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Selaginella subeffusa, a new spikemoss from Southeast Yunnan, China

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Keywords: microspore, morphology, phylogeny, *Selaginella effusa*, *Selaginella monospora*, taxonomy, Yunnan.

Summary. Based on extensive herbarium research of the *Selaginella monospora* group (incl. *S. effusa*, *S. microclada*, *S. monospora*, *S. subdiaphana*, and *S. submonospora*) and on molecular phylogenetic evidence, an additional new species to this group was discovered. It was collected from Dawei Mountain in southeast Yunnan, and here named as *Selaginella subeffusa*. The new species distinctly differs from similar species by its coriaceous and densely imbricate ventral leaves on main stems and branches, 2.2–3.1 mm long and 1.1–1.5 mm wide, with enlarged acroscopic base, and strongly overlapping stem and branches, and with denticulate margins; microspores verrucate and perforate. Phylogenetic analyses of three plastid regions (*rbcL*, *atpI*, *psbA*) showed that *S. subeffusa* clustered with *S. submonospora* and nested between the “*S. microclada* – *S. effusa*” clade and the “*S. monospora*” clade.

Selaginella subeffusa – новый вид с юго-востока Юньнаня, Китай

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Ключевые слова: микроспоры, морфология, таксономия, филогения, Юньнань, *Selaginella effusa*, *Selaginella monospora*.

Аннотация. На основе обширных исследований гербарных образцов видов группы *Selaginella monospora*, включающей *S. effusa*, *S. microclada*, *S. monospora*, *S. subdiaphana* и *S. submonospora*, и молекулярно-филогенетических данных был обнаружен новый вид в этой группе. Он был собран с горы Давей на юго-востоке провинции Юньнань и назван *Selaginella subeffusa*. Новый вид четко отличается от близких видов кожистыми вентральными листьями, плотно черепитчато расположенными по главному стеблю и боковым ветвям, 2,2–3,1 мм длиной и 1,1–1,5 мм шириной, зубчатыми по краю, с увеличенным акроскопическим основанием, сильно перекрывающимися стебель и боковые ветви; микроспоры бородавчатые и перфорированные. Филогенетический анализ трех пластидных фрагментов (*rbcL*, *atpI*, *psbA*) показал, что образцы *S. subeffusa* сгруппированы с образцами *S. submonospora* и расположены между кладами “*S. microclada* – *S. effusa*” и “*S. monospora*”.

Introduction

The genus *Selaginella* P. Beauv. is the largest lycophyte genus, comprising about 700–800 species world-wide (Jermy, 1990; Zhang, 2004; Zhang et al., 2013; Weststrand, Korall, 2016). It is distributed predominantly in tropical regions (Jermy, 1986), although it is adapted to live in diverse ecosystems (Jermy, 1990; Valdespino, 1993). Since the publication of “Flora of China” in 2013 (Zhang et al., 2013), several new species and new records of *Selaginella* have been reported (Wu et al., 2017; Zhang, 2018; Shalimov et al., 2019; Zhang et al., 2020; He et al., 2021; Yang et al., 2021; Huang et al., 2022; Shalimov, Zhang, 2022).

The *Selaginella monospora* Spring group includes: *S. effusa* Alston, *S. microclada* Baker, *S. monospora* Spring (syn. *S. effusa* var. *dulongjiangensis* W. M. Chu, *S. medogensis* Ching et S. K. Wu, *S. monospora* var. *ciliolata* W. M. Chu, *S. trichophylla* K. H. Shing), *S. subdiaphana* (Wall. ex Hook. et Grev.) Spring, *S. submonospora* Shalimov et X. C. Zhang, and the here described *S. subeffusa* Shalimov et X. C. Zhang. Species of this group are widely distributed from the Indo-Himalayan region to China, and south to Indochina and Indonesia (Shalimov, Zhang, 2021). This assembly is characterized by creeping or suberect, or rarely erect main stems (i. e. *S. effusa*), with vegetative leaves denticulate or denticulate to ciliolate at margin, and megaspores verrucate or papillate on proximal faces and vermiculate on distal faces with micro echinate ornamentation. The spore ornamentation pattern here described for the *S. monospora* group corresponds to what Zhou et al. (2015) called “the *S. effusa* subtype”, which, however, is also found in *S. labordei* Hieron. ex Christ.

Material and methods

This study is mainly based on examination of herbarium specimens preserved at CSH, KUN, PE, PYU (acronyms follow Thiers, 2022) and online data sources: GBIF (<https://www.gbif.org/>) and CVH (<https://www.cvh.ac.cn/en>), which were used for additional verification of species determination. We examined high resolution type specimens of all concerned species treated in this study as described by Baker (1884), Alston (1932), Spring (1850), and Zhang et al. (2013).

Morphological observations were conducted using a Nikon DXM1200F camera connected to a stereomicroscope (Nikon SMZ 1000) and computer; measurements were done using D 3.10 software (<http://www.nikoninstruments.com>).

For scanning electron microscopy studies, dried and mature mega- and microspores were mounted on double-sided sticky tape, and sputter-coated with gold palladium. Spores were photographed and measured at different magnifications using a Hitachi S-4800 at 10–20 kV.

Phylogenetic analyses

For molecular analyses, total genomic DNA was isolated from silica dried material using the Plant Genomic DNA Kit (Tiangen Biotech, Beijing, China) following the manufacturer’s protocol, primers, PCR condition of three chloroplast genes (*rbcL*, *atpI*, and *psbA*), and the phylogenetic analysis was conducted as described in Shalimov et al. (2019). All examined accession from GenBank and newly generated sequences of 73 samples used here are listed in Appendix 1.

Results and discussion

Taxonomic treatment

Selaginella subeffusa Shalimov et X. C. Zhang, **sp. nov.** (Fig. 1, 2, 3).

Diagnosis. *Selaginella subeffusa* is morphologically intermediate between *S. microclada* and *S. effusa*, from which it is separated by its coriaceous leaves, ventral leaves densely imbricate on main stems and branches, each 2.2–3.1 × 1.1–1.5 mm; strobili 4.2–7.6 × 2.0–2.5 mm, and ventral and dorsal sporophylls margins denticulate.

Holotype: “China, Yunnan, Hekou, Dawei Mt., Sancha river, on forest slope, alt. 1120 m. 5 X 1999. Yu-Min Shui et al. 11716” (PE 01866084!).

Description. *Plants* terrestrial, evergreen, main stems creeping or suberect, robust, angulate, 15–30 cm long. *Rhizophores* restricted to base or proximal ½ of main stem and branches, borne on ventral side in axil of branches. *Main stems* pinnately branched several times, stramineous to reddish, 1–2 mm in diam. in lower part, stem oval or terete, some primary lateral branches developing into long branch systems; primary leafy branches 11–15 pairs, secondary branches once forked or 2–3 times pinnately branched, adjacent primary branches on main stem 1–3 cm apart; leafy portion of main stem 0.3–0.6 mm wide including leaves, ultimate branches 0.2–0.5 mm wide including leaves. *Axillary leaves* broadly-ovate or ovate-triangular, 1.4–2.5 × 0.9–1.4 mm, base obtuse, margin denticulate, apex acuminate. *Dorsal leaves* asymmetrical, leaves shifted to the side, ovate, 1.2–1.9 × 0.6–1.0 mm, carinate on abaxial surface, base obtuse, margin denticulate,



Fig. 1. *Selaginella subeffusa* Shalimov et X. C. Zhang, sp. nov. Digitized images of holotype: Yu-Min Shui et al. 11716 (PE 01866084).

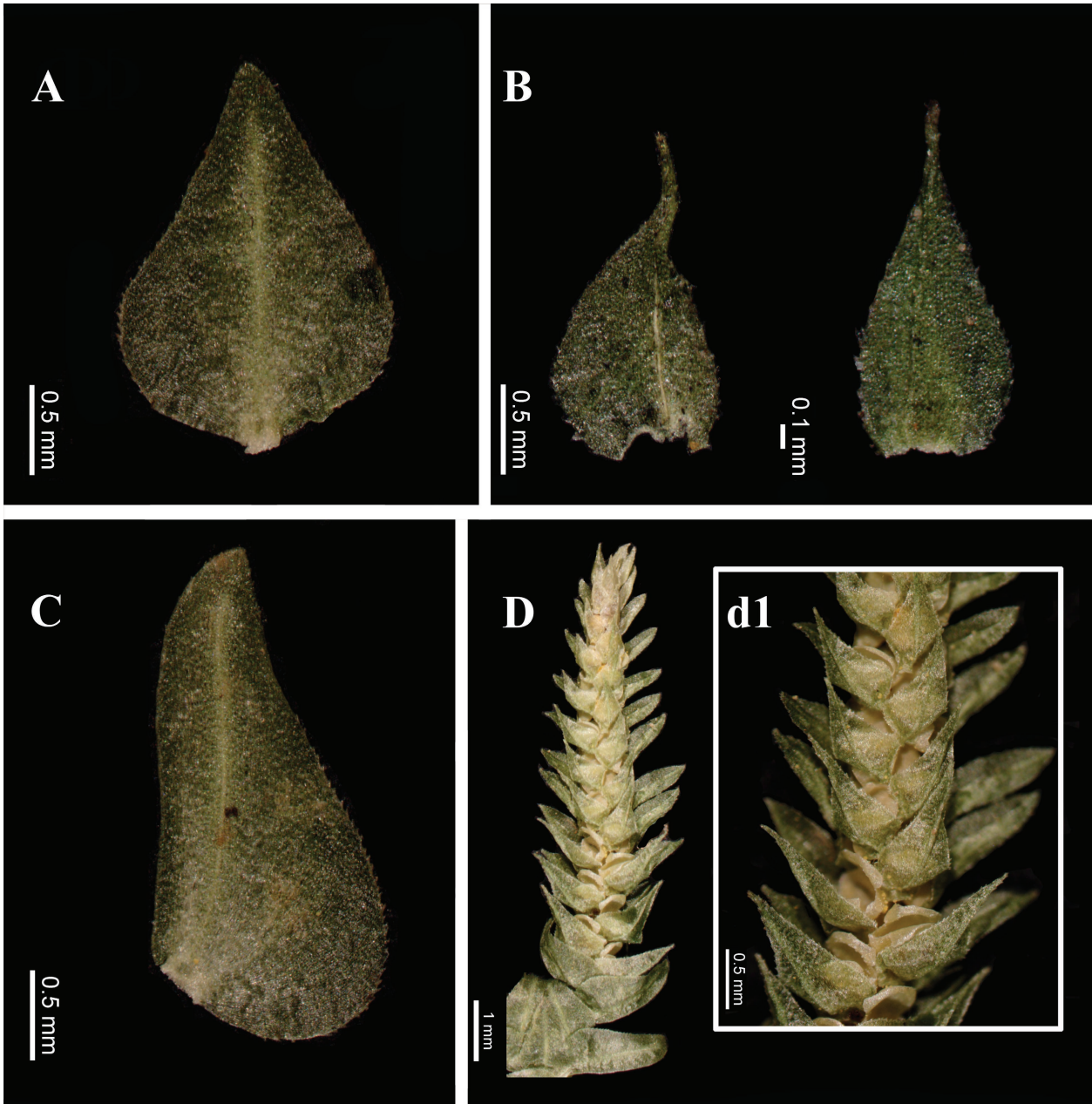


Fig. 2. *Selaginella subeffusa* Shalimov et X. C. Zhang: **A** – Axillary leaf, lower surface; **B** – Dorsal leaves, upper surface; **C** – Ventral leaf, lower surface; **D** – Strobili, lower surface, **d1** – close-up section of strobili. **A–D** from the holotype, Yu-Min Shui et al. 11716 (PE 01866084).

apex aristate. *Ventral leaves* asymmetrical, distant to imbricate, oblong or oblong-ovate, 2.2–3.1 × 1.1–1.5 mm, margin denticulate, apex subacute; basiscopic base decurrent, margin entire; acroscopic base rounded, strongly overlapping stem and branches, margin denticulate. *Strobili* solitary, terminal, compact, dorsiventrally complanate, 4.2–7.6 × 2.0–2.5 mm, strongly dimorphic, margins narrowly hyaline; dorsal sporophylls ovate-lanceolate, carinate with a complete and denticulate laminar-flap, margin denticulate, apex acuminate; ventral sporophylls ovate-triangular, strongly carinate

in central part, margin denticulate, apex long acuminate; megasporophylls in basal portion on ventral side of strobilus; microsporophylls in ventral and dorsal rows throughout strobili; microsporangia orbicular, rather thin with uniform cells; *megaspores* white, 253.8–330.7 μm in diam., verrucate but with few and distant verrucae on distal face, surface with vermiculate micro-sculpture of dense spinules; *microspores* yellowish orange, 25.2–32.4 μm in diam., densely verrucate on proximal and distal faces, micro-sculpture of surfaces perforate (Fig. 2).

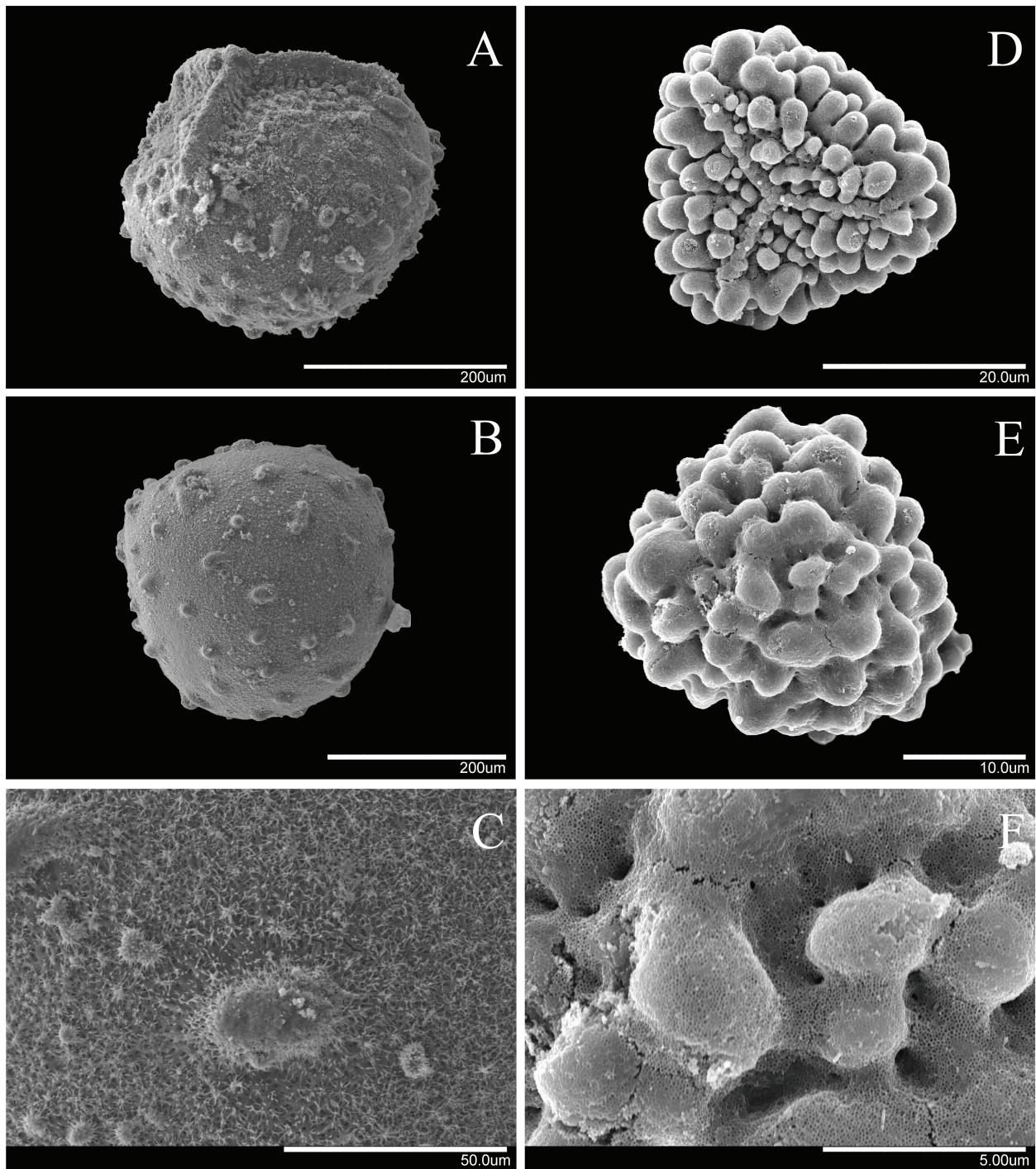


Fig. 3. *Selaginella subeffusa* Shalimov et X. C. Zhang (Yu-Min Shui et al. 11716; holotype: PE 01866084): **A**, **B**, **C** – Megaspore, **A** – Proximal-equatorial face, **B** – Distal face, **C** – Close-up of megaspore surface, proximal face; **D**, **E**, **F** – Microspore, **D** – Proximal face, **E** – Distal face, **F** – Close-up of microspore surface, proximal face.

Ecology. Mountain slopes in evergreen forest; 1080–1120 m.

Conservation status. *Selaginella subeffusa* is known from only two collections from Dawei Mountain, the exact size of each population is unknown. We tentatively assessed it as Data Deficient (DD) according to the IUCN (2021) categories and criteria.

Etymology. The specific epithet ‘*subeffusa*’ refers to its close relationship and morphological similarity to *S. effusa*.

Additional specimens examined (Paratype): CHINA: “Yunnan, Pingbian, Dawei Mt. National Park, Alt. 1080 m. 8 II 2018. Yi-Fan Li and Lei Liu B180051” (CSH0150370, CSH0150371).

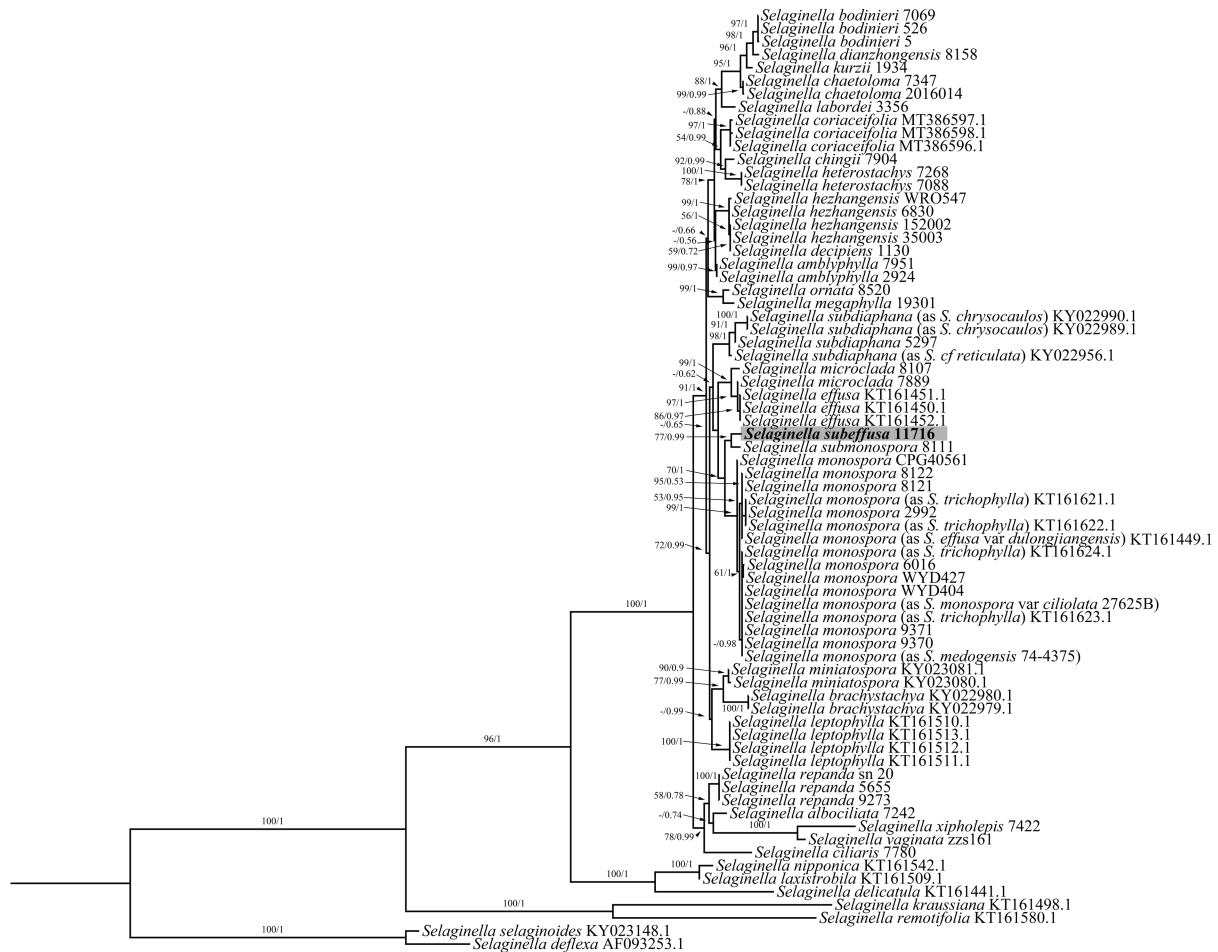


Fig. 4. The 50 % majority rule consensus tree derived from maximum likelihood showing the position of *Selaginella subeffusa*. Support values (BSML/PPBI) are shown above the main branches; the dash (–) indicates BS < 50 %. The new species name is boldfaced and highlighted in grey.

Phylogenetic Analysis

The concatenated matrix of three chloroplast DNA markers (*rbcL+atpI+psbA*) had 2042 characters, with 131 variable sites and 378 parsimony-informative sites. The reconstruction of the phylogeny tree derived from ML and BI analyses was topologically identical, hence the ML tree is shown in Fig. 4. Molecular data showed that *S. subeffusa* clustered with *S. submonospora* (Shalimov, Zhang, 2022), however, they are morphologically distinct. The *S. subeffusa* – *S. submonospora* clade is monophyletic (BS = 77, BP = 0.99) and sister to *S. microclada* – *S. effusa* clade (BS = 99, BP = 1) and *S. monospora* clade (BS = 99, BP = 1).

Morphological observations

Gross morphology

Selaginella subeffusa is morphologically similar to *S. effusa* but differs in its creeping or suberect main stems and branches (vs. erect in *S. effusa*), coriaceous and imbricate (vs. herbaceous and distant

or approximate) ventral leaves, and microspores verrucae with perforate surface (vs. verrucae or spherulate with smooth surface). It is also similar to *S. microclada*, especially in its habit and shape of lateral branches, densely arranged ventral leaves and amplexicaul dorsal leaves. However, *S. subeffusa* differs from the latter by its coriaceous (vs. herbaceous) leaves, strongly dimorphic (vs. slightly dimorphic) sporophylls. The most relevant morphological characters differentiating *S. subeffusa* from related species are summarized in Table and shown in Figure 5.

Spore morphology

Spore micromorphology of *S. subeffusa* was observed and documented (Fig. 3). Megaspores are verrucate with vermiculate micro-sculpture of dense spinules surface (Fig. 3, A, B, C). Morphologically similar megaspore features were reported for *S. effusa*, *S. microclada*, and *S. monospora* (Zhou et al., 2015; Wang et al., 2018; Shalimov, Zhang, 2021, 2022). However, microspores of *S. subeffusa* are

characterized by its irregularly sized verrucae and perforate microsculpture surface (Fig. 3, D, E, F). Furthermore, *S. subeffusa* is clearly distinct from

closely related species as compared with images provided in recent studies (i. e., Zhou et al., 2015; Wang et al., 2018; Shalimov, Zhang, 2021, 2022).

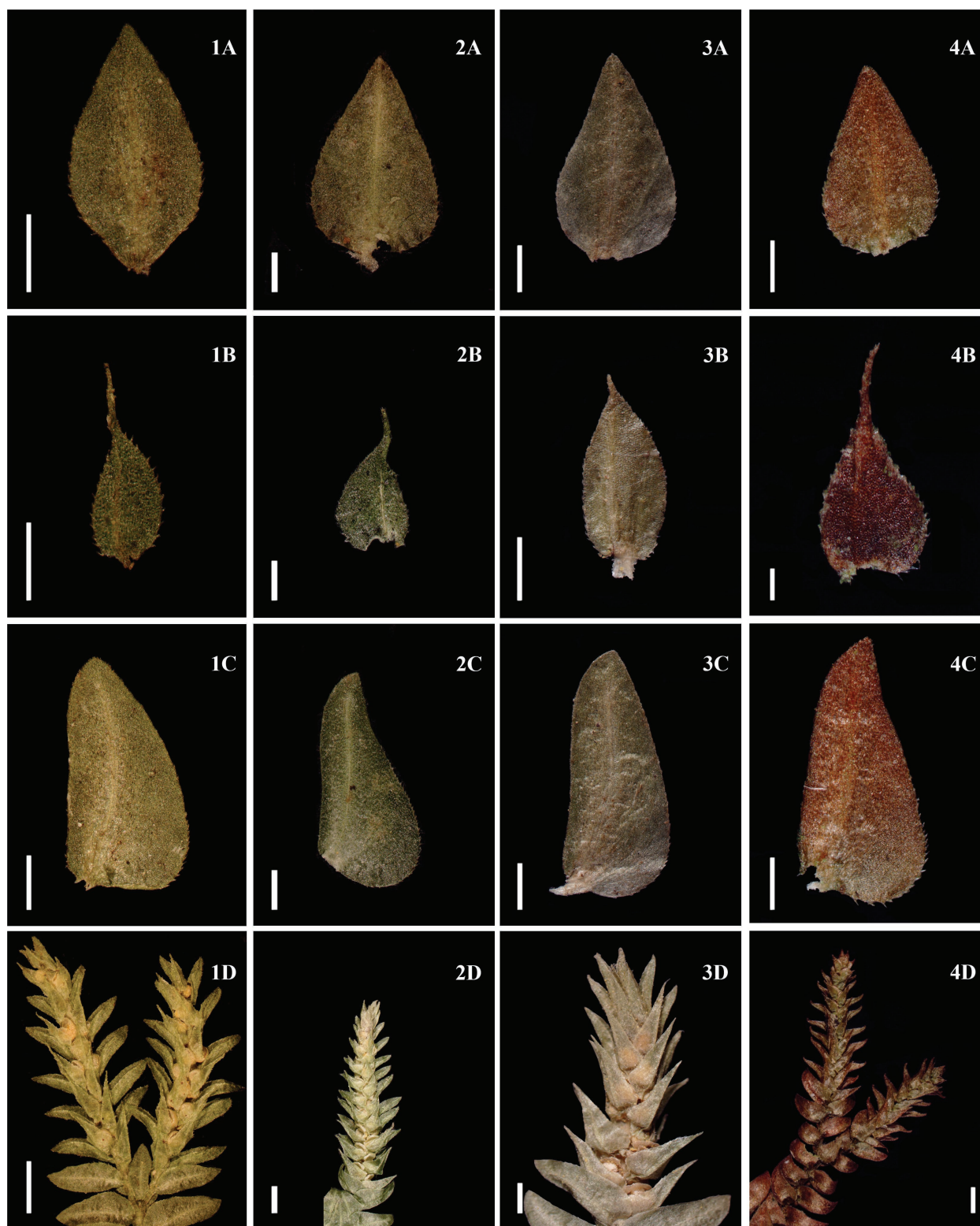


Fig. 5. Comparison of *Selaginella subeffusa* leaves and strobilus with related species: **1A–D** – *Selaginella effusa* (X.-C. Zhang et al. 5465, PE); **2A–D** – *S. subeffusa* (Y.-M. Shui et al. 11716, PE); **3A–D** – *S. microclada* (Feng 11473, PE); **4A–D** – *S. monospora* (CPG Expedition CPG40561 (Y. J. Lai, Q. Zhang), PE). **A** – Axillary leaves, lower surface; **B** – Dorsal leaves, upper surface; **C** – Ventral leaves, lower surface; **D** – Strobili, lower surface. Scale bars = 0.2 mm (**4B**); 1 mm (**1D**, **2D**, **4D**); 0.5 mm (**1A–1C**, **2A–2C**, **3A–3D**, **4A**, **4C**).

Table

Comparison of *Selaginella subeffusa* and related species

Characters		<i>S. effusa</i>	<i>S. subeffusa</i>	<i>S. microclada</i>	<i>S. monospora</i>
Habit and size (cm)		erect, 10–45	creeping, 15–30	long creeping, 35–85 or more	creeping, 30–50
Axillary leaves	shape	ovate, ovate-triangular, or ovate-elliptic	ovate, broadly-ovate or ovate-triangular	ovate, narrowly ovate, or narrowly elliptic	ovate
	size (mm)	2–3.5 × 1.2–2.8	1.4–2.5 × 0.9–1.4	2–3 × 0.8–1.6	1.2–2.5 × 1–2
	apex	acuminate	acuminate	acuminate	acuminate
	margin	ciliate	denticulate	denticulate	denticulate-ciliate
Dorsal leaves	shape	obliquely ovate-elliptic	ovate	ovate-lanceolate or elliptic	ovate
	size (mm)	1.5–3.2 × 0.6–1	1.2–1.9 × 0.6–1.0	1–1.6 × 0.3–0.7	1.2–1.9 × 0.5–1
	margin	ciliate	denticulate	denticulate	ciliate
	apex	aristate, arista curved, 0.8–1.6 mm	aristate	acuminate or shortly aristate	aristate to cuspidate
Base of dorsal leaf		subcordate or cuneate	obtuse	obtuse	obtuse or subcordate
Ventral leaves	shape	oblong or oblong-ovate	oblong or oblong-ovate	ovate-triangular or oblong-falcate	ovate-triangular, oblong or oblong ovate
	size (mm)	2.2–5 × 1–2.2	2.2–3.1 × 1.1–1.5	2.6–5.5 × 0.9–2.3	2–3.2 × 0.8–1.6
	margin	denticulate	denticulate	denticulate	denticulate, ciliate
	apex	subacute	subacute	subacute	acute
Acroscopic margin of ventral leaves	overlapping	strongly overlapping stem and branches	strongly overlapping stem and branches	slightly overlapping stem and branches	slightly overlapping stem and branches
	margin	ciliate along basal half, otherwise (denticulate apically)	denticulate	denticulate	denticulate, ciliate
Basiscopic margin of ventral leaves		ciliate at base, otherwise subentire apically	entire throughout	subentire or entire throughout	ciliate at base, subentire from middle of laminate to apically
Strobili	size (mm)	6.0–12.0 × 1.5–3.0	4.2–7.6 × 2.0–2.5	3.0–20.0 × 1.9–3.2	6.0–10.0 × 1.2–2.3
Dorsal sporophylls	shape	oblong-lanceolate	ovate-lanceolate	lanceolate	ovate-lanceolate
	margin	ciliolate	denticulate	minutely denticulate	denticulate
	apex	acute or acuminate	acuminate	acuminate	acuminate
Ventral sporophylls	shape	ovate-triangular shortly	ovate-triangular	ovate-lanceolate	ovate-lanceolate
	margin	ciliolate	denticulate	denticulate	denticulate
Megaspore	diameter (µm)	202.8–290.7* (160.0–280.0)233.3 × 258.7(173.3–320.0)**	253–330	305–420	280–432
	ornamentation	verrucae and/or papillate	verrucae	verrucae	verrucae and/or papillate
	surface	subsmoth	vermiculate	vermiculate	vermiculate
	micro-sculptures	spinulose* granulate/tuberculate	densely spinulose	spinulose	densely spinulose

Table (continued)

Characters		<i>S. effusa</i>	<i>S. subeffusa</i>	<i>S. microclada</i>	<i>S. monospora</i>
Microspore	diameter (μm)	26.54–33.19* (17.0–28.8)23.7 × 29.8(20.9–39.2)**	25–32	28–40	27–33
	ornamentation	verrucae or/and spherulate* tuberculate**	verrucae, surface perforate	verrucae, nearly rugulate	verrucae/ spherulate
	micro-sculptures	–	–	spinulose	fine reticulate

Note: More detail and photo see in: *Zhou et al. (2015), and ** Wang et al. (2018).

Key to *Selaginella subeffusa* and related species

1. Plants with long-creeping stems (up to 85 cm or more); sporophylls slightly dimorphic (sometimes appearing uniform); dorsal leaves ovate-lanceolate or elliptic; margin denticulate, apex acuminate or shortly aristate *S. microclada*
+ Plants with creeping, suberect, ascending or erect stems (less or up to 50 cm); sporophylls strongly dimorphic; dorsal leaves obliquely ovate-elliptic, broadly ovate-elliptic or ovate; margin denticulate or denticulate to ciliate, apex shortly acuminate or aristate to cuspidate 2
2. Ventral leaves strongly overlapping on stem and branches, acroscopic base enlarged, broader
..... 3
+ Ventral leaves not overlapping on stem and branches, acroscopic base not enlarged, oblique
..... *S. submonospora*
3. Axillary and ventral leaves strongly overlapping stems and branches 4
+ Axillary and ventral leaves slightly overlapping stems and branches 5

4. Main stem erect, vegetative leaves herbaceous, ventral leaves distant or approximate *S. effusa*
+ Main stem creeping or suberect, vegetative leaves coriaceous, ventral leaves imbricate
..... *S. subeffusa*
5. Ventral leaves ovate-triangular, at right angles to the stem; dorsal leaves with base subcordate, apex aristate to cuspidate; megaspores white-yellow
..... *S. monospora*
+ Ventral leaves ovate to ovate-lanceolate, at angles to the stem; dorsal leaves with base obtuse or slightly subcordate, apex short aristate; megaspores reddish-brown *S. subdiaphana*

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REFERENCES

- Alston A. H. G. 1932. Notes on *Selaginella* – II. *Journal of Botany, British and Foreign* 70: 61–67.
- Baker J. G. 1884. A synopsis of the genus *Selaginella*. *Journal of Botany, British and Foreign* 22: 241–247.
- He M., He Z.-R., Zhang L.-B., Zhou X.-M. 2021. *Selaginella qingchengshanensis* (sect. *Heterostachys*; Selaginellaceae), a new species from Sichuan, China. *Phytotaxa* 522(4): 285–293. DOI: 10.11646/phytotaxa.522.4.2
- Huang L., Li S.-H., Dong S.-Y. 2022. Two new species of the Lycophyte genus *Selaginella* (Selaginellaceae) from China, with notes on the phylogenetic positions of related species. *Systematic Botany* 47(1): 85–96. DOI: 10.1600/036364422X16442668423400
- IUCN [2021]. *The IUCN Red List of Threatened Species*. Version 2021-3. URL: <http://www.iucnredlist.org> (Accessed 05 April 2022).
- Jermey A. C. 1986. Subgeneric names in *Selaginella*. *The Fern Gazette* 13: 117–118.
- Jermey A. C. 1990. Sellaginellaceae. In: K. Kubitzki (eds.) *The families and genera of vascular plants*. Vol. 1. Berlin: Springer. Pp. 39–45.
- Shalimov A. P., Zhang X.-C. 2021. A taxonomic revision of *Selaginella monospora* Spring (Selaginellaceae). *Turczaninowia* 24, 3: 175–193. DOI: 10.14258/turczaninowia.24.3.14

- Shalimov A. P., Zhang X.-C.** 2022. *Selaginella submonospora* (Selaginellaceae), a new species from Yunnan. *Turczaninowia* 25, 1: 154–166. DOI: 10.14258/turczaninowia.25.1.15
- Shalimov A. P., Zhu Y.-M., Zhang M.-H., Zhang X.-C.** 2019. *Selaginella dianzhongensis* (Selaginellaceae), a new spikemoss from China. *PhytoKeys* 118: 75–87. DOI: 10.3897/phytokeys.118.30375
- Spring A. F.** 1850. Monographie de la Famille des Lycopodiacees, Seconde partie. *Mémoires de l'Académie Royales des Sciences, Lettres et Beaux Arts de Belgique* 24: 1–358.
- Thiers B.** [2022]. *Index Herbariorum*: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. URL: <http://sweetgum.nybg.org/science/ih/> (Accessed 5 April 2022).
- Valdespino I. A.** 1993. Selaginellaceae. In: *Flora of North America North of Mexico*. Vol. 2. Pteridophytes and gymnosperms. Oxford: Oxford Univ. Press. Pp. 38–63.
- Wang L., Zhang X.-C., Liu J.** 2018. Studies on the complementary relationship of surface ornamentations between megaspores and microspores of *Selaginella* P. Beauv. (Selaginellaceae). *Microscopy Research and Technique*: 1–15. DOI: 10.1002/jemt.23148
- Weststrand S., Korall P.** 2016. A subgeneric classification of *Selaginella* (Selaginellaceae). *American Journal of Botany* 103(12): 2160–2169. DOI: 10.3732/ajb.1600288
- Wu Y.-D., Zhang H.-R., Zhang X.-C.** 2017. *Selaginella guihaia* (Selaginellaceae): A new spikemoss species from southern China and northern Vietnam around the Gulf of Tonkin. *PhytoKeys* 80: 41–52. DOI: 10.3897/phytokeys.80.11126
- Yang J., Zhang M.-H., Wang Y.-R., Yuan L.-X., Zhang X.-C.** 2021. An extraordinary rosette and resurrection new spikemoss, *Selaginella iridescens* (Selaginellaceae) from Hainan Island, China. *Taxonomy* 1: 302–312. DOI: 10.3390/taxonomy1040024
- Zhang M.-H., Wei R., Xiang Q.-P., Ebihara A., Zhang X.-C.** 2021. Integrative taxonomy of the *Selaginella helvetica* group based on morphological, molecular and ecological data. *Taxon* 70(6): 1–25. DOI: 10.1002/tax.12565
- Zhang X.-C.** 2004. Selaginellaceae. In: X.-C. Zhang (ed.). *Flora Republica Popularis Sinicae*. Vol. 6. Beijing: Science Press. Pp. 86–219.
- Zhang X.-C.** 2018. Some new records of *Selaginella* from China. *Philippine Journal of Systematic Biology* 12, 1: 22–23.
- Zhang X.-C., Nooteboom H. P., Kato M.** 2013. Selaginellaceae. In: Z. Y. Wu, P. H. Raven, D. Y. Hong (eds.). *Flora of China*. Vols 2–3. Beijing: Science Press, St. Louis: Missouri Botanical Garden Press. Pp. 37–66.
- Zhang X.-C., Shalimov A. P., Kang J.-S., Zhang M.-H.** 2020. *Selaginella subvaginata* (Selaginellaceae), a new spikemoss from China. *Journal of Species Research* 9(3): 221–232. DOI: 10.12651/JSR.2020.9.3.221
- Zhou X.-M., Jiang L.-J., Zhang L., Gao X.-F., He Z.-R., Zhang L.-B.** 2015. Spore morphology of *Selaginella* (Selaginellaceae) from China and its systematic significance. *Phytotaxa* 237(1): 1–67. DOI: 10.11646/phytotaxa.237.1

Appendix

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. 2924 (PE)	Yunnan, China	MH814883	MH814827	MH814855
<i>Selaginella amblyphylla</i> Alston	Zhang X.-C. 7951 (PE)	Yunnan, China	MH814884	MH814828	MH814856
<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 brachystachya</i> (Hook. et Grev.) Spring	Sledge W. A. 913 (L)	Sri Lanka	KY022979	–	–
<i>Selaginella brachystachya</i> (Hook. et Grev.) Spring	Klackenberg J. 434 (S)	Sri Lanka	KY022980	–	–
<i>Selaginella cf. reticulata</i>	Fraser-Jenkins C. R. 1653 (L)	Nepal	KY022956	–	–

Appendix (continued)

Taxon	Voucher	Country	rbcl	atpI	psbA
<i>Selaginella chaetoloma</i> Alston	Guo Z.-Y. 2016014 (PE)	Guizhou, China	MH814888	MH814832	MH814860
<i>Selaginella chaetoloma</i> Alston	Zhang X.-C. 7347 (PE)	Guizhou, China	MH814889	MH814833	MH814861
<i>Selaginella chingii</i> Alston	Zhang X.-C. 7904 (PE)	Guangxi, China	MH814890	MH814834	MH814862
<i>Selaginella chrysocaulos</i> (Hook. et Grev.) Spring	Gaoligong Shan Biodiversity Survey 27010 (GH)	China, Yunnan	KY022989	–	–
<i>Selaginella chrysocaulos</i> (Hook. et Grev.) Spring	Li H. 12202 (GH)	China, Yunnan	KY022990	–	–
<i>Selaginella ciliaris</i> (Retz.) Spring	Zhang X.-C. 7780 (PE)	Yunnan, China	MH814892	MH814836	MH814864
<i>Selaginella coriaceifolia</i> X. M. Zhou, N. T. Lu et Li Bing Zhang	Zhang L.-B. et al. 7307 (CDBI, MO, VNMN)	Quang Binh, Vietnam	MT386596	–	–
<i>Selaginella coriaceifolia</i> X. M. Zhou, N. T. Lu et Li Bing Zhang	Zhang L.-B. et al. 7347(CDBI, MO)	Quang Binh, Vietnam	MT386597	–	–
<i>Selaginella coriaceifolia</i> X. M. Zhou, N. T. Lu et Li Bing Zhang	Zhang L.-B. et al. 7371 (CDBI, MO, VNMN)	Quang Binh, Vietnam	MT386598	–	–
<i>Selaginella decipiens</i> Warb.	Zhang X.-C. 1130 (PE)	Guangxi, China	MH814893	MH814837	MH814865
<i>Selaginella deflexa</i> Brack.	Palmer 2651(KANU)	Hawaii	AF093253		
<i>Selaginella delicatula</i> Alston	Gao & al. HGX10734 (CDBI)	Sichuan, China	KT161441	–	–
<i>Selaginella dianzhongensis</i> X.-C. Zhang	Zhu Y.-M. 8158 (PE)	Yunnan, China	MH814909	MH814853	MH814881
<i>Selaginella effusa</i> Alston	Zhang 5438 (CDBI)	Guangxi, China	KT161450	–	–
<i>Selaginella effusa</i> Alston	Zhang 5442 (CDBI)	Guangxi, China	KT161451	–	–
<i>Selaginella effusa</i> Alston	Wang 20051 (CDBI)	Guizhou, China	KT161452	–	–
<i>Selaginella effusa</i> var. <i>dulongjiangensis</i> W. M. Chu	Chu et al. 31299 (PYU)	Yunnan, China	KT161449	–	–
<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 hezhangensis</i> P. S. Wang et X. Y. Wang	FLPH Sichuan Expedition 152002	Sichuan, China	OM864654	OM864639	OM864647
<i>Selaginella hezhangensis</i> P. S. Wang et X. Y. Wang	Jiang X.-L. 35003 (PE)	Sichuan, China	OM864655	OM864640	–
<i>Selaginella hezhangensis</i> P. S. Wang et X. Y. Wang	Zhang X.-C. 6830 (PE)	Guizhou, China	OM864656	OM864641	OM864648
<i>Selaginella hezhangensis</i> P. S. Wang et X. Y. Wang	Wei R., Yang J. WRO547	Sichuan, China	OM864657	OM864642	OM864649

Appendix (continued)

Taxon	Voucher	Country	rbcL	atpI	psbA
<i>Selaginella kraussiana</i> (Kunze) A. Braun	Zhou 062 (CDBI)	Yunnan, China, Cult.	KT161498	–	–
<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	–	–
<i>Selaginella leptophylla</i> Baker	Zhang 5853 (CDBI)	Guizhou, China	KT161510	–	–
<i>Selaginella leptophylla</i> Baker	Zhang 5199 (CDBI)	Guangxi, China	KT161511	–	–
<i>Selaginella leptophylla</i> Baker	Zhou 011 (CDBI)	Sichuan, China	KT161512	–	–
<i>Selaginella leptophylla</i> Baker	Zhou et al. DJY05380 (CDBI)	Sichuan, China	KT161513	–	–
<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 miniatospora</i> (Dalzell) Baker	C. van Hardeveld, H. van der Werff 120 (U)	Tamil Nadu, India	KY023080	–	–
<i>Selaginella miniatospora</i> (Dalzell) Baker	Klackenberg J., Lundin R. 567 (S)	Kerala, India	KY023081	–	–
<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 monospora</i> Spring	Yan Y.-H. et al. WYD427 (PE)	Guangdong, China	OK247712	OK247695	OK247725
<i>Selaginella monospora</i> Spring	CPG Expedition CPG40561 (PE)	Meghalaya, India	OK247709	OK247692	OK247722.1
<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	OK24769	OK247724
<i>Selaginella monospora</i> Spring	Zhang X.-C. 6016 (PE)	Guangxi, China	OK247704	OK247687	OK247719
<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	–	–

Appendix (continued)

Taxon	Voucher	Country	rbcL	atpI	psbA
<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	–	–
<i>Selaginella repanda</i> (Desv. ex Poir.) Spring	Zhang X.-C. 5655 (PE)	Yunnan, China	MH814904	MH814848	MH814876
<i>Selaginella repanda</i> (Desv. ex Poir.) Spring	Zhang X.-C. 9273 (PE)	Yunnan, China	MH814905	MH814849	MH814877
<i>Selaginella repanda</i> (Desv. ex Poir.) Spring	Li B.-G. sn 20 (PE)	Yunnan, China	MH814906	MH814850	MH814878
<i>Selaginella selaginoides</i> (L.) P. Beauv. ex Schrank et Mart.	Weststrand S. 104 (UPS)	Sweden	KY023148	–	–
<i>Selaginella subdiaphana</i> (Wall. ex Hook. et Grev.) Spring	Zhang X.-C. 5297 (PE)	Tibet, China	OM864658	OM864643	OM864650
<i>Selaginella subeffusa</i> Shalimov et X. C. Zhang	Shui Y.-M. et al. 11716 (PE)	Yunnan, China	ON711493*	ON711491*	ON711492*
<i>Selaginella submonospora</i> Shalimov et X. C. Zhang	Zhang X.-C. et al. 8111 (PE)	Yunnan, China	OM864660	OM864646	OM864653
<i>Selaginella trichophylla</i> K. H. Shing	Zhang et al. 6784 (CDBI, MO, VNMN, PYU)	Cao Bang, Vietnam	KT161624	–	–
<i>Selaginella trichophylla</i> K. H. Shing	Chu et al. 31925 (PYU)	Yunnan, China	KT161621	–	–
<i>Selaginella trichophylla</i> K. H. Shing	Chu et al. 29310 (PYU)	Yunnan, China	KT161622	–	–
<i>Selaginella trichophylla</i> K. H. Shing	Jiang 318 (PYU, CDBI)	Hainan, China	KT161623	–	–
<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