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The Meruliaceae of Russia. I. *Bjerkandera*

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Key words: basidiomycetes, aphyllophoralean fungi, meruliaceous fungi, modifications variability, broadleaf wood-associated fungi, Russia, Saint Petersburg parks.

Summary. This paper opens a taxonomical survey on the genera of Meruliaceae (Polyporales, Basidiomycota) presented in Russian mycobiota. All the meruliaceous fungi represent an obligate component of heterotrophic block of forest ecosystems and considerable demanded biotechnological resource. The purpose of the present elaboration is a revision of East European and North Asian material on *Bjerkandera* genus highlighting its species' and intraspecific morphological variability and substrate specialization. The macroscopic descriptions are based on a study of fresh and dried specimens. The material of the herbaria of Komarov Botanical Institute (St. Petersburg, LE) and Institute of Zoology and Botany of Estonian Agricultural University (TAA) is studied. Micromorphological analysis is included the hyphal system revealing, the hyphae, basidia/basidiospores morphometry, and microchemical tests of the structures in question. The genus *Bjerkandera* is accepted in its original Karstenian sense, although the concepts by Pilát, Corner, Pouzar, and Zmitrovich et al. were discussed. The genus is characterized by two-layered context with rather loose tomentum and dense layer above the hymenophore, monomitic to pseudodimitic hyphal system, clamped generative hyphae, and ellipsoid-cylindrical basidiospores not staining in Cotton blue and Melzer's reagent. Only two species, *Bjerkandera adusta* and *B. fumosa* were recognized in the genus, and a possible position of *B. subsimulans* and *B. terebrans* was discussed, too. The polymorphism of *B. adusta* is exhaustively presented and the form *tegumentosa* was epitypified and described. The polymorphism of *B. fumosa* is also presented, and the form *flavipora* was correctly published and epitypified. The relationships between two species are discussed and the key for species delimitation is presented here. Distributional patterns are presented for both species as well as their substrate range. The substrates of *B. adusta* and *B. fumosa* in old-growth arboreta of Saint Petersburg are presented.

Мерулиевые грибы России. I. Род *Bjerkandera*

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Ключевые слова: базидиомицеты, афиллофоровые грибы, мерулиевые грибы, модификационная изменчивость, грибы широколиственных пород, Россия, парки Санкт-Петербурга.

Аннотация. Статья открывает таксономический обзор родов семейства Meruliaceae (Polyporales, Basidiomycota), представленных в микобиоте России. Мерулиевые грибы представляют облигатный компонент гетеротрофного блока лесных экосистем и значительный биотехнологический ресурс. Цель данной работы – таксономическая обработка восточноевропейского и североазиатского материала по роду *Bjerkandera*, с особым вниманием к описанию внутривидового полиморфизма. Макроскопические описания основаны на исследовании свежих и высушенных образцов, хранящихся в гербариях Ботанического института им. В. Л. Комарова (г. Санкт-Петербург, Россия, LE) и Института Зоологии и ботаники Сельскохозяйственного университета г. Тарту (Эстония, TAA). Микроморфологический анализ включал выявление гифальной системы, морфометрию гиф, базидий и спор и микрохимические тесты структур. Род *Bjerkandera* принят в его оригинальной трактовке П. Карстеном, хотя обсуждены также концепции А. Пилата, Э. Корнера, З. Поузара и И. В. Змитровича и соавторов. Род характеризуется двухслойной тканью с рыхлым верхним слоем и темной линией над

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гименофором, мономитической или псевдодимитической гифальной системой, пряжками на генеративных гифах и эллипсоидально-цилиндрическими базидиоспорами, не изменяющими окраски в реактиве Мельцера и Хлопчатобумажном синем. В роде принимается два вида – *Bjerkandera adusta* и *B. fumosa*. Таксономическое положение *B. subsimulans* и *B. terebrans* требует корректировки. Подробно описан внутривидовой полиморфизм *B. adusta*, причем произведена эпитипификация f. *tegumentosa*. Представление полиморфизма *B. fumosa* сопровождается корректным оформлением и эпитипификацией f. *flavipora*. Подробно обсуждена проблема разграничения двух видов и представлен видовой ключ. Собран материал по географическому распространению двух видов и их субстратной приуроченности, включая полученные авторами данные о субстратной приуроченности видов, выявленной в старовозрастных посадках широколиственных пород на территории г. Санкт-Петербурга.

This paper opens a taxonomical survey on the genera of Meruliaceae (Polyporales, Basidiomycota) presented in Russian mycobiota. The Meruliaceae family unites a certain corticioid (Zmitrovich, 1997), some polyporoid (Binder et al., 2013) and even lentinoid (Zmitrovich, Malysheva, 2013) fungi associated to the wood in various stages of humification and causing a white rot. All the meruliaceous fungi represent an obligate component of heterotrophic block of forest ecosystems and considerable demanded biotechnological resource.

The genus *Bjerkandera* was described by P. Karsten (1879) for annual tyromycetoid polypores characterized by colored pore layer which is separated from the context by a dense zone. The generic name refers to Clas Bjerkander (1735−1795), a Swedish naturalist. During a long time, the genus kept two species, *B. adusta* (Willd.) P. Karst. and *B. fumosa* (Pers.) P. Karst., but initially it contained also *B. dichroa* (Fr.) P. Karst. [= *Gloeoporus dichrous* (Fr.) Bres.], *B. amorpha* (Fr.) P. Karst. [= *Skeletocutis amorpha* (Fr.) Kotl. et Pouzar], *B. kymatodes* (Fr.) P. Karst. (= *Skeletocutis amorpha*), *B. diffusa* (Fr.) P. Karst. (an ambiguous species), and *B. isabellina* (Fr.) P. Karst. (a synonym of *B. adusta* in current use). Ames (1913) and later Donk (1974), who have adhered two-species concept of the genus, wrote about the distinct layer which precedes a tubes formation and that this layer is highly characteristic.

Further, various authors included the type *B. adusta* (and, therefore, the genus as a whole) into such genera as *Gloeoporus* Mont. (Pilát, 1937; Corner, 1989), *Tyromyces* P. Karst. (Pouzar, 1966) or *Grifola* Gray (Zmitrovich et al., 2006).

The reasons for inclusion of *Bjerkandera* type to the *Gloeoporus* were two-layered nature of tyromycetoid basidiocarps and a certain degree of gelatinization of hymenophoral tissues. However, as it was noted by Corner (1989), the degree of tube gelatinization is rudimentary in *G. adustus* (Willd.) Pilát and *G. fumosus* (Pers.) Pilát – in contrast to *G. dichrous* and some tropical genus representatives.

The reasons for merging of *Bjerkandera* into *Tyromyces* were a monomitic hyphal system in both genera and rather comparable tyromycetoid morphotypes. Further, it was shown that the hyphal system in tyromycetoid fungi is rather diverse and that *Bjerkandera* basidiocarps have a morphotype intermediate between grifoloid and tyromycetoid ones, therefore, both *B. adusta* and *B. fumosa* were moved into the *Grifola*.

A recent molecular testing of polypore genera confirms a monophyletic nature of *B. adusta*/*B. fumosa* grouping as a sister lineage of indigo-colored corticioid *Terana coerulea* (Lam.) Kuntze (Floudas, Hibbett, 2015). A great work on corrections of sequences misidentifications in *Bjerkandera adusta*/*B. fumosa* pair was provided by Jung et al. (2014).

The purpose of the present elaboration is a revision of East European and North Asian material on *B. adusta* and *B. fumosa* highlighting their intraspecific morphological variability and substrate specialization.

Materials and Methods

The macroscopic descriptions were based on a study of fresh and dried specimens. The materials of the herbaria of Komarov Botanical Institute (St. Petersburg, Russia, LE) and Institute of Zoology and Botany of Estonian Agricultural University (Estonia, TAA) were studied. Microscopic preparations were mounted from dried material in Melzer's solution, 10 % ammoniacal Congo Red and 5 % aqueous solution of KOH, using a LOMO Micmed-6 light microscope. The hyphal system was revealed and described according to updated technique (Zmitrovich et al., 2009). The size of mature spores was measured on 30 spores in distilled water and Melzer's solution.

Results and Discussion

Meruliaceae Rea, 1922, British Basid.: 620.

Phanerochaetoideae (Jülich) Parmasto, 1986, Windahlia, 16: 17.

Bjerkandera P. Karst., 1879, Medd. Soc. Fauna Fl. Fenn., 5: 38.

= *Myriadoporus* Peck, 1884, Bull. Torrey Bot. Cl., 11, 3: 27.

Basidiocarp annual or wintering, pileate, decurrent to prostrate, soft to pliable. Upperside when present subtomentose, matt or rugulose at drying, hygrophanous. Context two-layered with rather loose tomentum and dense layer above the hymenophore. Hymenophore as a single tube layer of ceraceous consistency. Hyphal system monomitic in the tubes and pseudodimitic in the context. Generative hyphae with clamp connections. Cystidia none. Basidia clavate with median constriction, 4-spored, with a basal clamp. Basidiospores ellipsoid-cylindric, smooth, thin-walled, negative in Melzer's reagent. Worldwide distributed oligotypic genus associated to the white-rot of hardwoods, rarely conifers.

Type species: *Polyporus adustus* Willd.: Fr., 1821, Syst. Mycol., 1: 363 (selected by Murrill, 1903).

Type specimen is deposited in Friesian herbarium of the Uppsala University Museum of Evolution (Sweden, UPS) marked as "Finland, Mustiala, leg. P. Karsten" (Ryvarden, 1991).

Anamorph: *Geotrichum*-like (Romero et al., 2007).

In Eurasian continent the genus contains two polymorphic species characterized below. In Americas, two additional species, *Bjerkandera atroalba* (Rick) Westphalen et al. and *B. centroamericana* Westphalen et al. (Westphalen et al., 2015), plus some ambiguous Murrill's taxa were reported.

Key to species

1. Pores 6–7 per mm, pore surface combines whitish (tube mouths) and smoky-gray to grayish-black tinges, dense zone above tubes is grayish-black ..... 1. ***B. adusta***

– Pores (1)2–4(5) per mm, pore surface combines whitish (tube mouths) and buff to isabelline tinges, dense zone above tubes is brownish-cinnamon .... 2. ***B. fumosa***

1. ***Bjerkandera adusta*** (Willd.: Fr.) P. Karst., 1879, Medd. Soc. Fauna Fl. Fenn. 5: 38. ≡ *Boletus adustus* Willd., 1787, Fl. Berol. Prodr.: 392. – *Polyporus adustus* Willd.: Fr., 1821, Syst. Mycol., 1: 363. – *Leptoporus adustus* (Willd.: Fr.) Quél., 1886, Enchir. Fung.: 177. – *Polystictus adustus* (Willd.: Fr.) Gillot et Lucand, 1890, Bull. Soc. Hist. Nat. Autun, 3: 173. – *Gloeoporus adustus* (Willd.: Fr.) Pilát in Kavina et Pilát, 1937, Atlas Champ. Eur., 3: 137. – *Tyromyces adustus* (Willd.: Fr.) Pouzar, 1966, Folia Geobot. Phytotax. Bohemoslov., 1: 370. – *Grifola adusta* (Willd.: Fr.) Zmitr. et Malysheva in Zmitr., Malysheva et Spirin, 2006, Mycena, 6: 21.

= *Boletus fuscoporus* J.J. Planer, 1788, Ind. Pl. erfurt. Fung. add.: 26.

= *B. pelloporus* Bull., 1791, Hist. Champ. France: 365.

= *B. carpineus* Sowerby, 1799, Col. Fig. Engl. Fung. Mushr., 2: pl. 231.

= *B. crispus* Pers., 1800 ("1799"), Observ. Mycol., 2: 8.

= *B. concentricus* Schumach., 1803, Enum. Pl., 2: 387.

= *Poria argentea* Ehrenb., 1818, Sylv. Mycol. Berol.: 31.

= *Boletus isabellinus* Schwein., 1822, Schr. Naturf. Ges. Leipzig 1: 96.

= *Polyporus murinus* Rostk. in Sturm, 1838, Deutschl. Fl., 3, Abt. 4: 117.

= *P. subcinereus* Berk., 1839, Ann. Nat. Hist., Mag. Zool. Bot. Geol., 3: 391.

= *P. halesiae* Berk. et M.A. Curtis, 1853, Ann. Mag. Nat. Hist., Ser. 2, 12: 434.

= *P. scanicus* Fr., 1863, Monogr. Hymenomyc. Suec., 2, 2: 269.

= *P. lindheimeri* Berk. et M.A. Curtis, 1872, Grevillea, 1, 4: 50.

= *P. fumosogriseus* Cooke et Ellis, 1881, Grevillea, 9, 51: 103.

= *Daedalea oudemansii* var. *fennica* P. Karst., 1882, Medd. Soc. Fauna Fl. Fenn., 9: 69.

= *Myriadoporus adustus* Peck, 1884, Bull. Torrey Bot. Cl., 11, 3: 27.

= *Polystictus gloeoporoides* Speg., 1889, Boln Acad. Nac. Cienc. Córdoba, 11, 4: 451.

= *Polyporus macrosporus* Britzelm., 1894, Ber. Naturw. Ver. Schwaben, 31: 174.

= *P. ochraceocinereus* Britzelm., 1895, Botan. Zbl., 62: 311.

= *P. burtii* Peck, 1897, Bull. Torrey Bot. Cl., 24: 146.

= *Coriolus alabamensis* Murrill, 1907, N. Amer. Fl., 9, 1: 19.

= *Polyporus excavatus* Velen., 1922, České Houby, 4–5: 641.

= *P. cinerascens* Velen., ibid.: 642.

= *P. atropileus* Velen., 1925, Mykologia (Prague), 2: 74.

= *P. tegumentosus* Velen., ibid.: 74.

= *Daedalea solubilis* Velen., 1926, Mykologia (Prague), 3: 102.

Icon.: Bulliard (1790: pl. 501, 2, ut *Boletus pelloporus*); Rostkovius (1837: tab. 38 ut *Polyporus adustus*); Kennedy, Larcade (1971: figs 1–12, ut *Polyporus adustus*); Phillips (1981: p. 236); Breitenbach, Kränzlin (1986: fig. 329); Gilbertson, Ryvarden (1986: fig. 65); Ryvarden, Gilbertson (1993: fig. 72); Roy, De (1996: fig. 13); Bernicchia (2005: fig. 140; pl. p. 610); Niemelä (2005: fig. 53); Jung et al. (2014: fig. 1A); Ryvarden, Melo (2014: fig. 76).

Basidiocarps 1–4.5 × 2–10 × 0.3–1.5 cm, annual (wintering), as sessile, decurrent or patch-like resupinate clustering pilei of tough-fleshy consistency. Upperside (when present) subtomentose to matt or rugulose at drying, cream to isabelline with gray tinges, often with pale or subochraceous obscure zonation, grayish or blue-grayish along the margin, rather loose and spongy. The margin as a rule acute, sometimes border-like, slightly undulating, white, then with cineraceous shades, sterile up to 2 mm at the maturity. Context two layered with rather loose light cream or grayish upper layer 0.2–1 cm thick and dense grayish-black layer (so-called "black line") above the hymenophore. Hymenophore as a single tube layer 0.02–0.5 cm thick of ceraceous consistency, initially cream, then smoky-gray to blackish mouse-gray. Pores 6–7 per mm, angular, rather thin-walled; pore surface combines whitish (tube mouths) and smoky-gray to grayish-black tinges (fig. 1).

Hyphal system monomitic in the tubes and pseudodimitic in context. Generative hyphae 2–4 μm in diam., regularly branched at acute margin, with regular clamp connections. Pseudoskeletal hyphae 3–6(10) μm in diam., fibrous or ramified, thick-walled to subsolid in KOH, in some parts swelling at 10 μm in cross. Cystidia none. Basidia 10–15 × 4–5.5 μm, clavate with median constriction, 4-spored, with a basal clamp. Basidiospores (4)4.3–5.5(6.5) × (2.2)2.5–3.5 μm, ellipsoid-cylindric, smooth, thin-walled, negative in Melzer's reagent (fig. 2).

On dying trees, fallen logs and branches, stumps, buried wood and small debris of many hardwoods, rarely conifers, causing a white rot. For pathogenic significance – see Brooks (1925).

Substrata: *Acacia*, *Acer*, *Aesculus*, *Ailanthus*, *Alnus*, *Betula*, *Carpinus*, *Castanea*, *Celtis*, *Corylus*, *Crataegus*, *Cytisus*, *Eucalyptus*, *Fagus*, *Fraxinus*, *Juglans*, *Larix*, *Malus*, *Myoporum*, *Olea*, *Platanus*, *Populus*, *Prunus*, *Rhamnus*, *Robinia*, *Rosa*, *Quercus*, *Salix*, *Sambucus*, *Sorbus*, *Syringa*, *Tamarix*, *Tilia*, *Ulmus*, *Abies*, *Larix*, *Picea*, *Pinus* (Ţura et al., 2011; Bondartseva et al., 2014; Ryvarden, Melo, 2014).

General distribution: EUROPE (Austria, Belarus, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom); SOUTH AMERICA (Argentina, Brazil, Chile); CENTRAL AMERICA (Costa Rica, Cuba); NORTH AMERICA (Canada, Mexico, USA); ASIA (Armenia, Azerbaijan, Georgia, Iran, Israel, Japan, Korea, Mongolia, Nepal, Russia, Sri Lanka, Turkey); SOUTHERN HEMISPHERE (Papua New Guinea, Australia, New Zealand); AFRICA (Ethiopia, Malawi) (Ţura et al., 2011).

Distribution in Russia: see Tables 1, 2.

Cultural characteristics: Nobles (1965); Westhuizen (1971).

Note: In the field, the species can be easily identified due to smoke or mouse-gray hymenial fields with white-cream sterile border, by small pores 6−7 per mm, and black line above the hymenophore. Some variants of *B. fumosa* can come nearer to the discussed species, but they are easily separated by more obscure dense zone of cinnamomeous colors and (in median) larger pores which are as a rule anisodiametric. After wintering, its blackish-gray hymenophore can change the color to coffeate (resembling those of *B. fumosa*), but in this state white reticulum (glacing tube moths) absent and pores in median stay sufficiently smaller.

The variability of the species concerns mode of growth organization and the degree of tubes development. A lot of forms were described during species history and the basic ones are described below.

Forma ***resupinata*** (Bourdot et Galzin) Domański, Orloś et Skirg., 1967, Flora Polska, Grzyby (Mycota), Aphyllophorales: 114. – *Leptoporus adustus* f. *resupinatus* Bourdot et Galzin, 1928 ("1927") Hyménomyc. France (Sceaux): 552.

Basidiocarps as resupinate patches 3–10 and more cm in diam. with well-developed mucedinous margin. The hymenophore is well-developed, but pores can be locally enlarged at 2–5 per mm (Bondartsev, 1953). The micromorphology varies as in a neutral type. This is prostrate growth form of the fungus known on many hardwoods.

Forma ***tegumentosa*** (Velen.) Bondartsev, 1953, Tinder Fungi Europ. U.S.S.R. Caucasus: 240. – *Polyporus tegumentosus* Velen., 1925, Mykologia (Prague), 2: 74 (see fig. 3).

Basidiocarps as decurrent to resupinate prostrating pilei 4–6 cm in the largest dimension with-

Fig. 1. The most widespread («effused-reflexed») morphotype of *Bjerkandera adusta* presented by clustering pilei, developing from a common effused "stroma". Scale bar – 1 cm.

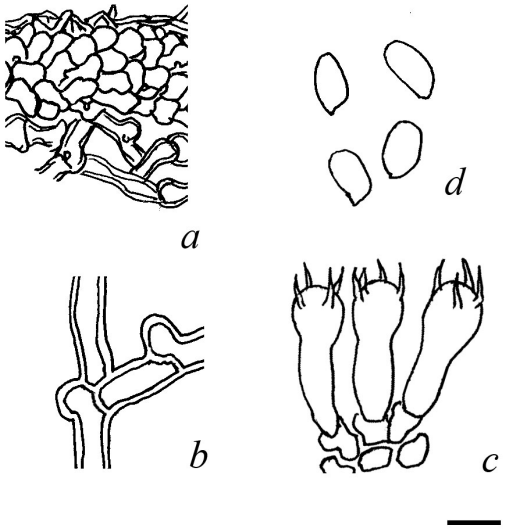

Fig. 2. The microstructures of *Bjerkandera adusta*: *a* – the hyphal structure of a sterile colored «tegument» (f. *tegumentosa*, LE 287571), *b* – a typical hystion, composing a sterile tissues of the fungus, *c* – basidia, *d* – basidiospores. Scale bar – 5 μm.

Fig. 3. *Bjerkandera adusta* f. *tegumentosa* (LE 287571), growing in a natural conditions. Scale bar – 1 cm.

out a hymenophore. A central fields of the patches ochraceous-gray, or mouse-gray, margin white. The fungus resembles a stromata of pyrenomycete *Kretzschmaria deusta* (Hoffm.) P. M. D. Martin. The micromorphology varies as in a neutral type. This is sterile and more or less prostrate, but negatively geotropic (with upward subhymenial filed) growth form of the fungus known on many hardwoods.

Epitype: Russia, Saint Petersburg, "Literatorskie mostki" museum necropolis, on stump of *Acer platanoides*, 12 VII 2015, leg. et det. I. V. Zmitrovich (LE 287571).

Basidiocarps 2.1 × 1.5 × 0.05–0.2 cm, wrinkled due to basidiocarp initial centers, prostrate with inrolling undulating margin and centrally sterile (tegumentose) negatively geotropic subhymenial fields of isabelline, then mouse-gray coloration. On marginal areas under lens can be allocated whitish net with cellars 7–10 per mm and ca. 0.1 mm deep. The micromorphology varies as in a neutral type. The tegument structure is pictured in fig. 2*a*. Basidia and basidiospores not developed.

Forma ***solubilis*** (Velen.) (Velen.) Bondartsev, 1953, Tinder Fungi Europ. U.S.S.R. Caucasus: 239. – *Daedalea solubilis* Velen., 1926, Mykologia (Prague), 3: 102.

Basidiocarps as easily separated from substrate dorsally attached resupinate patches 2–4 cm in diam. with well-developed bolster-like margin. The pores of normal sizes, but of daedaleoid appearance,

smoky-gray. The micromorphology varies as in a neutral type. This is resupinate growth form of the fungus which has a certainly disordered hymenophore. Known on hardwoods.

Exsiccates examined. F. O. Westerberg "Flora Suecica", no. 10, Sweden, 6 X 1912, leg. F. O. Westerberg (ut *Polyporus stereoides*), det. A. S. Bondartsev. – J. Lütkemüller "Kryptogamae exsiccatae, no. 308, Austria, on dry trunk in the garden (ut *Polyporus adustus*). – A. de Mágócst-Dietz "Kryptogamae exsiccatae", no. 308b: Hungaria, Budapest, Botanical garden, trunk of *Ailanthus glandulosa* (ut *Polyporus adustus*). – "Farlow Herbarium" distr. Harvard Univ., "California Fungi" distr. Herb. Univ. California, no. 246, Los Gatos canyon, on *Alnus rubra*, 23 II 1924, leg. H. E. Parks (ut *Polyporus adustus*). – V. Litschauer et H. Lohwag "Fungi selecti exiccati europaei", no. 121: Austria, Wien, Botanical garden, on dry *Fagus sylvatica*, 12 VII 1929, leg. V. Litschauer (ut *Poria canescens* P. Karst.), det. A. S. Bondartsev ut *Bjerkandera adusta* f. *resupinata*. – E. Leppik "Fungi Estonici exsiccati, fasc. 1", no. 18, Tartumaa, on fallen *Populus tremula*, 15 VI 1930, leg. E. Leppik (ut *Leptoporus adustus*); ibid., no. 19, Tartu, Botanical garden, on drying *Aesculus hippocastanum*, 6 VII 1930, leg. E. Leppik (ut *Leptoporus adustus*). – S. Lundell et J. A. Nannfeldt "Fungi Exsiccati Suecici, Praesertim Upsaliensis", no. 57, Upland, Uppsala, Carolinapark, on stumps of frondose tree, 8 VII 1933, leg. S. Lundell (ut *Polyporus adustus*). – K. E. Murashkinsky "Hymenomycetes Sibiriae", Kazakhstan, Borovoye, on *Sambucus*, I 1936 (ut *Coriolus adustus* f. *resupinatus*). – S. Lundell et J. A. Nannfeldt "Fungi Exsiccati Suecici, Praesertim Upsaliensis", no. 2616, Gästrikland, Gävle, Vallshage, on dead trunk of *Sambucus racemosa*, 21 VIII 1956, leg. J. A. Nannfeldt (ut *Polyporus adustus*). – "Plantae Norvegicae" distr. Mus. Bot. Univ. Oslo, no. 95, Lyngdal, on *Tilia cordata*, 26 IX 1969, leg. L. Ryvarden. – "Herbier National de Mycologie du Canada", no. GCF 26, Quebec, Gatineau park, on wood, X 1979, leg. N. Binyamini. – "Fungi Rossici" distr. Mus. Bot. Univ. Helsinki, no. 2, Karelia, Vodlozero Nat. Park, on *Populus tremula*/*Phellinis tremulae*, 23 VIII 1994, leg. R. Penttilä. – "Fungi Rossici" distr. Mus. Bot. Univ. Helsinki, no. 36, Karelia, Vodlozero Nat. Park, on *Populus tremula*, 25 VIII 1994, leg. R. Penttilä.

2. ***Bjerkandera fumosa*** (Pers.: Fr.) P. Karst., 1879, Medd. Soc. Fauna Fl. Fenn. 5: 38. ≡ *Boletus fumosus* Pers., 1801, Syn. Meth. Fung., 2: 530. − *Polyporus fumosus* Pers.: Fr., 1821, Syst. Mycol., 1: 363. − *Gloeoporus fumosus* (Pers.: Fr.) Pilát in Kavina et Pilát, 1937, Atlas Champ. Eur., 3: 149. − *Tyromyces fumosus* (Pers.: Fr.) Pouzar, 1966, Folia Geobot. Phytotax. Bohemoslov., 1: 370. − *Polystictoides fumosus* (Pers.: Fr.) Teixeira, 1986, Rev. Brasil. Bot., 9, 1: 43. − *Grifola fumosa* (Pers.: Fr.) Zmitr. et Malysheva in Zmitr., Malysheva et Spirin, 2006, Mycena, 6: 21.

= *Boletus imberbis* Bull., 1791, Hist. Champ. France, 10: 339.

= *Daedalea saligna* Fr., 1818, Observ. Mycol., 2: 241.

= *Polyporus pallescens* Fr., 1818, Observ. Mycol., 2: 256.

= *P. demissus* Berk., 1845, London J. Bot., 4: 345.

= *P. salignus* var. *holmiensis* Fr., 1874, Hymenomyc. Eur.: 544.

= *P. fragrans* Peck, 1878, ("1877"), Ann. Rep. N. Y. St. Mus. Nat. Hist., 30: 45.

= *Bjerkandera pallescens* subsp. *pura* P. Karst., 1882, Medd. Soc. Fauna Fl. Fenn., 9: 69.

= *Polyporus hederae* Ade, 1911, Mitt. Bayer. Bot. Ges., 2: 371.

= *P. decurrens* Velen., 1922, České Houby, 4−5: 657.

= *P. emergens* Velen., 1922, ibid.: 657.

= *P. eminens* Velen., 1922, ibid.: 639.

P. robiniae Velen., 1922, ibid.: 658.

P. tyttlianus Velen., 1922, ibid.: 686.

P. aberrans Velen., 1925, Mykologia (Prague), 2, 5: 73.

Icon.: Sowerby (1799: tab. 230, ut *Boletus pelloporus*); Bulliard (1798: tab. 445, ut *Boletus imberbis*); Breitenbach, Kränzlin (1986: fig. 330); Gilbertson, Ryvarden (1986: fig. 66); Ryvarden, Gilbertson (1993: fig. 73); Roy, De (1996: fig. 14); Bernicchia (2005: fig. 141; pl. p. 611); Niemelä (2005: fig. 54); Jung et al. (2014: fig. 1B); Ryvarden, Melo (2014: fig. 77).

Basidiocarps 1–7 × 1.5–10 × 0.3–2 cm, annual (wintering), as sessile, decurrent or subresupinate clustering pilei of tough-fleshy consistency. Upperside tomentose to matt or appressedly hispid-squamulose, whitish, pale-cream to isabelline, or tan, sometimes with cinnamomeous obscure median zone, rather loose and spongy. The margin more or less obtuse, border-like on resupinate parts, slightly undulating, white-cream, then with isabelline and cinnamomeous shades, sterile up to 2 mm at the maturity. Context with anise odor when fresh, two-layered with buff soft fibrous upper layer 0.3–1.5 cm thick and dense brownish-cinnamon layer above the

hymenophore. Hymenophore as a single tube layer 0.02–0.7 cm thick of ceraceous consistency, initially cream, then tan to coffeate. Pores (1)2–4(5) per mm, round or angular, isodiametric or anisodiametric; pore surface combines whitish, cream or yellowish (tube mouths) and buff to isabelline (pore substructure) tinges (fig. 4).

Hyphal system monomitic in the tubes and pseudodimitic in context. Generative hyphae 2.5–4.5 µm in diam., regularly branched at acute margin, with regular clamp connections. Pseudoskeletal hyphae 3.2–7(12) µm in diam., fibrous or ramified, thick-walled to subsolid in KOH, in some parts swelling at 12 µm in cross. Cystidia none. Basidia 19–23 × 4.5–7 µm, clavate with median constriction, 4-spored, with a basal clamp. Basidiospores 5.5–7.2 × 2.5–3.7 µm, ellipsoid-cylindric, smooth, thin-walled, negative in Melzer's reagent (fig. 5).

On dying trees, fallen logs and branches, stumps, buried wood and small debris of many hardwoods, causing a white rot. For pathogenic significance – see Bondartsev (1924).

Substrata: *Acer*, *Aesculus*, *Ailanthus*, *Alnus*, *Betula*, *Corylus*, *Cytisus*, *Eucalyptus*, *Fagus*, *Fraxinus*, *Juglans*, *Malus*, *Myoporum*, *Philadelphus*, *Populus*, *Prunus*, *Quercus*, *Salix*, *Sambucus*, *Sorbus*, *Tilia*, *Ulmus* (Ryvarden, Melo, 2014), *Cedrus deodara* (Roy, De, 1996).

General distribution: EUROPE (Austria, Belarus, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Hungary, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Romania, Russia, Slovakia, Sweden, Switzerland, Ukraine, United Kingdom), NORTH AMERICA (Canada, USA), ASIA (China, India, Kazakhstan, Russia, Thailand, Uzbekistan), NORTH AFRICA (Bondartsev, 1953; Gilbertson, Ryvarden, 1986; Ryvarden, Gilbertson, 1993; Roy, De, 1996; Bondartseva, 1998).

Distribution in Russia: see Tables 3, 4.

Cultural characteristics: Nobles (1965).

Note: This is rather variable species, easily recognized by two-layered context with obscure lower dense strate and strongly developed whitish reticu-

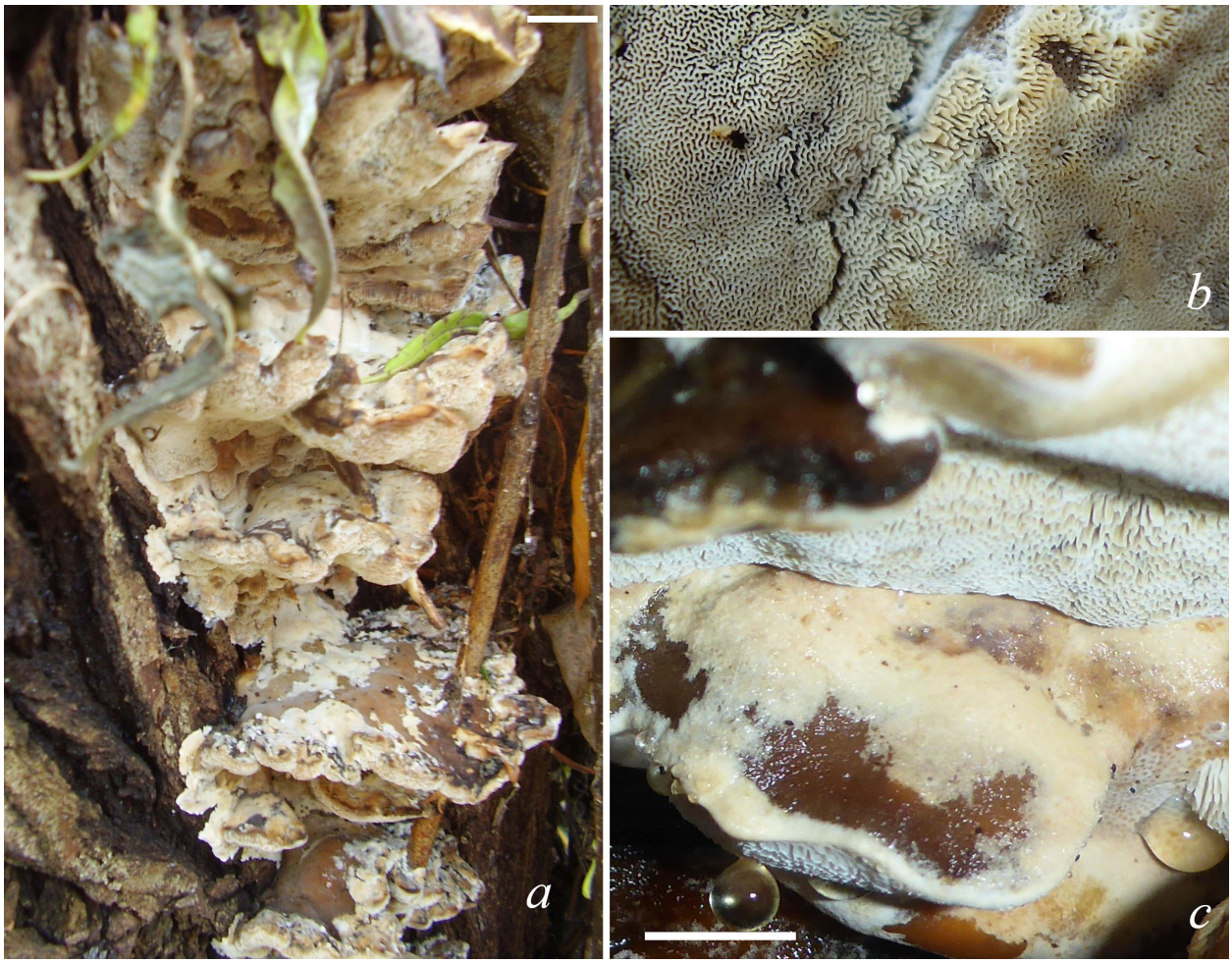

Fig. 4. The most widespread («imbricate») ecotype of *Bjerkandera fumosa* presented by clustering pilei, developing from a common «stroma», deeply rooted into substrate (*Salix fragilis*): *a* – a general view, *b* – pore surface with labyrinthine areas, *c* – wintered basidiocarps. Scale bar: *a* – 10 mm, *b*, *c* – 5 mm.

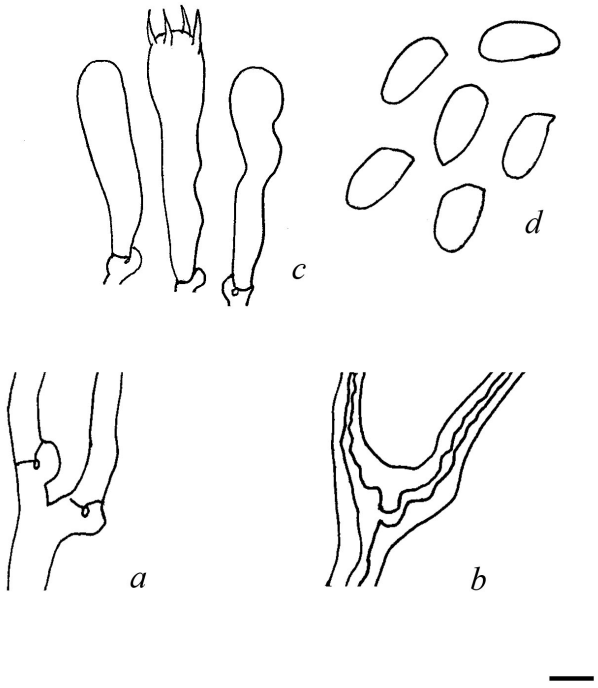

Fig. 5. The microstructures of *Bjerkandera fumosa*: *a* – a typical hystion, composing the subhymenium, *b* – a typical hystion, composing the context, *c* – basidia, *d* – basidiospores. Scale bar – 5 μm.

lum over tube moths. In some cases, the hymenophore looks to be whitish-cream without deep coloration, but usually tan or coffeate shades are well expressed. The cap clusters reminiscent those of *B. adusta*, but two species easily distinguishable due to diverse pore shape and sizes, coloration of the context and hymenophoral fields. *B. fumosa* has typically more thick basidiocarps with more or less obtuse margin and haven't a mouse-gray tinges in the hymenophore coloration. The coffeate wintered specimens of *B. adusta* differs by smaller pores (6−7 per mm vs. 1−5 per mm in *B. fumosa*) and dense ceraceous black line above the tube (dense zone in *B. fumosa* is looser and of cinnamomeous color). Several chromatic and growth forms were described during species history, the basic ones are listed below.

Forma ***flavipora*** (Bourdot et Galzin) Zmitr. et Bondartseva, comb. nov. (MB 813429). – *Leptoporus imberbis* f. *flaviporus* Bourdot et Galzin, 1925, Bull. trimest. Soc. mycol. France, 41, 1: 131 (see fig. 6).

As a neutral type, but with yellowish-cream to lemon-yellow pore surface without a coffeate substructure.

Epitype: Russia, Saint Petersburg, Botanical garden of the Komarov Botanical Institute, on drying *Sorbus aucuparia*, 15 IX 2014, leg. & det. I. V. Zmitrovich (LE 287572).

Fig. 6. *Bjerkandera fumosa* f. *flavipora* (LE 287572). Scale bar – 5 mm.

Basidiocarps 4.5 × 2.5 × 1.7 cm, as sessile decurrent clustering pilei of tough-fleshy consistency. Upperside tomentose, slightly scrupose, pale-cream with isabelline margin, rather loose and spongy. The margin more or less obtuse, undulating, isabelline 2.5 mm. Context two-layered with buff soft fibrous upper layer ~1.3 cm thick with weak coffeate streak above the hymenophore. Hymenophore as a single tube layer ~0.05 cm thick, of ceraceous consistency, buff in section. Pores 3–4 per mm, angular and anisodiametric; pore surface yellowish-cream. The micromorphology varies as in a neutral type. Basidiospores 5.5–6.5 × 2.5–3.0 μm.

Forma ***saligna*** (Fr.) Donk, 1933, Med. Bot. Mus. Univ. Utrecht, 9: 164. – *Polyporus salignus* Fr., 1838, Epicr.: 452.

As a neutral type with decurrent base of cap clusters, daedaleoid pores and almost white upperside. Known on *Salix* sp. in the Netherlands, Sweden, Belarus and Orel Region of the Russia (Donk, 1933; Bondartsev, 1953).

Forma ***alba*** (Huds.) Donk, 1933, Med. Bot. Mus. Univ. Utrecht, 9: 164. – *Boletus albus* Huds., 1762, Fl. Angl.: 626.

Resembling the previous form, but with sessile (not decurrent) caps with more intensively colored uppeside. Known on *Salix* sp. in the Netherlands, France and Sweden (Donk, 1933).

Exsiccates examined. L. Romell "Fungi Exsiccati Praesertim Scandinavici", no. 11, Sweden, Holm, on trunk of *Quercus* sp., 24 XI 1889, leg. L. Romell (ut *Polyporus holmensis*). – "Terek District Station of Plant Protection" (dupl. herbarium), no. 634, on stumps of *Juglans regia*, 25 X 1926, leg. A. Lobik (ut *Polyporus imberbis*). – J. Smarods "Fungi Latvici", Vidzeme, on Fraxinus excelsior, 19 XI 1935, leg. J. Smarods. – E. Leppik, V. Litschauer "Fungi Estonici" (Mycotheca Lab. Phytopath. Univ. Tartuensis), dupl., on fallen trunk of *Sambucus nigra*, 9 XI 1939, leg. E. Leppik (ut *Septoporus imber-*

bis). – S. Lundell et J.A. Nannfeldt "Fungi Exsiccati Suecici, Praesertim Upsalienses", no. 440, Upland, Bondkyrka parish, on stump of *Populus tremula* (?), 28 IX 1935, leg. S. Lundell (ut *Polyporus fumosus*). – A. Jones "Mycological Collections" distr. Herb. Univ Illinois, no. 95, on dead *Ulmus* sp., 22 XI 1959, leg. A. Jones (ut *Polyporus fumosus*). – A. Jones "Mycological Collections" distr. Herb. Univ Illinois, no. 157, on dead *Ulmus* sp., 13 XI 1960, leg. A. Jones (ut *Polyporus fumosus*). S. Lundell, J.A. Nannfeldt et L. Holm "Fungi Exsiccati Suecici, Praesertim Upsalienses", no. 3088, Västmaland, Norberg, on stump of Ulmus glabra, 27 VIII 1963, leg. I. Nordin.

Apart from aforementioned species, Murrill (1907) gives two additional descriptions which hardly correlated to any known taxa. Their diagnoses are presented below.

Bjerkandera terebrans (Berk. et M. A. Curtis) Murrill, 1907, N. Amer. Fl., 9, 1: 42. ≡ *Polyporus terebrans* Berk. et M. A. Curtis, 1869 ("1868"), J. Linn. Soc. Bot., 10: 306.

"Pileus subfleshy, thick, flabelliform, convex, 4 × 4–5 × 1 cm, attached by a thick, laterally-compressed, concolorous, pubescent elongation resembling a stipe, but probably the result of an effort of the part of sporophore to escape from the substratum; surface isabelline to luteous, pubescent-scabrous, azonate, smooth; margin obtuse, entire: context white to isabelline, homogeneous, soft-corky, nearly 1 cm thick; tubes whitish when young, fuliginous in dried specimens, less than 1 mm, mouths 4 to a mm, edges obtuse, entire. Spores not examined" (Murrill, 1907).

Type locality: Cuba (without exact region indication).

Substrata: on dead trees.

Distribution: known only from the type locality.

It is probably a certain form of *B. fumosa*, but stipe-like base not allow to reject also possibility of variant of *Osteina obducta* (Berk.) Donk.

Bjerkandera subsimulans (Berk. et M. A. Curtis) Murrill, 1907, N. Amer. Fl., 9, 1: 42. ≡ *Polyporus simulans* Berk. et M. A. Curtis in Sacc., 1888, Syll. Fung., 6: 117; nec *Bjerkandera simulans* P. Karst., 1888, Rev. Mycol., 10, 37: 73 = *Postia tephroleuca* (Fr.) Jülich, 1982.

"Pileus explanate, fleshy-tough, sessile, dimidiate of fan-shaped, often attached by a narrow base, 5–10 × 10–15 × 0.3–0.7 cm, surface smooth, partially glabrous and partially clothed with scanty, flexible hairs; margin thin, acute, broadly sterile, lobed, with a zone of appressed hairs and blackish as tough scorched for 5–10 mm: context fibrous, hard and corky when dry, white to isabelline; tubes 2–5 mm long, white to fuliginous, mouths angular, irregular, 1 to 3 a mm, edges thin. Spores not examined" (Murrill, 1907).

Type locality: Cuba (without exact region indication).

Substrata: dead trunks.

Distribution: known only from the type locality.

This superficial description corresponds in a certain respects to *Abortiporus biennis* (Bull.) Singer.

This work was carried out in the Laboratory of Systematics and Geography of Fungi of the Komarov Botanical Institute of the Russian Academy of Sciences in canvas of the State task N 01201255602.

Table 1

Herbarium data on distribution of *Bjerkandera adusta* over Russia territory and its substrate preferences

Region	Substrata	Date of collection	Collector	Herbarium numbers
European part				
Bryansk Region, Bryansk vic.	*Fraxinus excelsior*	VII 1907	A. S. Bondartsev	LE 26254
Kaliningrad Region, Golubaya river	–	25 VI 2010	V. M. Kotkova	LE 268941
Kaluga Region, Kaluga vic.	*Salix* sp.	10 X 1909	Chernyshov	LE 26141
Kaluga Region, Ugra National Park	*Fraxinus excelsior*	28 VII 2013	S. V. Volobuev	LE 299084
Karelia Republic, Lakhdenpokhja	*Betula* sp.	10 X 1950	A. S. Bondartsev	LE 26286

Continuation of Table 1

Region	Substrata	Date of collection	Collector	Herbarium numbers
Karelia Republic	*Populus tremula*	20 IX 1995	V. M. Lositskaya	LE 85364
Karelia Republic, Matrosy	*Populus tremula*		V. M. Kotkova	LE 203909
Kursk Region, Kursk	timber wood	1907	A. S. Bondartsev	LE 26191
Kursk region, Korochi	*Acer* sp.	28 VIII 1945	L. A. Lebedeva	LE 26219
Leningrad Region, Nadevitsy	*Betula* sp.	31 VII 1932	T. L. Nikolaeva	LE 26255
Leningrad Region, Siverskaya	*Picea abies*	4 VII 1936	R. Singer	LE 26189
Leningrad Region, Yanega	*Populus tremula*	19 IX 1961	M. A. Bondartseva	LE 26212
Leningrad Region, Berezovye Ostrova protected area	*Populus tremula*	23 VII 2003	V. M. Kotkova	LE 242293
Leningrad Region, Berezovye Ostrova protected area	*Alnus incana*/ *Gloeoporus dichrous*	8 VII 2004	V. M. Kotkova	LE 268485
Leningrad Region, Cheremenetskiy protected area	*Populus tremula*	7 IX 2002	V. M. Kotkova	LE 283875
Leningrad Region, Kurgalsky protected area	*Populus tremula*	11 IX 1997	I. V. Zmitrovich	LE 203484
Leningrad Region, Kurgalsky protected area	*Quercus robur*	12 IX 1997	I. V. Zmitrovich	LE 203408
Mari El, Kuvshin forestry	–	20 VII 1937	B. P. Vassilkov	LE 26258
Moscow Region, Pushkino	*Betula* sp.	27 VIII ?	A. S. Bondartsev	LE 26248
Moscow Region, Mikhailovskoye	*Populus tremula*	1 V 1907	A. S. Bondartsev	LE 26164
Moscow Region, Gorodishche	*Populus* sp.	20 IX 2008	N. V. Psurtseva	LE 265214
Nizhegorod Region	*Pinus sylvestris* cones/ litter	5 VIII 1997	W. A. Spirin	LE 208432
Orel Region, Lovchikovo	*Tilia cordata*	1 VIII 2011	S. V. Volobuev	LE 298944
Orel Region, Turovka	*Corylus avellana*	11 VIII 2012	S. V. Volobuev	LE 298777
Orel Region, Naryshkino	*Populus tremula*	6 X 2012	S. V. Volobuev	LE 291153
Rostov Region, Rostov-on-Don	*Betula pendula*	15 V 2009	Yu. A. Rebriev	LE 287095
Saint Petersburg, Botanical Garden of Komarov Botanical Institute	–	VIII 1908	A. S. Bondartsev	LE 26147
Tver Region, Tsentralno-Lesnoi reserve	*Betula* sp.	5 IX 2011	V. M. Kotkova	LE 284240
Tula Region, Tula vic.	timber wood	1911	Trusova	LE 26203
Udmurtia Republic, Izhevsk vic.	*Tilia cordata*	15 IX 1964	Kyganova	LE 26237
Caucasia				
Chechen Republic, Terek	*Vitis* sp.	20 V 1926	L. Guseva	LE 26079
Chechen Republic, Naurskaya	–	20 V 1926	L. Guseva	LE 26181

End of Table 1

Region	Substrata	Date of collection	Collector	Herbarium numbers
Karachaevo-Cherkessia Republic, Teberda reserve	*Carpinus betulus*	19 VIII 2012	N. V. Psurtseva	LE 288328
Stavropol Territory, Pyatigorsk	*Fagus sylvatica*	12 IX 1926	A. Lobik	LE 26257
Stavropol Territory, Zheleznovodsk	*Fagus sylvatica*	13 VII 1926	G. Lagadidze	LE 26234
Siberia				
Gorno-Altai Autonomous Republic, Kaitanak	*Betula* sp.	19 VII 1968	M. A. Bondartseva	LE 26146/162
Gorno-Altai Autonomous Republic, Kaitanak	*Salix* sp.	19 VII 1968	M. A. Bondartseva	LE 26156
Irkutsk Region, Orlenga	*Betula* sp.	2 IX 1967	M. A. Bondartseva	LE 26167/68
Irkutsk Region, Irkutsk vic.	–	26 VIII 1911	Alexandrov	LE 26166
Krasnoyarsk Territory, Monastyrskoye	*Betula* sp.	28 VI 1920	A. L. Yavorskiy	LE 26179/190
Krasnoyarsk Territory, Stolby	*Betula* sp.	8 XI 1968	M. A. Bondartseva	LE 26152
Far East				
Khabarovsk Territory, Vinogradovka	–	XI 1929	A. S. Bondartsev	LE 26144
Khabarovsk Territory, Khabarovsk vic.	*Acer* sp.	9 V 1935	L. V. Ljubarskiy	LE 26213
Khabarovsk Territory, Bolshekhekhtsyrskiy reserve	*Betula* sp./*Trichaptum*	20 VIII 1979	M. A. Bondartseva	LE 26135
Khabarovsk Territory, Bastak reserve	*Corylus avellana*	21 VII 2011	N. V. Bukharova	LE 290715
Primorye Territory, Kangauz	*Carpinus* sp.	1928	A. S. Bondartsev	LE 26184

Table 2

The substrate preferences of *Bjerkandera adusta* in old-growth arboreta on Saint Petesburg territory

Old-growth arboreta	Substrata
The Peter the Great Botanical Garden of the Komarov Botanical Institute of RAS	*Acer platanoides*, *Alnus incana*, *Amelanchier canadensis*, *Betula pendula*, *Crataegus oxyacantha*, *Duschekia fruticosa*, *Fraxinus excelsior*, *Juglans regia*, *Larix sibirica*, *Malus baccata*, *Phellodendron amurense*, *Populus alba*, *Quercus robur*, *Sambucus racemosa*, *Salix alba*, *S. fragilis*, *Sorbus aucuparia*, *S. intermedia*, *Tilia cordata*, *T. platyphyllos*, *Ulmus laevis*, *Ulmus scabra.*
"Literatorskie mostki" museum necropolis	*Acer platanoides*, *Philadelphus coronarius*, *Quercus robur*, *Sorbus aucuparia*, *Syringa josikaea*, *S. vulgaris*, *Tilia cordata*, *T. platyphyllos*, *Ulmus scabra*
Volkovskoye cemetery	*Acer platanoides*, *A. negundo*, *Betula pendula*, *Fraxinus excelsior*, *Philadelphus coronarius*, *Populus nigra*, *Quercus robur*, *Sorbus aucuparia*, *Syringa josikaea*, *Tilia cordata*, *T. platyphyllos*, *Ulmus laevis*, *U. scabra*
The dendrarium of the Kirov Forest Management Academy	*Acer platanoides*, *Alnus glutinosa*, *Corylus avellana*, *Crataegus sanguinea*, *Fraxinus excelsior*, *Malus baccata*, *Salix fragilis*, *Sorbus aucuparia*, *Tilia cordata*, *Ulmus laevis.*

Table 3

Herbarium data on distribution of *Bjerkandera fumosa* over Russia territory and its substrate preferences

Region	Substrata	Date of collection	Collector	Herbarium numbers
European part				
Bryansk Region, Bryansk	*Betula* sp.	20 VII 1908	A. S. Bondartsev	LE 26325
Karelia Republic, Sortavala forestry	*Sorbus aucuparia*	21 VIII 1993	A. V. Ruokolainen	LE 208915
Kostroma Region, Vasilyevka	–	1907	A. S. Bondartsev	LE 2635
Kursk Region, Kursk	*Acer* sp.	25 V 1906	A. S. Bondartsev	LE 26318
Kursk Region, Kursk, Lazaretny garden	*Fraxinus excelsior*	25 IX 1906	A. S. Bondartsev	LE 26349
Kursk Region, Les-na-Vorskle	*Betula* sp.	–	I. E. Brezhnev	LE 26339
Leningrad Region, Nizhnesvirsky reserve	*Populus tremula*	4 VIII 2014	N. I. Kalinovskaya	LE 303809
Mordovia Republic, Mordovsky reserve	*Ulmus glabra*	10 IX 2013	S. Yu. Bolshakov	LE 301234
Moscow Region	*Malus domestica*	22 X 1984	M. V. Gordienko	LE 26295
Orel Region, Alexandrovka	*Populus tremula*	5 X 2012	S. V. Volobuev	LE 292076
Orel Region, Tureika	*Quercus robur*	2 IX 2012	S. V. Volobuev	LE 298611
Rostov Region, Veshenskaya	*Betula* sp.	1 X 2004	Yu. A. Rebriev	LE 227757/768
Saint Petersburg, Botanical garden of Komarov Botanical Institute	*Ulmus glabra*	–	A. S. Bondartsev	LE 26352
Saint Petersburg, Volkovskoye cemetery	*Ulmus laevis*	16 IX 2003	W. A. Spirin	LE 208178
Udmurtia Republic, Kigbay	*Salix* sp.	5 IX 1965	Kychanova	LE 26344
Udmurtia Republic, Izhevsk	*Salix* sp.	9 IV 2009	V. I. Kapitonov	LE 247363
Caucasia				
Stavropol Territory, Pyatigorsk, Beshtau	*Carpinus betulus*	IX 1934	A. S. Bondartsev	LE 26355
Urals				
Sverdlovsk Region, Serginsky	*Ulmus* sp.	18 IX 1957	N. T. Stepanova-Kartavenko	LE 26319
Far East				
Sakhalin Territory, Krasnopolye	*Ulmus japonica*	31 VIII 1954	V. N. Ljubarskiy	LE 26367

Table 4

The substrate preferences of *Bjerkandera fumosa* in old-growth arboreta on Saint Petesburg territory

Old-growth arboreta	Substrata
The Peter the Great Botanical Garden of the Komarov Botanical Institute of RAS	*Acer platanoides*, *Crataegus sanguinea*, *Malus domestica*, *baccata*, *Salix fragilis*, *Sorbus aucuparia*, *S. intermedia*, *Tilia cordata*, *Ulmus laevis*, *U. scabra.*
"Literatorskie mostki" museum necropolis	*Acer platanoides*, *Salix alba*, *Sorbus aucuparia*, *Syringa vulgaris*, *Tilia cordata*

End of Table 4

Old-growth arboreta	Substrata
Volkovskoye cemetery	*Acer negundo*, *Fraxinus excelsior*, *Salix alba*, *Sorbus aucuparia*, *Syringa josikaea*, *Tilia cordata*, *Ulmus scabra*
The dendrarium of the Kirov Forest Management Academy	*Acer platanoides*, *A. negundo*, *Alnus incana*, *Betula pendula*, *Cornus sanguinea*, *Crataegus sanguinea*, *Fraxinus excelsior*, *Larix sibirica*, *Malus baccata*, *Picea glauca*, *Populus nigra*, *Quercus robur*, *Salix fragilis*, *Sambucus racemosa*, *Sorbaria sorbifolia*, *Sorbus aucuparia*, *Syringa josikaea*, *Tilia cordata*, *T. platyphyllos*, *Ulmus laevis.*

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