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SIDERA TIBETICA (*HYMENOCHAETALES*, *BASIDIOMYCOTA*), A NEW SPECIES TO RUSSIA

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The first findings of recently described polypore fungus *Sidera tibetica* are revealed in the Caspian lowland forests of the Samursky National Park in the Republic of Dagestan, Russia. Basidiomata collected on *Pinus brutia* var. *eldarica* were studied by both light microscopy and molecular methods. Detailed information on new localities and habitats of *Sidera tibetica* as well as the collection numbers of specimens deposited in the Mycological Herbarium of the Komarov Botanical Institute of RAS (LE) are provided. Two complete sequences of ITS1–5.8S–ITS2 nuclear ribosomal DNA for Caucasian specimens of *S. tibetica* have been obtained and submitted to the GenBank database. Newly generated sequences are formed a separate well-supported clade in the Maximum Likelihood phylogenetic analysis together with all available ITS nrDNA sequences of *S. tibetica* originated from Belarussian and Chinese collections including the reference sequence from a holotype.

Keywords: biodiversity, biogeography, DNA barcodes, North-Eastern Caucasus, pine plantations, polypores, Republic of Dagestan

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INTRODUCTION

The genus *Sidera* Miettinen et K.H. Larss. was introduced by O. Miettinen and K.-H. Larsson (2011) initially to combine four species – *Sidera lenis* (P. Karst.) Miettinen (type species), *S. lowei* (Rajchenb.) Miettinen, *S. lunata* (Romell ex Bourdot et Galzin) K.H. Larss., *S. vulgaris* (Fr.) Miettinen – based on both their micromorphology and molecular data. These species formed a monophyletic group as a member of *Rickenella* clade within *Hymenochaetales* (Larsson et al., 2006). Peculiar crystal rosettes on subicular and sometimes tramal hyphae, typical for representatives of the genus, inspired the taxon authors to choose the Latin name *sidus*, meaning "star", for the genus name *Sidera*. Along with star-like crystals, the main morphological features of the genus are whitish resupinate basidiomata, generative hyphae with clamp connections, and allantoid basidiospores. As for types of hyphal system, both monomitic and dimitic species are known among representatives of the genus (Miettinen, Larsson, 2011). Most of *Sidera* species have poroid hymenophore with an exception for hydnoid species *S. lunata*. All species of the genus *Sidera* cause a white rot (Liu et al., 2023).

Currently, 19 species are accepted in *Sidera* (Miettinen, Larsson, 2011; Du et al., 2019, 2020; Liu et al., 2021, 2022, 2023; Xu et al., 2023). At the same time, only three species (*Sidera lenis*, *S. lunata*, *S. vulgaris*) of the genus were previously registered in Russia (Bolshakov et al., 2022). During ongoing investigations of wood-inhabiting aphyllophoroid fungi on the territory of the Samursky National Park in the Republic of Dagestan (Volobuev, 2020, 2021; Volobuev, Shakhova, 2022), new specimens from the genus *Sidera* were collected and identified as belonging to *Sidera tibetica* Z.B. Liu, Jian Yu et F. Wu. This work aimed to describe new collections of *S. tibetica* as a new to Russia species based on morphological and phylogenetic evidence.

MATERIALS AND METHODS

Study area. Field work was carried out by the author in September 2022 on the territory of "Delta Samura" site of the Samursky National Park in Magaramkentsky district of the Republic of Dagestan using the standard route method (Lodge et al., 2004). The forest vegetation of the Samur River delta is represented by riparian forests, which develop in a narrow belt along the streams in periodically flooded areas, and interfluvial forests on the overflow non-flooded terraces and interfluvial territories. The main forest-forming species of riparian forests are *Alnus glutinosa* subsp. *barbata* (C.A. Mey.) Yalt., *A. incana* (L.) Moench, *Populus alba* L., *P. nigra* L., and *Salix alba* L., *S. excelsa* S.G. Gmel. (Novikova, Polyanskaya, 1994). Lianas presented by *Clematis orientalis* L., *C. vitalba* L., *Hedera pastuchovii* Woronow, *Humulus lupulus* L., *Lonicera caprifolium* L., *Periploca graeca* L., *Rubus* spp., *Smilax excelsa* L., and *Vitis vinifera* L. (Litvinskaya, Murtazaliev, 2015) are common for this forest type. Interfluvial forests are mainly dominated by *Carpinus betulus* L. and *Quercus robur* subsp. *pedunculiflora* (K. Koch) Menitsky

Fig. 1. Plantations of *Pinus brutia* var. *eldarica* in the Samursky National Park (photo S.V. Volobuev).

with *Euphorbia amygdaloides* L. or *Hedera pastuchovii* in an herbaceous layer (Novikova, Polyanskaya, 1994).

Fungal specimens were collected within a plot of man-made forest plantations of *Pinus brutia* var. *eldarica* (Medw.) Silba (Fig. 1). The shrub layer is represented by species characteristic for the forests of the Samursky National Park – *Acer campestre* L., *Cornus sanguinea* subsp. *australis* (C.A. Mey.) Jáv., *Corylus avellana* L., *Crataegus germanica* (L.) Kuntze and some others. Along with them, in some places there are stands of *Ulmus minor* Mill. In addition, recovery of some lianas such as *Clematis vitalba*, *Hedera pastuchovii*, *Periploca graeca*, *Smilax excelsa* is observed. The herbaceous layer is drastically transformed, with a significant number of synanthropic species, especially in gaps and open patches. In more humidified areas, *Phragmites australis* (Cav.) Trin. ex Steud. dominates in the composition of the herbaceous layer.

Morphological investigations. The specimens collected in this study are deposited in the Mycological Herbarium of the Komarov Botanical Institute RAS, St. Petersburg (LE). Macro-morphological (pore surface) measurements and photographs were made based on dried specimens using a Zeiss Axio Zoom.V16 motorized stereomicroscope with a ZEISS Axiocam 712 color digital camera (Carl Zeiss Microscopy Deutschland GmbH, Oberkochen, Germany). Microscopic identification were performed by light microscopy technique using an Axio Imager.A1 microscope with magnification up to 1000× and a Zeiss Axiocam 506 color digital camera (Carl Zeiss Microscopy Deutschland GmbH, Oberkochen, Germany). A total of 20 basidiospores stained with 0.1% Cotton Blue were measured. Microscopic measurements were made using Zeiss Zen 3.2 software.

Molecular studies. Genomic DNA was extracted from small pieces of dried basidiomata with PhytoSorb (Sintol, Moscow, Russia) according to the manufacturer's instructions. The internal transcribed spacer regions of the nuclear ribosomal DNA (ITS nrDNA) were amplified with the primers pair ITS1F/ITS4B (Gardes, Bruns, 1993). PCR reactions were performed

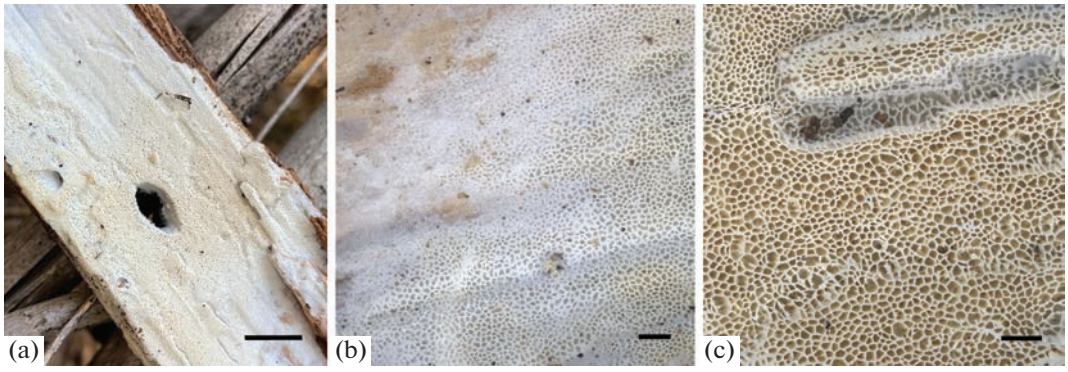

Fig. 2. *Sidera tibetica* LE F-342596 (photo S.V. Volobuev): a – basidioma *in situ*; b – margin of basidioma; c – pore surface. Scale – 1 cm (a), 1 mm (b, c).

with 2× BioMaster HS-Taq PCR-Color reaction mix (Biolabmix, Novosibirsk, Russia) in a total volume of 20 µl. Products of amplification were visualized by 1% agarose gel electrophoresis, and then purified using the CleanMag DNA (Evrogen, Russia) purification kit. Sequencing was performed on an ABI model 3500 Genetic Analyzer (Applied Biosystems, Foster City, USA). Raw data were edited and assembled in MEGA X (Kumar et al., 2018). The newly obtained sequences were deposited in the NCBI GenBank database.

The sequences were aligned with 37 additional sequences retrieved from GenBank database (Table 1), using a MAFFT v. 7 web tool (Katoh et al., 2019) with the E–INS–i option. The maximum-likelihood (ML) phylogenetic analysis using the IQ-TREE web server (Trifinopoulos et al., 2016) with 1000 ultra-fast bootstrap repeats was performed to identify the phylogenetic position of newly sequenced specimens.

The nomenclature of fungal taxa follows the Index Fungorum (2023). Names of vascular plants are given according to the Plants of the World Online database (POWO, 2023).

RESULTS AND DISCUSSION

As a result of morphological and molecular phylogeny investigations of collected specimens, a new species to Russia, *Sidera tibetica*, was identified. Studied specimens from the Samursky National Park are completely corresponds to the morphological description from the protologue (Liu et al., 2022), including whitish to yellowish-cream pore surface with round to angular pores, 7–8 per mm, and white, indistinct, thinning out sterile margin (Fig. 2), and smooth, lunate, hyaline, thin-walled basidiospores, (3.0)3.1–3.2(3.3) × (1.0)1.1–1.2 µm, Q = 2.75–2.86.

Specimens examined: Russia, Republic of Dagestan, Magaramkentsky District, the Samursky National Park, 41.895378° N, 48.499018° E, –36 m a.s.l., on fallen trunk of *Pinus brutia* var. *eldarica* in herb-mosses pine forest, 19.09.2022, coll. and det. S.V. Volobuev (LE F-342596, GenBank nrITS – OR457650); *ibid.*, 41.894898° N, 48.499529° E, –39 m a.s.l., on fallen branches of *P. brutia* var. *eldarica* in herb-mosses pine forest, 19.09.2022, coll. and det. S.V. Volobuev (LE F-342597, GenBank nrITS – OR457651).

A total of 37 available nrITS sequences of all *Sidera* species and two sequences of *Skvortzovia furfuracea* (Bres.) G. Gruhn et Hallenberg as an outgroup were chosen to perform phylogenetic analysis. The final dataset contained 39 nrITS sequences and consisted of 2435 characters, including gaps. In general, tree topology obtained (Fig. 3) confirmed the species delimitation in the genus *Sidera* up to date. Newly generated two complete nrITS sequences from Caucasian specimens are nested within a separate well-supported clade of *Sidera tibetica*. This lineage with strong support value (100% ML bootstrap) combines all known sequences of *S. tibetica* originated from Belarussian and Chinese collections including the reference sequence from a holotype (OM974253).

Specimens of *S. tibetica* collected on fallen trunk and branches of *Pinus brutia* var. *eldarica* in pine plantations on the territory of Samursky National Park corresponds to substrate preferences of the species. Indeed, all known collections of *S. tibetica* were made on dead pine wood – rotten or fallen trunks or branches. Among representatives of the genus *Pinus* L., two species, *P. armandi* Franch. and *P. yunnanensis* Franch., were previously noted as hosts for *S. tibetica* (Liu et al., 2022; Liu et al., 2023). The only exception is the specimen collected on rotten wood of *Picea* sp. in the Belovezhskaya Pushcha National Park, Belarus (Liu et al., 2023). At the same time, taking into account the co-occurrence of pine and spruce in the area, as well as the fact that xylotrophic saprotrophs, to which *S. tibetica* belongs, may inhabit a substrate with similar characteristics (both spruce and pine are coniferous trees), the detection of this fungus on *Picea* sp. seems to be quite natural.

Geographically, new records of *S. tibetica* on the territory of the North-Eastern Caucasus in the Republic of Dagestan reduce the disjunction of the species distribution area. Until the present study *S. tibetica* was registered only in different regions of China (from type

Table 1. Voucher information and GenBank accession numbers for ITS sequences used in this study

Species	Specimen	Origin (country)	GenBank accession no.	Reference
Sidera americana Z.B. Liu et Yuan Yuan	Dai 19173	Canada	MW198477	Liu et al. (2023)
	Dai 12730 (holotype)	USA	MW198478	Liu et al. (2023)
S. borealis Z.B. Liu et Yuan Yuan	Cui 11216 (holotype)	China	MW198485	Liu et al. (2023)
	Dai 24187	China	OQ134536	Liu et al. (2023)
S. inflata Z.B. Liu et Y.C. Dai	Cui 13610 (holotype, BJFC 028475)	China	MW198480	Liu et al. (2021)
S. lenis (P. Karst.) Miettinen	Miettinen 11036.1	Finland	FN907914	Miettinen, Larsson (2011)
	NSK 1017015	Russia	OR364533	Unpublished
S. lowei (Rajchenb.) Miettinen	Ryvarden 40576	Venezuela	FN907917	Miettinen, Larsson (2011)
	Ryvarden 38817	New Zealand	FN907919	Miettinen, Larsson (2011)
S. lunata (Romell ex Bourdot et Galzin) K.H. Larss.	Stokland 15063 (O)	Norway	DQ873593	Larsson et al. (2006) (as *Athelopsis lunata*)
S. malaysiana Z.B. Liu et Y.C. Dai	Dai 18570 (holotype, BJFC 026859)	Malaysia	MW198481	Liu et al. (2021)
S. minutipora (Rodway et Cleland) Y.C. Dai, F. Wu, G.M. Gates et Rui Du	Cui 16720 (BJFC 030019)	Australia	MN621349	Du et al. (2020)
	Gates FF257	Australia	FN907922	Miettinen, Larsson (2011) (as *Sidera vulgaris*)
S. minutissima Y.C. Dai, F. Wu, G.M. Gates et Rui Du	Dai 19529 Dai 19529 (holotype, BJFC)	Sri Lanka	MN621352	Du et al. (2020)
	Dai 22495	China	OM974248	Liu et al. (2023)
S. parallela Y.C. Dai, F. Wu, G.M. Gates et Rui Du	Cui 10346 (holotype, BJFC 011241)	China	MK346145	Du et al. (2020)
	Cui 10361	China	MK346144	Du et al. (2020)
S. punctata Z.B. Liu et Y.C. Dai	Dai 22119 (holotype, BJFC 036011)	China	MW418438	Liu et al. (2021)
S. roseo-bubalina Z.B. Liu et Y.C. Dai	Dai 11277 (holotype, BJFC 007251)	China	MW198483	Liu et al. (2021)
S. salmonea Z.B. Liu, J. Yu et F. Wu	Dai 23343	China	OM974249	Liu et al. (2022)
	Dai 23354	China	OM974250	Liu et al. (2022)
Sidera sp.	UC2023008	USA	KP814157	Rosenthal et al. (2017)
S. srilankensis Y.C. Dai, F. Wu, G.M. Gates et Rui Du	Dai 19581	Sri Lanka	MN621345	Du et al. (2020)
	Dai 19654 (holotype, BJFC)	Sri Lanka	MN621344	Du et al. (2020)
S. tenuis Y.C. Dai, F. Wu, G.M. Gates et Rui Du	Dai 18697 (holotype, BJFC 027166)	Australia	MK331865	Du et al. (2020)
	Dai 18698	Australia	MK331866	Du et al. (2020)
S. tianshanensis B.K. Cui et T.M. Xu	Cui 19143 (holotype)	China	OP920995	Xu et al. (2023)
	Cui 19196	China	OP920998	Xu et al. (2023)
S. tibetica Z.B. Liu, Jian Yu et F. Wu	Dai 23648 (holotype, BJFC 038220)	China	OM974253	Liu et al. (2022)
	Dai 23407	China	OM974252	Liu et al. (2022)
	Dai 21057	Belarus	MW198484	Liu et al. (2023)
	Dai 22151	China	MW477794	Liu et al. (2023)
	LE F-342596	**Russia**	**OR457650**	**current study**
	LE F-342597	**Russia**	**OR457651**	**current study**

Table 1. (Contd.)

Species	Specimen	Origin (country)	GenBank accession no.	Reference
S. vesiculosa Rui Du et M. Zhou	BJFC025377 (holotype)	Singapore	MH636564	Du et al. (2019)
	BJFC025367	Singapore	MH636565	Du et al. (2019)
S. vulgaris (Fr.) Miettinen	Ryvarden 37198	New Zealand	FN907918	Miettinen, Larsson (2011)
Skvortzovia furfuracea (Bres.) G. Gruhn et Hallenberg	PRA-JV25256	Czech Republic	OM104985	Vondrák et al. (2023)
	KHL 11738 (GB)	Finland	DQ873648	Larsson et al. (2006) (as *Resinicium furfuraceum*)

locality in the north-western part to the eastern-coastal area of the country) and outside Asia, in Belarus, based on the record in the Belovezhskaya Pushcha National Park (Liu et al., 2022; Liu et al., 2023).

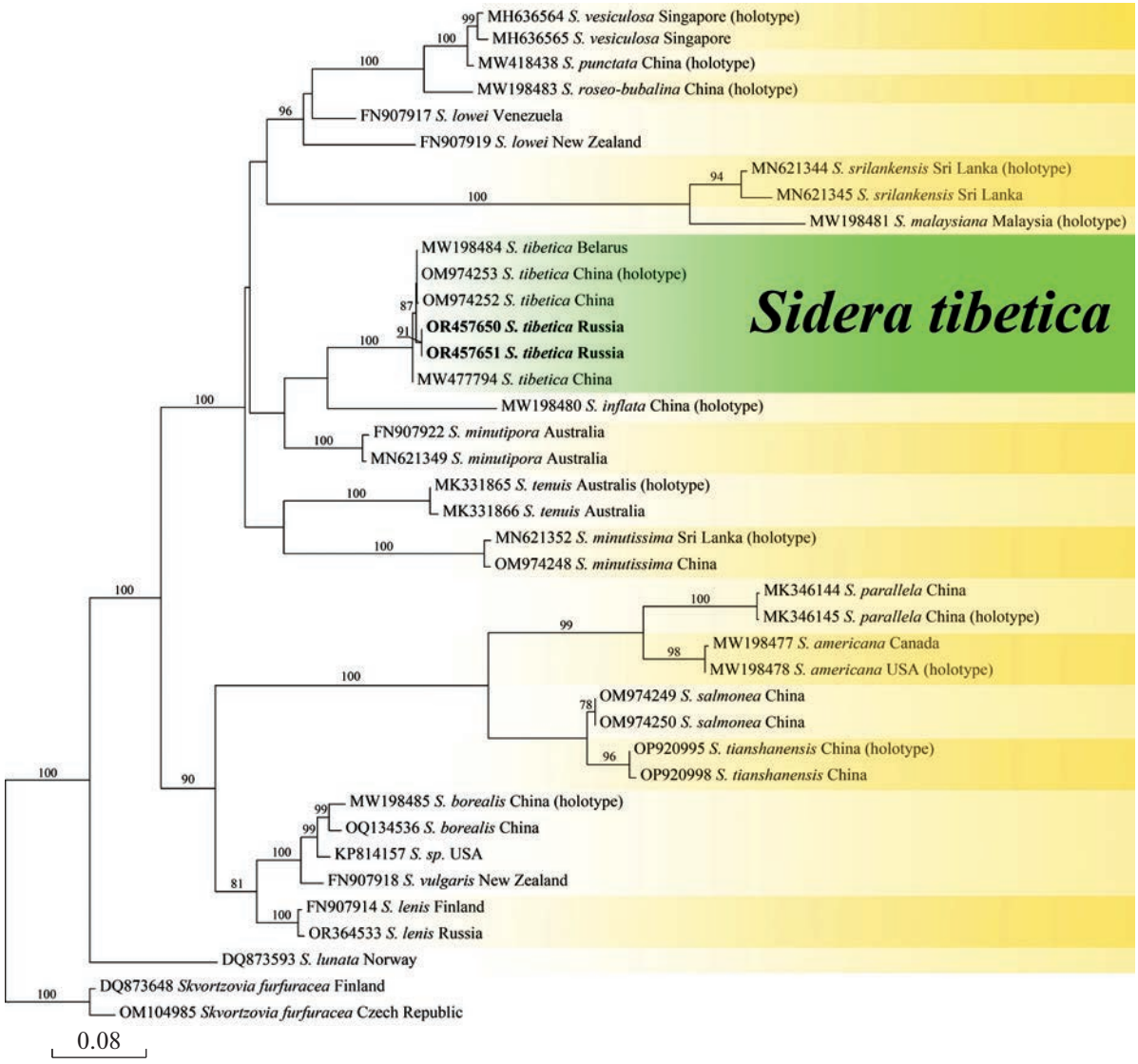

Fig. 3. Phylogenetic position of ITS nrDNA *Sidera tibetica* sequences newly generated in this study (in bold face) based on Maximum likelihood method. Bootstrap support values are shown above branches (BS ≥ 75%). The scale bar represents the expected number of nucleotide changes per site.

CONCLUSION

Based on presented data, a species list of the genus *Sidera* recorded for Russia is supplemented by *Sidera tibetica*, and currently it includes four species – *Sidera lenis*, *S. lunata*, *S. tibetica*, and *S. vulgaris*. The rapid progress in the description of new fungal species, primarily based on the study of DNA nucleotide sequences, determines the urgency of molecular revision of all the accumulated herbarium material on this taxon. Specimens of *Sidera* collected in Siberia and the Russian Far East, where the discovery of species new to the country is quite expected, are of undoubted interest, as well as materials collected in the European part of Russia and the Caucasus.

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Sidera tibetica (*Hymenochaetales*, *Basidiomycota*) – новый для России вид

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Впервые на территории прикаспийских низменных лесов Самурского национального парка (Республика Дагестан, Россия) обнаружен недавно описанный вид трутовых грибов *Sidera tibetica*. Базидиомы, собранные на *Pinus brutia* var. *eldarica*, были изучены как с помощью световой микроскопии, так и молекулярными методами. Приведены подробные сведения о новых выявленных местонахождениях и местообитаниях *Sidera tibetica*, а также коллекционные номера образцов, депонированных в Микологический гербарий Ботанического института РАН им. В.Л. Комарова (LE). Получены и депонированы в базу данных GenBank две полные последовательности ITS1–5.8S–ITS2 ядерной рибосомальной ДНК для кавказских образцов *S. tibetica*. Новые последовательности образуют отдельную хорошо поддерживаемую кладу в филогенетическом анализе на основе метода максимального правдоподобия вместе со всеми доступными ITS ярДНК последовательностями *S. tibetica* из белорусских и китайских образцов, включая референсную последовательность из голотипа.

Ключевые слова: биоразнообразие, биогеография, ДНК-штрихкоды, Северо-Восточный Кавказ, Республика Дагестан, сосновые посадки, трутовики