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New records of *Polyporus pseudobetulinus*, a rare polypore fungus (Basidiomycota, Aphyllophorales) in Scandinavia, and notes on associated beetles

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One of the rarest Nordic pore fungi, *Polyporus pseudobetulinus* (Basidiomycota) was found to have two separate distribution and host patterns in North Europe. In its well-known northern and eastern range the species grows on aspen. Now it is newly reported from *Salix cinerea* in the surroundings of Stockholm, Sweden. Spore dimensions vary slightly between these two populations. Eleven beetle species are recorded for the fungus. The Corylophidae and Latridiidae are attracted by anamorphic fungi that cover dead fruit bodies. The colonizing patterns of beetle larvae within the fruit-bodies are discussed and illustrated.

1. Introduction

An increasing interest in forest conservation and red-listed saproxylic species is linked with polypores – a fungal group which offers valuable tools for evaluating species diversity of forest organisms. Famous for its high nature values, the Pisavaara Strict Nature Reserve in the Perä-Pohjanmaa Province of Finland is a solitary forest-covered hill accumulating atmospheric water and feeding numerous brooks that run down its slopes. The combination of high humidity and old-growth forest makes this site a favourable habitat for giant aspen trees which harbour specific saproxylic organisms, both fungi and insects. One of the specialities is a viable population of *Polyporus pseudobetulinus* (Pilát) Thorn, Kotir. & Niemelä.

Fairly unexpectedly *P. pseudobetulinus* was recently found in southern Sweden. This evidently isolated population maintains many peculiarities if compared with the general ecology and distribution of *P. pseudobetulinus* in Eurasia. Here we give a brief account of these new finds. Amongst the other rare polypores, *Polyporus pseudobetulinus* has significantly larger fruit bodies, growing mostly on thick-trunked aspens. Results presented here are part of our ongoing study on beetles linked to rare and insufficiently known polypores.

2. Material and methods

Fungal specimens were collected in the field by the authors (abbreviated as DSS and HGT respectively). A closer microscopic study was carried out with a research microscope, sections mounted in Cotton Blue or Melzer's reagent, and studied at 1,250 × magnification and phase contrast illumination. Thirty spores per specimen were measured. Herbarium specimens, dried in ventilated air at +45°C, are preserved in the Herbarium of the Botanical Museum, Finnish Museum of Natural

History, University of Helsinki (H), except for those obtained on loan from the private herbaria of Sonja Kuoljok and Sture Westerberg. Other herbaria are abbreviated as TAA (Institute of Zoology and Botany, Tartu) and S (Swedish Museum of Natural History).

Specimens examined microscopically: FINLAND. Perä-Pohjanmaa: Rovaniemi Rural Commune, Pisavaara Strict Nature Reserve, 30.VIII. 1979 T. Niemelä 1547 (H). Pohjois- Karjala: Nurmes, NW of Hiidenportti, close to Kuhmo border, Repokangas, 28.VII.1992 Tynkkynen (H). Lieksa, NE part, Savijärvi, Saarvavaara, *Populus* 12.VII. 1992 Sorvari & Ikonen (H). SWEDEN: Uppland: Vada, Helgöå, *Salix cinerea*, 7.VII.2003 H.G. Toresson (H). Norrbotten: Luleå, Stockarsmyran NW, *Salix pentandra,* S. Westerberg (H).

Radial sections of polypore fruit bodies were preserved for rearing of beetle imagines. Fruit bodies with beetle larvae were stored in plastic bags for 2–3 months in +4° C, and then exposed at room temperature for another 2–3 months. Beetles were preserved in 70% alcohol for further identification and then mounted on pins. Beetle specimens will be donated after their investigation to the Zoological Museum, Finnish Museum of Natural History, University of Helsinki. Beetle nomenclature follows Silfverberg (2004). Authors of the Latin names of beetles are indicated in Table 2.

Specimens surveyed for insects: FINLAND. Perä-Pohjanmaa: Rovaniemi Rural Commune / Tervola, Pisavaara Strict Nature Reserve, Kuusiloma S, Grid 27°E 7354:415, *Populus tremula*, 27.VIII.2003 D.S. Schigel 1556, 1557 and 1558 (H). Liljalaki SE, Grid 27°E 7354:414, *Populus tremula*, 30.VIII.2003 D.S. Schigel 1616 and 1617 (H). SWEDEN. Uppland: Vada, Helgöå, *Salix cinerea*, 7.VII.2003 H.G. Toresson (H). 7.VIII. 2003 H.G. Toresson (H). Kista, Hansta, *Salix cinerea* VII.2003 H.G. Toresson (H).

3. Results

After ten years of searching for beetles that inhabit the rare wood-rotting fungus *Polyporus pseudobetulinus*, eight fungal specimens were eventually collected in 2003, each represented by a single fruit body. Five fruit bodies of *Polyporus pseudobetulinus* were collected by DSS in Finland, Perä-Pohjanmaa, Rovaniemi rural commune and Tervola, in the Pisavaara Strict Nature Reserve. This place was reported as one of the richest sites where both old aspen trees and *P. pseudobetulinus* are found (Martikainen *et al.* 2000). Rocky steps of the Pisavaara hill make an uneven pattern of forest density and ground moisture – a mosaic of dry stony slopes, wet brook valleys, exposed windfall areas and thickets of spruce. Old aspen trees remain standing dead in all of the above mentioned sites. However, only in a few of them there is a combination of relatively high ground humidity and dead aspen crowns exposed to the sun – a preferable habitat for the fungus.

Fig. 1. Fruit bodies of *Polyporus pseudobetulinus* growing on *Salix cinerea* in Uppland, Sweden. Photo HGT.

Two localities of *Polyporus pseudobetulinus* were discovered by HGT in the year 2003 from Sweden, Uppland: Vada, Helgöå and Kista, Hansta. The Helgöå locality is situated by a regularly flooded river bank covered by *Salix cinerea* L. The Hansta locality is within the borders of Stockholm municipality, in an abandoned, ditched, wet, and previously cultivated meadow at the bottom of a broad valley, now sparsely covered with 40–50 years old birches and along the ditches with *Salix cinerea.* These willows make the substrate for *P. pseudobetulinus* in this locality (Fig. 1). Both these southern Swedish localities are open and fairly exposed.

The fruit bodies of *Polyporus pseudobetulinus* bodies collected in Uppland (Fig. 1) and Norr-

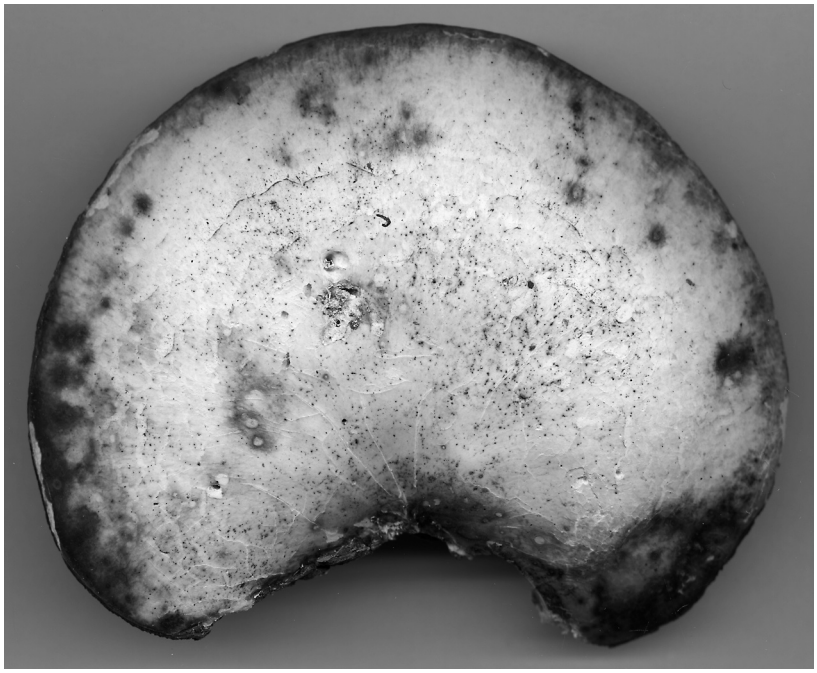

Fig. 2. Fruit body of *Polyporus pseudobetulinus*, seen from above. Specimen Westerberg. Photo DSS.

botten (Fig. 2) were smaller: pileus width 5–12 cm and thickness 1–3 cm, compared with width 7–20 cm and thickness up to 4.5 cm of the specimens from Finnish Lapland (Fig. 3). Despite these size differences and the uncommon substrate, we believe that the specimens belong to the species *P. pseudobetulinus.* Main macroscopic characteristics agree with the Lapland material, such as pore shape and size 0.9–3 pores/mm, and the shape and colour of fruit bodies. Two specimens (7.VII.2003 Toresson and Westerberg) from Sweden were studied microscopically (Table 1); the remaining two from Uppland were rotten. Microscopic characters were found in general similar to the specimens collected in Finnish Lapland and Finnish Karelia and those described by Thorn *et al.* (1990), in particular the skeleto-binding hyphae and the absence of clamps. The Uppland–Norrbotten population of *P. pseudobetulinus* had slightly narrower basidia and basidioles, and longer spores (Table 1).

The fruit bodies of *Polyporus pseudobetulinus* were collected at different stages of decomposition. Summarizing preliminary rearing results (Schigel 2005) with new data, we observed 11 beetle species, of which only three proved to undergo larval development in the fruit bodies of *Polyporus pseudobetulinus*: *Cis comptus, Sulcacis affinis* and *Dacne bipustulata* (Table 2). These are characteristic species developing in polypores of the trametoid and piptoporoid consistency classes (Schigel *et al.* 2004). Imagines of *Atheta picipes, Orthoperus rogeri, Corticarina*

Fig. 3. Detached fruit bodies of *Polyporus pseudobetulinus*, from below. Both overwintered (right, specimen Schigel 1557) and recently dead (left, specimen Schigel 1558) ones bear patches of anamorphic fungi. Photo DSS.

Table 1. Spore dimensions of *Polyporus pseudobetulinus* from Sweden (specimen 7.VII.2003 Toresson and Westerberg), Finland (Niemelä 1547; 28.VII.1992 Tynkkynen; 12.VII.1992 Sorvari & Ikonen), and comparison with the reference data. Abbreviations follow Kotiranta & Saarenoksa (2005) with changes: L = spore length, L* = mean spore width, W = spore width, W* = mean spore width, Q = L/W ratio, Q* = mean Q value (L*/W*). Spore dimensions set in **bold face** cover 95% of measured spores.

Specimen/reference	L	L*	W	W*	Q	Q*
7.VII.2003 Toresson	(7.5–)**7.8–10.0**(–10.5)	8.85	(2.8–)**2.9–3.3**(–3.4)	3.06	(2.50–)**2.59–3.23**(–3.40)	2.89
Westerberg	(8.1–)**8.2–9.8**(–10.9)	9.11	(2.6–)**2.7–3.2**(–3.3)	2.99	(2.66–)**2.71–3.45**(–3.52)	3.06
Niemelä 1547	(7.6–)**7.8–8.9**(–9.1)	8.34	(2.7–)**2.8–3.1**(–3.3)	2.95	(2.53–)**2.62–2.96**(–3.11)	2.83
28.VII.1992 Tynkkynen	(7.2–)**7.4–9.0**(–9.3)	8.09	(2.7–)**2.9–3.2**(–3.5)	3.05	(2.31–)**2.40–2.91**(–3.00)	2.66
12.VII.1992 Sorvari & Ikonen	(7.0–)**7.2–9.0**(–9.4)	8.12	**2.8–3.2**(–3.7)	3.09	(2.32–)**2.40–2.87**(–3.36)	2.63
Thorn et al. (1990)	(6.5–)**7.2–9.5**(–10.4)	–	(2.2–)**2.5–3.6**(–3.8)	–	(2.0–) **2.2–3.4**(–3.9)	–

Table 2. Beetles associated with *Polyporus pseudobetulinus* in Finland and Sweden. Localities are abbreviated as following: P = Pisavaara Strict Nature Reserve, Finland; H = Heinävaara, Finland and U = Uppland, Sweden. The stage of beetle life cycle (LCL) is marked "L" in case of larval development in the fruit body or "I" if only imaginal record was made. Location of beetles inside the fruit body (frb) are marked C = in context, CH = in the context / hymenophore transition, H = inside the hymenophore, HS = at the hymenophore surface. Number of specimens (N) is indicated, but beetle – fungus associations meeting the Lawrence (1973: 165) criterion are marked "10+" instead of the number of larvae or reared imago specimens.

Family	Species	Locality	LCL		N
Ciidae Leach 1819	*Cis comptus* Gyllenhall, 1827	P, H, U	L	C, CH	10+
	Cis bidentatus (Olivier, 1790)	P	?L	C, CH	6
	Cis boleti (Scopoli, 1763)	P	I	HS	1
	Sulcacis affinis (Gyllenhall, 1827)	U	L	C, CH, H	10+
	Sulcacis fronticornis (Panzer, 1809)	U	?L	–	1
Erotylidae Latreille, 1802	*Dacne bipustulata* (Thunberg, 1781)	P, U	L	C	10+
Corylophidae LeConte, 1852	*Orthoperus corticalis* (Redtenbacher, 1849)	P	I	HS	1
	Orthoperus rogeri Kraatz, 1874	P	I	HS	2
Latridiidae Erichson, 1841	*Corticarina lambiana* (Sharp, 1910)	P	I	HS	1
Cerylonidae Billberg, 1820	*Cerylon ferrugineum* Stephens, 1830	P	I	HS	2
Staphylinidae Latreille, 1802	*Atheta picipes* (Thomson, 1856)	P	I	HS	1

lambiana, and *Cerylon ferrugineum* are attracted by moist and anamorphic-fungi-covered basidiocarps (Fig. 3), while both larvae and imagines of *Cis comptus* show no preference to any definite decomposition stage. *Cis boleti*, *Cis bidentatus,* and *Sulcacis affinis* were found on dry, dead fruit bodies. For the spatial colonisation patterns inside the fruit body, see Fig. 4.

4. Discussion

Polyporus pseudobetulinus is rare throughout its holarctic distribution. It is a red-listed, endangered species both in Finland and Sweden. Among the fungi belonging to the genus *Polyporus* and growing on the wood of deciduous trees, *P. pseudobetulinus* occupies the Salicaceae species of the genera *Populus* and *Salix*. The typical host of *P. pseudobetulinus* is a thick trunk of *Populus* over 30 cm in diameter with partly detached bark and still-existing crown, or a tall stump. In North America the reported host tree is *Populus balsamifera* L. (Thorn *et al.* 1990), in Eurasia *Populus tremula* L. Fungal fruit bodies tend to appear relatively high above the ground, especially in wet forests, but they were also found in dry and open sites.

All Finnish specimens were collected on as-

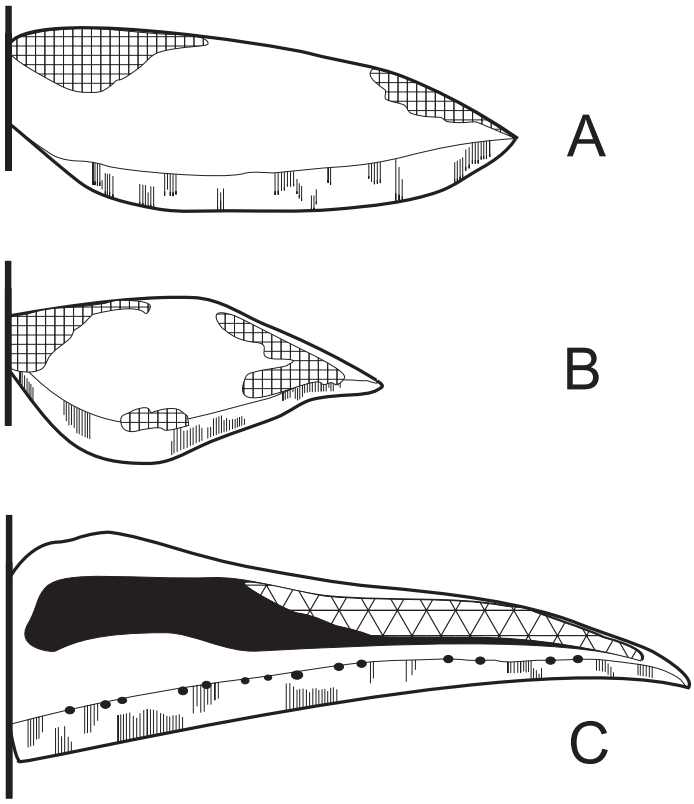

Fig. 4. Spatial distribution of beetle larvae in the fruit bodies of *Polyporus pseudobetulinus*, radial sections through the middle of fruit body. Triangle-filled = zone occupied by *Dacne bipustulata,* square-filled = burrows of *Cis comptus* and *C. bidentatus*; black patches = burrows of *Sulcacis affinis*. A, B – specimens Schigel 1558 and 1616 from Pisavaara Strict Nature Reserve, Finland; C – specimen VII.20003 Toresson, Uppland, Sweden.

pen. Heikki Kotiranta labelled in 1987 in Pisavaara a number of aspen trees harbouring *Polyporus pseudobetulinus*. Now one of them was refound (Schigel 1556–1558), still producing fruit bodies of the fungus. It is probable that the same individual of *P. pseudobetulinus* was occupying the tree for over 16 years – a remarkable period of time for the species with annual fruit bodies.

Of the ten records in Sweden (our data plus http://fungus.dataservice.se) six are from *Populus tremula* in Sollefteå (Ångermanland), Skellefteå (Västerbotten), Lycksele (Lycksele Lappland), Luleå and Piteå (Norrbotten) and four from willows. An old record from aspen, "Gotska Sandön, Beckrevskullen, 11.VIII.1958 P. Petterson" (Thorn et al. 1990), is the nearest locality to the new collections from Stockholm area.

We have examined two specimens of *Polyporus pseudobetulinus* collected in North Sweden on *Salix*. One was collected in Lule Lappmark, Kaptasluokta, 14.XI.2000 on *Salix caprea* in a damp deciduous forest by Sonja Kuoljok (specimen shared between herb. S and Kuoljok private herbarium). Another fruit body was collected in Norrbotten on *Salix pentandra* by Sture Westerberg. Thus two localities from the capital region in Sweden we report here are among the first European records from *Salix cinerea*. *Polyporus pseudobetulinus* was reported from *Salix* also in Japan (Núñez & Ryvarden 1995).

Another record from unusual substrate *Alnus incana* (L.) Moench is known from Estonia, "Lääne-Viru Co., Laekvere Com., Venevere Forest Div., 21.09.1956 E. Parmasto" (Parmasto 2004), but the specimen in TAA herbarium was destroyed by insects. For distribution maps and more data on morphology, nomenclature and ecology of *Polyporus pseudobetulinus* see Thorn *et al.* (1990) and Martikainen *et al.* (2000).

For over 100 polypore species collected in Northern and Eastern Europe we have observed a positive correlation between the size of the fruit body and a high number of beetle species and individuals. Larger fruit body provides a variety of potential ecological niches and higher volume of larval food source. On the opposite, rare and ephem-

eral fungi with irregular fruiting periods are not expected to support populations of fungus-feeding specialists. The rarity of *P. pseudobetulinus* makes it unlikely for a specialized beetle fauna to develop, and, indeed, a set of fairly common beetle species appeared on *Polyporus pseudobetulinus*.

Cis comptus was found in all localities, but only on one specimen from Uppland. From the Finnish material we reared several tens of individuals. Atte Komonen (pers. comm.) also reared numerous *Cis comptus* individuals from dead and heavily decayed fruit bodies of *Polyporus pseudobetulinus* that were collected by Reijo Penttilä in 1998 in Finland, Kainuu: Sotkamo, and Heinävaara (Martikainen *et al.* 2000). *Cis bidentatus* larvae colonise the fruit bodies together with *C. comptus* and in a similar way. We were not able to distinguish the species in the field, and so the way of sharing of ecological niches remains unclear to us.

Sulcacis affinis, a small-sized ciid beetle, is an effective destructor of trametoid and piptoporoid polypores; this beetle species was the most numerous one in the Uppland material. In addition, a single individual of *Sulcacis fronticornis* was reared from the same fruit body.

Dacne bipustulata is one of the most characteristic erotylid beetles developing in relatively elastic and soft, but not watery and fragile, polypores. Several tens of individuals were reared from the Pisavaara and Uppland materials. *D. bipustulata* was the second most abundant beetle species after *Cis comptus*.

Single imagines of *Cis boleti*, *Atheta picipes*, *Cerylon ferrugineum*, *Corticarina lambiana* and *Orthoperus corticalis* were collected in Pisavaara. *Orthoperus corticalis, O. rogeri* and *Corticarina lambiana* share similar substrate preferences and they were possibly attracted not by dead fruit bodies themselves, but by anamorphic fungi developing on the polypore. A dotted colour pattern caused by these anamorphic fungi on the fruit body (Fig. 3) is reported to be due to a *Cladosporium* (Thorn *et al.* 1990).

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