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PENSOFT

A northern record of *Meripilus giganteus* (Fr.) P. Karst., 1882 (Polyporales, Agaricomycetes) from Dubki Park, Saint Petersburg, Russia

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Abstract

We present a new record for the polypore *Meripilus giganteus* (Fr.) P. Karst., 1882 from Dubki Park, Saint Petersburg, Russia. This is one of the northernmost records in Europe for this species. The morphological description of *M. giganteus* LE 287654 is given and its ecological preferences, which highlight an unusual ecological situation of this species in Dubki Park, are discussed.

Keywords

Endangered species, Giant Polypore, new record, oak zone, polypores.

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Introduction

Meripilus giganteus (Fr.) P. Karst., 1882 (Polyporales, Agaricomycetes), also known as Giant Polypore, is distributed throughout the temperate forest zone of the Northern Hemisphere and in New Zealand. In the northern part of its geographic range, *M. giganteus* more or less follows the northern limit of the distribution of *Quercus* spp. (Ryvarden and Melo 2017), whereas in the southern part, it is associated with diverse broadleaf and subtropical tree species. In the Northern Hemisphere, southernmost outposts of *M. giganteus* are found in the vicinity of Pittsburgh (USA), and the northernmost ones are in the vicinities of Oslo and Bergen (Norway) as well as Helsinki (Finland). Most records lie between 43° and 58° N (Ryvarden and Gilbertson 1994; GBIF 2019). In Russia, there are several records of this species from the Caucasus and Krasnodar Region (Bondartsev 1953; Bondartseva 1998), but this fungus was not reported from the northern part of the *Quercus* zone until now.

On 19 September 2018, *M. giganteus* was found in Dubki Park, Saint Petersburg, Russia. This is the first record of the species from the territory of Saint Petersburg and the boreal zone of Russia.

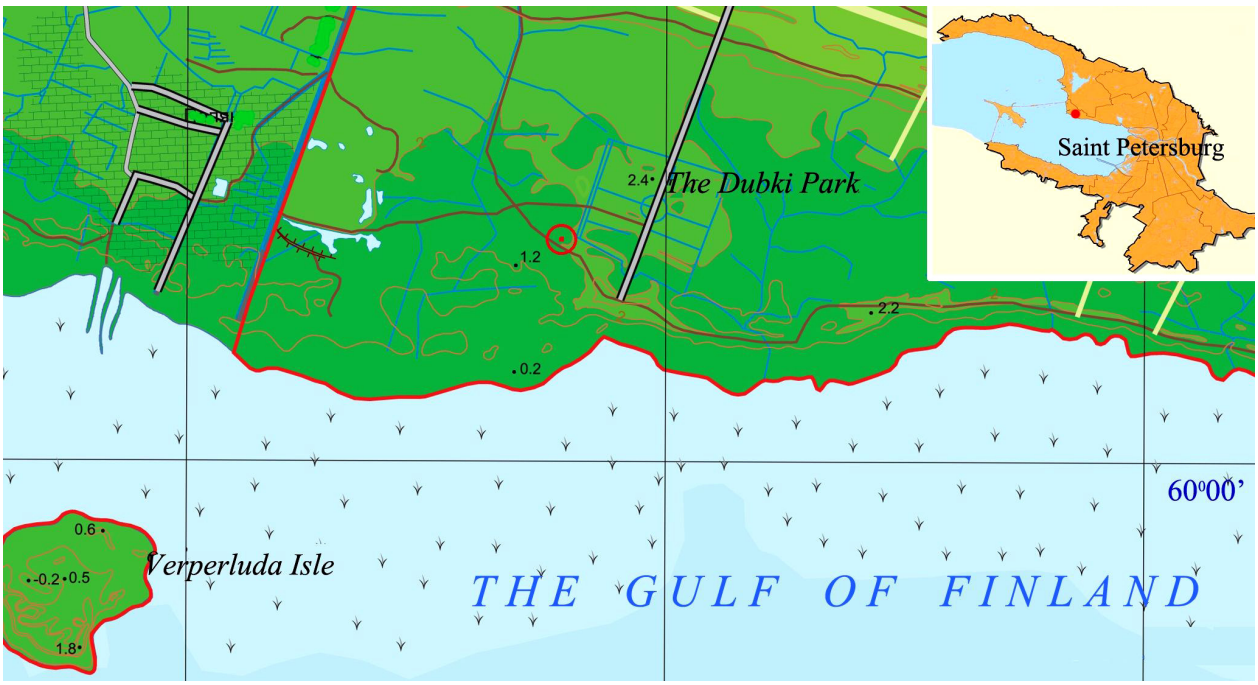

Figure 1. The location of Dubki Park (Saint Petersburg, Russia) (red circle), where *Meripilus giganteus* LE 287654 was found.

Methods

Dubki Park is located at 60.00°N, 030.01°E (Fig. 1) and is part of the Historic Centre of Saint Petersburg and Related Groups of Monuments World Heritage Site. The park is also part of the North Coast of the Neva Bay State Nature Reserve. The park area covers approximately 60.5 ha. Fragments of complex oak-spruce forests develop on binomial sediments: 1) Dog's mercury oak forests, 2) ground-elder oak forests, 3) black alder nemoral oak forests, 4) mixed alder-birch ground-elder oak forests. Some oaks (*Quercus robur* L.) here are over 300 years old (Khramtsov et al. 2013). The park is artificially drained and, thus, has optimum conditions for the development of nemoral zonal complexes. The parks' forest stands represent one of the northern outposts of the *Quercus*-zone in Eastern Europe, with the territory.

Basidiomata were studied in the laboratory as described by Gilbertson and Ryvarden (1986). Freehand sections and squash mounts were examined in 5% potassium hydroxide and 2% Cotton Blue. In total of 60 spores were measured. The material is deposited in mycological herbarium of Komarov Botanical Institute of the Russian Academy of Sciences (LE).

Results

New record. Russia, Saint Petersburg, old part of Dubki Park; 60.00°N, 030.01°E; 19 Sep. 2018; N.I. Kalinovskaya coll.; on roots of *Quercus robur*; LE 287654. Figure 1.

The material was collected at the end of vegetative growth period in September 2018. Living and dead standing trees, fallen logs, stumps, wood debris and forest litter were observed. The find was made on a 250–300-year-old oak in ground-elder oak forest (Fig. 2).

Taxonomy. The genus *Meripilus* P. Karst. belongs to the order Polyporales, where it is considered as either belonging to Meripilaceae Jülich (Justo et al. 2017) or Meruliaceae Rea (Zmitrovich 2018). A closely related

Figure 2. *Alnetum glutinosae–Quercetum aegopodiosum* forest in Dubki Park, Saint Petersburg, where *Meripilus giganteus* LE 287654 was found. (Photo by N.I. Kalinovskaya).

Table 1. The parts of the world and the countries in which *Meripilus giganteus* was recorded (GBIF 2019)

Continent/region	Countries
Asia	Japan
Europe	Austria, Belgium, Czechia, Denmark, Finland, France, Germany, Ireland, Isle of Man, Italy, Luxembourg, Netherlands, Norway, Poland, Russia, Serbia, Slovakia, Spain, Sweden, United Kingdom, Ukraine
North America	Canada, USA
Oceania	New Zealand

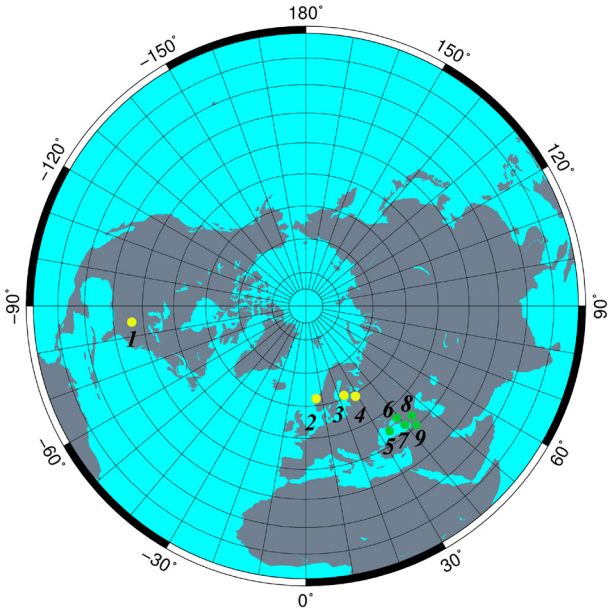

Figure 3. The southernmost and northernmost records of *Meripilus giganteus* in the Northern Hemisphere (GBIF, 2019) and known northern records of this species in Russia and adjacent areas (Bondartsev, 1953; Bondartseva, 1998; LE herbarium): *1* = southernmost record near Pittsburgh, USA (40.70°N, 7.90°E); *2* = northernmost record near to Oslo, Norway (60.10°N, 10.20°E); *3* = northern find in Helsinki, Finland (60.20°N, 24.90°E); *4* = northern find in Saint Petersburg (60.00°N 30.01°E); *5* = Republic of Crimea (45.31°N, 34.02°E; 1530 km from new record), *6* = Krasnodar Krai (45.19°N, 38.06°E, 1740 km from new record); *7* = Republic of Adygea (44.79°N, 40.34°E 1780 km from new record); *8* = Chechnya (43.44°N, 45.04°E, 2120 km from new record); *9* = Georgia (42.03°N, 42.98°E, 2259 km from new record).

genus is *Physisporinus* P. Karst., which characterized, however, by ceriporioid morphotype with bruising basidiomata. In essence, *Meripilus* is a "grifoloid physisporinus" adapted to development into hollow butts of trees. The presence of sarcoskeletals in the internal tissues of *M. giganteus* is a convergent phenomenon and is highly characteristic for the grifoloid morphotype.

Known distribution. The countries worldwide where *M. giganteus* has been recorded are given in Table 1, and the southernmost and northernmost records in the Northern Hemisphere are shown in Figure 3. In the Southern Hemisphere it is known from New Zealand (GBIF 2019). In occurring in both the Northern and South hemispheres, this species demonstrates the so-called bipolar distribution pattern. The presence of rather distant disjunctive parts of the species range confined to deciduous forests (Japan and New Zealand) suggests that this species is a relict of former climatic eras when it had a wider distribution (Zmitrovich 2017; Zmitrovich et al. 2018). However, the occurrence of such disjunctions in spore-disseminated organisms may also have other reasons related to their specialization and distribution patterns. For example, Shiryaev (2016) discovered two pronounced latitudinal maxima in the diversity of clavarioid species in the temperate zones of both the Northern and Southern hemispheres, with a sharp decrease in the vast tropical region that separates these maxima. Another example is *M. giganteus*, which has a disjunct range, which includes New Zealand and which may be anthropogenic in nature, as this species is associated with an artificial planting of forests containing European broadleaf species which now constitute the majority of the forests in this country. In this case, the fungus might have been unintentionally brought to New Zealand with woody substrate. Another consideration is the possibility that an ecosystem could be less resistant to species invasion, such as *M. giganteus* in Japan, than the neighboring continental ecosystems of the Far East, where *M. giganteus* is not found.

Morphological description. *Meripilus giganteus* forms large basidiomata of grifoloid habit, annual, with numerous imbricate, fan-shaped to spatulate clustered pilei growing from strong common stem, single pilei 3–18 cm wide and long with tapering base, up to 2.5 cm thick (the founded basidiomes cluster as a whole reaching 25 cm wide and 15 cm long). Context tough and fleshy when fresh, brittle when dry, whitish-cream, with hyaline to blackish streaks, up to 1.5 cm thick near the bases of the individual pilei. Upperside a trichodermis turning into a cutis, glabrous or radially-fibrillose, smooth or somewhat scrupose, cream-ochraceous to blackish-brown when bruised, somewhat concentrically zonate, when dry the thinner parts of the pileus often become radially wrinkled. Margin thin, entire to lobed and wavy, often detlexed when dry. Stem short and stout, ochraceous and smooth, distinctly fibrous. Hymenophore as a single tube layer up to 8 mm thick; pore surface white to pale, darkening when touched in fresh condition, pores small, 3–5 per mm, dissepiments entire; tube layer up to 8 mm thick, concolorous with the pore surface (Fig. 4). Hyphal system sarcodimitic. Generative hyphae 3–7.5 μm in diam., simple-septate, in the trama more or less parallel, thin-walled, in the context and stipe unbranched or sparingly branched, rather thick-walled, sarcoskeletals 6–17 μm wide, regularly branched at more or less right angle, thick-walled to subsolid, with scattered to almost no septa. Cystidia absent, but fusoid leptocystidia present, 15–45 × 5–8 μm, simple-septate at the base. Basidia

Figure 4. *Meripilus giganteus* LE 287654 basidiome clusters. **1.** General view in a native biotope. **2.** Pilei upperside. **3.** Hymenophore and context in a field. **4.** Hymenophore when bruised. **5.** Pores under a millimeter ruler. Scale bars = 1 cm (photo by N.I. Kalinovskaya).

20–45 × 6.5–8.5 µm, clavate with a median constriction, 4-spored, simple-septate at the base. Basidiospores 5–7.5 × 4.5–6.5 µm (n = 60), broadly ellipsoid to subglobose, hyaline, smooth, with a prominent wall and a central globule, negative in Melzer's reagent, cyanophilous.

Discussion

Meripilus giganteus was found in Dubki Park on a small hill, near a drainage ditch, in an area of *Alnetum glutinosae–Quercetum aegopodiosum* (a result of hydroamelioration of spruce–birch swamp forest) (Fig. 2). Basidiome clusters were found on oak roots within hollow formed by a fallen tree (*Tilia cordata* Miller). The habitat was rather in shadow because a large oak and several *Tilia* trees grew around. There were signs of anthropogenic disturbances to the habitat, such as footpaths, the drainage ditch, and two old, cut oak stumps.

Elsewhere in the world, *M. giganteus* grows on the roots and butts of live deciduous (*Acer* L., *Aesculus* L., *Alnus* Mill., *Arbutus* L., *Betula* L., *Castanea* Mill., *Celtis* L., *Ceratonia* L., *Corylus* L., *Eucalyptus* L'Her., *Fagus* L., *Myrica* L., *Persea* Mill., *Pittosporium* Banks ex Sol., *Platanus* L., *Populus* L., *Prunus* L., *Pyrus* L., *Quercus* L., *Tilia* L., *Ulmus* L.) and coniferous (*Abies* Mill., *Larix* Mill., *Pinus* L.) trees. This fungus causes a white rot (Ryvarden and Gilbertson 1994; Bondartseva 1998; Ryvarden and Melo 2017), and is characterized as a pathogenic saprotroph (Zmitrovich et al. 2015). For the development of its sporulation, this fungus requires a significant mycelial mass according to Bondartsev (1953), and in the Caucasus, one basidiocarp cluster had a mass of 18 kg. As a facultative pathogen, this species primarily infests the roots and lower part of the trunk of predominantly deciduous trees, most often oak and beech, which have attained a large size and have sustained injuries caused by fire, animals (on animal trails or pasturing), and humans (in parkland with significant recreational activity). *Meripilus giganteus* shares ecological niche characteristics with other polypores that grow on broadleaf trees, such *Grifola frondosa* (Dicks.) Gray, *Ganoderma applanatum* (Pers.) Pat., *Climacodom septentrionalis* (Fr.) P. Karst., *Irpiciporus litschaueri* (Lohwag) Zmitr., *Spongipellis spumea* (Sowerby) Pat., *Cerioporus squamosus* (Huds.) Quél., *Sparassis laminosa* Fr., or on conifer trees, such as *Bondarzewia mesenterica* (Schaeff.) Kreisel and *Ischnoderma benzoinum* (Wahlenb.) P. Karst. *Meripilus giganteus* may directly compete for habitat with these other species, and climate change and other environmental conditions may strengthen or weaken the competitiveness of *M. giganteus*. Judging by its global range, *M. giganteus* prefers rather dry, warm soil conditions, and this species' presence within a boreal zone represents an anomaly.

The *Quercus* forest in Dubki Park is not natural, and in the absence of human alterations and impacts, the native vegetation at the site where *M. giganteus* was found would have been northern European spruce forests with *Picea abies* (L.) H. Karst. and swamp shrub and moss understory (Gribova and Neuhäusl 1989). In the event of the removal of the drainage at the site, the

succession vegetation series would lead to swamp-spruce forests with transitional peatlands, to grass–fern–spruce forests in the diluvial zone, and to *Vaccinium myrtillus*–spruce forests in a placore (Zmitrovich 2012). In retrospect, *Quercus robur* is able to survive in Dubki Park due to the direct or indirect human effects of artificial drainage. Concerning *Alnus glutinosa* (L.) Gaertn. and *A. incana* (L.) Moench, in the diluvial zone they are part of the natural successive series of vegetation outside of human influence.

Our new record of *M. giganteus* in Dubki Park, Saint Petersburg, is rather distant from the previously known limit of its geographic range in Europe. In Russia and adjacent areas, *M. giganteus* occurs where broadleaf forests having *Carpinus* are widespread, namely in the Krasnodar Krai, the republics of Chechnya, Adygea, Crimea, and Georgia (Bondartsev 1953; Bondartseva 1998; LE herbarium). The distance between the nearest Russian locality and the new record is slightly more than 1,500 km. The Krasnodar Krai area represents a southern arid margin of the Russian broad-leave vegetation zone.

The suboceanic climate that is characteristic of northwestern Russian species locality is the reason that broadleaf tree species can survive within the taiga vegetation zone; milder winters mean that they are less likely freeze out than in typical taiga forests. However, a typical taiga hydrological soil regime has a negative impact on broadleaf trees. As a result of ground drainage, an ecotone broadleaf vegetation tends to expand to the north in this region. In Dubki Park, *M. giganteus* was found on an oak tree in its characteristic biotope; the exposure was southern and the fungus was growing in micro- and mesoclimatic conditions, which correspond to conditions more characteristic of the southern parts of the species' distribution. Therefore, in Dubki Park *M. giganteus* is at the limit of its environmental tolerances at the northern boundary of its geographic range.

We have begun to survey for this species in other parks of Saint Petersburg and the adjacent Leningrad Oblast bordering the Gulf of Finland.

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Authors' Contributions

IZ confirmed the identification, wrote the morphological description and other sections of the manuscript, and produced the map; NK did the fieldwork, collected and initially identified the specimen, and described the habitat; SP wrote sections of the text on the ecology and biogeography *Meripilus giganteus* and helped revise the manuscript; AM helped write the morphological description, and helped revise the manuscript; OE discussed the manuscript and helped revise the manuscript and its submission process.

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