

## Aphylloroid fungi (Basidiomycota) on juniper on the Gunib Plateau, inner-mountain Dagestan

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Volobuev S.V., Ivanushenko Yu.Yu. (2020): Aphylloroid fungi (Basidiomycota) on juniper on the Gunib Plateau, inner-mountain Dagestan. – Czech Mycol. 72(1): 83–93.

Aphylloroid fungi growing on *Juniperus oblonga* on the Gunib Plateau (1630–1910 m a.s.l.) were studied. An annotated list of 18 species in 14 genera of Agaricomycetes is presented. Among them, 17 species are recorded for the first time for the Plateau. *Amphinema byssoides*, *Brevicellium olivascens*, *Heterobasidion annosum* s. str., *Hyphodontia arguta*, *Lyomyces juniperi*, *Peniophora junipericola*, *Radulomyces confluens*, *Rhizoctonia fusispora*, *R. ochracea*, *Steccherinum fimbriatum*, *Tomentella atramentaria*, *T. badia* and *Tyromyces lacteus* are reported as new to the Republic of Dagestan and the North-Eastern Caucasus. *Rhizoctonia ochracea* is listed for the first time for the Caucasus and for the third time in Russia.

**Key words:** Agaricomycetes, biodiversity, mountain habitat, *Juniperus oblonga*.

**Article history:** received 7 April 2020, revised 5 May 2020, accepted 12 May 2020, published online 4 June 2020.

**DOI:** <https://doi.org/10.33585/cmy.72106>

Volobuev S.V., Ivanushenko Yu.Yu. (2020): Nelupenaté houby (Basidiomycota) na jalovci na planině Gunib v horách Dagestánu. – Czech Mycol. 72(1): 83–93.

Studie přináší přehled nelupenatých hub rostoucích na *Juniperus oblonga* na planině Gunib (1630–1910 m n. m.); je prezentován komentovaný seznam 18 druhů, patřících do 14 rodů z třídy Agaricomycetes. Sedmnáct z nich je zaznamenáno poprvé z této planiny. *Amphinema byssoides*, *Brevicellium olivascens*, *Heterobasidion annosum* s. str., *Hyphodontia arguta*, *Lyomyces juniperi*, *Peniophora junipericola*, *Radulomyces confluens*, *Rhizoctonia fusispora*, *Rhizoctonia ochracea*, *Steccherinum fimbriatum*, *Tomentella atramentaria*, *Tomentella badia* a *Tyromyces lacteus* jsou poprvé uvedeny z území Dagestánu a severovýchodního Kavkazu. V případě *Rhizoctonia ochracea* jde o první záznam z Kavkazu a třetí z území Ruska.

## INTRODUCTION

The genus *Juniperus* L. is the largest in the *Cupressaceae* family, including about 75 species belonging to three sections (Adams 2014). One of the most widespread representatives of the genus *Juniperus* in the Caucasus is the elongated juniper or long-leaved juniper (*Juniperus oblonga* M. Bieb.; Fig. 1), which grows from the Caspian lowland to subalpine altitudes of the Caucasus (Asadulaev & Sadykova 2011). Adams (2014) mentions *J. oblonga* for Armenia as *J. communis* var. *oblonga* Loudon. In this study, *J. oblonga* is considered an independent species, following Galushko (1978), Murtazaliev (2009) and Asadulaev & Sadykova (2011). In Dagestan, juniper forests can be found in all geomorphological regions of the Republic. *Juniperus oblonga* occupies vast areas in inner-mountain and high-mountain Dagestan (Asadulaev & Sadykova 2011). In addition to the above species, the genus *Juniperus* is represented by five other species in the Republic of Dagestan: *J. foetidissima* Willd., *J. hemisphaerica* C. Presl, *J. oxycedrus* L., *J. polycarpus* K. Koch and *J. sabina* L. (Murtazaliev 2009, Asadulaev & Sadykova 2011).

*Juniperus oblonga* has valuable medicinal properties and is applied in medicine and pharmacology owing to the content of essential oils in all organs of the plant (Asadulaev & Sadykova 2011), which in turn determines the specific features of its wood and a set of species of xylobiontic fungi adapted to growing on it. To date, a few special works on aphylloroid fungi inhabiting species of the genus *Juniperus* (Karadelev 1995, Bernicchia 2000, Belomesyatseva 2002, Sell & Kotiranta 2011) have been published, but there is no such study in Dagestan.

In the forests of the Gunib Plateau, the elongated juniper is part of a phytocoenosis formed by *Pinus kochiana*, *Betula litwinowii*, *B. pendula* and *B. raddeana*, with an admixture of *Salix caprea*, *Populus tremula*, *Carpinus betulus*, *Acer campestre*, *Sorbus torminalis*, *Tilia cordata* and other trees.

The climatic parameters of the Plateau are characterised as continental. Annual precipitation is uneven with an average sum of 680 mm per year. The greatest amount of precipitation falls during the summer months (80–90%). The average annual air temperature is +6.7 °C with a mean annual maximum temperature of +16.5 °C (August) and a mean minimum temperature of –5.2 °C (January). The period of temperatures above zero lasts on average 270 days (Asadulaev & Sadykova 2011, Sadykova 2019).

The aim of this study was to identify the species diversity of aphylloroid fungi growing on *Juniperus oblonga* in the Gunib Plateau.



**Fig. 1.** The elongated juniper (*Juniperus oblonga*) growing on south-facing slope. Photo Yu.Yu. Ivanushenko.

#### MATERIAL AND METHODS

Material was collected in accordance with the standard techniques (Ivoilov et al. 2017) in the course of October 2018, May and September 2019 during a survey along tracks in the Upper Gunib Nature Park and the territory of the experimental base of the Mountain Botanical Garden of the Dagestan Federal Research Center of the Russian Academy of Sciences (RAS), located on the Gunib Plateau (inner-mountain Dagestan) in the range of 1630–1910 m a.s.l.

Identification of the collected material was performed using a LOMO Mikmed-6 microscope (magnifications 600× and 1500× with oil immersion lens), a standard set of chemicals (5% KOH, Melzer reagent, 0.1% cotton blue), and identification books for corticioids (Bernicchia & Gorjón 2010), polypores (Ryvarden & Melo 2017) and tomentelloid fungi (Kõljalg 1996). The specimens studied were deposited into the main collection of the Mycological Herbarium of the Komarov Botanical Institute of RAS (LE), Saint Petersburg.

## RESULTS AND DISCUSSION

As a result of the mycological observation, 66 specimens were collected, and 18 species of aphyllorphoid fungi occurring on *Juniperus oblonga* wood in the environment of the Gunib Plateau were identified. Species new to Dagestan are marked with an asterisk. Fungal species names are provided in compliance with the Index Fungorum database ([www.indexfungorum.org](http://www.indexfungorum.org)). The following data is presented for each species: scientific name, data on specimens studied incl. coordinates, altitude, substrate characteristics, habitat, date of collection, and reference numbers to specimens available in the Mycological Herbarium of LE.

## LIST OF SPECIES

All mentioned localities are located in Russia, North-Eastern Caucasus, Republic of Dagestan, Gunib District, Gunib Plateau. Abbreviations used in the list below: SV = Sergey Volobuev, YuI = Yuliya Ivanushenko, d = diameter.

**Agaricales**

\* ***Radulomyces confluens*** (Fr.) M.P. Christ.

**Specimen examined:** 42°24'51.6" N, 46°55'34.0" E, 1831 m a.s.l., on fallen trunk of *J. oblonga* (d < 5 cm) in herb-fern birch forest, 31 May 2019, leg. & det. SV & YuI (LE 314763).

The species commonly prefers dead wood of deciduous trees, but has also been recorded on coniferous trees (Bernicchia & Gorjón 2010). It is interesting that Eriksson et al. (1981) mentioned this species as remarkably common also in the subalpine deciduous forests of Northern Lapland. Our record from the Gunib Plateau confirms the high ecological amplitude of the species and its wide distribution area in Eurasia.

***Schizophyllum commune*** Fr.

**Specimen examined:** 42°23'46.2" N, 46°55'17.7" E, 1724 m a.s.l., on fallen trunk of *J. oblonga* (d < 5 cm) in herb-rich birch forest with pine, 27 Sep 2019, leg. & det. SV & YuI.

**Atheliales**

\* ***Amphinema byssoides*** (Pers.) J. Erikss.

**Specimens examined:** 42°23'49.1" N, 46°55'21.9" E, 1663 m a.s.l., on fallen branches of *J. oblonga* (d = 5–10 cm) in herb-moss pine-dominated forest with birch, 28 Sep 2019, leg. & det. SV (LE 314753); 42°24'2.7" N, 46°55'8.0" E, 1720 m a.s.l., on fallen branches of *J. oblonga* (d < 5 cm) in herb-rich birch forest, 5 Oct 2018, leg. & det. SV.

### *Cantharellales*

\* *Rhizoctonia fusispora* (J. Schröt.) Oberw., R. Bauer, Garnica & R. Kirschner  
**Specimen examined:** 42°23'43.7" N, 46°55'21.1" E, 1718 m a.s.l., on fallen trunk of *J. oblonga* (d < 5 cm) in herb-moss pine-dominated forest, 27 Sep 2019, leg. & det. SV (LE 314765).

\* *Rhizoctonia ochracea* (Masse) Oberw., R. Bauer, Garnica & R. Kirschner  
**Specimen examined:** 42°23'49.1" N, 46°55'21.9" E, 1663 m a.s.l., on fallen branches of *J. oblonga* (d = 5–10 cm) in herb-moss pine-dominated forest with birch, 28 Sep 2019, leg. & det. SV (LE 314764).

The first record of this species for the Caucasus and the third record for Russia. Basidiocarps of this fungus were collected both on angiosperms and gymnosperms (Roberts 1998, Bernicchia & Gorjón 2010, Martini on-line), but here it was found in association with *Juniperus* for the first time.

### *Hymenochaetales*

\* *Hyphodontia arguta* (Fr.) J. Erikss.

**Specimens examined:** 42°24'51.6" N, 46°55'34.0" E, 1831 m a.s.l., on fallen trunk of *J. oblonga* (d = 2–3 cm) in herb-fern birch forest, 31 May 2019, leg. & det. SV & YuI (LE 314756); 42°24'52.0" N, 46°55'40.0" E, 1767 m a.s.l., on fallen trunk of *J. oblonga* (d > 10 cm) in juniper forest, 31 May 2019, leg. & det. SV.

\* *Lyomyces juniperi* (Bourdot & Galzin) Riebesehl & Langer Fig. 2

**Specimens examined:** 42°23'33.8" N, 46°55'53.4" E, 1685 m a.s.l., on bark of living trunk of *J. oblonga* (d > 10 cm) in herb-rich aspen forest with hornbeam, 29 Sep 2019, leg. & det. SV (LE 314758); 42°23'35.4" N, 46°55'44.9" E, 1701 m a.s.l., on living trunk of *J. oblonga* (d > 10 cm) in bare-ground hornbeam forest with birch, 29 Sep 2019, leg. & det. SV & YuI; 42°23'41.7" N, 46°55'30.1" E, 1686 m a.s.l., on fallen trunk of *J. oblonga* (d = 5–10 cm) in herb-rich birch forest with hornbeam, 27 Sep 2019, leg. & det. SV; 42°23'47.2" N, 46°55'31.6" E, 1630 m a.s.l., on fallen trunk of *J. oblonga* (d < 5 cm) in herb-rich birch forest, 27 Sep 2019, leg. & det. SV & YuI; 42°23'49.1" N, 46°55'21.9" E, 1663 m a.s.l., on fallen branch of *J. oblonga* (d < 2 cm) in herb-moss pine-dominated forest with birch, 28 Sep 2019, leg. & det. SV & YuI; 42°23'50.6" N, 46°55'21.8" E, 1679 m a.s.l., on fallen trunk of *J. oblonga* (d > 10 cm) in herb-moss aspen forest, 28 Sep 2019, leg. & det. SV & YuI; 42°24'2.7" N, 46°55'8.0" E, 1720 m a.s.l., on fallen branches of *J. oblonga* (d < 5 cm) in herb-rich birch forest, 5 Oct 2018, leg. & det. SV; 42°24'35.2" N, 46°54'25.3" E, 1876 m a.s.l., on dead standing trunk of *J. oblonga* (d > 10 cm) in herb-moss pine-dominated forest with birch, 29 May 2019, leg. & det. SV & YuI; 42°24'5.1" N, 46°55'27.4" E, 1727 m a.s.l., on bark of living trunk of *J. oblonga* (d > 10 cm) in juniper forest, 8 Oct 2018, leg. & det. SV; 42°24'51.6" N, 46°55'34.0" E, 1831 m a.s.l., on fallen branches of *J. oblonga* (d = 5–10 cm) in juniper forest, 31 May 2019, leg. & det. SV (LE 314759); on dead standing and fallen trunks and branches (d < 5 cm) of *J. oblonga* in juniper forest, 31 May 2019, leg. & det. SV & YuI; on dead standing trunks (d < 3 cm), fallen trunk (d = 5–7 cm) and fallen branch (d < 3 cm) of *J. oblonga* in herb-fern birch forest, 31 May 2019, leg. & det. SV & YuI; 42°24'52.0" N, 46°55'40.0" E, 1768 m a.s.l., on fallen trunk (d > 10 cm) and fallen branches (d = 5–10 cm) of *J. oblonga* in juniper forest, 31 May 2019, leg. & det. SV.

A frequent species on *Juniperus* in many European countries, but until the current research it was known in the Caucasus only from the NW part (Krasnodar Region, Russia) and from Iran (Ghobad-Nejhad et al. 2009).



## Polyporales

### *Irpex lacteus* (Fr.) Fr.

**Specimen examined:** 42°23'39.2" N, 46°55'29.0" E, 1725 m a.s.l., on dead branches of *J. oblonga* (d < 5 cm) in herb-rich pine-dominated forest with birch, 27 Sep 2019, leg. & det. SV (LE 314757).

### \* *Steccherinum fimbriatum* (Pers.) J. Erikss.

**Specimens examined:** 42°23'43.7" N, 46°55'21.1" E, 1718 m a.s.l., on fallen trunk of *J. oblonga* (d < 5 cm) in herb-moss pine-dominated forest, 27 Sep 2019, leg. & det. SV (LE 314766); 42°23'47.2" N, 46°55'31.6" E, 1630 m a.s.l., on fallen branch of *J. oblonga* (d < 1 cm) in herb-rich birch forest, 27 Sep 2019, leg. & det. SV & YuI; 42°23'49.1" N, 46°55'21.9" E, 1663 m a.s.l., on fallen branches of *J. oblonga* (d = 5–10 cm) in herb-moss pine-dominated forest with birch, 28 Sep 2019, leg. & det. SV.

### \* *Tyromyces lacteus* (Fr.) Murrill

**Specimen examined:** 42°24'2.7" N, 46°55'8.0" E, 1720 m a.s.l., on fallen branches of *J. oblonga* (d < 5 cm) in herb-rich birch forest, 5 Oct 2018, leg. & det. SV (LE 314760).

## Russulales

### \* *Heterobasidion annosum* (Fr.) Bref. s. str.

**Specimen examined:** 42°24'35.2" N, 46°54'25.3" E, 1876 m a.s.l., on dead standing trunk of *J. oblonga* (d > 10 cm) in herb-moss pine-dominated forest with birch, 29 May 2019, leg. & det. SV (LE 314755).

### \* *Peniophora junipericola* J. Erikss.

Fig. 3

**Specimens examined:** 42°23'35.4" N, 46°55'44.9" N, 1701 m a.s.l., on living trunk of *J. oblonga* (d > 10 cm) in bare-ground hornbeam forest with birch, 29 Sep 2019, leg. & det. SV & YuI (LE 314761); 42°23'39.2" N, 46°55'29.0" E, 1725 m a.s.l., on dead branches of *J. oblonga* (d < 5 cm) in herb-rich pine-dominated forest with birch, 27 Sep 2019, leg. & det. SV; 42°23'43.7" N, 46°55'21.1" E, 1718 m a.s.l., on fallen trunk of *J. oblonga* (d < 5 cm) in herb-moss pine-dominated forest, 27 Sep 2019, leg. & det. SV; 42°23'49.1" N, 46°55'21.9" E, 1663 m a.s.l., on fallen branches of *J. oblonga* (d = 5–10 cm) in herb-moss pine-dominated forest with birch, 28 Sep 2019, leg. & det. SV; 42°24'39.0" N, 46°54'15.5" E, 1911 m a.s.l., on dead branches of *J. oblonga* (d < 2 cm) in pine-dominated forest, 29 May 2019, leg. & det. SV & YuI; 42°24'5.1" N, 46°55'27.4" E, 1727 m a.s.l., on dead branches and on bark of living trunk of *J. oblonga* (d > 10 cm) in juniper forest, 8 Oct 2018, leg. & det. SV; 42°24'51.6" N, 46°55'34.0" E, 1831 m a.s.l., on fallen branches (d = 5–10 cm) and fallen trunk (d < 3 cm) of *J. oblonga* in juniper forest, 31 May 2019, leg. & det. SV (LE 314762); on dead standing and fallen trunks (d < 5 cm) of *J. oblonga* in herb-fern birch forest, 31 May 2019, leg. & det. SV & YuI; 42°24'52.0" N, 46°55'40.0" E, 1770 m a.s.l., on fallen branches of *J. oblonga* (d = 5–10 cm) in juniper forest, 31 May 2019, leg. & det. SV.

## Thelephorales

### \* *Tomentella atramentaria* Rostr.

**Specimen examined:** 42°24'2.7" N, 46°55'8.0" E, 1720 m a.s.l., on fallen branches of *J. oblonga* (d < 5 cm) in herb-rich birch forest, 5 Oct 2018, leg. & det. SV (LE 314768).

### \* *Tomentella badia* (Link) Stalpers

**Specimen examined:** 42°23'43.7" N, 46°55'21.1" E, 1718 m a.s.l., on fallen trunk of *J. oblonga* (d < 5 cm) in herb-moss pine-dominated forest, 27 Sep 2019, leg. & det. SV (LE 314769).



**Fig. 2.** Basidiocarps of *Lyomyces juniperi* on bark of living trunk of *Juniperus oblonga* (8 October 2018, not documented by voucher). Photo S.V. Volobuev.



**Fig. 3.** Basidiocarps of *Peniophora junipericola* on fallen trunk of *Juniperus oblonga* (LE 314762). Photo Yu.Yu. Ivanushenko.

***Tomentella ferruginea* (Pers.) Pat.**

**Specimen examined:** 42°24'2.7" N, 46°55'8.0" E, 1720 m a.s.l., on fallen branches of *J. oblonga* (d < 5 cm) in herb-rich birch forest, 5 Oct 2018, leg. & det. SV (LE 314767).

***Tomentella subtestacea* Bourdot & Galzin**

**Specimen examined:** 42°24'51.6" N, 46°55'34.0" E, 1831 m a.s.l., on fallen trunk of *J. oblonga* (d > 10 cm) in juniper forest, 31 May 2019, leg. & det. SV (LE 314770).

***Trechisporales***

\* ***Brevicellicium olivascens* (Bres.) K.H. Larss. & Hjortstam**

**Specimen examined:** 42°24'2.7" N, 46°55'8.0" E, 1720 m a.s.l., on fallen branches of *J. oblonga* (d < 5 cm) in herb-rich birch forest, 5 Oct 2018, leg. & det. SV (LE 314754).

The species is generally collected on angiosperms in Europe (Bernicchia & Gorjón 2010). Our find on juniper is a rare case but it is congruent with records known from Estonia (Sell & Kotiranta 2011).

***Trechispora microspora* (P. Karst.) Liberta**

**Specimen examined:** 42°24'2.7" N, 46°55'8.0" E, 1720 m a.s.l., on fallen branches of *J. oblonga* (d < 5 cm) in herb-rich birch forest, 5 Oct 2018, leg. & det. SV (LE 314771).

SUMMARY

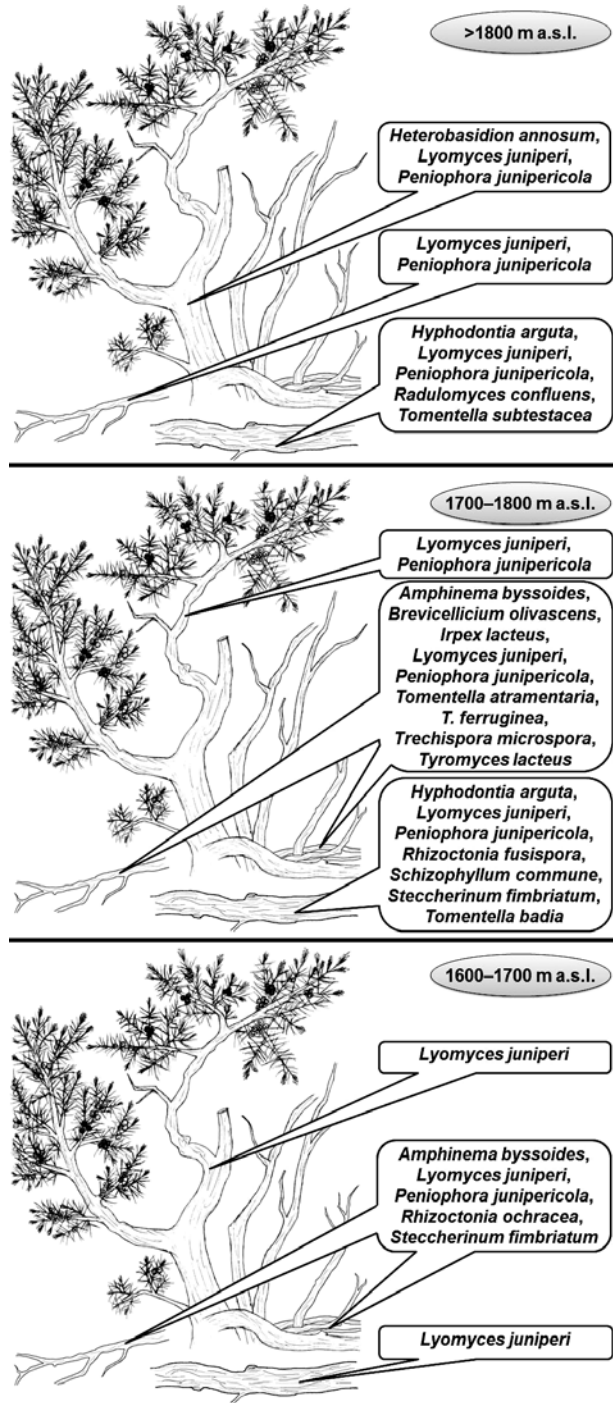
The 18 juniper-associated species belong to eight orders of Agaricomycetes (Basidiomycota). Seventeen recorded fungal species are new to the territory of the Gunib Plateau. Only *Irpex lacteus* was previously mentioned by the authors for the Gunib Plateau as a common species on dead trunks of *Alnus* and *Betula* (Ivanushenko et al. 2019). Thirteen species are listed for the Republic of Dagestan for the first time, including *Rhizoctonia ochracea*, recorded as the first find for the Caucasus and the third one for Russia. Until the current research, the species had been reported from the Altai (Roberts 1998) and from Sverdlovsk Oblast in the Urals (Shiryaev & Stavishenko 2011).

The highest occurrence was noted for *Lyomyces juniperi* (28 finds, or 42.4%) and *Peniophora junipericola* (15 finds, or 22.7%). A small number of records was made for *Hyphodontia arguta* (4), *Steccherinum fimbriatum* (3), and *Amphinema byssoides* (2). The records of the remaining 13 species are based on single finds.

The majority of fungal species associated with *Juniperus oblonga* was recorded on the Gunib Plateau within the altitudinal range of 1700–1800 m, comprising 14 species of aphylophoroid fungi (Fig. 4).

The species identified may be divided into four ecological trophic groups as follows: mycorrhizal fungi, saprotrophs, obligate pathogens, and facultative pathogens. There are four mycorrhiza-forming species (all representatives of the genus *Tomentella*), ten species of saprotrophs, one obligate pathogen species





**Fig. 4.** Distribution of juniper-associated Agaricomycetes species in an elevation gradient on the Gunib Plateau and basidiocarp locations on the plant (living and dead trunks and branches). Del. Yu.Yu. Ivanushenko and S.V. Volobuev.

(*Heterobasidion annosum* s. str.), and three species of facultative pathogens, including *Lyomyces juniperi*, *Peniophora junipericola*, and *Hyphodontia arguta*.

Among the wood-inhabiting species of aphylloroid fungi discovered, only *Lyomyces juniperi* and *Peniophora junipericola* grow mainly or exclusively on various species of the genus *Juniperus* (Karadelev 1995) and belong to the group of stenotrophs. Eurytrophs (species growing on different conifers) include *Amphinema byssoides* and *Heterobasidion annosum* s. str. Most species are pantotrophs, i.e. a group of species adapted to development both on conifers and hardwood (Volobuev 2015), for instance *Rhizoctonia fusispora*, *R. ochracea*, *Schizophyllum commune* and *Trechispora microspora*. At the same time, a number of species are more commonly found on deciduous trees, and only a few specimens have been collected from conifers. These include *Brevicellicium olivascens*, *Hyphodontia arguta*, *Irpex lacteus*, *Radulomyces confluens*, *Steccherinum fimbriatum* and *Tyromyces lacteus*.

#### ACKNOWLEDGEMENTS

The research was carried out thanks to a grant awarded by the Russian Science Foundation (project no. 19-77-00085). The authors are grateful to Prof. Z.M. Asadulaev, Dr. A.B. Ismailov, and I.M. Ibragimov (Mountain Botanical Garden, Dagestan Federal Research Center of RAS) for organisation of the field work. We also thank the reviewers for valuable comments on the manuscript.

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