

On *Salix*-associated *Polyporus pseudobetulinus* and *P. choseniae* in Russia

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New records of *Polyporus pseudobetulinus* on willow species from Arkhangelsk Region (North of European Russia) were made. The differences between *P. pseudobetulinus* and the similar *P. choseniae* are generalized, highlighting spore variability and hyphal system. The two species are rather distant from each other. *P. pseudobetulinus* is characterized by dimittic hyphal system with a predominance of fibre hyphae, lack of clamps, and somewhat sigmoid spores, whereas *P. choseniae* has dimittic hyphal system with a predominance of skeleto-binding hyphae, clamps, and symmetrically fusoid basidiospores. The ecological preferences and distribution patterns of both species are discussed.

Key words: European Russia, *Polyporus*, salicicolous, morphometry, taxonomy

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Introduction

Polyporus pseudobetulinus (Murashk. ex Pilát) Thorn, Kotir. & Niemelä (Agaricomycetes, Polyporaceae) is a rare boreal polypore species (Thorn et al. 1990, Kotiranta & Niemelä 1996, Martikainen et al. 2000) which is presumably associated with *Populus* spp., mainly *P. tremula*. During analysis of material collected by the authors in Arkhangelsk Region (North of European Russia), specimens associated with *P. balsamifera* and *Salix caprea* were found. Especially the latter is a rather unusual substrate for *P. pseudobetulinus*. A similar species with Palearctic distribution, *P. choseniae* (Vassilkov) Parmasto, is reported from *Salix* spp., including *Salix (Chosenia) arbutifolia* (Vassilkov 1967; Parmasto 1975). Since these two salicicolous polypores have not been intercompared in the literature, and the second one is little-known to European mycologists, the present study aims to a compar-

ative analysis of morphology and ecology of *P. pseudobetulinus* and *P. choseniae*.

Material and methods

Microscopical study of basidiomata was carried out as described by Gilbertson & Ryvarden (1986). Freehand sections and squash mounts were examined in 5% KOH and 2% Cotton Blue. Spore measurements are based on 30 spores per specimen. The following abbreviations are used: L = spore length, W = spore width, Q* = quotient of the mean spore length and mean spore width (L/W). Specimens are preserved in the herbaria of Komarov Botanical Institute (LE) and Institute of North Ecology (AR).

Descriptions of species

Polyporus choseniae – Fig. 1, 2, 5a

Polyporus choseniae (Vassilkov) Parmasto (as '*choseniae*'), *Folia Cryptog. Estonica* 5: 35. 1975 ('1974').

≡ *Piptoporus choseniae* Vassilkov, *Novosti sistematiki nizshikh rastenii* 4: 244. 1967.

Basidiomata annual, 4–9 cm diam, 0.5–1.5 cm thick, initially conchate, then convex, solitary or clustered, substipitate or attached to the substrate by a clearly pointed base. *Upper surface* initially uneven, regularly dotted near the base and radially fibrillose near the margin, initially yellowish-cream, then intensively ochraceous. *Margin* concolorous, radially fibrillose, initially straight, then incurved. *Hymenophore* a single tube layer, 0.5–4(–5) mm thick, weakly differentiated from context; pore surface initially yellowish cream, then sordid yellow with a bright pruina over pore margins; pores 1–4 per 1 mm, roundish, of regular shape and size. *Context* 0.5–1.7 cm thick, fleshy when fresh, drying suberose-coriaceous, white. *Hyphal system* dimitic with skeleton-binding hyphae. Generative hyphae 1.5–3 µm diam, clamped, regularly branched, hyaline, thin-walled. Skeletal hyphae of three types: 1) regularly dichotomously branched, 2.5–12.5 µm diam (diameter falls to dendrite periphery); 2) their arboriform appendages 2–15 × 1–3.5 µm; 3) fibre-like, mainly 2–5 µm diam, coiled, subsolid. *Cystidia* none. *Basidia* 20–40 × 5.5–7 µm, clavate, four-spored, with a basal clamp. *Spores* 8–11.7 × 3.1–4.7 µm ($Q^* = 2.5$), symmetrically fusoid with a short apiculus, smooth, thin-walled, acyanophilous, with oil-rich contents.

On dying and dead trunks of *Salix*-species in Siberia and occasionally in Mediterranean Europe.

Specimens studied: RUSSIA. **Magadan Reg.** On *Salix arbutifolia*, 16.VIII.1965 Vassilkov (LE 22545, typus). **Irkutsk Reg.** Kashelnikovskiy Distr., on *S. arbutifolia*, 10.VIII.1969 Nezdominogo (two collections, LE 30505, 30506).

Polyporus pseudobetulinus – Fig. 3, 4, 5b

Polyporus pseudobetulinus (Murashk. ex Pilát) Thorn, Kotir. & Niemelä, *Mycologia* 82(5): 583. 1990.

≡ *Ungulina pseudobetulina* Murashk. ex Pilát, *Bull. Soc. Mycol. France* 48: 23. 1932.

≡ *Piptoporus pseudobetulinus* (Murashk. ex Pilát) Pilát, *Atl. Champ. Eur.* 3: 123. 1937.

≡ *Royoporus pseudobetulinus* (Murashk. ex Pilát) A.B. De, *Mycotaxon* 69: 139. 1998.

Basidiomata annual, 4–15(–25) cm diam, 1–4.5 cm thick, initially unguulate, then convex,

solitary or paired, attached to the substrate by a slightly pointed base of subdorsal localization. *Upper surface* initially subtomentose, then naked and covered by thin cuticle, which can crack to areolate scales, cream with orange or (later) hazel with grayish tints. *Margin* concolorous, radially fibrillose, initially straight, then incurved. *Hymenophore* a single tube layer, 1–3(–10) mm thick, weakly to sharply differentiated from context; pore surface initially whitish, then creamish-orange to pale grey; pores 0.2–3 per 1 mm, irregular in shape and size, often sinuose and splitted. *Context* 1 to 3.5 cm thick, fleshy when fresh, drying spongiose-coriaceous, white to cream. *Hyphal system* dimitic. Generative hyphae 1.5–5 µm diam, simple-septate, rarely branched, hyaline, thin-walled. Skeletal hyphae of two types: 1) regularly dichotomously branched, 2.5–14.5 µm diam. (diameter falls to dendrite periphery), rather rarely present in context; 2) fibre-like, mainly 2–6 µm diam, coiled, subsolid, predominant in tube trama and context. *Cystidia* none. *Basidia* 18–35(–40) × 5–7 µm, clavate, four-spored, efbulate. *Spores* (5.5–)6–9(–11) × 2.4–3.5 µm ($Q^* = 2.3–3.4$), slightly amygdaloid, ventrally flattened with a prominent, asymmetric apiculus, smooth, thin-walled, acyanophilous, with homogeneous contents.

On dying and dead trunks of *Populus* and *Salix*-species (mainly on *Populus tremula*), throughout the Holarctic. Produces white rot.

Specimens studied: RUSSIA. **Krasnoyarsk Reg.** On *Populus tremula*, 27.VI.1959 Yavorsky (LE 208400). **Novosibirsk Reg.** Suzun forest economy, on *P. tremula*, VII.1964 Zhukov (LE 30512). **Leningrad Reg.** On *P. tremula*, 1936 Bondartsev (LE 30508). **Archangelsk Reg.** Koriazhma Distr., on *S. caprea*, 01.VIII.2008 Ezhov (AR 1387); on *S. caprea*, 03.VIII.2009 Ezhov (AR 710); on *S. caprea*, 03.VIII.2009 Ezhov (LE 269606); on *P. balsamifera*, 05.VIII.2009 Ezhov (AR 1239). Pinega Distr., Pinega Res., on *P. tremula*, 19.IX.2007 Ezhov (AR 709). Velsk Distr., on *P. tremula*, 04.XI.2006 Ershov (AR 711).

Discussion

The macroscopical differences between the two species have been interpreted controversially in the literature, especially pileus and pore characteristics (Table 1). The clear microscopical differences between the two species are the absence of clamp-connections in cultures of *P. pseudobetulinus* (Thorn et al. 1990) and spore shape and

size (Thorn 2000). The results of our comparative analysis, including also *Salix*-associated specimens of *P. pseudobetulinus* from the Arkhangelsk Region, are presented in Table 1. As seen from the material presented, all the Arkhangelsk findings on unusual substrata should be attributed to *P. pseudobetulinus*. During the present study, also additional data for delimitation of the two species was revealed.

Cap surface. Both species have a cutis. However, in *P. choseniae* regular dots in the cutis appear in earlier stages of basidiome development. These gelatinized areas are more intensively coloured. The colour varies from pale to ochraceous brown. The arrangement of the dots is tessellate near the base and radial near the margin, where cutis cracks radially with linearly arranged dots. The cutis in *P. pseudobetulinus* stays uncracked for rather long, and initial cracking area is associated with part near the base. As a result, the scales are large, areolate and rather rare; there are also specimens with uncracked cuticle devoid of scales.

Base of basidiome. Basidiomata of *P. choseniae* have a more prominent base, slightly decurrent from the hymenophoral side. However, the point of attachment is minute and often dorsally placed, and thus such decurrency is rather false. *P. pseudobetulinus* has a similar trend when young. In the most cases its basidiomata haven't this false decurrency, bearing a subdorsal base, like those of *Piptoporus betulinus* (Bull.) P. Karst.

Margin. The margin in both species is poorly differentiated from the hymenophore (in contrast to *P. betulinus*). However, on terminal stages of basidiome development it can be turned inside, appearing as rounded.

Hymenophore. The hymenophore in both species is a single tube layer varying from 1 to 5 (10) mm in thickness. Tube trama is more gelatinized than outer tissues. The pores of *P. choseniae* are smaller and rather regular, whereas *P. pseudobetulinus* is characterized by larger and irregular pores, which can split like in *P. betulinus*. The colour is sordid yellow in *P. choseniae* and cream with orange tint in *P. pseudobetulinus* (old specimens of both species are characterized by greyish pruina at the pore margin).

Hyphal system. The hyphal system in both species can be characterized as dimitic with skeleto-binding hyphae. In tube trama of *P. cho-*

seniae, together with rather standard dichotomous skeleto-binding hyphae, we found narrow binding-like appendages of robust skeletal. These appendages are highly similar to those in some trametoid polypores, like *Perenniporia*, *Trametes*, and *Ganoderma*. They are abundant in all examined sections. Formally, such a hyphal system should be classified as trimitic. However, this term is rather ambiguous (Zmitrovich et al. 2009). We use the term "dimitic with skeleto-binding hyphae" in a wide sense. The terminations of skeleto-binding hyphae in *P. choseniae* appear as coiled, fibre-like skeletal (Fig. 2).

Both tube trama and context of *P. pseudobetulinus* is composed of regular, coiled fibre hyphae (Fig 4). The ramified skeleto-binding bodies are occasionally dispersed within tissue. Therefore, such a structure is intermediate between *Polyporus*- and *Piptoporus*-types (the second type is characterized by total substitution of skeleto-binding bodies by fibre-like remnants, as it was shown by Corner 1984).

Spore characteristics. Spore shape and dimensions are clearly different (Fig. 5). Spores of *P. choseniae* are symmetrically fusoid (boletinoid according to Thorn 2000) with a short apiculus. Their shape and proportions are rather stable (Q^* varies around 2.5). Spores of *P. pseudobetulinus* are slightly amygdaloid, ventrally flattened and with a prominent, asymmetric apiculus (suiloid in bolete terminology). Their proportions are more variable (Q^* varies between 2.3–3.4 μm). They are also smaller and more attenuated.

Generic affiliation. Both species were initially attributed to the genus *Piptoporus* P. Karst. due to their apodate, seasonal basidiomata with subdorsal attachment. They were later transferred to *Polyporus* Adans. The reasons were the presence of a "short stipe" in *P. choseniae* (Parmasto 1975) and the production of white rot by *P. pseudobetulinus* (Thorn et al. 1990). Some years later, the latter species was transferred to *Royoporus* A.B. De (De 1998) due to the absence of clamps on generative hyphae. We don't follow this action since clampless representatives of *Polyporus* are obviously related to various clamped kins and cannot be allocated in a separate unit (*P. badius* is connected to *P. melanopus* -group, *P. brasiliensis* to *P. arcularius*-group, *P. pseudobetulinus* to *P. admirabilis* -group). *P. choseniae* seems not to be closely related to *P. pseudobetulinus*. It is

Table 1. Characteristics of *Polyporus chosoeniae* and *P. pseudobetulinus*.

Species & specimens	Substrate	Pores per mm	Scales	Spores characteristics			Clamps
				L, μm	W, μm	Q*	
Species descriptions in literature							
<i>P. chosoeniae</i> (Vassilkov 1967)	<i>S. arbutifolia</i>	1–3	spot-like	10–12.5	5.0	2.2	no mention
<i>P. chosoeniae</i> (Parmasto 1975)	<i>Salix</i> spp.	3(4)	spot-like, 0.2–0.4(0.8) mm diam.	10.6–11.7	4.3–4.5	2.5	+
<i>P. chosoeniae</i> (Bondartseva 1998)	<i>S. arbutifolia</i>	1–2(3)	spot-like	8.0–10.0	3.0–4.0	2.4	+
<i>P. chosoeniae</i> (Thorn 2000)	<i>Salix</i> spp.	3–4	as dark dots	(8.0–)9.7–12.2(–13.6)	(3.6–)4.1–5.3(–6.1)	2.3	+
<i>P. pseudobetulinus</i> (Ryvarden & Gilbertson 1994)	<i>Populus</i> spp.	1–3	pileus finely fibrillose, becoming areolate	(6.5–)7.2–10.0	2.5–3.4	2.9	–
<i>P. pseudobetulinus</i> (Bondartseva 1998)	<i>P. tremula</i>	1.5–3	spot-like	6.0–8.0 (–9.0)	2.5–3.5	2.4	no mention
<i>P. pseudobetulinus</i> (Thorn 2000)	<i>P. tremula</i> , <i>P. balsamifera</i>	3–4	appressed scales	7.0–9.5	2.5–3.5	2.8	–
Specimens examined							
<i>P. chosoeniae</i> (type, LE 22545)	<i>S. arbutifolia</i>	1.5–4	regularly dotted near the base	8.0–11.7	3.1–4.7	2.5	+
<i>P. pseudobetulinus</i> (LE 208400)	<i>P. tremula</i>	0.8–3	irregularly scaled	5.5–8.0	2.6–3.2	2.3	–
<i>P. pseudobetulinus</i> (AR 1387)	<i>S. caprea</i>	0.5–3	irregularly scaled	6.5–9.1	2.5–3.0	2.8	–
<i>P. pseudobetulinus</i> (LE 269606)	<i>S. caprea</i>	0.2–2.5	irregularly scaled	7.8–10.9	2.4–3.1	3.4	–
<i>P. pseudobetulinus</i> (AR 710)	<i>S. caprea</i>	1–3	irregularly scaled	5.5–8.1	2.5–2.9	2.5	–
<i>P. pseudobetulinus</i> (AR 1239)	<i>P. balsamifera</i>	0.5–2	practically without scales	6.5–7.8	2.8–3.0	2.5	–
<i>P. pseudobetulinus</i> (AR 711)	<i>P. tremula</i>	2–3	irregularly scaled	6.3–9.1	2.5–3.0	2.8	–

more probable that the species represents a certain branch of *P. varius*-group.

Ecology and distribution. *P. pseudobetulinus* prefers to colonize dead, standing wood of *Populus tremula* (Bondartsev 1953, Bondartseva 1998, Martikainen et al., 2000). It can also infest other *Populus* species and rarely *Salix* spp. (Núñez & Ryvarden 1995, Thorn et al., 2000, Schigel 2009). As a rule, host trees are rather old, and the fungus favours old-growth forests but can also be found on retained aspens in clear-cut areas (Martikainen et al. 2007, Andersson et

al. 2009, Schigel 2009). Our collections on *S. caprea* and *P. balsamifera* were made on dying trees near the ground. Usually the species occurs higher, ca. 3–5 m above the ground. The species has a Holarctic distribution following the distribution of *P. tremula* and *Salix* spp.

The data on substrate preference and distribution of *P. chosoeniae* is scarce. It was described from Russian Far East (Vassilkov 1967), where it was associated with *Salix (Chosoenia) arbutifolia*. It was collected time to time on other *Salix* species in Central and South Siberian regions. It

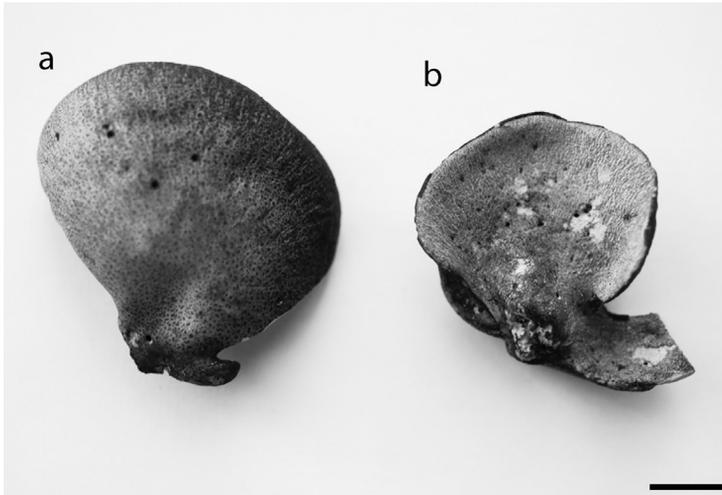


Fig. 1. *Polyporus choseniae* (type material). a = dotted and radially fibrillose upper surface; b = hymenophoral surface. Scale = 1 cm.

was also reported from Mediterranean Europe (Krisai-Greilhuber & Ryvarden 1997).

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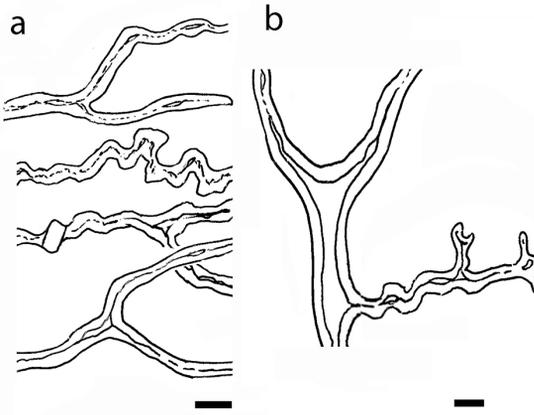


Fig. 2. Skeletal hyphae in *Polyporus choseniae*. a = skeleto-binding hyphae with coiled fibre terminals. b = skeleto-binding hypha with arboriform appendage. Scale = 10 μ m.



Fig. 3. *Polyporus pseudobetulinus*. Scale = 1 cm.

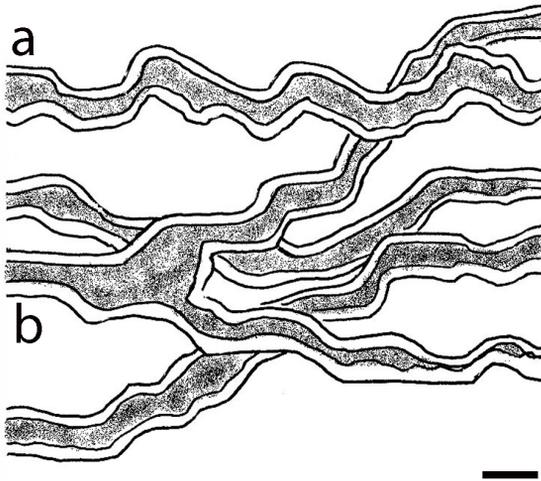


Fig. 4. Skeletal hyphae of *Polyporus pseudobetulinus*. a = coiled fibre hyphae, predominant in the basidiome. b = dichotomously branched skeleto-binding hyphae, initial to fibre skeletals. Scale = 10 μ m.

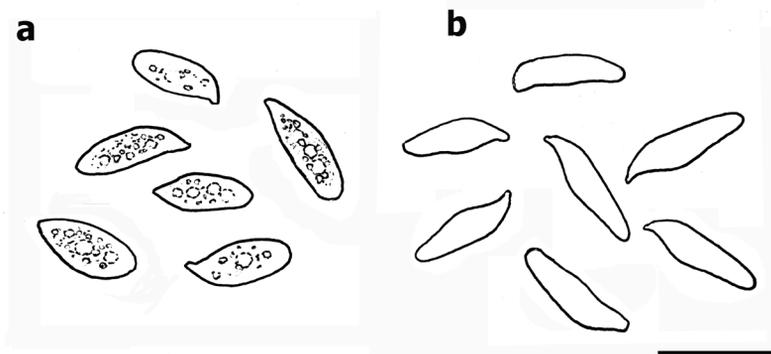


Fig. 5. Basidiospores of *Polyporus choseniae* (a) and *P. pseudobetulinus* (b). Scale = 10 μ m.