in diameter, dark brown at the base and stramineous upwards, 15-25 (32) cm long, with many blackish lanceolate scales at base and some minute fibrilliform scale-like hairs or paleasters (2-3 rows of cells

at base and 1 row upwards) on the upper part of the stipe and the rachis; laminae ovate to deltoid-ovate, simply pinnate to deeply bipinnatifid at base, gradually narrowed and pinnatifid toward the apex; free lateral pinnae 6-8 pairs, alternate or occasionally the lowest pair opposite, 5-15 mm apart, 2-3 pairs of lower pinnae nearly the same size, 8-10 × 2.2-3 cm, upper pinnae gradually shortened; pinnae lanceolate, crenate to deeply lobed, acuminate at

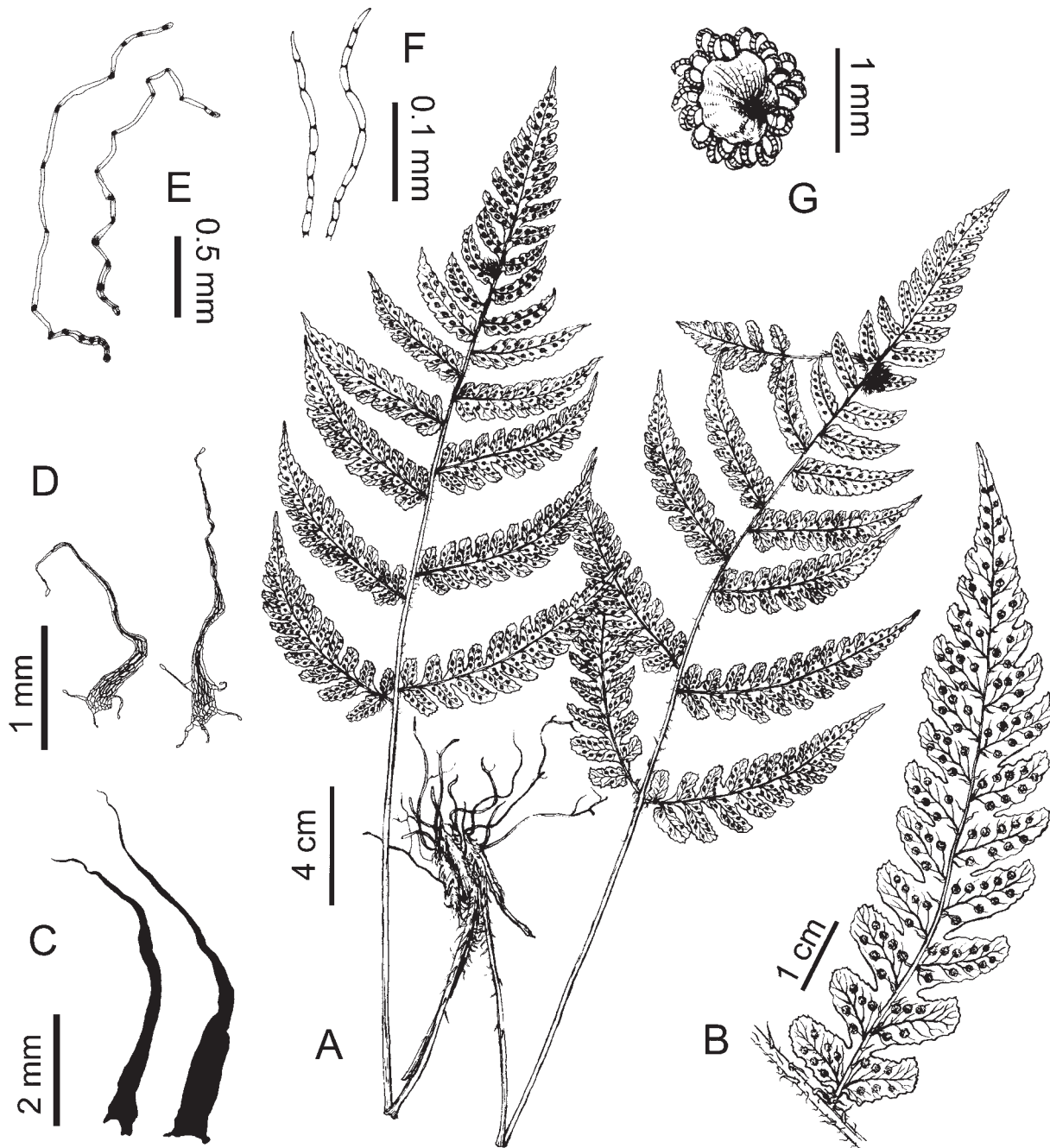


Figure 1. *Dryopteris gemmifera* S. Y. Dong. A, Habit; B, Pinna (middle); C, Scales on stipe base; D, Scales on abaxial side of costae; E, Scale-like hairs on adaxial side of costae; F, Uniseriate hairs on adaxial side of costae; G, Sorus with indusium. (All from S. Y. Dong 1568, holotype at IBSC).

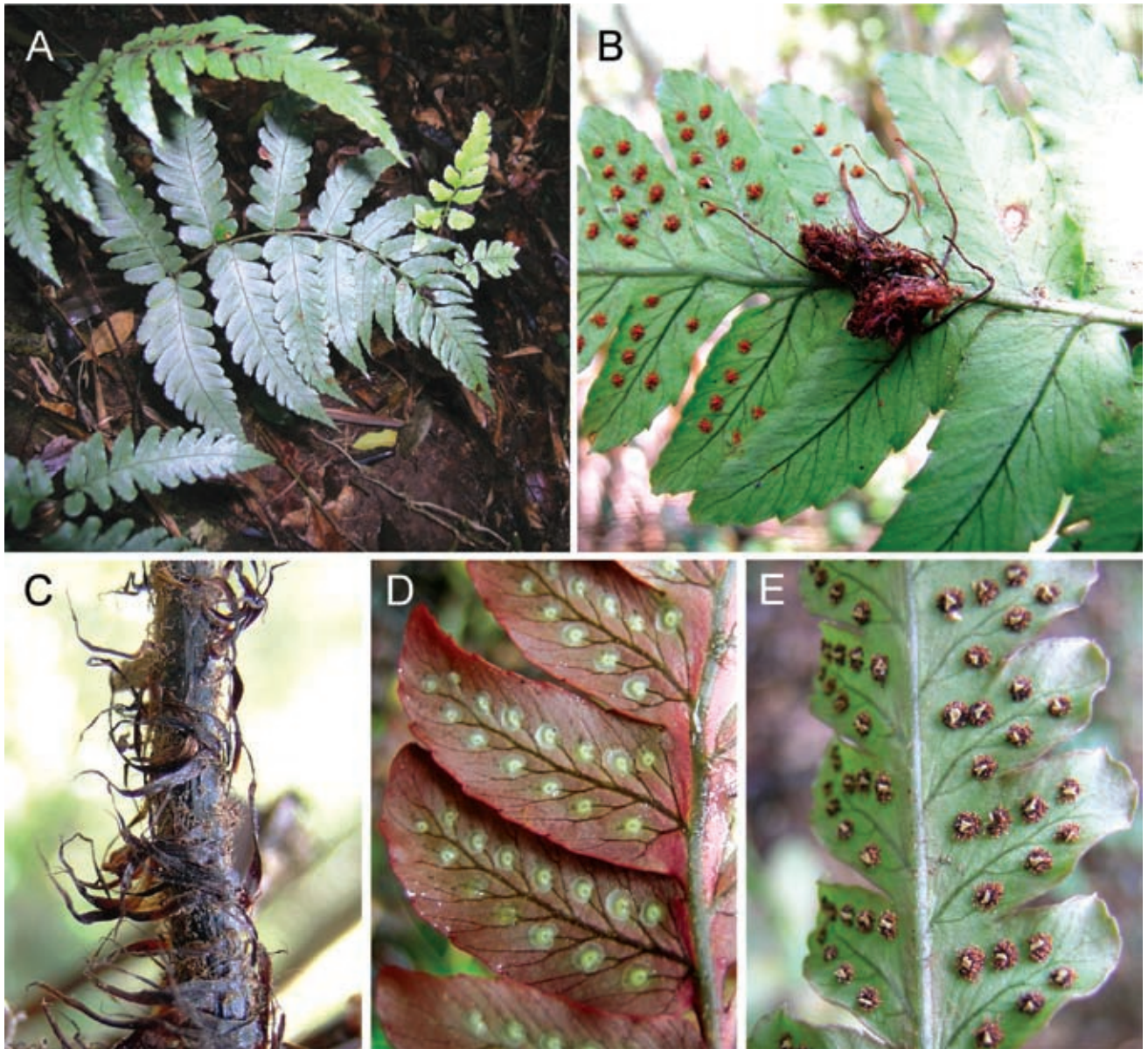


Figure 2. *Dryopteris gemmifera* S. Y. Dong. A, Habit; B, Two scaly buds on abaxial side at upper part of rachis; C, Stipe base showing scales; D, Portion of basal pinna showing young sori; E, Portion of middle pinna showing sori with mature sporangia.

apex and broadly cuneate at base, shortly petiolate (1-3 mm long) to sessile; large pinna with 8-10 pinnules on either side of the costa, basicopic pinnules only slightly longer than the acroscopic ones, nearly oblong, oblique to the costa, 1-2 × 0.5-0.6 cm, obtuse at the apex, sparsely and slightly serrate at margin. Veins free, 5-6 pairs in each pinnule, simple or forked 1-2 times. Laminae chartaceous, reddish when young but green when mature; rachis covered with many brown paleasters (fibrilliform scale-like hairs, 1-3(5) mm long), or with blackish scales (2-3 mm long) when young, with one or two scaly buds on the abaxial side at the upper part; costa abaxially with scales, some broadened and with several slender branches at base, flat or slightly convex, costae adaxially with similar scale-like hairs and a few uniseriate hairs at base. Sori round,

medial or subterminal on the veins, 3-5(7) pairs on each pinnule; indusia round-reniform, brown, thick and firm, curling when old, persistent; 64 spores per sporangium, spores ellipsoid, perisporia with typical short inflated folds and venulate surfaces.

Paratypes. **CHINA.** Hainan Island: Mt. Yinggeling, 18°58' N, 109°24' E, alt. 1,000 m, on mountain slope in primary rain forest, 29 Aug 2005, *S. Y. Dong 1461* (IBSC); Hainan: Mt. Pochuanling, 18°57' N, 109°24' E, alt. 1,300 m, on mountain slope in primary rain forest, 28 Nov 2005, *S. Y. Dong 1634* (IBSC); *ibid.* alt. 1,350 m, 29 Nov 2005, *S. Y. Dong 1647* (IBSC); *ibid.* 18°56' N, 109°25' E, alt. 1,190 m, 30 Nov 2005, *S. Y. Dong 1662* (PYU).

Habitat. Scattered on mountain slopes, in primary rain forest, alt. 1,000-1,350 m.

Distribution. Only known from the Yinggeling mountainous area, northeastern Hainan Island, China.

Affinity. The new species is close to *Dryopteris fuscipes* and *D. guangxiensis* in gross morphology. It differs from *D. fuscipes* by its lower pinnae only deeply lobed (vs. amply 1-pinnate), costae covered with some narrow, flat scales (vs. copious bullate scales), and by its rachis buds.

Dryopteris gemmifera agrees well with *D. guangxiensis* in the shape and division of its lamina. However, a detailed comparison shows several major differences listed in Table 1, including: rachis buds present or not, lamina ovate to deltoid-ovate versus narrow-deltoid, costal scales flat versus bullate, and different spores size ($39\text{-}40 \times 26\text{-}30 \mu\text{m}$ vs. $60\text{-}74 \times 41\text{-}45 \mu\text{m}$).

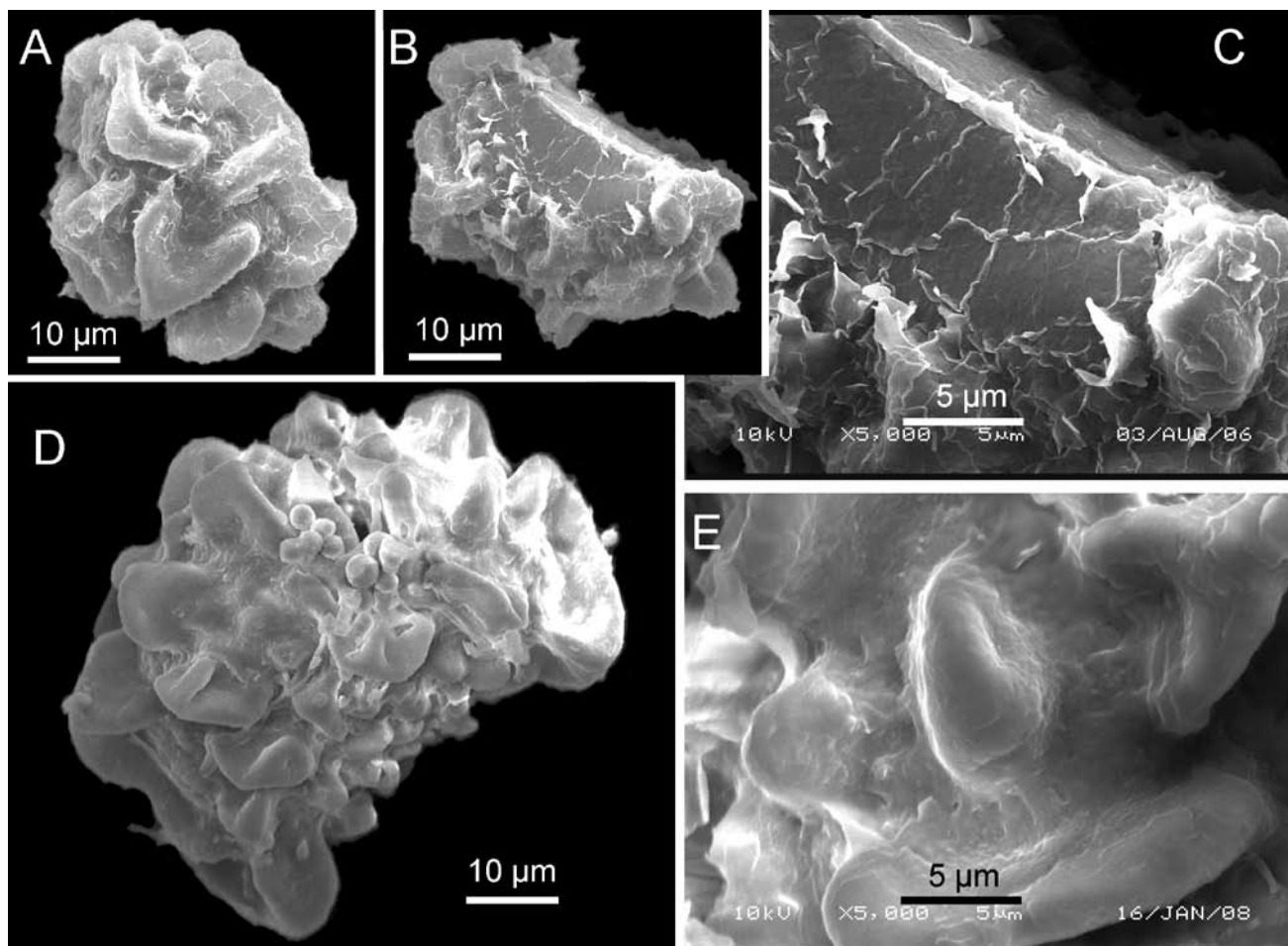


Figure 3. SEM photographs of spores of *Dryopteris gemmifera* and *D. guangxiensis*. A-C, *D. gemmifera* (From S. Y. Dong 1568 at IBSC); A, distal view, B-C, proximal view; D-E, *D. guangxiensis* D, equatorial view. (From S. Y. Dong 2308 at IBSC).

Table 1. Comparison of *Dryopteris gemmifera* and *D. guangxiensis*.

	<i>Dryopteris gemmifera</i>	<i>Dryopteris guangxiensis</i>
Rachis buds	Present	Absent
Ratio of lamina length to width	1.1-1.8 (2.0)	1.8-2.2
Size of lamina	17-28 × 11-19 (cm)	14-36 × 7-20 (cm)
Scales on stipe base	3-6(8) mm long	8-12 mm long
Abundance of scales on rachis and costa	Many when young, few when mature	Very few
Scales on rachis and abaxial side of costa	Flat and with several lateral hairs at base	Bullate and without lateral hairs at base
Spore size	39-40 × 26-30 μm (Figure 3A-B)	60-74 × 41-45 μm (Figure 3D)

Key to Species of *Dryopteris* from Hainan Island

1. Fronds simply pinnate.
 2. Laminae with a conform terminal pinna 1. *D. podophylla* (Hook.) Kuntze
 2. Laminae pinnatifid toward the apex, without a conform terminal pinna.
 3. Pinnae falcate, their bases cordate and apices obtuse; lamina coriaceous; veins invisible; sori indusiate..... 2. *D. cyclopeltiformis* C. Chr.
 3. Pinnae lanceolate, their bases truncate and apices acuminate; lamina herbaceous; veins visible; sori exindusiate..... 3. *D. scottii* (Bedd.) Ching
1. Fronds more divided: pinnate-pinnatifid to tripinnate.
 4. Stipe base scales brown; no scales on costae.
 5. Stipe base scales narrowly lanceolate; basal pinnae stalks 1-2 cm long; sori exindusiate 4. *D. polita* Rosenst.
 5. Stipe base scales ovate-lanceolate; basal pinnae stalks 0.2-0.5 cm long; sori indusiate 5. *D. sparsa* (D. Don) Kuntze
 4. Stipe base scales blackish; bullate and/or minute, narrow scales present on the distal side of costae.
 6. Pinnae pinnatifid to pinnatisect; rachis gemmiferous 6. *D. gemmifera* S.Y. Dong
 6. Pinnae more divided: bipinnate or tripinnate; rachis not gemmiferous.
 7. Basal basiscopic pinnule of the lowest pinna more developed; scales on abaxial side of costae hair-like and slightly bullate at base 7. *D. pacifica* (Nakai) Tagawa
 7. Basal basiscopic pinnule of the lowest pinna not more developed; scales on abaxial side of costae distinctly bullate.
 8. All pinnae sessile; lower pinnae inserted at a right angle to the rachis 8. *D. tenuicula* C.G. Matthew & Christ
 8. Lower pinnae more or less petiolate; inserted obliquely to the rachis.
 9. Lamina deltoid; lateral pinnae slightly oblique or nearly horizontal; basal pinnae long-deltoid, distinctly larger than the upper ones; indusia reddish..... 9. *D. subtriangularis* (Hope) C. Chr.
 9. Lamina broadly lanceolate; lateral pinnae oblique; basal pinnae lanceolate, as large as the upper ones; indusia brown.
 10. Pinnules usually deeply lobed and entire at apex; the base of basal pinna the widest 10. *D. integriloba* C. Chr.
 10. Pinnules not lobed, serrate at margin and apex; the base of basal pinna more or less narrowed 11. *D. fuscipes* C. Chr.

DISCUSSION

Dryopteris gemmifera is peculiar among *Dryopteris* species on account of the proliferous buds on its rachis. The proliferous bud is regarded as a character of rare occurrence, hitherto only known in *D. manniana* (Hook.) C. Chr. from Africa (Kramer, 1990). In contrast, rachis buds are more common in some species of *Polystichum*, a large genus related to *Dryopteris*. Because it is widely accepted as a diagnostic feature for either species or sections in *Polystichum* (Tagawa, 1940; Kung et al., 2001; Zhang and He, 2009a, 2009b; He and Zhang, 2010; Zhang et al. 2010), the presence of rachis buds may also represent a reliable character for discriminating *Dryopteris* species.

Apart from the rachis buds, spore characters provide additional evidence for the distinctness of the new species. *Dryopteris gemmifera* is closely related to *D. guangxiensis* in gross morphology, but the size of their spores is very different (Figure 3), indicating that *D. gemmifera* and *D. guangxiensis* most probably have different cytotypes.

The systematic position of this new species is interesting. Fraser-Jenkins (1986) proposed a subdivision of *Dryopteris*, including four subgenera and 17 sections based on lamina division, lamina texture, and the types of scales on leaf axes. According to this subdivision, *D. gemmifera* seems to belong to subgenus *Dryopteris*, which is characterized by lamina without a terminal pinna and without bullate scales. Apparently, *D. gemmifera* is close to *D. fuscipes* and *D. guangxiensis*, members of the subgenus *Erythrovariae*, characterized by their bullate scales on the leaf axes. Compared with *D. fuscipes* and other species in subgenus *Erythrovariae*, *D. gemmifera* does not possess the key character of the subgenus, i.e., the typically bullate scales. In addition, the new species is distinct from other *Dryopteris* species on account of its proliferous buds and relatively simplified fronds (2-pinnatifid). The morphological distinctness of *D. gemmifera* indicates that this new species is not a core member of subgenus *Erythrovariae* and may represent a unique evolutionary line in *Dryopteris*.

Based on the well developed spores, their size, and the 64 spores per sporangium, we infer that *D. gemmifera* is a diploid species with normal sexual reproduction. Due to a lack of appropriate materials for chromosome counting, we have not yet obtained any cytological data. The relationship between *D. gemmifera* and related species may be better understood when cytological data become available.

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中國海南島鱗毛蕨屬（鱗毛蕨科）一新種

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本文描述了特產於海南島的鱗毛蕨科 (Dryopteridaceae) 一新種：芽孢鱗毛蕨 (*Dryopteris gemmifera*)，隨文配有植株線繪圖、原色照片和孢子掃描圖。該新種的鑒別特徵為：葉片二回羽狀半裂，羽軸疏被狹而扁平的鱗片，特別是葉軸上生有 1-2 個芽孢。文中簡要比較了芽孢鱗毛蕨與兩個相近種：黑足鱗毛蕨 (*D. fuscipes*) 和廣西鱗毛蕨 (*D. guangxiensis*) 的異同，討論了該種的系統位置，提供了海南目前所知的 11 種鱗毛蕨的分種檢索表。

關鍵詞：鱗毛蕨屬；海南島；形態學；孢子；分類。