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Daedaleopsis Genus in Siberia and the Far East of Russia

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Abstract

The current article discusses the findings of the study of biodiversity, distribution, and ecology of *Daedaleopsis* species in the Siberia and Russian Far East are presented. In this part of Eurasia, the genus *Daedaleopsis* is represented by 3 species, *D. confragosa, D. tricolor* and *D. septentrionalis*. They are distributed in all regions of Siberia and the Russian Far East (the most common are *D. confragosa* and *D. tricolor*) and contribute to the decomposition of woody debris of several deciduous (*Acer, Alnus, Betula, Carpinus, Chosenia, Crataegus Quercus, Padus, Populus, Salix, Sorbus, Tilia*) and rarely coniferous (*Abies*) trees. Each species has its own pattern of geographical and substrate distribution. *D. confragosa* is mainly confined to the *Salix* and *Alnus* debris in the near-water habitats and has an azonal distribution, whereas *D. tricolor* is mostly abundant in southern regions where it mainly occurs on *Betula* and less frequently on *Alnus, Padus,* and *Salix.* Species *D. septentrionalis* is a geographic antipode of the *D. tricolor* – common in the northern regions and part of the forest zone, mainly found on woody debris of *Betula,* rarerly *Alnus* and *Salix*. The geographical and substrate distribution patterns of the *Daedaleopsis* species in the Siberia and Russian Far East are close to those in the European subcontinent. The database was uploaded to the Global Biodiversity Information Facility (GBIF) (Ural Federal University named after the first President of Russia B.N. Yeltsin publisher) on September 17th, 2020 to provide open access to data.

Keywords: Russia, Asian part, biodiversity, *Daedaleopsis*, distribution, ecology

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Introduction

The species of the genus *Daedaleopsis* Schroet, *D. confragosa* (Bolton) J. Schroet, *D. tricolor* (Pers.: Fr.) Bondartsev & Singer, and *D. septentrionalis* (P. Karst.) Niemelä are the classic morphological species distinguished by the structure of basidiocarps: the first has a poroid or daedaleoid hymenophore, and the second, as well as the third – lamellar, but differently colored caps. They are widespread in the Boreal region of the Northern Hemisphere: *D. confragosa* and *D. tricolor* are found in the forests of Eurasia and North America, whereas *D. septentrionalis* are scarcely distributed in Eurasia. In both continents, *Daedaleopsis* species take part in the decomposition of deciduous, rarely coniferous trees (Gilbertson and Ryvarden 1986; Ryvarden and Gilbertson 1993; Ryvarden and Melo 2014).

This group of ecologically important bracket fungi has not been sufficiently studied particularly in Russia, where all three species are recorded (Bondartseva 1998). There are very few data on their distribution and ecology in the Asian part of Russia (Siberia, Far East), and they do not always correspond to modern data about the biodiversity of the *Daedaleopsis* genus. This taxon, as a rule, is represented by only the species *D. confragosa* (Bondartsev 1953). It should be noted that these fungi, as producers of different bioactive compounds with antibacterial, antiviral, hypotensive, anti-tumor, gene-protective and antioxidant activities, possess a biotechnological potential (Rösecke and König 2000; Kim et al. 2001; Yaoita et al. 2002; Vidović et al. 2011; Teplyakova et al. 2012; Fakoyal et al. 2013; Knežević et al. 2017; Mukhin et al. 2020).

The current study is directed to the biodiversity, geography and ecology of the genus *Daedaleopsis* in Siberia and the Russian Far East.

Methods

The study included species from the Asian part of Russia, the vast territory including Siberia and the Far East. Siberia is part of Northern Asia bordered in the west by the Ural Mountains, and in the east by watershed ridges along the Pacific Ocean. It is divided into several physical-geographical countries: Western, Central and North-East Siberia, Altai-Sayan Mountainous, Baikal area and Transbaikalia Mountainous, Daurian. The Far East includes the territories along the northwestern coast of the Pacific Ocean from the Chukotka Peninsula in the north to the Primorsky Territory in the south, and according to physiographic division (Nizovtsev et al. 2004), it consists of Amur-Sakhalin and North Pacific Ocean Countries (Fig. 1).

The collection of 130 samples of basidiocarps of the *Daedaleopsis* species obtained from 1978–2007 during expeditions in Siberia and the Far East have been analyzed (Table 1). The herbarium samples are preserved at the Institute of Plant and Animal Ecology (UB RAS) and Ural Federal University named after the first President of Russia B.N. Yeltsin Each (UFU). The geographic coordinates for the samples were obtained with different accuracy, depending on the method of fixing the location of the sample. The quality of the geographical reference presented in the herbarium was estimated as follows: the location coordinate of the field work given in the collection gave uncertainty of the order of 1000 m (for samples of 1978–2007), since the location was recorded from physical maps, and checked using Google mapping services (https://maps.google.ru/maps). The taxonomic identification and verification of basidiocarps were performed according to the morphological features of basidiocarps (Gilbertson and Ryvarden 1986; Ryvarden and Gilbertson 1993; Hansen and Knudsen 1997; Bondartseva 1998; Ryvarden and Melo 2014). The nomenclature of species is assigned according to *Index Fungorum* (www.speciesfungorum.org). The dataset was

published through the Global Biodiversity Information Facility (GBIF) to provide open access to data (Mukhin and Vladykina 2020).

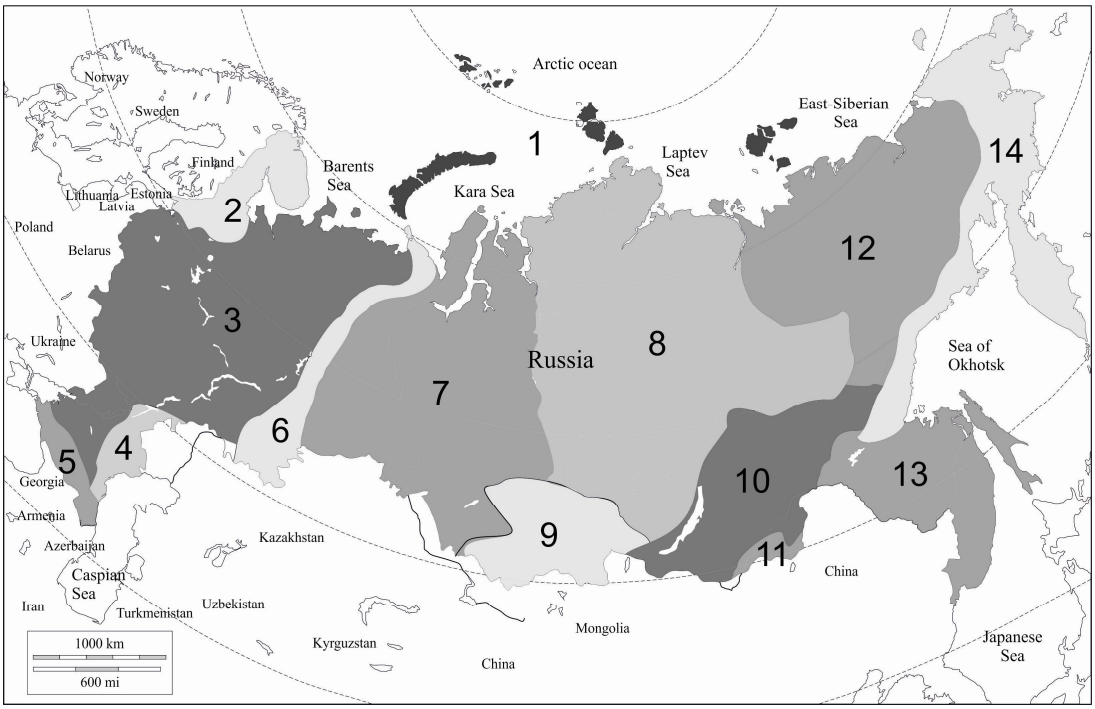

Figure 1. The physico-geographical countries of the Russian Federation: 1 – Arctic Islands, 2 – Kola-Karelian (Fennoscandia), 3 – East European (Russian Plain), 4 – Caspian, 5 – Caucasian Mountainous, 6 – Ural Mountainous, 7 – Western Siberia, 8 – Central Siberia, 9 – Altai-Sayan Mountainous, 10 – Baikal area and Transbaikalia Mountainous, 11 – Daurian, 12 – North-East Siberia, 13 – Amur-Sakhalin, and 14 – North Pacific Ocean.

Table 1. The List of Research Areas in Siberia and the Far East of Russia.

Physiographic country, region	Research area and localities
Western Siberia	**Tyumen oblast**. The vicinity of the settlement Mission (58.45000°N; 68.48000°E), Mazurovo (57.51000°N; 67.25000°E). **Yamalo-Nenets Autonomous Okrug**. Yamal Peninsula – Yadayakhodayakha river (67.16000°N; 71.67000°E), Khadytayakha river (67.01011°N; 69.53659°E), Valley lower the river Poluy (65.77674°N; 68.84874°E), Bolshaya Kheta river (67.59000°N; 84.33000°E). In the vicinity of the cities Salekhard (66.55000°N; 66.59000°E), Labytnangi (66.39000°N; 66.23000°E), settlement of Horsaim (66.35570°N; 67.17426°E), Polui river (65.77674°N; 68.84874°E), vicinity of the settlement of Khash-Gort (65.47000°N; 65.68000°E); Valley river Lagos-Yugan (60.92474°N; 73.09000°E), Floodplain of river Ob, Saranagut-Posl channel (65.47000°N; 65.68000°E). **Khanty-Mansi Autonomous Okrug**. Lyapin river (63.81609°N; 61.49339°E), the vicinity of the settlement Oktyabrskoe (62.48000°N; 65.99000°E), Alyabyevo (61.21923°N; 62.77640°E), Vyntya river (61.07000°N; 67.52000°E). **Sverdlovsk oblast**. Vicinity of the city Verkhoturye (57.30138°N; 60.32950°E), Nevyanskiy district (57.30138°N; 60.32950°E), Yekaterinburg, Botanical Garden of the Ural Branch of the Russian Academy of Sciences (56.78503°N; 60.56883°E). **Kurgan Oblast**. In the vicinity of the settlement Ketovo (55.34791°N; 65.32390°E).

Central Siberia	**The Republic of Sakha (Yakutia)**. Vicinity of the city Yakutsk (62.01000°N; 129.43000°E), Aldan river (63.26000°N; 129.33000°E), Highway "Vilyuyskoe" 46 km (62.04000°N; 128.92000°E), Spasskaya Pad (62.14000°N; 129.37000°E), Verkhnevilyuisky (63.28000°N; 120.31000°E).
Altai-Sayan	**Altai Republic**. Nature Reserve Teletskoye Lake (51.35000°N; 87.84000°E), Chike-Taman Pass (50.64000°N; 86.31000°E); Old Chuysky tract (52.51621°N; 85.27246°E); Estyube waterfall, Chuysky tract (51.74995°N; 87.39953°E), Mount Sarlyk (51.07700°N; 85.73500°E), Chuisky tract, river Sarlyk (51.11000°N; 85.59000°E), **Krasnoyarsk Oblast**. The vicinity of the settlement Tanzybey (53.08000°N; 92.56000°E), Aradan (52.57000°N; 93.44000°E).
Baikal area and Transbaikalia Mountainous	**Irkutsk Oblast**: The vicinity of the lake Baikal (53.88116°N; 109.35247°E), Olkhonsky district, Khuzhir (53.13000°N; 107.45000°E); Barguzinsky district, "Kedrovyy mys" (53.88116°N; 109.35247°E); Turskaya, Surroundings of the river "Kudareyka" (52.52751°N; 104.45552°E); Barguzinsky district, lake Baikal (53.88116°N; 109.35247°E); Primorsky Ridge (52.48722°N; 105.88805°E).
Amur-Sakhalin	**Khabarovsk Oblast**: The vicinity of the settlement Troitskoye (49.10210°N;136.50909°E), city Khabarovsk (48.28000°N; 134.75000°E), Lake Khanka (44.47000°N; 132.36000°E). **Primorsky Krai**. Nature Reserve Lazovsky (43.16000°N; 134.02000°E), Nature Reserve Kedrovaya Pad (43.06000°N; 131.30000°E), vicinity of the settlement Benevskoe (43.14000°N; 133.43000°E). **Sakhalin Oblast**. The vicinity of the settlement Poronaysk (49.21000°N; 143.08000°E), Uglegorsk (49.02019°N; 142.12343°E), Dolinsk (47.25138°N; 143.01805°E), Lake Ayrup (46.78294°N; 143.39684°E), surroundings of Lesogorsk (49.43739°N; 142.13049°E).
North Pacific Ocean	**Magadan Oblast**. In vicinity of the settlement Ust-Taskan (62.42000°N; 150.49000°E), Yagodnoye (62.31000°N; 149.37000°E), city of Magadan (59°58′N; 150°80′E), Armand river (59.39000°N; 150.08000°E). **Kamchatka Oblast**. Vicinity of the settlement Esso (55.56000°N; 158.41000°E), Milkovo (54.69000°N; 158.62000°E), Zhupanovo (54.08000°N; 159.97000°E), Bolsheretsky (52.82000°N; 156.28000°E).

The distribution and ecology of the studied fungi were characterized by relative abundance and substrate, as well as trophic spectra. The relative abundance (in %) was calculated, based on the ratio of the number of its specimens to the total number of specimens of studied species of the genus: Sj / SDC + SDS + SDT × 100%, where Sj is the number of specimens of one of the studied species, and SDC + SDS + SDT – the total number of records of all studied species. The substrate or trophic spectra were calculated according to the following formula: Nj / N1 + N2 + N3 … + NX × 100%, where Nj is the number of fungus specimens on one type of woody debris, N1 + N2 + N3 … + NX – the total number of its finds on all types of debris.

Results and Discussion

Biodiversity

The species *D. confragosa, D. tricolor* and *D. septentrionalis* with characteristic morphological features are found in the Asian part of Russia. The basidiocarps of *D. confragosa* have a poroid hymenophore and form dark yellow to light brown caps. The basidiocarps in *D. tricolor* and *D. septentrionalis* have a lamellar hymenophore. However, its upper part is reddish and zonal in *D. tricolor*, whereas it is brownish in the *D. septentrionalis* (Fig. 2). The most common species are considered

D. confragosa (42%), *D. tricolor* (39%), whereas *D. septentrionalis* is the least common in the studied area (19%).

Figure 2. Basidiocarps of the *Daedaleopsis* species:
D. confragosa (I), *D. tricolor* (II) *and D. septentrionalis* (III).

Geographic distribution

The *Daedaleopsis* species are found in all studied regions of Siberia and the Far East (Table 1). They were only not recorded in polar timberline in the Western Siberia (Tazovsky Peninsula – Nyda and Hadutte rivers; Gydan Peninsula – the Messoyakha River) and Central Siberia (vicinity of the city Norilsk and settlement Khatanga, Kotui and Kotuikan rivers, Taimyr Nature reserve – Ary-Mas, Lukunskiy). However, *D. confragosa* and *D. septentrionalis* have been found in the Yamal (Khadyta and Yadayakhodiyakha rivers) and Gydan Peninsulas (Bolshaya Kheta river).

D. confragosa is distributed in most studied regions of Siberia and the Far East. It is more common in the Western Siberia and North Pacific regions compared to other two species. In Central Siberia, Altai-Sayan and Amur-Sakhalin this species rarely occurs and has not been found in Baikal and Transbaikalia regions (Table 2). According to Kotiranta et al. (2016), it was recorded in Dauria-one of the southern regions of Siberia, bordering Mongolia. *D. confragosa* occurs in all latitudinal parts of the forest zone: from the forest-tundra to the forest-steppe.

Table 2. The occurrence (in %) of *Daedaleopsis* species in different regions of Siberia and Far East.

Physico-geographical country, region	*D. confragosa*	*D. tricolor*	*D. septentrionalis*
Western Siberia	59	26	15
Central Siberia	37	27	36
Baikal area and Transbaikalia	Not found	73	27
Altai-Sayan	22	61	17
Amur-Sakhalin	34	63	3
North Pacific Ocean	86	Not found	14

The species *D. tricolor is* also widely distributed in the studied area. It has not been found only in North Pacific region where the genus *Daedaleopsis* is represented by *D. confragosa* and *D. septentrionalis*. Among them, *D. confragosa* is regarded as the most common (Table 2). The absence of *D. tricolor* in the North Pacific region, particularly in the Magadan area, has been previously reported by Sazanova (2009). Parmasto (1961) included *D. tricolor* in the list of wood-decaying Basidiomycetes fungi of Kamchatka, however it has not been found in this region during the expedition in 1997.

D. tricolor is the most common species (60–70%) distributed in the southern parts of Siberia and the Far East: Altai-Sayan, Baikal area and Transbaikalia, Amur-Sakhalin countries. Together with *D. confragosa*, it has also been found in Dauria (Kotiranta et al. 2016). The confinement of *D. tricolor* to southern areas in Europe has also been reported by Ryvarden and Gilbertson (1993) and, in Russia – by Bondartseva (1998).

D. septentrionalis is relatively rare compared to other species of the genus, but it grows in all regions of Siberia and the Far East. It is most common in the Western and Central Siberia, as well as Baikal area and Transbaikalia, North Pacific Ocean Countries. This fungus is most distributed in the northern part of the forest zone and rare – in the southern part. It is common in North Pacific Ocean Country (northern part of the Far East) and rare in the Amur-Sakhalin region (southern part of Far East).

D. septentrionalis does not occur in Dauria (Kotiranta et al. 2016). In Europe, it has been found in Sweden and Finland (Ryvarden and Gilbertson 1993).

The distribution over woody substrates

The *Daedaleopsis* species mainly grows on woody debris of deciduous (*Acer, Alnus, Betula, Carpinus, Chosenia, Crataegus, Quercus, Padus, Populus, Salix, Sorbus, Tilia*) and were rarely found on coniferous *(Abies)* trees. The growth of this group of fungi on the woody debris of *Acer, Chosenia* and *Padus* in Eurasia has been originally described. The diversity of woody debris in decomposition of which fungi of genus take part changes significantly from region to region (Table 3).

Table 3. The substrate spectra of the *Daedaleopsis* species in Siberia and the Far East of Russia.

Woody debris	Physico-geographical country, region					
	1	2	3	4	5	6
Abies	–	Dt	–	–	–	–
Acer	–	–	–	–	Dt	–
Alnus	Dc	Dt	Dt, Ds	Dt, Ds	Dc, Dt	Dc
Betula	Dc, Dt, Ds	Dt, Ds	Dc, Dt, Ds	Dt	Dt	Ds
Carpinus	–	–	–	–	Dt	–
Chosenia	–	–	–	–	Dc, Dt, Ds	Dc
Crataegus	–	–	–	–	Dc	–
Padus	–	Dt, Ds	–	Dt	Dt	–
Populus	–	Dc, Dt	–	–	Dc	–
Quercus	–	–	–	–	Dc, Dt	–
Salix	Dc, Dt	Dc, Dt,	Dc, Ds	Dt, Ds Ds	Dc, Dt	Dc
Sorbus	–	–	–	Dt	–	–
Tilia	–	–	–	–	Dt	–

Note: *D. confragosa* (Dc), *D. tricolor* (Dt), *D. septentrionalis* (Ds). 1 – Western Siberia, 2 – Altai-Sayan, 3 – Central Siberia, 4 – Baikal area and Transbaikalia, 5 – Amur-Sakhalin, 6 – North Pacific Ocean.

In Siberia and the Far East, *D. confragosa* grows on the woody debris of *Alnus, Betula, Chosenia, Crataegus, Quercus, Populus, Salix,* and *Sorbus* (Table 3). The substrate spectrum of *D. confragosa* in study area is narrower than in Europe and North America where this fungus grows on wood of 17 and 33 tree species respectively (Gilbertson and Ryvarden 1986; Ryvarden and Gilbertson 1993). *D. confragosa* mostly grows on *Salix* (46%) and *Alnus* (27%) reflecting the pattern of its biotropical distribution – inhabitant of near-water thickets of willow and alder. The trophic preference of *D. confragosa* in Siberia and the Far East is the same as in the European subcontinent where it is also predominantly found on the woody debris of *Salix* (Ryvarden and Gilbertson 1993).

D. tricolor has the widest substrate spectrum among studied *Daedaleosis* species, including woody debris of *Abies, Acer, Alnus, Betula, Carpinus, Chosenia, Crataegus, Quercus, Padus, Populus, Salix, Sorbus,* and *Tilia*. Only this species has been found on the woody debris of *Abies, Acer, Carpinus, Sorbus,* and *Tilia* in studied area. The main

substrate for *D. tricolor* is *Betula* (35%), followed by *Salix* (12%), *Alnus* (13%), *Padus* (17%). This reflects the biotropical distribution of *D. tricolor* which is considered the habitant of birch forests on upland and near-water biotopes with thickets of alder, bird cherry and willow. In Europe, *D. tricolor* is mainly found on *Salix,* but not on *Betula* which, however, is also present in its substrate spectrum (Ryvarden and Gilbertson 1993).

The trophic spectrum of *D. septentrionalis* is narrow, including the woody debris of *Alnus, Betula, Chosenia, Padus,* and *Salix,* preferably *Betula, Alnus* and *Salix* 58%, 18% and 14% of specimens, respectively (Table 2). The predominant confinement to *Betula* is a characteristic of *D. septentrionalis.* In Europe, it has been mostly recorded on *Betula* woody debris and scarcely on *Alnus* and *Sorbus* (Ryvarden and Gilbertson 1993). The development of *D. septentrionalis* on the trunks of *Salix* and *Alnus* in Ural and Siberia has been reported by Bondartseva (1998).

Conclusion

The genus *Daedaleosis* is represented by 3 species in Siberia and the Far East: *D. confragosa, D. tricolor* and *D. septentrionalis*. They are all widespread in this part of Eurasia however have their own patterns of distribution. *D. confragosa* is a species represented in almost all regions and is mainly confined to the *Salix* and *Alnus* woody debris in near-water habitats. *D. tricolor* is most abundant in the southern part of the forest zone where it almost equally occurs in upland habitats on *Betula* and near-water habitats on *Alnus, Padus,* and *Salix. D. septentrionalis* is a geographic antipode of *D. tricolor,* since it is common in the northern part of the forest zone and mainly occurs on the wooden debris of *Betula*.

The distribution of *D. confragosa*, *D. tricolor* and *D. septentrionalis* in Siberia and the Far East of Russia, corresponds to their geographical patterns in the European subcontinent. These species are close to those in Europe concerning their trophic preferences. Thus, the geographical and trophic patterns of *D. confragosa*, *D. tricolor*, and *D. septentrionalis* are their relatively conserved characteristics.

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