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Antrodia hyalina (Polyporales, Basidiomycota), new species to the Caucasus

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Abstract: A rare polypore species *Antrodia hyalina* Spirin, Miettinen & Kotir. collected in Dagestan is reported for the Caucasus for the first time. Data on the finding from the Samurskiy National Park is listed with information on substrate, habitat, and voucher specimen kept in the Mycological Herbarium of the Komarov Botanical Institute (LE). The known distribution of the species in Russia and Europe is briefly discussed. New ITS nuclear ribosomal DNA sequence from studied specimen of *Antrodia hyalina* has been generated and deposited into the GenBank database.

Keywords: aphyllophoroid fungi, biodiversity, Dagestan, forest ecosystems, polypores, Samurskiy National Park.

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Antrodia hyalina (Polyporales, Basidiomycota) – новый вид для Кавказа

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Резюме: Впервые на Кавказе зарегистрирован редкий вид трутовых грибов *Antrodia hyalina* Spirin, Miettinen & Kotir., собранный на территории Дагестана. Приводятся сведения о находке из Самурского национального парка с информацией о субстрате, местообитании и ваучерном образце, хранящемся в Микологическом гербарии Ботанического института имени В.Л. Комарова (LE). Кратко обсуждается известное распространение вида в России и Европе. Новая последовательность ITS области ярДНК, полученная из исследованного образца *Antrodia hyalina*, депонирована в базу данных GenBank.

Ключевые слова: афиллофороидные грибы, биоразнообразие, Дагестан, лесные экосистемы, трутовики, Самурский национальный парк.

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Introduction

The genus *Antrodia* P. Karst. (Polyporales, Basidiomycota) is a polyphyletic taxon which unites poroid fungi causing a brown rot, possessing predominantly dimitic hyphal system and basidiospores not having any reaction with Melzer's reagent (Bernicchia, Gorjón, 2020). Recent multi-loci molecular phylogenetic studies provided reasons to accept separate genera *Amyloporia, Anthoporia, Brunneoporus,*

Cartilosoma, Fibroporia, Resinoporia, etc. (Rajchenberg et al., 2011; Bernicchia et al., 2012; Ortiz-Santana et al., 2013; Karasiński, Niemelä, 2016; Audet, 2017a, 2017b; Zmitrovich, 2018) along with *Antrodia* s. str. (Spirin et al., 2013a). At the same time, the broad taxonomic concept of the genus *Antrodia* is reflected in the major modern summary books on the poroid fungi of Europe (Ryvarden, Melo, 2017; Bernicchia, Gorjón, 2020) and is traditionally used in primary field inventories of fungal diversity.

In October 2021 the remarkable fungal specimen from the genus *Antrodia* s. lato has been collected during the ongoing investigation of species composition and ecology of aphyllophoroid fungi in lowland deciduous forests of the "Samurskiy" National Park started by the author since 2019 (Volobuev, 2020). This communication is devoted to a description of new finding and a brief discussion of its ecological and geographical relationships.

Material and methods

Basidiomata were collected from dead fallen branches of *Populus nigra* in the liana deciduous forest dominated by *Populus nigra* L., *Fraxinus excelsior* L. and *Carpinus betulus* L. (Fig. 1, A). The geographical coordinates of sampling area are N 41°51'50.4", E 48°32'44.1"; altitude is –35 m a.s.l. The voucher specimen is kept in the Mycological Herbarium of the Komarov Botanical Institute (LE) under the collection number LE F-334706.

Identification of specimen was performed by light microscopy technique following Volobuev (2020). Additionally, DNA analysis has been carried out according to the procedure described in Volobuev et al. (2021). For this, the ITS1-5.8S-ITS2 region of nuclear ribosomal DNA was amplified with the ITS1F/ITS4B primers (Gardes, Bruns, 1993) using Plant Direct PCR Master Mix (Thermo Scientific) without prior DNA purification according to the manufacturer's instructions. Sequencing was performed on an ABI model 3500 Genetic Analyzer (Applied Biosystems). The newly generated sequence was deposited in GenBank (accession no. OM281603).

The maximum-likelihood 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 the sampled material. Data for 43 additional ITS nrDNA sequences included in the final alignment and the GenBank accession numbers are presented in table (see supplementary files).

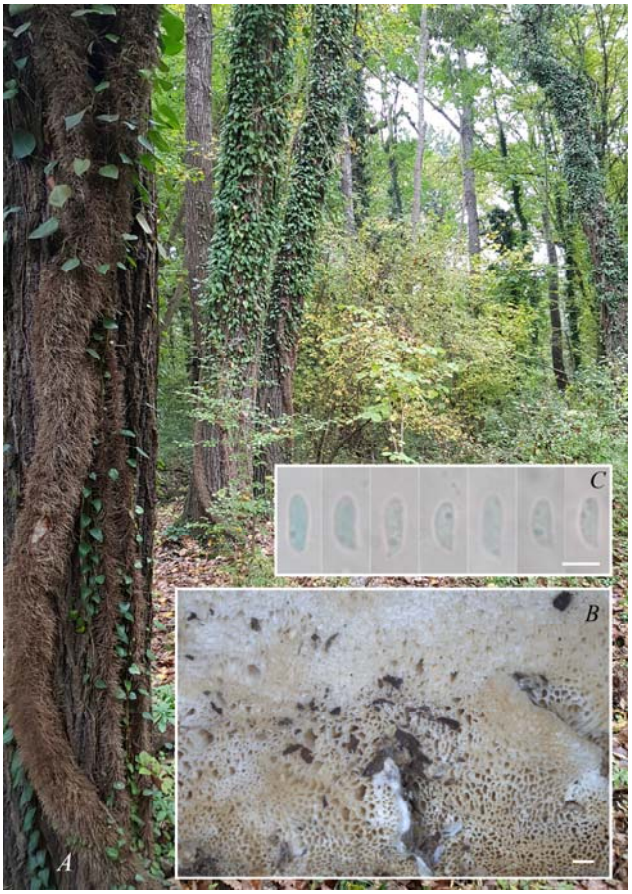

Fig. 1. Habitat (*A*), pore surface (*B*) and basidiospores (*C*) of *Antrodia hyalina*, LE F-334706. Scale bar: *B* – 1 mm, *C* – 5 µm.

Рис. 1. Местообитание (*A*), поверхность пор (*B*) и базидиоспоры (*C*) *Antrodia hyalina*, LE F-334706. Линейка: *B* – 1 мм, *C* – 5 мкм.

Results and discussion

The collected specimen is presented by resupinate cream-coloured with pale ochraceous tints basidioma having poroid hymenophore, angular to sinuous pores, 3–4 per mm, and well-developed white sterile margin (Fig. 1, B). Microscopic observation revealed the following main features: dimitic hyphal system consisting of generative hyphae with clamps and dominating skeletal hyphae with a subparallel arrangement, cylindrical to almost suballantoid, thin-walled, negative in Melzer's reagent, acyanophilous basidiospores, (5.7)6.3–8.0(8.1) x (2.1)2.3–2.5(2.6) µm (Fig. 1, C).

All listed characteristics allowed to identify the studied specimen as belonging to *Antrodia hyalina* Spirin, Miettinen & Kotir. (see the protologue in Spirin et al., 2013b). A detailed description of the species is also given in monographs on European polypores (Ryvarden, Melo, 2017; Bernicchia, Gorjón, 2020).

Based on a megablast search of NCBIs GenBank nucleotide database, the closest hit using the ITS sequence had highest similarity to JQ700283, holotype of *Antrodia hyalina* (voucher H (V. Spirin 2772); Identities = 700/703 (99 %), no gaps). Moreover, the performed phylogenetic inference confirmed the clustering of new generated ITS sequence from the Caucasian specimen together with all available sequences of *A. hyalina* in a strongly supported clade (Fig. 2). According to Audet (2017b) this clade was named as *Rhizoporia hyalina* (Spirin, Miettinen & Kotir.) Audet. However, there is one more combination, *Brunneoporus hyalinus* (Spirin, Miettinen & Kotir.) Zmitr., suggested by Zmitrovich (2018).

Following the above mentioned tradition of using a broad genus concept in mycological inventory studies, the name *Antrodia hyalina* has been retained not only in the title of this report but also in the further discussion.

In Russia the species was recorded in the European part from Arkhangelsk Oblast (Ezhov, 2013), Karelia (Ruokolainen, Shiryaev, 2020), Leningrad Oblast (Zmitrovich et al., 2015), Moscow (Spirin et al., 2013b), Nizhny Novgorod Oblast (Spirin et al., 2013b), Oryol Oblast (Volobuev, 2013a, 2013b), Samara Oblast (Spirin et al., 2013b), in the Urals from Sverdlovsk Oblast (Spirin et al., 2013b), and in Siberia from Tyva Republic (Kotiranta et al., 2016). Our record of *Antrodia hyalina* from Dagestan is the first one on the Caucasus.

Outside Russia, the species is known for Czech Republic, Finland (Spirin et al., 2013b), Ukraine (Ordynets et al., 2017), Germany, Norway, and Switzerland (Brunneoporus…, 2021).

The most preferable substrate for *Antrodia hyalina* is dead wood of *Populus tremula*, but there are collections derived from *Acer platanoides* and *Salix* sp. (Spirin et al., 2013b). Our specimen was collected on fallen branches of *Populus nigra* in the Samurskiy National Park. This fact is congruent with the ability of some non-pathogenic wood-inhabiting fungi to change a host tree within the same genus (e.g. *Populus tremula* and *P. nigra*).

Further research on species diversity and recording of fungal findings will not only provide valuable evidence for regional conservation planning, but will also provide new data on the overall distribution and ecology of fungal species in new habitats.

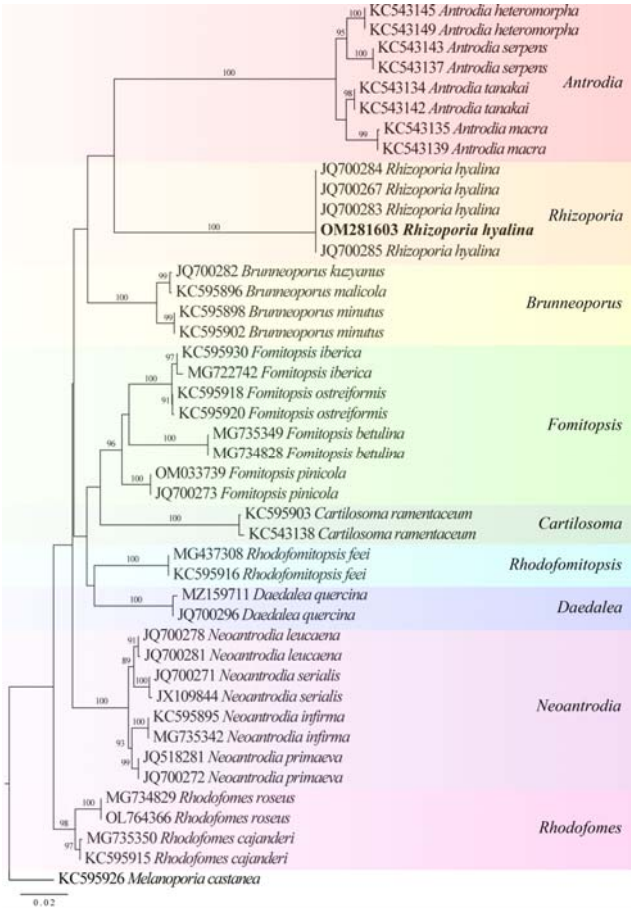

Fig. 2. Phylogenetic tree derived from Maximum Likelihood analysis based on nrITS1-5.8S-ITS2 data. Bootstrap support values shown above branches (BS > 80 %). New sequence obtained in this study is in bold face. The scale bar represents the expected number of nucleotide changes per site.

Рис. 2. Филогенетическое дерево по результатам анализа методом максимального правдоподобия на основе последовательностей ITS1-5.8S-ITS2 ярДНК. Значения bootstrap показаны над ветвями (BS > 80%). Жирным шрифтом выделена новая последовательность, полученная в данном исследовании. Масштабная линейка указывает ожидаемое количество нуклеотидных изменений на сайт.

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Supplementary files

Table / Таблица

Sequences included in this study
Последовательности, включенные в исследование

Species	Specimen, herbarium or collection, collector	Origin (country)	GenBank accession numbers (ITS)
Antrodia heteromorpha	H, D. Kosolapov	Russia	KC543145
	H, T. Niemela 2621	Canada	KC543149
Antrodia macra	H, J. Hottola 2729	Finland	KC543135
	H, T. Niemela 7865	Finland	KC543139
Antrodia serpens	H, epitype	Poland	KC543137
	H, P. Vampola	Slovakia	KC543143
Antrodia tanakai	H, M. Lindgren 113	Finland	KC543134
	H, V. Haikonen 16285	Finland	KC543142
Brunneoporus kuzyanus	LE 208476, V. Spirin	Russia	JQ700282
Brunneoporus malicola	H, O. Miettinen 10595.1	China	KC595896
Brunneoporus minutus	H, V. Spirin 2680	Russia	KC595898
	LE 208004, V. Spirin 1460	Russia	KC595902
Cartilosoma ramentaceum	O, P. Marstad 274-09	Norway	KC543138
	H, V. Spirin 2540	Russia	KC595903
Daedalea quercina	H, O. Miettinen 12662	Finland	JQ700296
	K(M) 250617, P. Kirk	United Kingdom	MZ159711
Fomitopsis betulina	LE-BIN 2894, N. Psurtseva	Russia	MG735349
	LE-BIN 3875, N. Fedosiyk	Russia	MG734828
Fomitopsis iberica	LE-BIN 3922, A. Kiyashko	—	MG722742
	H, P. Vampola	Czech Republic	KC595930
Fomitopsis ostreiformis	H, O. Miettinen 11573	Indonesia	KC595918
	H, O. Miettinen 14311	Indonesia	KC595920
Fomitopsis pinicola	H, O. Miettinen 12391	Finland	JQ700273
	LE-BIN 4361, N. Shakhova & S. Volobuev	Russia	OM033739
Melanoporia castanea	H, O. Miettinen 10517.1	China	KC595926
Neoantrodia infirma	LE-BIN 3669, N. Psurtseva	Russia	MG735342
	H, T. Niemela 7644	Finland	KC595895
Neoantrodia leucaena	H, J. Pennanen 927	Finland	JQ700278
	H, holotype	China	JQ700281
Neoantrodia primaeva	—	—	JQ518281
	H, O. Miettinen 177	Russia	JQ700272
Neoantrodia serialis	GB, neotype	Norway	JX109844
	H, O. Miettinen 12401	Finland	JQ700271
Rhizoporia hyalina	H, V. Spirin 2532	Russia	JQ700267
	H, holotype	Russia	JQ700283
	H, H. Kotiranta 19668	Russia	JQ700284
	LE 213042, I. Zmitrovich & V. Malysheva	Russia	JQ700285
	LE F-334706, S. Volobuev	Russia	OM281603
Rhodofomes cajanderi	LE-BIN 3546, A. Kiyashko	Russia	MG735350
	H, LE, V. Spirin	Russia	KC595915
Rhodofomes roseus	LE-BIN 3844, N. Psurtseva	Russia	MG734829
	LE-BIN 4758, N. Shakhova & S. Volobuev	Russia	OL764366
Rhodofomitopsis feei	H, O. Miettinen 13120	Indonesia	KC595916
	—	—	MG437308