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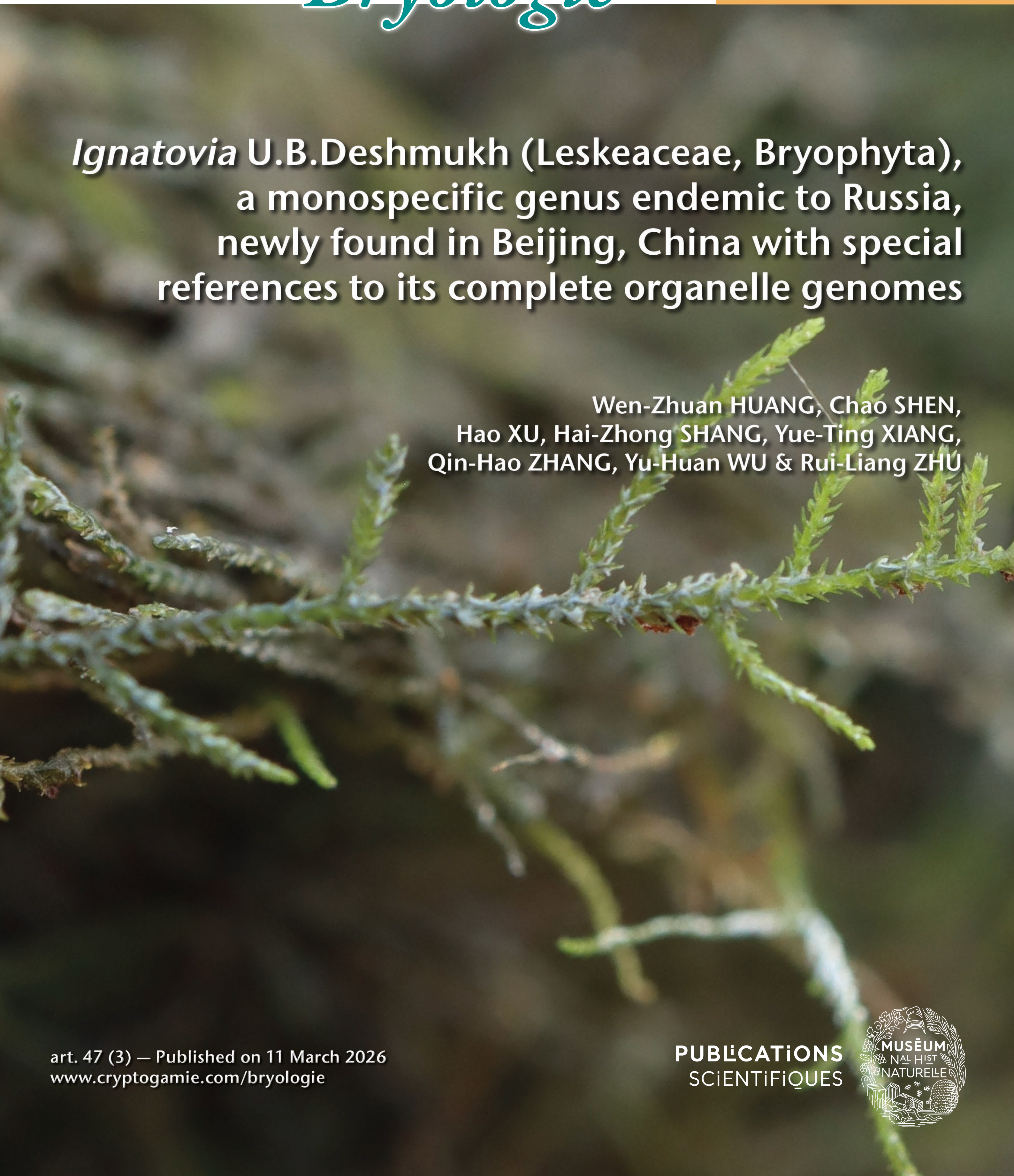

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Ignatovia U.B.Deshmukh (Leskeaceae, Bryophyta), a monospecific genus endemic to Russia, newly found in Beijing, China with special references to its complete organelle genomes

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ABSTRACT
The genus *Ignatovia* U.B.Deshmukh comprises the sole species *Ignatovia microphylla* (Ignatov & Ignatova) U.B.Deshmukh, which has been thus far known only from Russia. During our recent expeditions to Shangfangshan National Forest Park in Beijing, China, we encountered an interesting moss that can be assignable to *I. microphylla*, characterized by small leaves, round to oblate and thick-walled lamina cells that are somewhat bulging abaxially, nearly homogeneous thick-walled cells in the cross-section of the stem, a cross-section of the costa without stereids, and triangular inner perichaetial leaves. Molecular phylogenetic analyses based on nrITS1-5.8S-ITS2 and *trn*L-F further support the morphological identification. Our finding represents the first report of *I. microphylla* outside Russia, a new generic record for China. Additionally, we assembled and annotated its organelle genomes. The results showed that the complete chloroplast genome is 124 918 base pairs (bp) in length

KEY WORDS
Beijing,
chloroplast genome,
mitochondrial genome,
mosses,
phylogeny,
new record.

with 29.2% GC content, consisting of 82 protein-coding genes, 37 tRNA genes, and eight rRNA genes. The complete mitogenome is 103 161 bp in length with a GC content of 41.0%, comprising 40 protein-coding genes, 24 tRNA genes, and three rRNA genes. The discovery of *I. microphylla* could lay the foundation for investigating biogeographical patterns and species evolution in further studies.

RÉSUMÉ

Ignatovia *(Leskeaceae, Bryophyta), un genre monospécifique endémique de Russie, nouvellement trouvé à Pékin, Chine, avec des références spéciales aux génomes complets de ses organelles.*

Le genre *Ignatovia* U.B.Deshmukh comprend la seule espèce *Ignatovia microphylla* (Ignatov & Ignatova) U.B.Deshmukh, qui n'est connue jusqu'à présent qu'en Russie. Au cours de nos récentes expéditions dans le parc forestier national de Shangfangshan à Pékin, en Chine, nous avons rencontré une mousse intéressante qui peut être attribuée à *I. microphylla*, caractérisée par de petites feuilles, des cellules laminaires rondes à oblongues et à parois épaisses, quelque peu bombées abaxialement, des cellules à parois épaisses presque homogènes dans la section transversale de la tige, une section transversale de la nervure sans stéréides, et des feuilles périchétiales internes triangulaires. Les analyses phylogénétiques moléculaires basées sur nrITS1-5.8S-ITS2 et *trn*L-F confirment l'identification morphologique. Notre découverte représente le premier rapport d'*I. microphylla* en dehors de la Russie, un nouveau signalement du genre pour la Chine. En outre, nous avons assemblé et annoté les génomes de ses organelles. Les résultats ont montré que le génome complet du chloroplaste est de 124 918 pb avec 29,2 % de contenu en GC, comprenant 82 gènes codant pour des protéines, 37 gènes d'ARNt et huit gènes d'ARNr. Le mitogénome complet est de 103 161 pb avec une teneur en GC de 41,0 %, comprenant 40 gènes codant pour des protéines, 24 gènes d'ARNt et trois gènes d'ARNr. La découverte d'*I. microphylla* pourrait jeter les bases de l'étude des schémas biogéographiques et de l'évolution des espèces dans le cadre d'études ultérieures.

MOTS CLÉS
Beijing,
génome chloroplastique,
génome mitochondrial,
mousses,
phylogénie,
nouveau signalement.

INTRODUCTION

China is the country with the richest diversity of bryophytes in the world, encompassing 3 082 species across 609 genera (Wang *et al.* 2018; Zhu *et al.* 2022). However, our understanding of this diversity remains insufficient in China because many areas remain poorly investigated. Since 2018, eight genera have been added to the Chinese bryoflora, including *Konstantinovia* Bakalin & Fedosov (Bakalin *et al.* 2021a), *Mawenzhangia* Enroth, Shevock & Ignatov (Enroth *et al.* 2018), *Protoharpanthus* Bakalin, Fedosov & D.G.Long (Bakalin *et al.* 2021b), *Ramudaria* D.K.Singh, S.Majumdar, D.Singh & Molinari (Xu *et al.* 2022), *Rheoshevockia* Ignatov, W.Z.Ma & D.G.Long (Ma *et al.* 2018), *Sinomylia* P.C.Wu, Y.Jia & M.Z.Wang (Wu *et al.* 2018), *Soella* R.L.Zhu, L.Shu, QiongHe & Y.M.Wei (Zhu *et al.* 2018), and *Sphaerocarpos* P.Micheli ex Boehm. (Xiang & Zhu 2019). These studies have significantly enhanced our understanding of bryophyte diversity in China. Despite this, it is important to note that these new records were primarily found in the southern and southwestern regions of China (e.g., Hengduan Mountains, Himalayas), where the unique species diversity attracts considerable attention of numerous bryologists, while little has been known from northern China, especially those urban areas.

During a bryophyte expedition to Shangfangshan National Forest Park in Beijing, northern China, we encountered a diminutive moss resembling *Ignatovia microphylla* Ignatov & Ignatova) U.B.Deshmukh. This moss is characterized by small leaves, typically measuring between 0.15 and 0.25 mm, and a transverse section of the stem composed of nearly homogeneous thick-walled cells, without a central strand. Through a review of the literature and phylogenetic analyses based on the ITS and *trn*L-F loci, we confirmed that the moss belongs to *I. microphylla*, a species known only in the Primorsky Territory of Russia (Ishchenko *et al.* 2022; Ignatov *et al.* 2019). This species and genus have not been previously reported outside Russia; thus, its discovery in Beijing represents the first record of this genus in China.

Ignatovia (Leskeaceae) is a replacing name for *Lazarenkoa* Ignatov & Ignatova, a later homonym of the Ascomycetes fungal genus *Lazarenkoa* Zerova (Ignatov *et al.* 2019; Deshmukh 2021). *Ignatovia* is placed in the Leskeaceae Schimp., a morphologically heterogeneous and phylogenetically polyphyletic family (Ignatov *et al.* 2019; Spence 2014; Li *et al.* 2024). Recently, proposals have emerged to broaden the delimitation of Leskeaceae and merge the traditionally recognized family Thuidiaceae with it (Allen 2018; Kučera *et al.* 2021). However, this taxonomic treatment has not yet been widely accepted (Goffinet & Buck 2020; Hodgetts *et al.* 2020; Wang *et al.* 2023; Brinda & Atwood 2025). Conversely, Li *et al.* (2024) have proposed an opposing view advocating for the merging of Leskeaceae with Thuidiaceae. The relationship between Thuidiaceae and Leskeaceae remains a contentious topic for the foreseeable future. Therefore, providing additional molecular data related to Leskeaceae and Thuidiaceae, particularly from organelle genomes, is of significant value for future analyses of their relationships.

The primary objectives of this study are to newly report the occurrence of *Ignatovia* in Beijing, China, and present

Table 1. — Sequences used in the present study, including taxa, countries, voucher specimens, and GenBank accession numbers (ITS, and *trn*L-F). Newly sequenced specimens are set in **boldface**; **—**, means data missing.

Taxa	Countries	Voucher specimen	ITS	trnL-F
Abietinella abietina (Hedw.) M. Fleisch.	China	HIMC2011232 (HIMC)	JX853713	JX853719
Abietinella hystricosa (Mitt.) Sakurai	China	HIMC201106008 (HIMC)	JX853712	JX853718
Abietinella sp.	China	HIMC1009118 (HIMC)	JX853714	JX853720
Actinothuidium hookeri (Mitt.) Broth.	China	—	KF770664	KF770502
Boulaya mitteni (Broth.) Cardot	Japan	*Tanaka 7308* (HIRO)	FM161080	AM990347
Bryonoguchia molkenboeri I (Sande Lac.) Z.Iwats. & Inoue	China	—	KF770666	KF770504
Bryonoguchia molkenboeri II	Russia	*Ignatov & Ignatova 13-1936* (MW)	KX396260	KX396255
Echinophyllum sachalinense I (Lindb.) T.J.O'Brien	Russia	*Ignatov et al. 13-1469* (MW)	KX396259	KX396255
Echinophyllum sachalinense II	Russia	*Ignatov & Ignatova 13-233* (MW)	KX396264	KX396250
Elodium paludosum (A. aeger) Austin ex C.F.Parker	China	—	KF770667	KF770505
Haplocladium angustifolium (Hampe & Müll.Hal.) Broth.	China	—	KF770659	KF770497
Haplocladium microphyllum (Sw. ex Hedw.) Müll.Hal.	China	—	KF770660	KF770498
Haplocladium strictulum (Cardot) Reimers	China	—	KF770661	KF770499
Helodium blandovii (F.Weber & D. Mohr) Warnst.	United States	*Schofield 108637*	AY009803	AY009852
Ignatovia microphylla I (Ignatov & Ignatova) U.B.Deshmukh	Russia	*Tumurova VL-1-14* (MHA, UUH)	MN850404	MN849424
Ignatovia microphylla II	Russia	*Fedosov, Ishchenko & Shkurko s.n.* (MW, MHA)	OQ085094	—
***Ignatovia microphylla* HTC064**	**China**	***R. L. Zhu et al. 20200903-51* (HSNU, HTC)**	**PQ814309**	**PQ821839**
Lescuraea mutabilis (Brid.) Lindb. ex I.Hagen	China	—	KF770682	KF770520
Leskea gracilescens I Hedw.	United States	*Tan #91502* (MHA)	MH558262	MN871403
Leskea gracilescens II	United States	*6.X.2013 Ignatov* (MHA)	MH558263	MN871404
Leskea gracilescens III	United States	*Buck 57814* (NY1221900)	MH558264	MN871396
Leskea obtusa I Renauld & Cardot	United States	*Buck 30103* (NY489398)	MH558266	MN871398
Leskea obtusa II	United States	*Buck 22206* (NY489277)	MH558265	—
Leskea obtusa III	United States	*Buck 46377* (NY680473)	MH558267	MN871397
Leskea polycarpa I Hedw.	Russia	*11.XI.2009 Donskov* (MHA)	MH558269	MN871399
Leskea polycarpa II	Russia	*Pisarenko #3765* (MHA)	MH558272	MN871402
Leskea polycarpa III	Russia	*1.VII.2010 Bezgodov #34* (MHA)	MH558270	MN871400
Leskea polycarpa IV	Russia	*Ignatov #08-355a* (MHA)	MH558271	MN871401
Leskea scabrinervis Broth. & Paris	China	—	KF770663	KF770501
Lindbergia serrulata C.Gao, T.Cao & W.H.Wang	China	—	KF770670	KF770508
Lindbergia sinensis (Müll.Hal.) Broth.	China	—	KF770668	KF770506
Myrinia pulvinata (Wahlenb.) Schimp.	Russia	*Chernyadyeva* (CBFS19991)	MK327351	MK314034
Pelekium minutulum (Hedw.) Touw	Russia	*Bezgodov, Ateeva 217* (MW)	KX396265	KX396256
Bryochenea vestitissima (Besch.) Touw	Russia	*Ignatov 08-35* (MW)	KX396261	KX396252
Platylomella lescurii (Sull.) A.L.Andrews	United States	*Vanderpoorten s.n.* (AV, BG)	AY242371	AY242379
Pseudoleskeopsis zippeli (Dozy & Molk.) Broth.	China	*Redfearn 36225* (H)	AY568548	AY683603
Rauiella fujisana (Paris) Reimers	China	*Wang, M 400* (PE)	AY568546	AY683600
Sasaokaea aomoriensis (Paris) Kanda	Japan	*Takaki s.n.* (S)	JF280974	JF280981
Scorpidium cossonii (Schimp.) Hedenäs	Sweden	*Hedenas* (S; B61807)	AY625996	AY626013
Thuidium cymbifolium (Dozy & Molk.) Dozy & Molk.	China	*He, Q. 061* (PE)	AY568542	KF770482
Thuidium thermophilum Czernjad.	Russia	*8.VIII.1991 O.A. Chernyagina* (LE)	EF368013	EF368012

the complete genomes of its chloroplast and mitochondrion for the first time.

MATERIAL AND METHODS

Taxon sampling

The Chinese specimen of *Ignatovia microphylla* was collected from Shangfangshan National Forest Park in Beijing by Rui-Liang Zhu, Chao Shen and Hao Xu on 3 September 2024. The voucher specimen (*R.L.Zhu et al. 20240903-51*) has been deposited in the the herbarium of the East China Normal University (HSNU) and the herbarium of the Hangzhou Normal University (HTC). To determine the phylogenetic position of this Chinese species, we conducted an analysis utilizing the same two DNA loci employed by Ignatov *et al.* (2019): *trn*L-F, and nrITS1-5.8S-ITS2. *Lescuraea mutabilis* (Brid.) Lindb. ex I.Hagen, *Myrinia pulvinata* (Wahlenb.) Schimp. and *Scorpidium cossonii* (Schimp.) Hedenäs were selected as outgroups, while the remaining 37 accessions were downloaded from GenBank. A list of taxa, including collection localities, vouchers, herbarium codes, and GenBank accession numbers, is provided in Table 1.

Morphological study

The species pictures were taken using a digital camera (Canon M6; Canon, Tokyo, Japan). A Leica stereo zoom scope (Leica EZ4; Leica, Wetzlar, Germany) and an Olympus microscope (Olympus BX51; Olympus, Tokyo, Japan) were used to examine the specimens, and microscopic images were captured by a digital camera (MOTICAM S6; Motic, Xiamen, China) attached to the microscope.

DNA extraction, sequencing, assembly and annotation

The sample preparation, DNA extraction, and sequencing followed protocols used in earlier studies (Huang *et al.* 2019; Xiang *et al.* 2022). We used the GetOrganelle pipeline (Jin *et al.* 2020) for the *de novo* assembly of the nuclear DNA and complete circular organelle genome. The newly generated chloroplast and mitochondrial genome were deposited in GenBank (accession number: PQ821839 and PQ821862, respectively). The genomes were annotated automatically using CPGAVAS2 (Shi *et al.* 2019) and then adjusted using Geneious v.11.1.5 (Kearse *et al.* 2012) based on the *Haplocladium microphyllum* (Sw. ex Hedw.) Müll. Hal. as reference plastome and *Thuidium tamariscinum* (Hedw.) Schimp. as mitochondrial genome. Circular organelle genomes maps were drawn using OrganellarGenome DRAW (Lohse *et al.* 2013). The assembled nuclear data were aligned with published data using *Ignatovia microphylla* as reference (nrITS1-5.8S-ITS2 accession number, MN850404) in Geneious version 11.1.5 (Kearse *et al.* 2012) and then annotated and extracted.

Phylogenetic analyses

The *trn*L-F, and nrITS1-5.8S-ITS2 partitions were aligned using MAFFT v7.311 (Katoh & Standley 2013) and ambiguous alignment regions were trimmed using trimAl v1.2 (Capella-Gutiérrez *et al.* 2009). The resulting individual alignments were concatenated in Geneious ver. 11.1.5 (Kearse *et al.* 2012). Phylogenetic analyses were carried out using maximum likelihood (ML) and Bayesian inference (BI) methods in IQtree version 2.0.6 (Minh *et al.* 2020) and MrBayes 3.2.6 (Ronquist *et al.* 2012), respectively. We performed phylogenetic analyses using three different data sets: nuclear ITS, *trn*L-F, and concatenated data set of two loci. Maximum likelihood (ML) analyses were performed in IQtree v2.0.6 (Minh *et al.* 2020) with the sampling repeated 1000 times. The best-fitting substitution model was selected by ModelFinder (Chernomor *et al.* 2016; Kalyaanamoorthy *et al.* 2017) according to the Bayesian Information Criterion (BIC). For BI analyses, each DNA region was also assigned its own substitution model, as determined by the Akaike information criterion (Chernomor *et al.* 2016; Kalyaanamoorthy *et al.* 2017). Two independent analyses consisting of four Markov chain Monte Carlo chains were run for 5 000 000 generations, with one tree sampled for every 1 000 generations. The posterior distribution of trees was summarised by a > 50% majority-rule consensus tree after discarding the first 25% of samples as burn-in. Convergence was assessed by examining the likelihood plots in Tracer version 1.7 (Rambaut *et al.* 2018).

RESULTS

Phylogenetic results

The aligned 2-loci data set comprised 1 216 characters: nrITS1-5.8S-ITS2 (778 bp), and *trn*L-F (438 bp). Maximum likelihood (ML) and Bayesian inference (BI) analyses resulted in almost identical trees with strong support for most nodes. The BI topology tree with bootstrap values (BS_{ML} and PP_{BI}) is shown in Fig. 1.

Phylogenetic analyses of the concatenated dataset (Fig. 1A) revealed that the Chinese moss forms a maximum clade with two other accessions of *I. microphylla* from Russia (BS_{ML} = 100; PP_{BI} = 1), including one accession from the holotype voucher specimen. The phylogenetic analyses of ITS alone (Fig. 1B) also placed the Chinese plants nested within the two accessions of *I. microphylla* from Russia (BS_{ML} = 100; PP_{BI} = 1). The phylogenetic analyses of *trn*L-F alone (Fig. 1C) demonstrated that the Chinese plants form a highly supported clade with another accession of *I. microphylla* from the holotype voucher specimen (BS_{ML} = 99; PP_{BI} = 0.97).

Organelle genomes

The chloroplast genome of *Ignatovia microphylla* was 124 918 bp in length and possessed a circular DNA molecule with the typical quadripartite structure, consisting of a large single-copy (LSC) region of 86 929 bp, a small single-copy (SSC) region of 18 492 bp, and a pair of inverted repeats (IRs) of 19 500 bp (Fig. 2A). Nucleotide composition was 35.4% A, 35.4% T, 14.5% G, and 14.7% C, with an overall GC content of 29.2%. It contains127 genes, including 82 protein-coding genes, eight rRNAs, and 37 tRNAs; of these, nine genes (four rRNAs and five tRNAs) are duplicated in the IR regions (Fig. 2A). Among these genes, 19 intron-containing genes were identified, 17 of which contain one intron, while only the genes *clp*P and *ycf*3 harbored two introns (Fig. 2A).

The mitogenome of *I. microphylla* assembled as a single circular chromosome of 103 161 bp with 41.0% GC content (Fig. 2B), including coding regions with a total length of 32 355 bp, introns with 32 189 bp, and intergenic spacers with 38 617 bp. We identified 67 genes, including three rRNAs, 24 tRNAs and 40 protein-coding genes (Fig. 2B). There were a total of 27 introns distributed over 16 genes, among which the gene *cox*1 had the largest number of introns (four) (Fig. 2B).

New record for China

Family LESKEACEAE Schimp.
Genus *Ignatovia* U.B.Deshmukh

Ignatovia microphylla (Ignatov & Ignatova) U.B.Deshmukh
(Fig. 3)

Phytotaxa 497 (2): 173. (Deshmukh 2021). — Type: **Russia** • Primorsky Territory, Partizansk District, Nakhodka City surroundings, foothills of the Lozovyj Range (former Chandolaz), E-facing slope, or rocks in streamlet bed; 43°00’51.1”N, 133°01’13.6”E; 240 m alt.; 21.IX.2015; *O.D. Tumurova VL-1-14* (holotype: MHA; isotype: UUH).

SPECIMEN EXAMINED. — **China** • Beijing City, Fangshan District, Shangfangshan National Forest Park; on wet rock; 39°40’22.99”N,

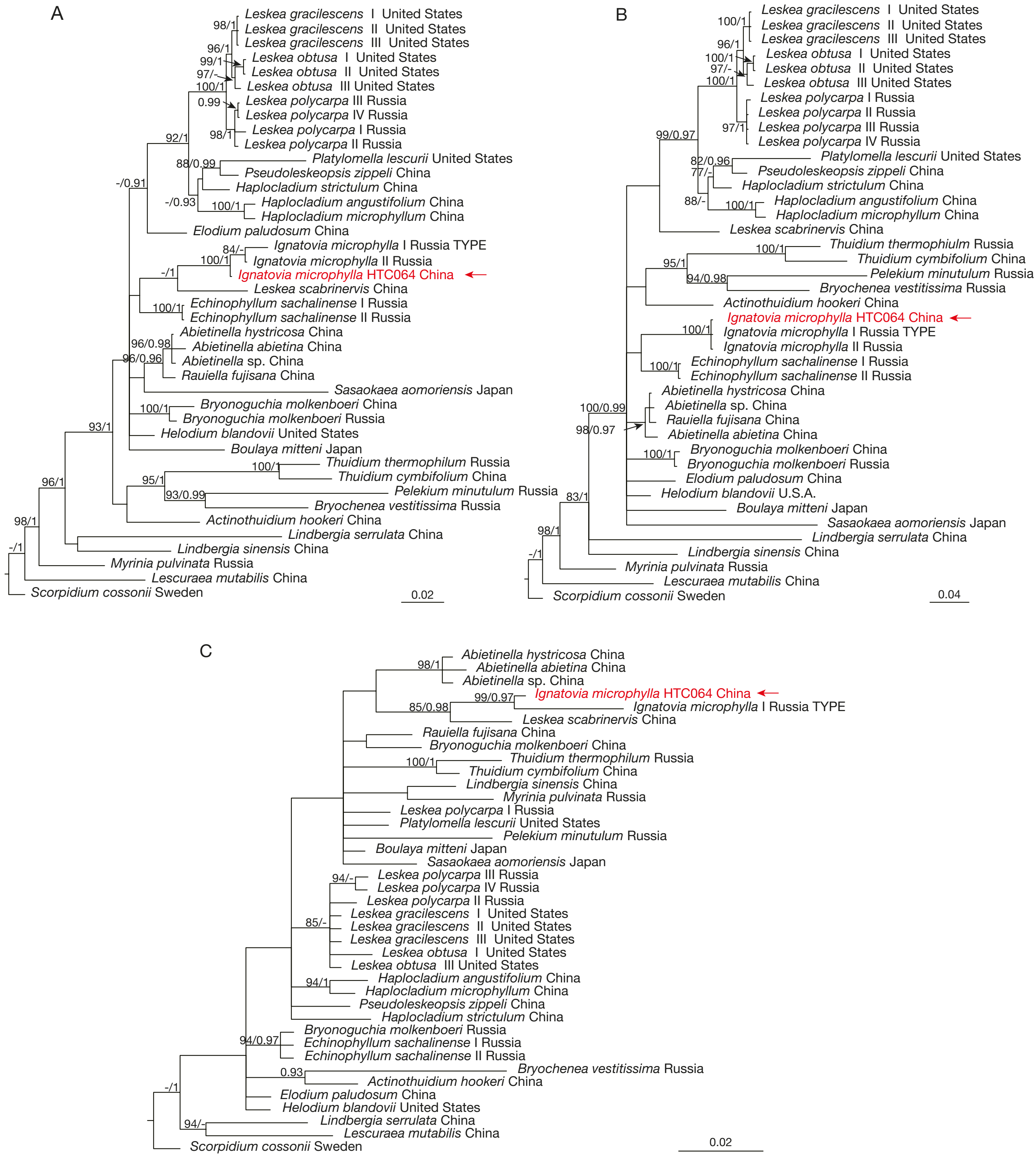

FIG. 1. — Phylogeny tree of Thuidiaceae and Leskeaceae species. The topology derived from the Bayesian tree is shown. **A**, phylogeny tree based on ITS + *trn*L-F dataset; **B**, phylogeny tree based on ITS dataset; **C**, phylogeny tree based on *trn*L-F dataset. ML bootstrap values BS ≥ 75 are shown at **left** and Bayesian posterior probabilities values PP ≥ 0.95 at **right**. The newly sequenced Chinese accessions are marked in **arrows**.

115°49'18.23"E; 407 m alt.; 3.IX.2024; *R. L. Zhu et al. 20240903-51* (HSNU, HTC).

DISTRIBUTION AND HABITAT. — This species and genus were previously known only from Russia (Ignatov *et al.* 2019; Ishchenko *et al.* 2022), the present report represents a new addition to the moss flora of China. In China, it was collected on wet rock, associated with *Anomodon minor* Lindb.

DESCRIPTION

Plants tiny, green to yellow-green, in prostrate tufts. Stems irregularly branched, up to 1.3 cm long, cross-section of stem

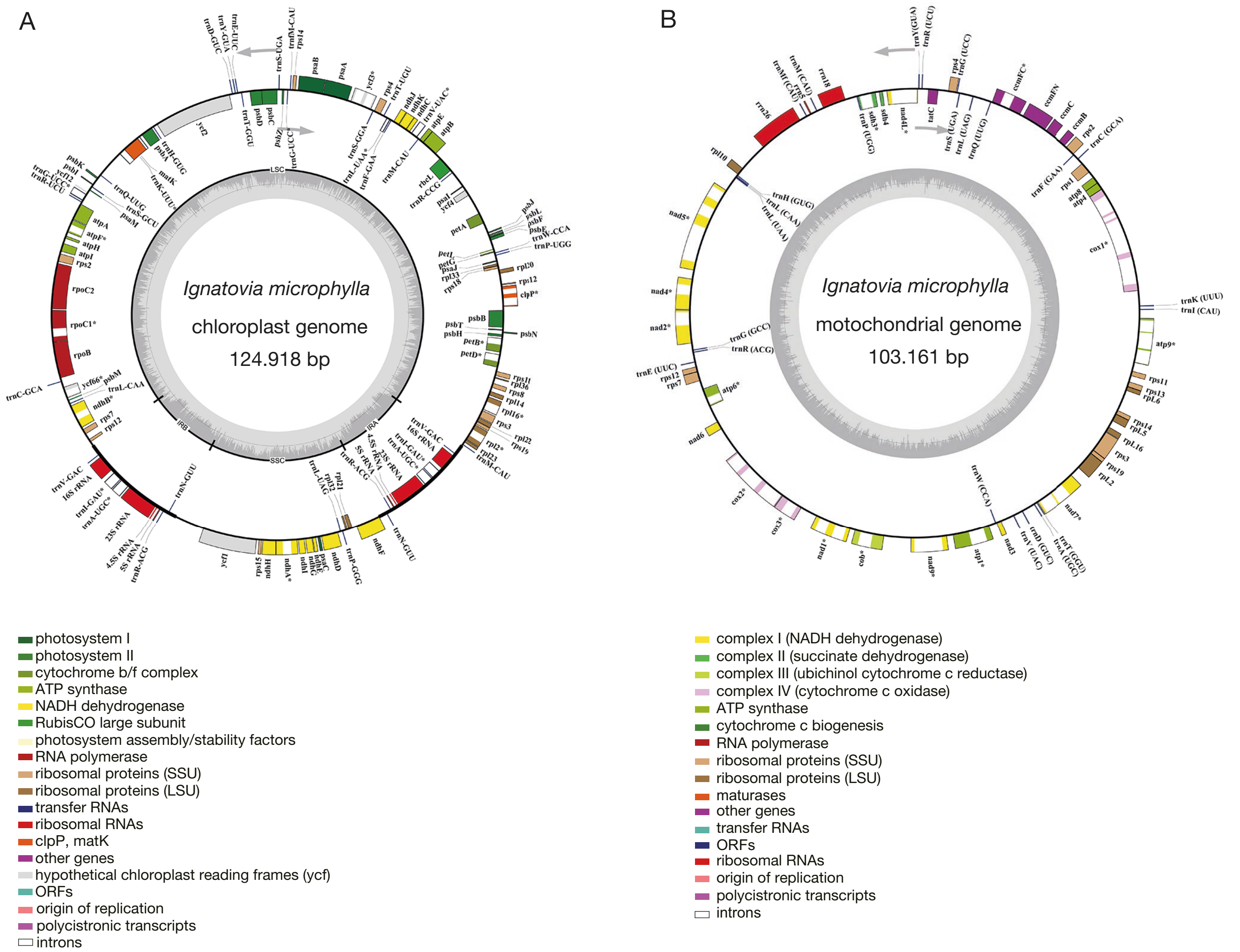

FIG. 2. — Circular genome maps of the plastome (**A**) and mitogenome (**B**) of *Ignatovia microphylla* (Ignatov & Ignatova) U.B.Deshmukh. Genes shown on the outside of the circle are transcribed clockwise, whereas those on the inside are transcribed counter-clockwise. The asterisk * indicates intron-containing genes.

oval, diameter *c.* 0.12 mm, composed of nearly homogeneous cells, epidermal cells with slightly thicker walls than cells inwards, without central strand. Paraphyllia absent. Stem leaves appressed when dry, erectopatent when moist, ovate-lanceolate to triangular, 0.25-0.32 × 0.1-0.13 mm, plane; branch leaves shorter, ovate-triangular, 0.15-0.30 × 0.08-0.11 mm, plane. Both stem and brunch leaves smooth or only slightly irregularly crenulate near apex. Costa *c.* 40 µm wide at base, occupying ⅓-¼ the leaf base, ending shortly below the apex or reaching apex, in transverse section with two rows of cells, rarely three, without stereids. Laminal cells unistratose, isodiametric to oblate throughout, 4-8 µm, thick-walled, with low bulgings on dorsal surface, alar cells not differentiated. Autoicous. Both perigonia and perichaetia grows on stem. Perigonial leaves small, ovate-lanceolate, 0.25-0.35 × 0.15-0.17 mm, costa absent. Perichaetial leaves triangular and narrowly acute, 0.5-0.6 × 0.21-0.32 mm, costa robust, extends to the leaf apex. Sporophyte not seen.

DISCUSSION

Ignatovia microphylla is characterized by the following features: 1) small leaves, less than 0.5 mm in length, ovate-lanceolate to narrow-triangular (Fig. 3C); 2) thick-walled laminal cells that are round to oblate and somewhat bulging abaxially (Fig. 3N, O); 3) nearly homogeneous thick-walled cells in the cross-section of the stem (Fig. 3M); 4) a cross-section of the costa devoid of stereids (Fig. 3L); 5) an autoicous sexual condition (Fig. 3F); and 6) inner perichaetial leaves that are triangular (Fig. 3H).

For the sexual condition of *Ignatovia microphylla*, when Ignatov *et al.* (2019) first published this species, they were unable to identify a mother plant with both androecium and gynoecium in the limited material examined. Consequently, the sexual condition was recorded as dioicous with a question mark in the protologue (Ignatov *et al.* 2019). However, in the material collected from China, we successfully identified

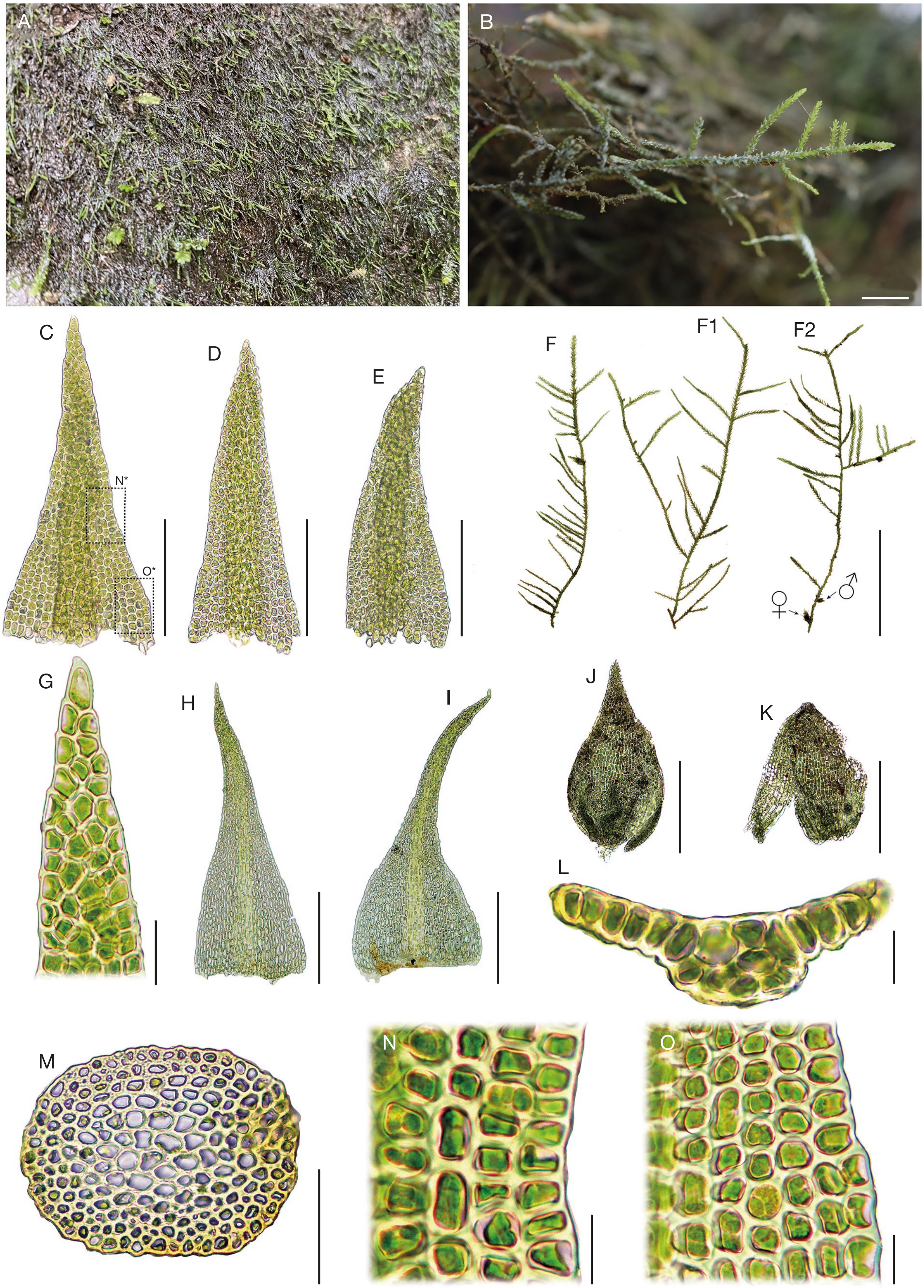

Fig. 3. — *Ignatovia microphylla* (Ignatov & Ignatova) U.B.Deshmukh: **A**, field population on rock; **B**, closer view of plant; **C**, stem leaf; **D**, **E**, branch leaves; **F**, plants; **G**, apex of leaf; **H**, **I**, perichaetial leaves; **J**, **K**, perigonial leaves; **L**, cross section of leaf; **M**, cross section of stem; **N**, middle laminal cells; **O,** basal laminal cells. All from *R.L. Zhu et al. 20240903-51* (HSNU, HTC). Scale bars: A, B, 2 mm; C-E, 100 µm; F, 5 mm; G, 20 µm; H-K, 200 µm; L, N, O, 10 µm; M, 50 µm.

such mother plants, which exhibited both androecium and gynoecium on the stem (Fig. 3F). We confirmed that the sexual condition of this species is autoicous.

Ignatovia microphylla shares similarities with *Arvernella microclada* Hugonnot & Hedenäs in terms of their overall plant appearance and leaf shape, as well as the undifferentiated stem cells in transverse sections. However, the costa of *I. microphylla* is robust, terminating shortly below the apex or reaching the apex (Ignatov *et al.* 2019; Fig. 3C-E, G), while it is absent or virtually absent in *A. microclada* (Hugonnot & Hedenäs 2015; Lüth 2019). Additionally, the median leaf laminal cells of *A. microclada* are oblong-rhomboidal, or more rarely, rectangular to short linear-vermicular (Hugonnot & Hedenäs 2015; Lüth 2019), whereas the median laminal cells of *I. microphylla* are isodiametric to oblate (Ignatov *et al.* 2019; Fig. 3N). Furthermore, the inner perichaetial leaves of *A. microclada* are rectangular-oblong and suddenly or progressively acuminate (Hugonnot & Hedenäs 2015), while those of *I. microphylla* are triangular and narrowly acute (Ignatov *et al.* 2019; Fig. 3H, I). *Ignatovia microphylla* is also similar to *Arvernella pisarenkoi* Ignatov & Ignatova and *A. sibirica* Ignatov & Ignatova. However, the costa of both *A. pisarenkoi* and *A. sibirica* is forked, reaching 0.2-0.4 times the leaf length in *A. pisarenkoi* and approximately 0.2 times the leaf length in *A. sibirica* (Ignatov *et al.* 2021; Pisarenko *et al.* 2022). In contrast, the costa of *I. microphylla* is robust, terminating just below the apex or reaching the apex (Ignatov *et al.* 2019; Fig. 3C-E, G).

Ignatovia microphylla also can be confused with *Microamblystegium saxicola* Fedosov, Ignatova & Jan Kučera. However, the costa of *M. saxicola* is single, 0.3-0.7 times the leaf length, and its median laminal cells are rhomboidal or elongate-rhomboidal, smooth (Fedosov *et al.* 2021). In contrast, *I. microphylla* has a robust costa that extends to the leaf apex, and its median laminal cells are isodiametric to oblate, with low bulgings on the dorsal surface (Ignatov *et al.* 2019; Fig. 3N).

Ignatovia microphylla is also similar to *Leskea polycarpa*. However, *L. polycarpa* possesses paraphyllia on its stems and branches (Noguchi 1991; Wu 2001), whereas *I. microphylla* lacks paraphyllia (Ignatov *et al.* 2019). Additionally, the middle laminal cells of *L. polycarpa* are rhomboidal to subrectangular, mostly with a central papilla on the dorsal surface (Noguchi 1991; Wu 2001), while those of *I. microphylla* are isodiametric to oblate, exhibiting low bulgings on the dorsal surface (Ignatov *et al.* 2019; Fig. 3N). Furthermore, *Leskea scabrinervis* Broth. & Paris is also similar to *I. microphylla*, and the differences between the two species have been thoroughly discussed in Ignatov *et al.* (2019).

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REFERENCES

Allen B. H. 2018. — Moss flora of Central America. Part 4. Fabroniaceae-Polytrichaceae. *Monographs in Systematic Botany from the Missouri Botanical Garden* 132: 1-830.

Bakalin V. A., Fedosov V. E., Fedorova A. V. & Ma W.-Z. 2021a. — Obtusifoliaceae, a new family of leafy liverworts to accommodate *Konstantinovia*, newly described from the Hengduan Mts. (South China) and *Obtusifolium* (Cephaloziineae, Marchantiophyta). *Plant Systematics and Evolution* 307 (6): 1-16. https://doi.org/10.1007/s00606-021-01779-8

Bakalin V. A., Fedosov V. E., Long D. G., Fedorova A. V. & Maltseva Y. D. 2021b. — *Protoharpanthus* gen. nov. (Harpanthaceae)—a relict relative of *Harpanthus* from the Sino-Himalaya. *The Bryologist* 124 (2): 218-229. https://doi.org/10.1639/0007-2745-124.2.218

Brinda J. C. & Atwood J. J. 2025. — The Bryophyte Nomenclator. https://www.bryonames.org [accessed on 13 January 2025].

Capella-Gutiérrez S., Silla-Martínez J. M. & Gabaldón T. 2009. — trimAl: a tool for automated alignment trimming in large-scale phylogenetic analyses. *Bioinformatics* 25 (15): 1972-1973. https://doi.org/10.1093/bioinformatics/btp348

Chernomor O., von Haeseler A. & Minh B. Q. 2016. — Terrace aware data structure for phylogenomic inference from supermatrices. *Systematic Biology* 65 (6): 997-1008. https://doi.org/10.1093/sysbio/syw037

Deshmukh U. B. 2021. — *Ignatovia*, a new replacement name for *Lazarenkoa* Ignatov & Ignatova (Leskeaceae, Bryophyta). *Phytotaxa* 497 (2): 173-174. https://doi.org/10.11646/phytotaxa.497.2.11

Enroth J., Shevock J. R. & Ignatov M. S. 2018. — *Mawenzhangia thamnobryoides* (Bryophyta, Lembophyllaceae), a new moss genus and species from the Shangri-la region of Yunnan Province, China. *Phytotaxa* 346 (3): 237-246. https://doi.org/10.11646/phytotaxa.346.3.3

Fedosov V. E., Ignatova E. A., Fedorova A. V. & Kučera J. 2021. — *Microamblystegium* – a new genus of Amblystegiaceae from Shikotan Island (South Kurils, Russian Far East). *Arctoa* 30 (2): 417-424. https://doi.org/10.15298/arctoa.30.27

Goffinet B. & Buck W. R. 2020. — Classification of the Bryophyta. http://bryology.eeb.uconn.edu/classification/ [accessed on 13 January 2025].

Hodgetts N. G., Söderström L., Blockeel T. L., Caspari S., Ignatov M. S., Konstantinova N. A., Lockhart N., Papp B., Schröck C., Sim-Sim M., Bell D., Bell N. E., Blom H. H., Bruggeman-Nannenga M. A., Brugués M., Enroth J., Flatberg K. I., Garilleti R., Hedenäs L., Holyoak D. T., Hugonnot V., Kariyawasam I., Köckinger H., Kučera J., Lara F. & Porley R. D. 2020. — An annotated checklist of bryophytes of Europe, Macaronesia and Cyprus. *Journal of Bryology* 42 (1): 1-116. https://doi.org/10.1080/03736687.2019.1694329

Huang W.-Z., Ma W.-Z., Schneider H., Yu Y. & Wu Y.-H. 2019. — Mitochondrial genome from *Andreaea wangiana* reveals structural conservatism and a trend of size reduction in mosses. *The Bryologist* 122 (4): 597-606. https://doi.org/10.1639/0007-2745-122.4.597

Hugonnot V. & Hedenäs L. 2015. — *Arvernella microclada* Hugonnot & Hedenäs (Amblystegiaceae), a new minute species from France, requiring a separate genus. *Journal of Bryology* 37 (3): 184-191. https://doi.org/10.1179/1743282015Y.0000000005

Ignatov M. S., Dugarova O. D., Fedorova A. V. & Ignatova E. A. 2019. — *Lazarenkoa*, a new moss genus from the

Russian Far East. *Arctoa* 28 (2): 226-230. https://doi.org/10.15298/arctoa.28.21

Ignatov M. S., Ignatova E. A. & Kuznetsova O. I. 2021. — A rare European endemic moss genus *Arvernella* is discovered in Sakhalin, Russian Far East, where it is also rare. *Arctoa* 30 (1): 1-7. https://doi.org/10.15298/arctoa.30.01

Ishchenko Yu. S., Shkurko A. V., Kuznetsova O. I., Fedorova A. V. & Fedosov V. E. 2022. — New records of rare and otherwise interesting mosses from The Ussurijsky State Reserve (Primorsky Territory, Russia). *Arctoa* 31: 155-165. https://doi.org/10.15298/arctoa.31.17

Jin J.-J., Yu W.-B., Yang J.-B., Song Y., Depamphilis C. W., Yi T.-S. & Li D.-Z. 2020. — GetOrganelle: A fast and versatile toolkit for accurate de novo assembly of organelle genomes. *Genome Biology* 21: 241. https://doi.org/10.1186/s13059-020-02154-5.

Kalyaanamoorthy S., Minh B. Q., Wong T. K. F., von Haeseler A. & Jermiin L. 2017 — ModelFinder: fast model selection for accurate phylogenetic estimates. *Nature Methods* 14: 587-589. https://doi.org/10.1038/nmeth.4285

Katoh K. & Standley D. M. 2013. — MAFFT multiple sequence alignment software version 7: improvements in performance and usability. *Molecular Biology and Evolution* 30: 772-780. https://doi.org/10.1093/molbev/mst010

Kearse M., Moir R., Wilson A., Stones-Havas S., Cheung M., Sturrock S., Buxton S., Cooper A., Markowitz S., Duran C., Thierer T., Ashton B., Meintjes P. & Drummond A. 2012. — Geneious basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. *Bioinformatics* 28 (12): 1647-1649. https://doi.org/10.1093/bioinformatics/bts199

Kučera J., Ignatova E. A., Ignatov M. S., Fedorova A. V., Kuznetsova O. I. & Fedosov V. E. 2021. — *Rauiella thuidioides*, sp. nov. (Leskeaceae, Musci), a new species from the Russian Far East. *Arctoa* 30 (2): 425-433. https://doi.org/10.15298/arctoa.30.28

Li Y.-F., Luo L., Liu Y., He Q., Yu N.-N., Gaowa N., Yi Z.-Q., Wang J.-J., Han W., Peng T., Ho B. C., He X.-L., Zhang L., Chen Z.-D., Jia Y. & Wang Q.-H. 2024. — The Bryophyte Phylogeny Group: A revised familial classification system based on plastid phylogenomic data. *Journal of Systematics and Evolution* 62 (4): 577-588. https://doi.org/10.1111/jse.13063

Lohse M., Drechsel O., Kahlau S. & Bock R. 2013. — OrganellarGenomeDRAW—a suite of tools for generating physical maps of plastid and mitochondrial genomes and visualizing expression data sets. *Nucleic Acids Research* 41: W575-W581. https://doi.org/10.1093/nar/gkt289

Lüth M. 2019. — *Mosses of Europe – a photographic flora. Vol. 1.* Michael Lüth, Freiburg, 1306 p.

Ma W.-Z., Long D. G., Kuznetsova O. I., Ignatova E. A. & Ignatov M. S. 2018. — *Rheoshevockia* (Symphyodontaceae, Bryophyta), a new rheophytic moss genus from Yunnan, China. *Arctoa* 27 (2): 104-111. https://doi.org/10.15298/arctoa.27.10

Minh B. Q., Schmidt H. A., Chernomor O., Schrempf D., Woodhams M. D., von Haeseler A. & Lanfear R. 2020. — IQ-TREE 2: New models and efficient methods for phylogenetic inference in the genomic era. *Molecular Biology and Evolution* 37: 1530-1534. https://doi.org/10.1093/molbev/msaa015

Noguchi A. 1991. — *Illustrated Moss Flora of Japan. Part 4.* Hattori Botanical Laboratory, Nichinan-shi, 242 p.

Pisarenko O. Yu., Kuznetsova O. I., Ignatova E. A. & Ignatov M. S. 2022. — A further range extension of the genus *Arvernella* (Bryophyta). *Arctoa* 31 (1): 1-6. https://doi.org/10.15298/arctoa.31.01

Rambaut A., Drummond A. J., Xie D., Baele G. & Suchard M. A. 2018. — Posterior summarization in Bayesian phylogenetics using Tracer 1.7. *Systematic Biology* 67 (5): 901-904. https://doi.org/10.1093/sysbio/syy032

Ronquist F., Teslenko M., van der Mark P., Ayres D. L., Darling A., Hohna S., Larget B., Liu L., Suchard M. A. & Huelsenbeck J. P. 2012. — MRBAYES 3.2: efficient Bayesian phylogenetic inference and model selection across a large model space. *Systematic Biology* 61: 539-542. https://doi.org/10.1093/sysbio/sys029

Shi L., Chen H., Jiang M., Wang L., Wu X., Huang L. & Liu C. 2019. — CPGAVAS2, an integrated plastome sequence annotator and analyzer. *Nucleic Acids Research* 47: W65-W73. https://doi.org/10.1093/nar/gkz345

Spence J. R. 2014. — Leskeaceae Schimper. *in* Flora of North America Editorial Committee (eds), *Flora of North America. Volume 28. Bryophyta, part 2.* Oxford University Press, Oxford: 340-365.

Wang L.-S., Jia Y., Zhang X.-C. & Qin H.-N. 2018. — *Species Catalogue of China. Volume 1 Plants. A Synoptic Checklist (I).* Science Press, Beijing, 141 p.

Wang Z., Li Y., Wu X., Yin S. & Dong C. 2023. — First fossil record of *Pelekium* (Thuidiaceae) from the middle Miocene Zhangpu amber in Asia. *Historical Biology* 36 (3): 602-608. https://doi.org/10.1080/08912963.2023.2176764

Wu P.-C. 2001. — *Flora Bryophytorum Sinicorum. Vol. 6. Hookeriales Hypnobryales.* Science Press, Beijing, 290 p.

Wu P.-C., Jia Y. & Wang M.-Z. 2018. — *Sinomylia*, a new genus of Myliaceae in China, and its systematic relationship. *Chenia* 13: 15-19.

Xiang Y.-L., Jin X.-J., Shen C., Cheng X.-F., Shu L. & Zhu R.-L. 2022. — New insights into the phylogeny of the complex thalloid liverworts (Marchantiopsida) based on chloroplast genomes. *Cladistics* 38 (6): 649-662. https://doi.org/10.1111/cla.12513

Xiang Y.-L. & Zhu R.-L. 2019. — Sphaerocarpales (Marchantiophyta) new to China, with special references to a new species of *Sphaerocarpos* from Hengduan Mountains. *The Bryologist* 122 (4): 586-596. https://doi.org/10.1639/0007-2745-122.4.586

Xu H., Xu J.-J., Ma X.-Y. & Zhu R.-L. 2022. — Taxonomic notes and range extension of the monospecific genus *Ramudaria* (Lophocoleaceae, Marchantiophyta) endemic to India. *Phytotaxa* 556 (2): 160-168. https://doi.org/10.11646/phytotaxa.556.2.5

Zhu R.-L., Ma X.-Y., Cao C. & Cao Z.-Y. 2022. — Advances in research on bryophyte diversity in China. *Biodiversity Science* 30 (7): 22378. https://doi.org/10.17520/biods.2022378

Zhu R.-L., Shu L., He Q. & Wei Y.-M. 2018. — *Soella* (Marchantiophyta: Lejeuneaceae), a new genus from China and Japan. *The Bryologist* 121 (3): 324-339. https://doi.org/10.1639/0007-2745-121.3.324

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