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A taxonomic revision of *Selaginella monospora* Spring (Selaginellaceae)

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Summary. During a taxonomic revision of *Selaginella* from the Himalaya which is a part of the ongoing “Flora of Pan-Himalaya” project, we studied the taxonomy of *Selaginella monospora* and its closely related species. We found that *S. microclada* once treated as a synonym of *S. monospora* should be accepted as a distinct species. In contrast, *S. trichophylla*, *S. monospora* var. *ciliolata*, *S. medogensis*, and *S. effusa* var. *dulongjiangensis* are reduced to synonymy of *S. monospora* based on molecular phylogenetic analyses and morphological characters. *Selaginella monospora* is characterized by denticulate to ciliolate leaves and strongly dimorphic sporophylls vs. denticulate leaves and slightly dimorphic sporophylls in *S. microclada*. A lectotypification of *S. medogensis* was also made in the present study.

Таксономическая ревизия *Selaginella monospora* Spring (Selaginellaceae)

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Ключевые слова: Китай, Индия, лектотипификация, новые синонимы, таксономия, филогенетический анализ, *Selaginella*.

Аннотация. В процессе таксономической ревизии рода *Selaginella* Гималаев, которая является частью продолжающегося проекта «Флора Пан-Гималаев», мы обнаружили, что после недавней типификации традиционное понимание таксона *S. monospora* изменилось, что потребовало пересмотра номенклатуры данного вида и его родства. *Selaginella microclada*, традиционно принимавшаяся как синоним *S. monospora*, должна быть признана отдельным видом, а *S. trichophylla*, *S. monospora* var. *ciliolata*, *S. medogensis* и *S. effusa* var. *dulongjiangensis* сводятся в синонимы к *S. monospora* на основе изучения гербарных коллекций, в том числе типовых, и молекулярно-филогенетического анализа рассматриваемой группы. *Selaginella monospora* ха-

рактируется зубчатыми или реснитчатыми листьями и сильно диморфными спорофиллами, в отличие от *S. microclada*, которой свойственны зубчатые листья и слегка диморфные спорофиллы. В настоящем исследовании также обнаружилось лектотипификация *S. medogensis*.

INTRODUCTION

Selaginella P. Beauv. is the only genus of family Selaginellaceae comprising approximately 700–800 species (Jermy, 1990; Zhang, 2004; Zhang et al., 2013; Weststrand, Korall, 2016). The taxonomy of some species groups in this genus have remained unresolved although the infrageneric classification has been the subject of several recent studies (Zhou et al. 2015a; Weststrand, Korall, 2016; Zhang et al. 2020). *Selaginella monospora* Spring is widely distributed from Indo-Himalaya to China, Myanmar, Laos, and Vietnam (Alston, 1934, 1945; Chun et al., 1964; Panigrahi, Dixit, 1966; Iwatsuki, 1975, 1988; Tagawa, Iwatsuki, 1979; Ching, Wu, 1983; Dixit, 1992; Thapa, 2002; Zhang, 2004; Ghosh et al., 2004; Singh, Panigrahi, 2005; Chu, 2006; Wu, 2006; Jiang, 2013; Zhang et al., 2013; Fraser-Jenkins et al., 2015; Fraser-Jenkins et al., 2017; Shalimov et al., 2019a). It is rather a common species in Southwest China, and similar plants were described from Xizang and Yunnan as *S. medogensis* Ching et S. K. Wu (1983), *S. trichophylla* K. H. Shing (1993), *S. monospora* var. *ciliolata* W. M. Chu (2006), and *S. effusa* var. *dulongjiangensis* W. M. Chu (2006). However, the taxonomic status of these taxa was uncertain (Zhang et al., 2013).

Herein, we use molecular and morphological data to draw further taxonomic conclusions and to stimulate and direct future taxonomic work in *S. monospora* group.

Material and Methods

Molecular study

We sampled 57 individuals representing 35 species of *Selaginella* including the type specimens of the *S. medogensis*, *S. trichophylla*, *S. monospora* var. *ciliolata*, and *S. effusa* var. *dulongjiangensis* from GenBank and our data. Outgroups were chosen from different evolution lineages in *Selaginella* (*S. nipponica*, *S. helvetica*, *S. laxistrobila*, *S. braunii*, *S. uncinata*, *S. delicatula*, *S. krausiana*, *S. remotifolia*, *S. deflexa*, *S. selaginoides*) (Appendix 1).

Phylogenetic reconstruction was based on the chloroplast genes *rbcL*, *atpI*, *psbA*. Total genomic

DNA was extracted from silica-gel-dried leaf materials following the protocols and the primers and procedures described in Shalimov et al. (2019b). All sampling information is provided in Appendix 1. The raw sequences of *Selaginella* were assembled with ContigExpress. The alignments produced by Clustal X v.1.83 (Thompson et al., 1997) followed by manual adjustment in BioEdit v.7.1.11 (Hall, 1999), and gaps were treated as missing data.

Phylogenetic trees were constructed using maximum likelihood (ML) and Bayesian inference (BI). Models of nucleotide substitution were selected by jModelTest 0.1.1 (Posada, 2008). The ML analysis was run in RAxML 7.2.6 (Stamatakis, 2006) with 1000 bootstrap replicates under the GTRGAMMA model. Bayesian inference using the GTR+I+G model (four gamma categories) was executed in MrBayes version 3.1.2 (Huelsenbeck, Ronquist, 2001). Bayesian trees were started from random trees, and four Markov chain Monte Carlo (MCMC) simulations were run simultaneously and sampled every 1000 generations for 10 million generations. The average standard deviation of split frequencies (< 0.01) was used to assess the convergence of the two runs. Bayesian posterior probabilities (PP) were calculated as the majority consensus of all sampled trees with the first 25 % discarded as burn-in.

Morphological study

This revision is based on numerous specimens deposited at CDBI, CSH, E, GXMG, KUN, KYO, L, NY, PE, PYU, TI, U, and US. Type specimens and general collections from other herbaria (B, K, KYO, L, P, and US) were examined through digital images. We also used the JSTOR Global Plants project database (<https://plants.jstor.org>) and GBIF Global Biodiversity Information Facility (<https://www.gbif.org>). Herbarium abbreviations are according to Thiers (2021).

Morphological characters, such as ventral (lateral), dorsal (median) and axillary leaves, strobili and arrangement of branches were carefully observed. The morpho-photographs of the plants were taken with a Nikon DXM 1200F camera connected to a stereomicroscope (Nikon SMZ 1000) and computer, and measurement were done by

D 3.10. Morphological features for included species were illustrated with axillary, dorsal, ventral leaves and strobili.

For the study of spore morphology, scanning electron microscopy (SEM) was used. Morphology of spores was examined from several collections for *S. microclada*, *S. monospora*, *S. trichophylla*, and *S. monospora* var. *ciliolata*. The spores were taken from mature sporangia and fixed on double line tape, and then covered with gold-palladium mixture. Spores were photographed and measured under different magnifications using a Hitachi S-4800 at 10–20 kV. The terminology used to describe the species is based on Tryon and Lugardon (1991) and Zhou et al. (2015b). For the black background,

contrast and brightness of the images were optimized in Adobe Photoshop.

Results

Interpretation of the lectotype of *S. monospora* designated by Fraser-Jenkins et al. (2017)

S. monospora was described by Spring (1850) based on several collections from India, Nepal, and Bhutan. We carefully checked the syntypes of *S. monospora* and specimens from the whole distribution area and realized that the syntypes represented two distinct species (Table 1–2).

Table 1

Taxonomic identity of the syntypes of *Selaginella monospora*

Herbarium barcode	Collection information	Taxa
B 20 0147434	India: Assam, Griffith s. n.	<i>species A</i>
B 20 0147435	India: Assam, Griffith s. n.	<i>species A</i> , with misidentification of upper left plants as <i>S. semicordata</i>
B 20 0147541	India: Assam, Griffith s. n.	<i>species A</i>
K001067477	India: Assam, Griffith s. n.	<i>species A</i>
K001067478	Bhutan ('Bootan'), Griffith W. 391	<i>species B</i> Lectotype of <i>S. monospora</i> chosen by Fraser-Jenkins et al. (2017)
K001067480	Nepal, Buchanan-Hamilton F. s. n. 1810	<i>species A</i>
K001067481	India, J. Mack 2	<i>species A</i>
K001067482	[Myrung] wood, Khasiya, Griffith W. s. n.	mixed gathering <i>species A</i> <i>species B</i>
K001067483	India, J. Mack 2	<i>species A</i>
K001067484	India: Khasiya, Griffith W. s. n.	<i>species B</i>
P00523054	India, Assam, Griffith s. n.	<i>species B</i>
US 00134380	Bootan, Griffith W. 391	mixed gathering <i>species B</i> <i>species A</i>
US 01392970	India: Khasiya, Griffith s. n.	<i>species B</i>
K000009117	India: Khasiya, Griffith s. n.	<i>species B</i>

Table 2

Morphological comparison between the taxa

Characteristics	Species A	Species B
Axillary leaves	ovate, narrowly ovate, or narrowly elliptic, 2–3 × 0.8–1.6 mm, margin denticulate.	ovate, 1.2–2.5 × 1–2 mm, margin ciliolate
Dorsal leaves	ovate-lanceolate or elliptic, 1–1.6 × 0.3–0.7 mm, base obtuse, margin denticulate, acuminate or shortly aristate at apex	ovate, 1.2–1.9 × 0.5–1 mm, base subcordate or obtuse, margin ciliolate, aristate to cuspidate at apex
Ventral leaves	ovate-triangular or oblong-falcate, 2.6–5.5 × 0.9–2.3 mm, margin subentire, entire or denticulate	ovate-triangular, 2–3.2 × 0.8–1.6 mm, margin denticulate to ciliolate
Strobili	3–20 × 1.9–3.2 mm, margin minutely denticulate	6.0–10 × 1.2–2.3 mm, margin denticulate
Sporophylls	slightly dimorphic	strongly dimorphic

The *Species A* is characterized by dorsal leaves ovate-lanceolate or elliptic, base obtuse, margin denticulate, apex acuminate or shortly aristate; strobili dorsiventrally complanate, sporophylls slightly dimorphic; lateral branches densely arranged, ventral leaves slightly ascending or spreading, ovate-triangular or oblong-falcate, margin denticulate, apex subacute. The *Species B* is characterized by dorsal leaves ovate, base obtuse or subcordate, margin ciliolate to denticulate, apex aristate to cuspidate; strobili dorsiventrally complanate, sporophylls strongly dimorphic; lateral branches flabellate arranged, ventral leaves ovate-triangular, oblong or oblong-ovate, margin ciliolate to denticulate, apex acute.

Fraser-Jenkins et al. (2017) lectotypified *S. monospora* Spring based on one of the original specimens cited in Spring's protologue: "Bhutan, *W. Griffith*, Herbarium Hookerianum", i. e. *W. Griffith* 391 in K (K001067478). This specimen belongs to the above *Species B*, which is characterized by strongly dimorphic strobili, flabellate lateral branches; dorsal leaves with denticulate to ciliolate at margin, aristate to cuspidate at apex; ventral leaves denticulate to ciliolate at acroscopic base.

Spring (1850) described *S. gorvalensis* at the same time with *S. monospora*. The type was cited as "Hindustania superior, Gorval, Griffith" (Spring, 1850). Alston (1945) noticed that this collection was in fact from Khasia, and reduced it to *S. monospora*.

We found that the morphology of *S. gorvalensis* matched the above *Species B* in the syntypes of

S. monospora, and *S. trichophylla* (Shing, 1993) as well as *S. monospora* var. *ciliolata* (Chu, 2006) also belong to the *Species B*. The remaining part of the original syntypes of *S. monospora* have the same morphology characters (*Species A*) and are identical to the morphology of *S. microclada* Baker which was regarded as a synonym of *S. monospora* until now. Therefore, the resurrection of *S. microclada* is a consequence of the lectotypification of *S. monospora* by Fraser-Jenkins et al. (2017).

Morphology

The traditional concept of *S. monospora* s. l. is in fact a mixture of two different species, i. e., *S. microclada* and *S. monospora*. *Selaginella microclada* (*species A*) is characterized by slightly dimorphic sporophyll and thus the strobili appear more or less uniform; ventral and dorsal leaves denticulate; dorsal leaves oval-lanceolate or elliptic, base obtuse, apex acuminate or shortly aristate (Fig. 1, 1A–D). While, *Selaginella monospora* (*species B*) is characterized by strongly dimorphic sporophylls; ventral and dorsal leaves ciliolate to denticulate; dorsal leaves ovate, base subcordate or obtuse, apex cuspidate-aristate (Fig. 1, 2A–D).

Selaginella trichophylla, and *S. monospora* var. *ciliolata* are two similar eco-types of *S. monospora* with short spines on the dorsal and ventral leaves (Table 3).

Table 3

Morphological comparisons among *Selaginella microclada*, *S. monospora* (incl. *S. gorvalensis*, *S. trichophylla*, *S. monospora* var. *ciliolata*), *S. effusa* var. *dulongjiangensis*, and *S. medogensis*

Species/ Characteristics	<i>S. microclada</i>	<i>S. monospora</i> (incl. <i>S. gorvalensis</i> , <i>S. trichophylla</i> , <i>S. monospora</i> var. <i>ciliolata</i>)	<i>S. effusa</i> var. <i>dulongjiangensis</i>	<i>S. medogensis</i>
Main stems	long creeping, 35–85 cm or more	creeping, 20–50 cm	creeping, ca. 20–25 cm	creeping, ca. 25 cm
Axillary leaves	ovate, narrowly ovate, or narrowly elliptic, 2–3 × 0.8–1.6 mm, margin denticulate	ovate, 1.2–2.5 × 1–2 mm, margin ciliolate	broadly elliptic or ovate-elliptic, 1.1–2.0 × 0.7–1.7 mm, margin denticulate	ovate-triangular or narrowly elliptic, 1.2–2.3 × 0.6–1.1 mm, margin denticulate
Base of axillary leaves	base exauriculate	base exauriculate	base obtuse	base exauriculate
Dorsal leaves	ovate-lanceolate or elliptic, 1–1.6 × 0.3–0.7 mm, carinate or strongly carinate, margin denticulate	ovate, 1.2–1.9 × 0.5–1 mm, not carinate, margin ciliolate (more densely ciliolate at base)	obliquely ovate-elliptic 0.5–1.4 × 0.3–0.8 mm, margin denticulate	ovate, 0.9–1.6 × 0.4–0.7 mm, carinate or strongly carinate, margin denticulate

Table 3 (end)

Species/ Characteristics	<i>S. microclada</i>	<i>S. monospora</i> (incl. <i>S. gorvalensis</i> , <i>S. trichophylla</i> , <i>S. monospora</i> var. <i>ciliolata</i>)	<i>S. effusa</i> var. <i>dulongjiangensis</i>	<i>S. medogensis</i>
Base of dorsal leaves	obtuse, not peltate,	obtuse or subcordate, not peltate	obtuse	oblique, not peltate
Apex of dorsal leaf	acuminate or shortly aristate	aristate to cuspidate	shortly aristate	caudate
Ventral leaves	ovate-triangular or oblong-falcate, 2.6– 5.5 × 0.9–2.3 mm, margin subentire or entire or denticulate; apex subacute	ovate-triangular, 2–3.2 × 0.8–1.6 mm, margin denticulate to ciliolate, apex acute	oblong or oblong- ovate 1.7–3.0 × 0.9–1.7 mm, margin denticulate, apex obtuse	oblong or oblong- ovate, 1.6–3.5 × 1–2.0 mm, margin denticulate, apex subacute
Acroscopic base of ventral leaf	enlarged, broader, strongly overlapping stem and branches,	enlarged, broader, overlapping stem and branches,	e n l a r g e d , broader, strongly overlapping stem and branches, margin denticulate at base in middle to apex subentire	a c r o s c o p i c base enlarged, broader, strongly overlapping stem and branches, margin denticulate at base (denticulate or subentire to apex)
Basiscopic base of ventral leaf	margin subentire or entire	margin entire	margin entire	margin denticulate at base (elsewhere denticulate or subentire)
Strobili	3–20 × 1.9–3.2 mm, margin minutely denticulate	6.5–10 × 1.2–2.3 mm, margin denticulate	4.0–7.0 × 1.1– 1.7 mm, margin denticulate	3.4–4.8 × 1.8– 2.2 mm, margin denticulate
Sporophylls	slightly dimorphic	dimorphic	dimorphic	dimorphic

Selaginella medogensis from Xizang is characterized by lateral leaves base broader, apex acute, margin denticulate; dorsal leaves narrow ovate or ovate, not carinate, short acuminate at apex, margin denticulate; dorsal sporophylls linear-lanceolate, ventral sporophylls triangle-lanceolate (Fig. 1, 3A–D).

Selaginella effusa var. *dulongjiangensis* is similar to *S. effusa* and *S. medogensis*, however, the main stems of *S. effusa* var. *dulongjiangensis* are creeping with spaced short flabellate branches (Fig. 1, 4A–D).

Micromorphology of spores

Our analysis of the morphology of spores also confirmed the micromorphological differences of mega- and microspores between *S. microclada* (in previous study considered as *S. monospora*) and *S. monospora*. The proximal and distal surfaces of

megaspores of *S. microclada* covered with verrucae or papillate ornamentation (Fig. 2A, C), sometimes with vermiculate structures, whereas *S. monospora* are covered by verrucae or papillate ornamentation on proximal and distal sides (Fig. 2E, G). The surface of megaspores varied from smooth with rare vermiculation (in present study) to more vermiculate without spinulose micro-sculptures (see in Zhou et al., 2015b for *S. trichophylla*), or surface with vermiculate microstructure and covered by rarely spinulose micro-sculptures (see in Zhou et al., 2015b for *S. monospora* var. *ciliolata*). Our observation of *S. monospora* showed verrucate ornamentation with vermiculate surface, which covered by spinulose micro-sculptures (Fig. 2E, G).

The morphology of spores of *S. medogensis* was reported by Liu et al. (2005) for *S. mutensis* (illegal name for *S. medogensis*) and Zhou et al. (2015b). As report by Liu et al. (2005), its megaspores have irregular verrucate ornamentation and

spinulose micro-sculptures on both surfaces. Zhou et al. (2015b) mentioned verrucate or papillate ornamentation, but did not report vermiculate

structures of the surface (see Zhou et al., 2015b) and spinulose micro-sculptures.

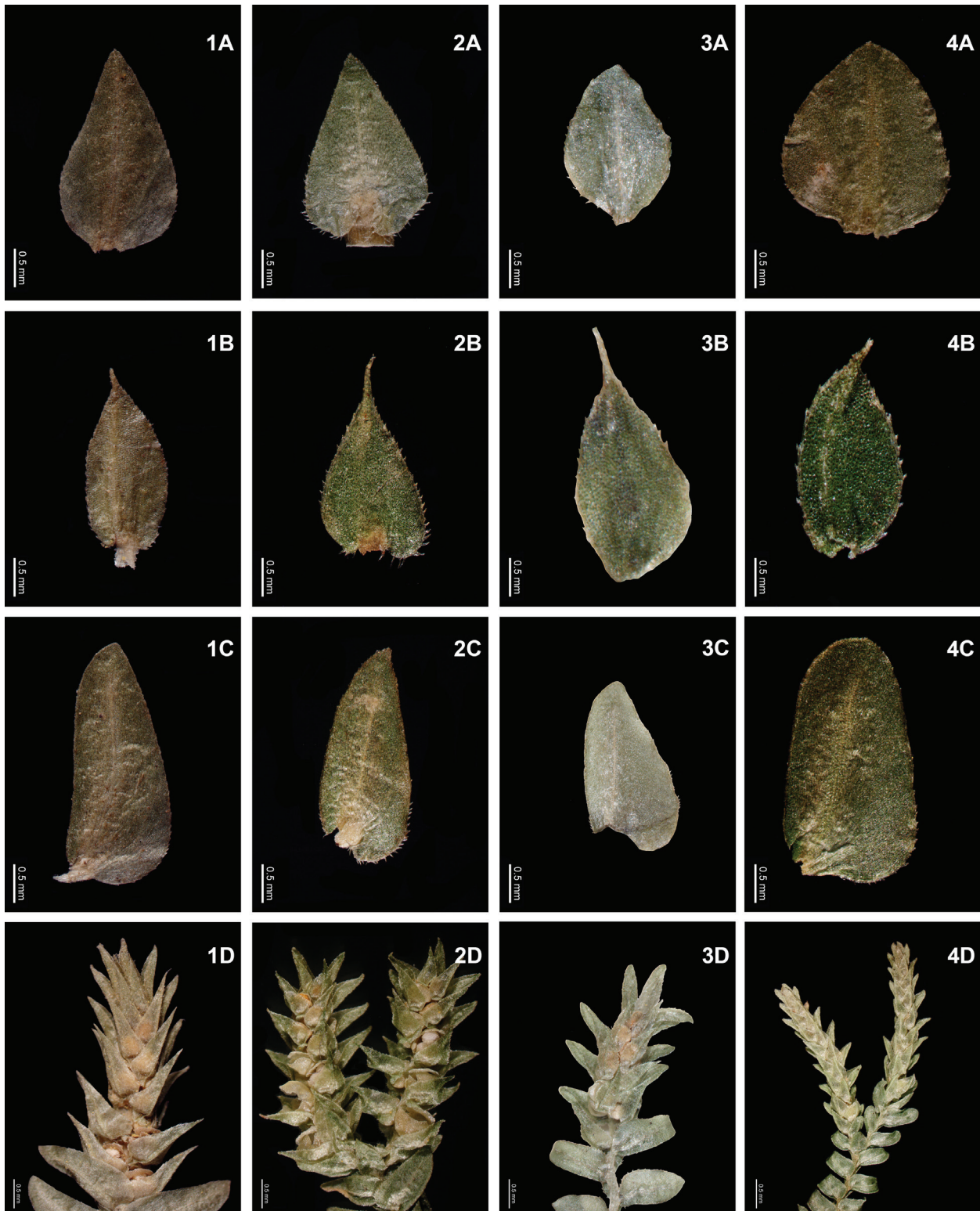


Fig. 1. Differences in vegetative leaves and strobilus: **1A–D** – *S. microclada* (Feng 11473, PE); **2A–D** – *S. monospora* (from paratype of *S. monospora* var. *ciliolata* (Lu et Zhang 27625–B, PE)); **3A–D** – *S. medogensis* (Qinghai-Xizang Complex Exped. 74-4375, PE); **4A–D** – *S. effusa* var. *dulongjiangensis* (W. M. Chu et Z. R. He 31299, PE). **A** – Axillary leaves; **B** – Dorsal leaves; **C** – Ventral leaves; **D** – Strobila.

Megaspores of *S. effusa* var. *dulongjiangensis* were reported by Zhou et al. (2015b), the surface had verrucae and was sometimes with vermiculate ornamentation, micro-sculptures were usually covered with dense spinules.

Microspores of *S. microclada* on proximal and distal sides had verrucae or spherulate ornamentation, surface covered with spinulose micro-sculptures (Fig. 2B, D). Our results considered previous report of Zhou et al. (2015b) for “*S. monospora*”.

Microspores of *S. monospora* was previously reported for *S. trichophylla* and *S. monospora* var. *ciliolata* by Zhou et al. (2015b). They have verrucate or spherulate ornamentation, that is the same with our result, with fine reticulate micro-sculptures (Fig. 2F, H).

Microspores of *S. medogensis* were reported by Liu et al. (2005) and Zhou et al. (2015b), surface had verrucate or spherulate ornamentation, but Liu et al. (2005) additionally reported fine reticulate micro-sculptures.

As reported by Zhou et al. (2015b), microspores of *S. effusa* var. *dulongjiangensis* are covered with irregularly sized and spaced verrucae, the surface with dense spinules micro-sculptures. Summary on the difference between mega- and microspores of *Selaginella microclada* and *S. monospora* (incl. *S. gorvalensis*, *S. trichophylla*, and *S. monospora* var. *ciliolata*) with additional data on *S. medogensis* and *S. effusa* var. *dulongjiangensis* are presented in Table 4.

Table 4

Morphological comparison of mega- and microspores *Selaginella microclada*, *S. monospora* (incl. *S. trichophylla*, *S. monospora* var. *ciliolata*), *S. medogensis*, and *S. effusa* var. *dulongjiangensis*

<i>S. microclada</i> *	<i>S. monospora</i> (incl. <i>S. trichophylla</i> *, <i>S. monospora</i> var. <i>ciliolata</i> *)	<i>S. effusa</i> var. <i>dulongjiangensis</i> *	<i>S. medogensis</i> **
Megaspores the proximal and distal surfaces			
verrucate and/or papillate	verrucate and/or papillate	verrucate	verrucate or irregular sizes verrucae
Megaspores micro-sculptures			
irregular rugae, spinulose	irregular rugae, spinulose	spinulose micro-sculptures	spinulose micro-sculptures
Microspores			
Microspores the proximal surfaces			
verrucate or/and spherulate, with reticulate microsculptures	verrucate or/and spherulate	irregularly sized and spaced verrucae	verrucate or/and spherulate
Microspores the distal surface			
spherulate ornamentation, with reticulate micro-sculptures	spherulate ornamentation, fine reticulate micro-sculptures	dense spinules	spherulate ornamentation, fine reticulate micro-sculptures

Note: * More detail and photo see in Zhou et al. (2015b); ** More detail and photo see in Liu et al. (2005).

Phylogenetic Analysis

The combined plastid dataset (*rbcL* + *atpI* + *psbA*) data matrix contains 57 accessions representing 35 *Selaginella* species. The alignment has 2040 characters, 382 (382/2041 = 18.71 %) of which are potentially parsimony informative. The ML tree with PP and ML bootstrap values (BS) is shown in Fig. 3. Phylogenetic analysis result showed that *S. microclada* (included 6 samples, clade A) is sister to *S. monospora* (included 16 samples, clade B) (PP = 1.0, BS = 98; Fig. 3). Clade B includes *S. trichophylla*, *S. monospora* var. *ciliolata*, *S. medogensis*, and *S. effusa* var. *dulongjiangensis*

with strong support (PP = 1.0, BS = 99). This is confirmed by their gross morphology and micromorphology of spores described above.

Discussion

The molecular and morphological evidence suggests that *S. monospora* s. l. represents two distinct species. We resurrected the older name *S. microclada* from *S. monospora* for specimens with slightly dimorphic strobili. We treated *S. medogensis*, *S. trichophylla*, *S. monospora* var. *ciliolata*, and *S. effusa* var. *dulongjiangensis* as synonyms of *S. monospora*.

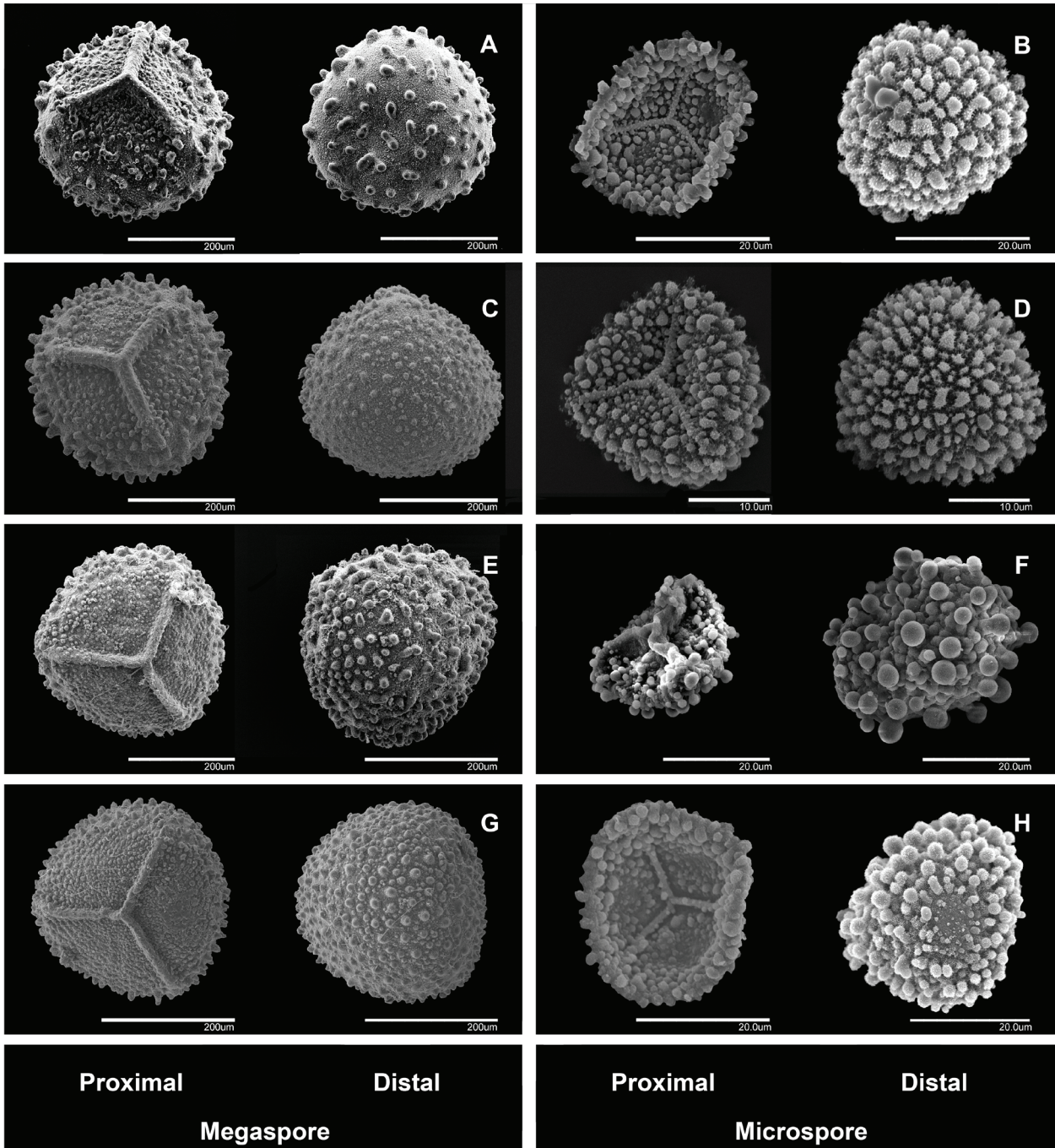


Fig. 2. Mega- and microspores of *Selaginella microclada* (A–D) and *Selaginella monospora* (E–H): A, C, E, G – Megaspores; B, D, F, H – Microspores. A, B from X. P. Qi Q070 (PE); C–D from D. D. Tao 1011 (PE); E–F from Lu et Zhang 27625–B (PE); G–H from Lu et Zhang 27625–B (PE).

The type specimens of *S. trichophylla* and *S. monospora* var. *ciliolata* are morphologically similar to *S. monospora* but leaf surface with spinules which are found from shaded and wet habitat, and the types of *S. medogensis* and *S. effusa* var. *dulongjiangensis* are morphological abnormalities (Fig. 1), there are only two nucleotide substitutions in the *rbcL* sequences with *S. monospora*.

We have observed enough specimens from the distribution ranges of *S. monospora*, made critical studies of the type specimens and conducted molecular phylogenetic analysis with related species. The traditional recognized *S. monospora* is a mixture of two distinct taxa, i. e., *S. microclada* and *S. monospora*.

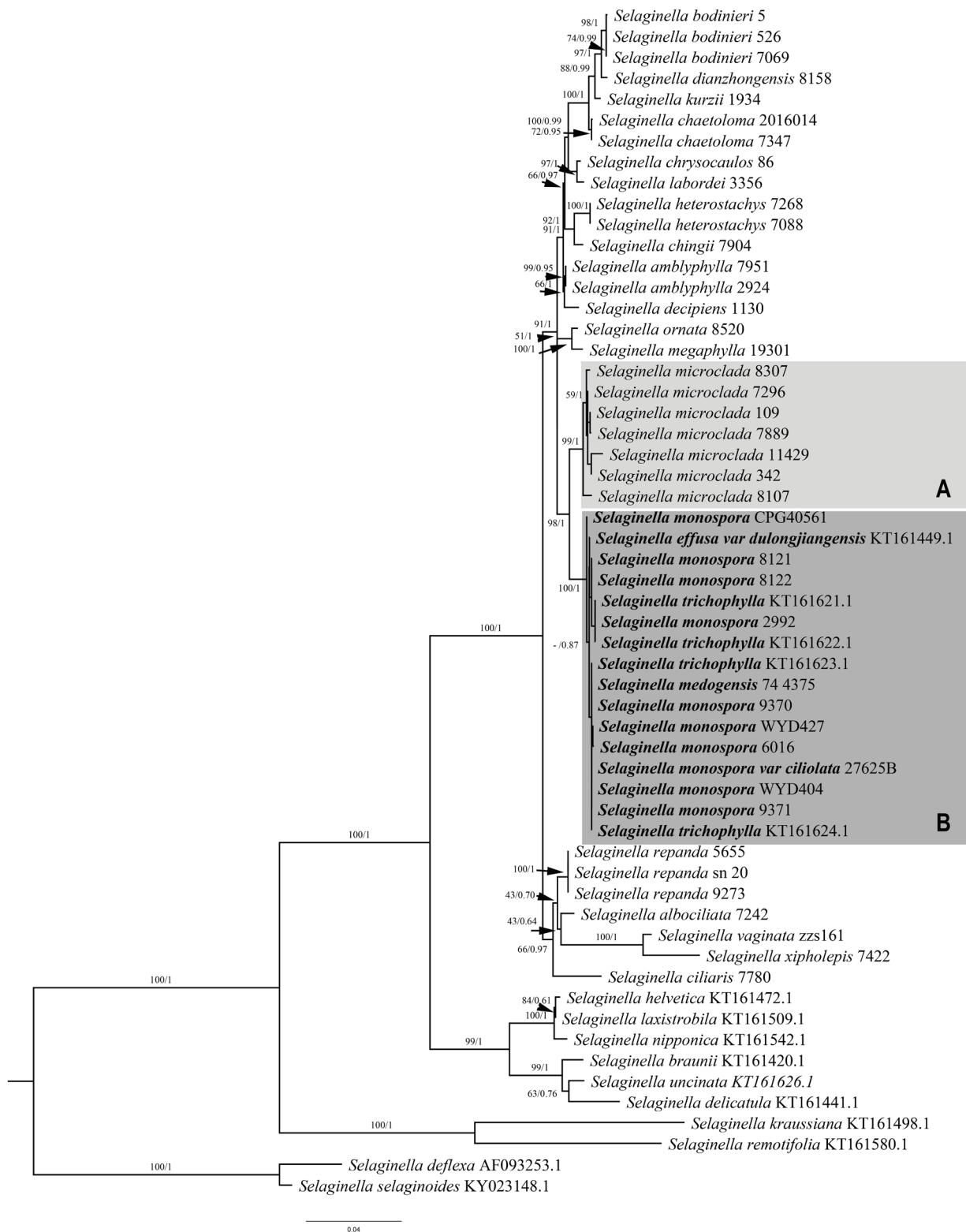


Fig. 3. The 50 % majority rule consensus tree derived from maximum likelihood showing the position of *Selaginella microclada* and *S. monospora*. Support values (BS_{ML}/PP_{BI}) are shown above the main branches; the dash (–) indicates BS < 50 %. The two distinct species are shown in bold.

TAXONOMIC TREATMENT

Key to *Selaginella monospora* and its related species

1. Sporophylls slightly dimorphic, dorsal leaves ovate-lanceolate or elliptic, base obtuse, margin denticulate, apex acuminate or shortly aristate

..... *S. microclada*

+ Sporophylls strongly dimorphic, dorsal leaves obliquely ovate-elliptic and ciliolate at margin or ovate-lanceolate or elliptic and denticulate at margin

..... 2

2. Ventral leaves strongly overlapping stems and branches, axillary leaves on main stems ovate, ovate-triangular, or ovate-elliptic

..... *S. effusa*

+ Ventral leaves not overlapping stems and branches, axillary leaves on main stems ovate to broadly ovate

..... *S. monospora*

Selaginella microclada Baker, 1884, J. Bot. 22: 246.

Type: “India, Sikkim, Chong-tong, alt. 4000 ft. 22 VII 1862. Dr. Anderson 1404” (K – [K001067485] image online!).

– *Selaginella monospora* sensu Alston, 1945, Proc. Nat. Inst. Sci. India 11: 228, p. p.; K. Iwats., 1975, Fl. E. Himalaya 8: 168, p. p.; K. Iwats., 1988, Univ. Mus. Univ. Tokyo Bull. 31: 243; Dixit, 1992, Selaginell. India: 92, p. p.; Thapa, 2002, Pterid. Nepal: 27; X. C. Zhang, 2004, Fl. Reipubl. Popularis Sin. 6(3): 186; Singh, Panigrahi, 2005, Ferns and Fern-Allies of Arunachal Pradesh 1: 62; X. C. Zhang et al., 2013, Fl. China 2–3: 61; Fraser-Jenkins et al., 2015, Ferns Fern-Allies Nepal 1: 73, p. p.; Fraser-Jenkins et al., 2017, Annot. Checkl. Indian Pteridophytes: 39, p. p.; Shalimov et al., 2019a, PhytoKeys 133: 34, p. p.

Plants 35–85 cm, main stems long creeping. Rhizophores at intervals throughout length of main stem, borne on ventral side in axils of branches. Main stems branched throughout, pinnately branched, stramineous, 1.5–2 mm in diam. in lower part, stem oval or terete, not sulcate, branches many, some primary lateral branches developed into long branch systems; primary leafy branches 8–12 pairs, once or twice pinnately branched or 2 or 3 times forked. Axillary leaves ovate, narrowly ovate, or narrowly elliptic, 2–3 × 0.8–1.6 mm, base exauriculate, margin denticulate. Dorsal leaves ovate-lanceolate or elliptic, 1–1.6 × 0.3–0.7 mm, carinate or strongly carinate, base obtuse, not peltate, margin denticulate, apex acuminate or shortly aristate. Ventral leaves ovate-triangular or oblong-falcate, 2.6–5.5 × 0.9–2.3

mm, basiscopic base decurrent, margin subentire or entire; acroscopic base enlarged, broader, strongly overlapping stem and branches, margin denticulate; apex subacute. Strobili solitary, dorsiventrally complanate (sometimes appearing uniform), 3–20 × 1.9–3.2 mm; sporophylls slightly dimorphic, resupinate, not white-margined; dorsal sporophylls lanceolate, sharply carinate, margin minutely denticulate, apex acuminate, with sporophyll-ptyx complete and denticulate; ventral sporophylls ovate-lanceolate, carinate, base dilated, margin denticulate; microspores yellowish orange or pale yellow, megaspores whitish.

Ecology: On damp banks in forests. (400)1300–1800(2600) m.

Distribution: BHUTAN, CHINA (Hainan, Guangdong, Guangxi, Guizhou, Xizang, Yunnan), NEPAL (Kathmandu, Kabhrepalanchok, Udayapur, Solukhumbhu, Sankhuwasabha, Tehrathum, Jhapa, Ilam, Taplejung), INDIA (Uttarakhand, Assam State, Sikkim, Darjeeling, Manipur, Meghalaya, West Bengal), LAOS, CAMBODIA, THAILAND, VIETNAM.

Selected specimens examined:

INDIA: Assam: “Tura Peak, Garo Hills, 4000 ft. IV 1888. G. Mann 65” (US01392971); “l. c. G. Mann s. n.” (L.3498106). **Meghalaya:** “Barapani, Khasi Hills, deep forest, on boulder, 3000 ft. 22 V 1949. W. N. Koelz 22751” (MICH1507940); *ibid.* “W. N. Koelz 22951” (MICH1507942). **Uttarakhand:** “Mussoorie, 1956. P. S. Sabharwa s. n.” (U). **Darjiling:** “7000 ft. IX 1958. S. S. Bir s. n.” (PE01622251; US01392974; U.1603187); *ibid.*, “2185 m, 3 XII 1932. T. N. Liou L 6336” (PE); *ibid.*, “3000 ft. 23 VIII 1869. F. Henderson s. n.” (E00754770); *ibid.*, “2500 ft. 31 X 1870. F. Henderson 13644” (E00754773; E00800129); *ibid.*, “19 VIII 1841. Dr. Samerson 430” (E00800136); *ibid.*, “7000 ft. 22 XII 1936, W. Koelz 10487” (US01392972); *ibid.*, “Lebong forest, 5500 ft. 8 VIII 1956. S. S. Bir 197” (US01392975). **Sikkim:** “Gangtok, common on moist banks, 5000 ft. 7 IV 1939, F. Ludlow, G. Sherriff, G. Taylor 4005” (PE 01622250; MICH1578741); *ibid.*, “Dikchu, 2010 m, 1972, Pradhan et al. 61” (E).

NEPAL: E Nepal: **Sankhuwasabha:** “en route from Harelo to Chichila, *Castanopsis hystrix* forest, on the moist rock. Alt. 1935 m, 2 VI 1978. H. Tabata, K.R. Rajbhandari, Y. Shimizu 11051” (PE 01622247); “Above Shinbun-Hatia Gola, alt. 1600–2100 m, 3 VIII 1977. H. Ohashi et al. 771954” (TI); “Seduwa, in shade under rocks, 5000 ft. 7 VI 1965. Banerjee, Upadhyay, Baskola 3322”

(US01392965); “Seduwa (Kasuwa Khola) prostrate, alt. 3000 ft. 6 V 1965. Banerjee, Upadhyay, Baskola 3374” (US01392966). **Solukhumbu:** “Near Namche, in shady of rocks, rare, alt. 8000 ft. 9 V 1965. Banerjee, Upadhyay, Baskola 3418” (US01392968); “Near Namche, in shade, alt. 8000 ft. 9 V 1965, Banerjee, Upadhyay, Baskola 3420” (US01392967). **Taplejung:** “Khebang below Siling Tzokupa, 20 XI 1963. H. Hara et al.” (TI). **Ilam:** “Densely forested, rocky stream-gully of Sudhung Khola, shortly below Sudhung khola, shortly below Sudhung, leading south below road, below Sundergaon, W. of Pashupatinagar on Ilam Road, 9 X 2001. C. R. Fraser-Jenkins 29549 (FN 5494)” (US01392964; L.3726784); “in Oak-forest on slopes above streams, between Chitregaon and Manebhanjyang, ca. 4–5 km N. E. of Pashupatinagar, on footpath to Manebhanjyang near indian border, N. E. of Ilam, 23 X 2001. C. R. Fraser-Jenkins 29069 (FN 5584)” (US01392963; L.3726782). **Jhapa:** “ca. ½ km below and S. of Kutedara on road to Bhudabare, N. of Charali on road to Phikal and Ilam, NE of Birtamod and NW of Kakkarbhitta, forested Khola (stream-gully), planted with ginger, below road, alt. 5000 ft. 16 VIII 1998, C. R. Fraser-Jenkins 26586 (FN 2564)” (US01392962; L.3726781).

BHUTAN: “Yongpu La, 6000 ft, on shady bank in forest, 10 XI 1938. F. Ludlow, G. Sherriff, G. Taylor 7210” (PE 01622248); “Shamgong, 11.6 km South of Shamgong on the road to Gayleghphug, 1500 m, growing on the forest floor, 9 V 1984. B. Bartalomew 1620A” (PE 01622249); “Gayleghphug, slope below Shan Khara, 27°01' N, 90°34' E, warm broad-leaved forest on steep hillside. *Selaginella* forming carpets on steep bank, 1250 m. 29 III 1982. A. J. C. Grierson, D. G. Long 4092” (E00754762); “Chukka district: Tabji Khola, Raidak valley, 26°51'N, 89°34'E, warm broad-leaved forest on shady mossy bank, 1700 m. 23 II 1982. A. J. C. Grierson, D. G. Long 3148” (E00800130); “1 km S of Tongsa, 27° 30' N, 90° 30' E, damp rock face in *Quercus* forest, ca. 2250 m. 17 V 1979, A. J. C. Grierson, D. G. Long 1115” (E00800133); “2 km below Putlibhir, on damp shady rock at roadside, ca. 2000 m. 7 VI 1975. A. J. C. Grierson, D. G. Long 18” (E00800140); “Tronsa/Trashiling, 7500 ft, wet shady banks, 5 VIII 1949, F. Ludlow, G. Sherriff, J.K. Hicks 17028” (L.3498102); “Yuto La, between Bumthang and Trongsa, shady banks in deciduous forest, 8500 ft. 4 VIII 1949. F. Ludlow, G. Sherriff, J. K. Hicks 17023” (L.4328981).

CHINA: Hainan: “Diaoluoshan, 8 I 1975. W. M. Chu 5895” (PYU); “Diaoluoshan, 6 I 1975. W.

M. Chu 5896” (PYU); “Wuzhishan, 28 XII 1974. W. M. Chu 1768” (PYU); “Jianfengling, 13 XII 1974. W. M. Chu 1512” (PYU). **Guangxi:** “Napo, Xiahua, Guinongshan, 1300 m. 15 IV 1998. H. N. Qin et al. 958” (KUN1288810). **Xizang:** “Nyingchi, Linzhi, 936 m. 9 V 2011. Q. Tian et al. TQ00517” (CSH0071243); “Megog, Beibeng, 810 m. 11 VII 1974. Qingzang team 74-1911” (PE00405934; PE00405933); “Medog, 12 IX 2016. Y. H. Yan et al. ZXL07275” (CSH0137167). **Yunnan:** “Zhenkang, 2800 m. III 1936. C. W. Wang 72509” (PE00405931); “Congyuan, Nangunhe nature reserve, 1 III 2001. J. C. Zhao 2000-3” (PE00405930); “Lushui, 2380 m. 18 VI 1981. Y. F. Han et al. 81-768” (PE01593691); “Lushui, II 1935. C. W. Wang 71971” (PE00244926, PE00244931); “Longling Xian, Longjiang Xiang. Xiaoheshan Provincial Preserve. Xiaotai Shan, Xiaoshui He, on W side of Gaoligong Shan, S of the new road from Baoshan to Tenchong via Nankang Yakou. 2011 m. 24°49'44"N, 98°45'36"E. Subtropical evergreen broadleaf forest. Disturbed by felling. Secondary forest with grassy cleared areas along streams. Growing under shrubs at edge of forest, 21 VIII 2003. Gaoligong Shan Biodiversity Survey 17312” (KUN1407313); “Gongshan, 1700 m. 1935. C. W. Wang 67309” (KUN); *ibid.*, “Chiu-Kiang, W of Champutung, 1700 m. X 1935. C. W. Wang 67309” (KUN0801785); *ibid.*, “Hills around Jengyueh, II 1913. G. Forrest 9694” (E00823623); “Hills around Jengyueh, 6–8000 ft, II 1913. G. Forrest 9697” (E00823624); *ibid.*, “Hills around Jengyueh, 5000 ft. V 1912. G. Forrest 7705” (E00823625); “Western Yunnan, without exact locality, 1952. R. C. Ching 50510” (PE00244911); “l. c., R. C. Ching 50513” (PE00244913); “Tenchong Xian, Jietou Xiang, Datang Cun. Vicinity of Erdagou Wailinggan, NNE of Datang. W side of Gaoligong Shan. 25°44'26.1"N, 98°42'9.8"E. 2080–2150 m. Growing under forest along trail. Herb. ca. 20 cm tall. 14 V 2006. Gaoligong Shan Biodiversity Survey 30168” (KUN1407319); *ibid.*, “Wuhe, Xieng, km 24.7 along Highway S, 317.1 km north along road to Tenghang village and ridge to the W of the river along trail to the Zhengding forest reserve station. 2146 m. 24°51'22"N, 98°45'23"E. Growing in a partially shaded dell on forest floor. 28 V 2005. Gaoligong Shan Biodiversity Survey 25074” (KUN1407318); *ibid.*, “Jietou Xiang, Zhoujiapo on the road between Jiefou and Datang, 25°33'11"N, 98°40'6"E, disturbed secondary broadleaved evergreen forest and scrub, 1680 m, 28 X 1998. L. Heng, B. Bartholomew, D. Zhilia 11139” (KUN1407312, E00246016); “Honghe, Pingbian, Wantang, 24 XI

2017. Y. F. Li B170094" (CSH0150753); "Luchun, Laobian, 1500 m. 21 X 1973. D. D. Tao 1011" (KUN0801833); "Luchun, Laobian, 1500 m., 28 IV 1974. Luchun Team 178" (KUN0801880); "Yuanyang, Fengchunling, Jiejipo, alt. 1300 m. 7 VI 1974. Luchun Team 1619" (KUN0801884, KUN0801866); "Luchun, alt. 1800 m. 11 V 1974. Luchun Team 675" (KUN0801879, KUN0801878); "Wenshan, Laojunshan, alt. 1500 m. 6 V 1962. G. M. Feng 22524" (KUN0801709, KUN0801708); "Xichou, Fadou, 14 III 1986. W. M. Chu et al. 21694" (PYU); "Jinping, Fenshuiling, Hetouzhai, 17 VII 1980. W. M. Chu 3835" (PYU); "Jinping, 16 V 1976. W. M. Chu et al. 6356" (PYU); "Luchun, 10 VI 1976. W. M. Chu et al. 6605" (PYU); "Gongshan, Dulongjiang, 2 X 2004. W. M. Chu, R. Zhao 31295" (PYU); "Gongshan, Dulongjiang, 13 IX 1999. W. M. Chu et al. 29310" (PYU); "Simao, Caiyanghe Nature Reserve, forest on clay slope along road in forest, 1500 m. 8 VIII 2007. K. Iwatsuki, S. K. Wu 0701" (KUN1226629); "Lu-chun, Niu-bo-shui-ku, along trail at edge of forest, 1850–1950 m. 2 VIII 1994. S. K. Wu, X. Cheng, Y. P. Yang, K. Iwatsuki, J. Murata, H. Nagamasu 1466" (KUN0801724); "Lu-chun, Ba-dong-dao-ban, along trail in sparse secondary forest, 1650 m. 1 VIII 1994. S. K. Wu, X. Cheng, Y. P. Yang, K. Iwatsuki, J. Murata, H. Nagamasu 1435" (KUN0801722); "Lu-chun, Fen-shui-ling, along trail at edge of dense secondary forest, 1700 m. 1 VIII 1994. S. K. Wu, X. Cheng, Y. P. Yang, K. Iwatsuki, J. Murata, H. Nagamasu 1420" (KUN0801721); "Shweli river drainage basin to summit of Shwell-Salween watershed east of Tengyueh, XI 1922, J. Rock 7689" (US01392969).

MYANMAR: Kachin: "Putao District, Putao Township, Maliraing area, buffer zone of Hkakaborazi National Park, around camp 3. 27°41'25.8"N, 97°23'49.4"E. Growing along the riverside, 638 m. 11 XI 2016. T. Y. New, K. Armstrong, D. Little, P. P. Hnin, B. Shaung, T. Naing, S. N. Syn, J. Dan, D. Ram 543" (NY02654079); "Kachin State. Putao District. Naungmung Township, buffer zone of Hkakaborazi National Park, around Hton Wan rest house. 27°30'10.3"N, 98°0'12.6"E. 729 m. 16 IX 2015. D. Little, K. Armstrong, S. Lwin, M.M. San, Z. N. Tun, P. S. Aung, A. Syn, A. Bai 1444" (NY02649226); "Kachin State. Putao District. Naungmung Township, buffer zone of Hkakaborazi National Park, around Tup Kwan rest house. 27°36'15.6"N, 98°9'31.3"E, 729 m. 16 X 2015. D. Little, K. Armstrong, S. Lwin, M. M. San, Z. N. Tun, P. S. Aung, A. Sun, A. Bai 1444" (NY02649226); "Kachin State. Putao District. Naungmung Township, buf-

fer zone of Hkakaborazi National Park, around Tup Kwan rest house. 27°36'15.6"N, 98°9'31.3"E, 1929 m. 25 IX 2015. K. Armstrong, D. Little, S. Lwin, M.M. San, Z.N. Tun, P.S. Aung, A. Syn, A. Bai 987" (NY02648619).

Sagaing: "Stilwell Road, Burma Assam Border, 1942, H. Young 36" (MICH1173545); "l. c. H. Young 24" (MICH1173544).

THAILAND: Loei: "Northeastern: Phu Kradung, S. of Loi, 16°53'N, 101°53'E, 1100 m. 7–9 XI 1970. Ch. Charoenphol, K. Larsen, E. Warncke 4709 (3rd Expedition 1970)" (L.3484642). **Udawn:** "Loey: Phu Kradung, on the plain at its summit, alt. ca. 1100–1200 m, on rather dry slope in forest. 28 XI 1965. M. Tagawa, K. Iwatsuki, N. Fukuoka 587" (L.3484655).

LAOS: "Sam-Nena, 9 X 1920. E. Poilane 2031" (L.3726783; P01229420); "env. de Nape, 13 X 1928. M. Delacour s. n." (P01229412; P01254282).

VIETNAM: Annam: "Massif du Honba, Aout, 1919, F. Vincens s. n." (P01229422). **Tuyên Quang:** "Tam Dao National Park: North of Vietnam, 900–1100 m., 21°27'47" N, 105°38'68"E, 31 X 2004. L. Q. Li, N. T. Hiep, Z. Y. Zhang, X. C. Zhang, T. G. Gao, Z. T. Wang, N. S. Khang, N. X. Tam 0638" (PE01849460).

Selaginella monospora Spring, 1850, Mém. Acad. Roy. Sci. Belgique. 24: 135, no. 80; Alston, 1945, Proc. Nat. Inst. Sci. India 11: 228; Panigrahi, Dixit, 1968, Proc. Nat. Inst. Sci. India, 34B (4): 201; Dixit, 1992, Selaginell. India: 92, p. p.; Fraser-Jenkins et al., 2015, Ferns Fern-Allies Nepal 1: 73, p. p.; Fraser-Jenkins et al., 2017, Annot. Checkl. Indian Pteridophytes: 39, p. p.

≡ *Lycopodium monosporum* (Spring) Hook, 1857, Bot. Misc. 9: 362.

= *Selaginella plumosa* var. *monospora* (Spring) Baker, 1883, J. Bot. 21: 145.

Type: (lecto – designated by Fraser-Jenkins et al., 2017) [BHUTAN] "Bootan [Khegumpa, N. of Dewangiri (Deotang)], W. Griffith 391 Journal [24 I 1838], Herbarium Hookerianum" (K – [K001067478] image online!).

= *S. gorvalensis* Spring, 1850, Mém. Acad. Roy. Sci. Belgique. 24: 256, no. 195.

≡ *Lycopodioides gorvalensis* (Spring) Kuntze, 1891, Revis. Gen. Pl. 2: 826.

Type: [INDIA] "Gorval, Griffith s. n., in error for Khasia" (K – [K000009117] image online!).

= *S. medogensis* Ching et S. K. Wu, 1983, Fl. Xizang. 1: 23, pl. 6, *syn. nov.*

≡ *S. effusa* var. *medogensis* (Ching et S. K. Wu) W. M. Chu, 2006, Fl. Yunnan. 20: 719.

Lectotype (designated here): [CHINA] “Xizang austro-orient., Medog, in sylvis alt. 800 m, 19 VIII 1974. Qinghai-Xizang Complex Exped. 74-4375” (PE! – [PE00405946]; iso – PE! [PE00405947], KUN! – [KUN1217049], PYU! fragm.). – [INDIA] “Pachak-shiri Distr., Laung, plastered on the moss covered banks in dense mixed forest, 2000–2500 m. 9 V 1938. F. Ludlow, G. Sherriff, G. Taylor 3723” (paralecto – PE! – [PE00405945], BM?).

= *S. trichophylla* K. H. Shing, 1993, Acta Phytotax. Sin. 31(6): 569, pl. 2, **syn. nov.**; W. M. Chu, 2006, Fl. Yunnan. 20: 83; X. C. Zhang et al., 2013, Fl. China 2–3: 61; Shalimov et al., 2019, PhytoKeys 133: 35.

≡ *S. monospora* subsp. *trichophylla* (K. H. Shing) X. C. Zhang, 2004, Fl. Reipubl. Popularis Sin. 6(3): 189.

Type: “China, Yunnan prov., Gongshan, Dulongjiang River, alt. 1450–1500 m, in sylvis frondosis, 22 VIII 1982, Qinghai-Xizang Exped. 9451” (PE! – [PE00452190]).

= *S. monospora* var. *ciliolata* W. M. Chu, 2006, Fl. Yunnan. 20: 719, **syn. nov.**

Type: “China, Yunnan prov., Jingdong, Ailao Shan, Xujiaba, alt. 2450 m, under evergreen broad-leaved forest, 22 IV 1982. J. J. He 13352” (PYU!; iso – PE!); “China, Yunnan prov., Wuliang Shan, 20 IV 1964. R. S. Wang et al. 14” (para – PYU!); “China, Yunnan prov., VII 1964, X. W. Ren 3824” (para – PYU!); “China, Yunnan prov., Wuliang Shan, Mengling, alt. 1800 m, on moist cliff in evergreen broad-leaved forest, 9 IX 1979. W. M. Chu, Z. Z. Jin 9073” (para – PYU!); “China, Yunnan prov., Wuliang Shan, Wenpu, Erdaoya, Qingtou, alt. 2100 m, under evergreen broad-leaved forest. 9 IX 1979. W. M. Chu, Z. Z. Jin 9299” (para – PYU!); “China, Yunnan prov., Malipo, Laojuan Shan, alt. 1600 m, under evergreen broad-leaved forest, 30 VII 1993. S. G. Lu, G. F. Zhang 27625-B” (para – PYU!, PE!); “China, Guandong prov., Xinyi, Datian Ding, alt. 1600 m, under evergreen broad-leaved forest, 23 VIII 1984. W. M. Chu et al. 18296” (para – PYU!, PE!); “NEPAL, East Nepal, Mai Majuwa-Dhara Pani, alt. 1500–1600 m, 4 XII 1963. H. Hara, H. Kanai, S. Kurasawa, G. Murata, M. Togashi, T. Tuyama s. n.” (para – KUN! – [KUN0801546], L – [L.3498103] image online!).

= *S. effusa* var. *dulongjiangensis* W. M. Chu, 2006, Fl. Yunnan. 20: 718, **syn. nov.**

Type: “China, Yunnan prov., Gongshan, Dulongjiang valley, between Kongdan and Xianjiudan,

on cliff at edge of evergreen broad-leaved forest, alt. 1500 m, 3 X 2004. W. M. Chu, Z. R. He 31299” (PYU!; iso – PE! – [PE n 2526065]), “China, Yunnan prov., Gongshan, Dulongjiang valley, Bukawang, on cliff at edge of evergreen broad-leaved forest, alt. 1440 m, 2 X 2004. W. M. Chu & Z. R. He 31291” (para – PYU! – [PYU01065937]).

Plants creeping, 30–50 cm. Rhizophores at intervals throughout length of creeping stem and branches, borne on ventral side in axils of branches. Main stems pinnately branched throughout, stramineous, terete, not sulcate; primary leafy branches 10–15 pairs, once or twice pinnately branched, secondary branches forked or once pinnately branched, tertiary branches forked, branchlets sparse, adjacent primary branches on main stem 2–4 cm apart; leafy portion of main stem including leaves 5–6 mm wide at middle, ultimate branches 2.8–3.2 mm wide including leaves. Axillary leaves ovate, 1.2–2.5 × 1–2 mm, base exauriculate, margin ciliolate. Dorsal leaves ovate, 1.2–1.9 × 0.5–1 mm, not carinate, base obtuse or subcordate, not peltate, margin ciliolate, apex aristate to cuspidate. Ventral leaves on branches distant, slightly ascending or spreading, ovate-triangular, oblong or oblong-ovate 2–3.2 × 0.8–1.6 mm, margin denticulate, apex acute; acroscopic base enlarged, broader, overlapping stem and branches, margin denticulate, ciliolate. Sometimes upper surface ventral leaves with spines. Strobili solitary, dorsiventrally complanate, 6.0–10 × 1.2–2.3 mm; sporophylls dimorphic, resupinate, not white-margined; dorsal sporophylls ovate-lanceolate, carinate, margin denticulate, apex acuminate, with sporophyll-ptyx complete and denticulate; ventral sporophylls ovate-lanceolate, carinate, margin denticulate; megasporophylls in basal portion on lower side of strobilus; microsporangia transversely elliptic, rather thin, upper margin cells differentiated; microspores pale yellow, megasporangia white-yellow.

Ecology: on moist cliff in evergreen broad-leaved forest. Alt. 1100–3033 m.

Distribution in Pan-Himalaya region: NEPAL (C Nepal, E Nepal), INDIA (Sikkim), BHUTAN, CHINA (Yunnan, Sichuan).

General distribution: INDIA (Assam, Sikkim, Meghalaya), NEPAL (Dolakha, Sankhuwasabha), BHUTAN, CHINA (Hainan, Guangxi, Guizhou, Guandong, Yunnan, Sichuan), MYANMAR (Kachin), VIETNAM (Cao Bang, Quảng Ninh).

Notes: In the protologue, Ching and S. K. Wu (in S. K. Wu, 1983) cited single specimens “Qinghai-Xizang Complex Exped. 4375” with the label as

“type” kept at HP (= PE). Both of these sheets had the field number “4375” attached, but the herbarium label already had the entry “74-4375”; to correct this omission we add the citation numbers from the herbarium label. Besides, these herbarium sheets contain a signature on the herbarium label with the name “*Selaginella mutensis* Ching and S. K. Wu sp. nov.” *nom. in shed. herb.*, this name was later used in the work of Liu et al., 2005.

Selected specimens examined:

BHUTAN: “Rukubi (2600) – Chendebi (2300) – Charikhachor (2250) – Neylong (2200), 14 IV 1967. H. Hara, H. Kanai, G. Murata, H. Ohashi, O. Tanaka, T. Yamazaki 4105” (KYO); “Yuto La, between Bumthang and Trongsa, 8500 ft. Shady banks in deciduous forest, 4 VIII 1949. F. Ludlow, G. Sherriff, J.H. Hicks 17023” (KYO; L.4328981).

CHINA: **Hainan:** “Wuzhi Mt. 18°53'N, 109°41'E, 1800 m, in forest, 18 XII 2004. Wuzhishan Fern Survey 134” (PE); “Wuzhishan, 1700–1800 m. 16 XI 2000. X. C. Zhang, G. M. Zhang, D. Li 1698” (PE); “Wuzhishan, 1700–1800 m. 16 XI 2000. X. C. Zhang, G. M. Zhang, D. Li 1704” (PE); “Wuzhishan, 1700–1800 m. 16 XI 2000. X. C. Zhang, G. M. Zhang, D. Li 1699” (PE); “Qiongzong li and Miao autonomous county, Wuzhi Mt. one peak to two peaks, 1800 m. 28 XII 1974. 236-6 n 01798” (PE 00405937); “Wuzhi Mt. 18°89'13"N, 109°70'39"E. 28 XI 2018. Y. R. Wang 9375” (PE); “Wuzhi Mt. 18°89'10"N, 109°20'34"E, 2 XI 2018. Y. R. Wang 9370” (PE); “Wuzhi Mt. 18°89'16"N, 109°70'12"E, 2 XI 2018. Y. R. Wang 9371” (PE); “Qiongzong, Wuzhishan, 1800 m. 28 XII 1974. 236-6 Team 01798” (PE00405937). **Guizhou:** “Pana, Chengfeng, on cliff, 25 IX 1930. Y. Tsiang 4418” (PE00405630); “T. N. Liou 6718” (PE00405632); “Du Yun City, Cape Mountain Nature Reserve, under forest, alt. 998 m. 7 X 2007. Z. X. Lin, Y. L. Lan 07313” (KUN); “I. c., Z. X. Lin, Y. L. Lan 07315” (KUN); “Duyun, Doupengshan Nature Reserve, 7 X 2007. Z. X. Lin, Y. L. Lan 07313” (HUST); *ibid.*, “7 X 2007. Z. X. Lin, Y. L. Lan 07315” (HUST); “Zhenfeng, 25 X 1930. Y. Tsiang 4418” (PE); “T. N. Liou 6718” (PE00405632). **Guandong:** “Anonymous 615” (PE00405928); “Sun Yat-sen University 615” (PE 00244908); “ZXL 10058” (CSH0044647); “Xin yi county, Fog ridge, 13 VIII 2004. Y. H. Yan, N. L. Jin, Y. Wang, X. F. Zhu WYD 404” (CSH0068766); “Xinyi, Dawuling, 3 VIII 2003. Y. H. Yan et al. 1403” (PE). **Guangxi:** “Gui Ping City, Da Ping Shan, Lv Chong, evergreen broad-leaved forest, sandstone, alt. 600 m.

24 IX 1987. H. G. Zhou, Y. Li 939” (PYU); “Gui Ping City, Lv Chong, bamboo forest, sandstone, alt. 200 m. 27 IX 1987, Y. Li, H. G. Zhou 1012” (PYU); “Gui Lin City, Yong Fu county, Baoli township Qingping village siding, broad-leaved forest, forest, yellow brown soil, alt. 326 m. 24°50'52.8"N, 110°08'24.0"E, 4 III 2013. Yongfu county census team, 450326130304011LY” (GXMG 0152819); “Jinxiu mountain, 2 XI 2018. Y. R. Wang 9540” (PE); “Guiping, Taipingshan, 24 IX 1987. H. G. Zhou, Y. Li 939” (PYU); “Guiping, Luchong, 27 IX 1987. Y. Li, H. G. Zhou 1012” (PYU). **Yunnan:** “Xichou county, Fadou village, dank humus under the forest, alt. 1600 m. 15 III 1987. W. M. Chu et al. 21738” (PYU); “Ping Bian county, Da Wei Shan, Y. Jiao 2000–03” (PYU); “Jing Dong county, on a dry hillside, alt. 2100 m. 1 X 1956. Y. Qiu 52468” (KUN0801134); “Jing Dong county, under a forest on a hillside, alt. 1800 m. 5 VI 1986. Wu Liang Shan team 0023” (KUN); “Houqiao, Tengchong county, forest, 1750–1800 m, 31 III 2003. X. C. Zhang 2992” (PE); “Gongshan, alt. 1300–1400 m, 24 I 2017. X. C. Zhang et al. 8121” (PE); Tengchong, Dahetou, 14 V 2016. Z. D. Fang et al. DJDC-653” (SABG); “Tengchong, Houqiao, 31 III 2003. X. C. Zhang 1403” (PE); “Tengchong, Houqiao, 12 IX 2003. X. C. Zhang 3007” (PE); “Tengchong, Houqiao, 12 IX 2003. X. C. Zhang 3009” (PE); “Yongde, Daxueshan, 8 XI 1982. W. M. Chu et al. 14863 (A)” (PYU); “Xichou, Fadou, 15 III 1987. W. M. Chu et al. 21738” (PYU); “Pingbian, Daweishan, Y. Jiao 2000–03” (PYU); “Jinping, 1400 m. 10 IV 1959. Class 1960 Plant Resources Investigation Team 1014” (PYU); “Fugong Xian, Lumadeng Xian, ca. 2.8 direct km SSW of the Yaping bridge, on the W side of the Nujiang, ca. 22.5 direct km N of Fugong city. 27°6'29"N, 98°52'11"E, disturbed secondary forest. Growing in thicket, moist, near stream in forest shade area, creeping perennial herb, 1255 m. 28 IV 2004. Gaoligong Shan Biotic Survey Expedition 19963” (E00268722); “Fugong Xian, Yaping Xian, Vicinity of Shibali logging station on the road from the Nujiang to Yaping pass, E side of Gaoligong Shan, 2485 m. 27°9'48"N, 98°46'58"E, growing on rock in forest, creeping herb, 28 IV 2004. Gaoligong Shan Biotic Survey Expedition 20013” (E00258354). **Sichuan:** “Jun Lian county, liberation commune Shui Tou creek, canyons, under broad-leaved forests, on rock walls, 14 VI 1978. H. S. Kung 5255” (PYU); “Jun Lian county, liberation commune shui tou creek, canyons, under broad-leaved forests, on wet rock walls, alt. 1100 m, 14

VI 1978, H. S. Kung 5229” (PYU); *ibid.*, “14 VI 1978. H. S. Kung 5225” (CDBI); “Shimian, Caoke, Tangjiashan, 15 IX 1991, s. l. 1434” (CDBI). **Xizang**: “Medog, Beibeng, 800–1400 m, 2 V 2021. Zhang X. C. et al. 11429” (PE).

INDIA: Assam: “Indochina, Assam, Griffith s. n.” (P00523054). **Sikkim**: “E Sikkim District. Above and S of Penlang Bazaar, below and on way up to Namphung Peak of the Tinjure ridge, W. of Tashi viewpoint, across valley to the north of Gangtok. Just below crest on N side of densely mixed-forest ridge, 29 IX 1998. C. R. Fraser-Jenkins 27054 (FN 3031)” (L.4328985); “Pachak-Shiri Distr., Laung, «plastered on the moss covered banks in dense mixed forest», 28°45'N, 94°15'E, 7–8000 ft. 9 V 1938. F. Ludlow et al. 3723” (PE00405945, ?BM). **Meghalaya**: “Arwah Cave, under forest, 4 IV 2019. CPG Expedition CPG40561 (Lai Y. J., Zhang Q.)” (PE).

NEPAL: C NEPAL: Dolakha: “Jiri, Dolakha, alt. ca. 2200 m, 4 X 1988. T. Nakaikae 3076” (PE). **E NEPAL: Sankhuwasabha**: “Seduwa, in shade under rocks, 5000 ft. 7 VI 1965. Banerjee, Upadhyay, Baskola 3322” (US01392965). **ILAM**: “Mai Majuwa-Dhara Pani, alt. 1500–1600 m, 4 XII 1963. H. Hara, H. Kanai, S. Kurasawa, G. Murata, M. Togashi, T. Tuyama s. n.” (KUN; L.3498103).

MYANMAR: Kachin: “Kachin state, 27°31'56.4"N, 96°08'51.1"E, alt. 2393 m. 18 X 2016. T. Y. Nwe et al. Tyn380” (PE); “Kachin sta-

te, 27°30'55.2"N, 96°78'03.2"E, alt. 3033 m. 20 X 2016. T. Y. Nwe et al. Tyn410” (PE).

VIETNAM: Quảng Ninh: “Tonkin (Dam-Ha: Sai Wong Mo Shan (Sai Vong Mo Leng) Lomg Ngong Village, 18 VII – 9 IX 1940. W. T. Tsang 30240” (E00829326).

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Appendix 1

Specimen information and GenBank accession numbers (* indicates new accession)

Taxon	Voucher	Country	rbcL	atpI	psbA
<i>Selaginella albociliata</i> P. S. Wang	Zhang X.-C. 7242 (PE)	Guizhou, China	MH814882	MH814826	MH814854
<i>Selaginella amblyphylla</i> Alston	Zhang X.-C. 7951 (PE)	Yunnan, China	MH814884	MH814828	MH814856
<i>Selaginella amblyphylla</i> Alston	Zhang X.-C. 2924 (PE)	Yunnan, China	MH814883	MH814827	MH814855
<i>Selaginella bodinieri</i> Hieron.	Zhang X.-C. 5 (PE)	Chongqing, China,	MH814885	MH814829	MH814857
<i>Selaginella bodinieri</i> Hieron.	Zhang X.-C. 526 (PE)	Sichuan, China	MH814886	MH814830	MH814858
<i>Selaginella bodinieri</i> Hieron.	Zhang X.-C. 7069 (PE)	Guizhou, China	MH814887	MH814831	MH814859
<i>Selaginella braunii</i> Baker	Zhang X.-C. 1332 (PYU, CDBI)	Hainan, China	KT161420.1	–	–
<i>Selaginella chaetoloma</i> Alston	Zhang X.-C. 7347 (PE)	Guizhou, China	MH814889	MH814833	MH814861
<i>Selaginella chaetoloma</i> Alston	Guo Z.-Y. 2016014 (PE)	Guizhou, China	MH814888	MH814832	MH814860
<i>Selaginella chingii</i> Alston	Zhang X.-C. 7904 (PE)	Guangxi, China	MH814890	MH814834	MH814862
<i>Selaginella chrysocaulos</i> (Hook. et Grev.) Spring	Zhang X.-C. 86 (PE)	Sichuan, China	MH814891	MH814835	MH814863
<i>Selaginella ciliaris</i> (Retz.) Spring	Zhang X.-C. 7780 (PE)	Yunnan, China	MH814892	MH814836	MH814864
<i>Selaginella decipiens</i> Warb.	Zhang X.-C. 1130 (PE)	Guangxi, China	MH814893	MH814837	MH814865
<i>Selaginella deflexa</i> Brack.	–	–	AF093253.1	–	–
<i>Selaginella delicatula</i> (Desv. ex Poir.) Alston	Gao et al. HGX10734 (CDBI)	–	KT161441.1	–	–
<i>Selaginella dianzhongensis</i> X.-C. Zhang	Zhu Y.-M. 8158 (PE)	Yunnan, China	MH814909	MH814853	MH814881
<i>Selaginella effusa</i> var. <i>dulongjiangensis</i> W. M. Chu	Chu et al. 31299 (PYU)	Yunnan, China	KT161449.1	–	–
<i>Selaginella helvetica</i> (L.) Link	Zhou 093 (CDBI)	–	KT161472.1	–	–
<i>Selaginella heterostachys</i> Baker	Zhang X.-C. 7088 (PE)	Guizhou, China	MH814896	MH814840	MH814868
<i>Selaginella heterostachys</i> Baker	Zhang X.-C. 7268 (PE)	Guizhou, China	MH814897	MH814841	MH814869
<i>Selaginella kraussiana</i> (Kunze) A. Braun	Zhou 062 (CDBI)	Yunnan, China, Cult.	KT161498.1	–	–
<i>Selaginella kurzii</i> Baker	Zhang X.-C. 1934 (PE)	Yunnan, China	MH814898	MH814842	MH814870
<i>Selaginella labordei</i> Hieron. ex Christ	Zhang X.-C. 3356 (PE)	Hubei, China	MH814899	MH814843	MH814871
<i>Selaginella laxistrobila</i> K. H. Shing	Chu et al. 24449 (PYU)	Yunnan, China,	KT161509.1	–	–

Taxon	Voucher	Country	rbcL	atpI	psbA
<i>Selaginella medogensis</i> Ching et S. K. Wu	Qinghai-Xizang Complex Exped. 74-4375 (PE)	Tibet, China	OK247696*	–	–
<i>Selaginella megaphylla</i> Baker	Jin X.-H. 19301 (PE)	Tibet, China	MH814901	MH814845	MH814873
<i>Selaginella microclada</i> Spring	100000 mountain investigation team 109 (PE)	Guangxi, China	OK247697*	OK247681*	OK247713*
<i>Selaginella microclada</i> Baker	Wei Ran 342 (PE)	Yunnan, China	OK247699*	OK247682*	OK247714*
<i>Selaginella microclada</i> Baker	Zhang X.-C. et al. 7296 (PE)	Guizhou, China	OK247700*	OK247683*	OK247715*
<i>Selaginella microclada</i> Baker	Zhang X.-C. 7889 (PE)	Guangxi, China	MH814902	MH814846	MH814874
<i>Selaginella microclada</i> Baker	Zhang X.-C. et al. 8107 (PE)	Yunnan, China	OK247701*	OK247684*	OK247716*
<i>Selaginella microclada</i> Baker	Zhang X.-C. et al. 8307 (PE)	Yunnan, China	OK247702*	OK247685*	OK247717*
<i>Selaginella microclada</i> Baker	Zhang X.C. et al. 11429 (PE)	Xizang, China	OK247698*	–	–
<i>Selaginella monospora</i> Spring	CPG Expedition CPG40561 (PE)	Meghalaya, India	OK247709*	OK247692*	OK247722*
<i>Selaginella monospora</i> Spring	Zhang X.-C. et al. 8121 (PE)	Yunnan, China	OK247705*	OK247688*	OK247720*
<i>Selaginella monospora</i> Spring	Zhang X.-C. et al. 8122 (PE)	Yunnan, China	OK247706*	OK247689*	OK247721*
<i>Selaginella monospora</i> Spring	Zhang X.-C. 2992 (PE)	Yunnan, China	OK247703*	OK247686*	OK247718*
<i>Selaginella monospora</i> Spring	Yan Y.-H. et al. WYD404 (PE)	Guangdong, China	OK247711*	OK247694*	OK247724*
<i>Selaginella monospora</i> Spring	Zhang X.-C. 6016 (PE)	Guangxi, China	OK247704*	OK247687*	OK247719*
<i>Selaginella monospora</i> Spring	Yan Y.-H. et al. WYD427 (PE)	Guangdong, China	OK247712*	OK247695*	OK247725*
<i>Selaginella monospora</i> Spring	Wang Y.-R. 9370 (PE)	Hainan, China	OK247707*	OK247690*	–
<i>Selaginella monospora</i> Spring	Wang Y.-R. 9371 (PE)	Hainan, China	OK247708*	OK247691*	–
<i>Selaginella monospora</i> var. <i>ciliolata</i> W. M. Chu	Lu S. G., Zhang G. F. 27625-B (PE)	Yunnan, China	OK247710*	OK247693*	OK247723*
<i>Selaginella nipponica</i> Franch. et Sav.	Zhou et al. DJY07479 (CDBI)	Sichuan, China	KT161542.1	–	–
<i>Selaginella ornata</i> (Hook. et Grev.) Spring	Zhang X.-C. 8520 (PE)	Yunnan, China	MH814903	MH814847	MH814875
<i>Selaginella remotifolia</i> Spring	Zhou 005 (PYU, CDBI)	Yunnan, China	KT161580.1	–	–
<i>Selaginella repanda</i> (Desv. ex Poir.) Spring	Li B.-G. sn_20 (PE)	Yunnan, China	MH814906	MH814850	MH814878
<i>Selaginella repanda</i> (Desv. ex Poir.) Spring	Zhang X.- C. 9273 (PE)	Yunnan, China	MH814905	MH814849	MH814877

Taxon	Voucher	Country	rbcL	atpI	psbA
<i>Selaginella repanda</i> (Desv. ex Poir.) Spring	Zhang X.-C. 5655 (PE)	Yunnan, China	MH814904	MH814848	MH814876
<i>Selaginella selaginoides</i> (L.) P. Beauv. ex Schrank et Mart.	S. Weststrand 104 (UPS)	Sweden	KY023148.1	–	–
<i>Selaginella trichophylla</i> K. H. Shing	Zhang et al. 6784 (CDBI, MO, VNMN, PYU)	Cao Bang, Vietnam	KT161624.1	–	–
<i>Selaginella trichophylla</i> K. H. Shing	Chu et al. 31925 (PYU)	Yunnan, China	KT161621.1	–	–
<i>Selaginella trichophylla</i> K. H. Shing	Chu et al. 29310 (PYU)	Yunnan, China	KT161622.1	–	–
<i>Selaginella trichophylla</i> K. H. Shing	Jiang 318 (PYU, CDBI)	Hainan, China	KT161623.1	–	–
<i>Selaginella uncinata</i> (Desv. ex Poir.) Spring	Zhang et Zhou DJY04101 (CDBI)	Sichuan, China	KT161626.1	–	–
<i>Selaginella vaginata</i> Spring	Zhang Z.-S. 161 (PE)	Shaanxi, China	MH814907	MH814851	MH814879
<i>Selaginella xipholepis</i> Baker	Zhang X.-C. 7422 (PE)	Guizhou, China	MH814908	MH814852	MH814880