

Contribution to the knowledge of genus *Amylostereum* in the Macedonian mycota

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Received: September 12, 2018 ▷ Accepted: March 15, 2019

Abstract. This is the first paper referring to the taxonomy of genus *Amylostereum* as part of the macedonian mycobiota. The species within the genus *Amylostereum* cause decaying of white rot type in conifers. According to the recent distribution studies conducted in Macedonia, the species *Amylostereum areolatum* is of conservation value and, therefore, is included in the *Macedonian Red List of Fungi*. Known only as a saprotroph on spruce trees, *Amylostereum chailletii* is commonly found on fallen fir branches, while *Amylostereum laevigatum* is known from different juniper species from several localities.

Key words: *Amylostereaceae*, host interaction, lignicolous fungi, mycodiversity, *Russulales*.

Introduction

Boidin (1958) described *Amylostereum* as a monotypic genus in the family *Amylostereaceae*. The species belongs to *Aphyllphorales*, particularly within the *Polyporaceae* sensu lato family (“polypore”, according to Ryvarden & Gilbertson 1993, 1994). These polypores are referred to by the practical forester as “tree polypores” (Seehann 1971). Boidin (1958) distinguished genus *Amylostereum* from the similar genus *Stereum* by the presence of amyloid spores and encrusted cystidia. The genus *Amylostereum* includes species with a crust-like, dry and leathery-corky fruit bodies, hymenium, and context brown with numerous light brown thick-walled and apically encrusted cystidia (lamprocystidia), yellowish brown in Melzer. The hyphae are thin-walled, hyaline, or thick-walled, brown and with clamps; basidiospores cylindrical or narrowly ellipsoid, smooth, thin-walled and distinctly amyloid.

So far, the surveys of *Amylostereum* in Macedonia have identified the presence of all three species known in Europe: *A. areolatum* (Chaillet ex Fr.) Boidin, *A. chailletii* (Pers.) Boidin and *A. laevigatum* (Fr.) Boidin. Detailed data on the taxonomy of *Amylostereum* in Macedonia have not been published so far, and the species of this genus are only identified and mentioned in relatively few mycological papers. Almost all *Amylostereum* species represent one of the key elements of boreal ecosystems, due to their wood-decomposing abilities. *Amylostereum* species may be also involved in wood decay of spruce and other conifers. *A. areolatum* (Vulnerable, VU) is included in the *Macedonian Red List of Fungi* (Karadelev & Rusevska 2013).

This paper provides taxonomic, ecological and distributional data, as well as species distribution maps, and a review of the local distribution for each species.

Material and methods

The sources for this study were published papers, exicates from different collections and, primarily, fieldwork carried out by the authors and other collectors. The taxa previously reported from Macedonia are also listed here and references are given, while most of the unpublished data are from the previous years.

As mentioned above, some of the specimens were stored at the Natural History Museum in Belgrade (BEO), the National Museum in Prague (PRM) and the Croatian National Fungarium (CNF). Quite a number of specimens deposited in BEO were collected by V. Lindtner during his subsequent field trips to Macedonia. Some of Lindtner's specimens sent for determination to A. Pilát are deposited in Prague. Collections in the Croatian National Fungarium in Zagreb were mostly collected and examined by M. Tortić. Most specimens have been preserved in the Macedonian Collection of Fungi (MCF), within the Mycological Laboratory at the Institute of Biology, Faculty of Natural Science and Mathematics, Ss Cyril and Methodius University in Skopje. The obtained data were recorded in a specialized database software MACFUNGI.

Laboratory analyses were carried out with the use of Melzer's reagent and 5% KOH. Measurements and pho-

tographs were examined at magnification up to 1000 ×, with a LW scientific microscope and MiniVID camera.

The species identification of *Amylostereum* followed Eriksson & Ryvarden (1973); Jülich (1984); Breitenbach & Kränzlin (1986); Domański (1991); Hansen & Knudsen (1997); Bernicchia & Gorjón (2010). The nomenclature follows Index Fungorum and Mycobank.

The studied species are listed in alphabetical order, followed by data on geographical distribution, altitude, substrate, forest association, and data source. Regarding the mapping of the distribution of species, data from the Regional Division of Macedonia (Melovski & al. 2013) were used.

The distribution map of species of genus *Amylostereum* in Macedonia is shown in Fig. 1.

Marks and abbreviations

MCF – Macedonian Collection of Fungi at the Institute of Biology, Faculty of Natural Sciences and Mathematics, Ss Cyril and Methodius University in Skopje

BEO – Natural History Museum in Belgrade

CNF – Croatian National Fungarium in Zagreb (previously abbreviated as: ZA)

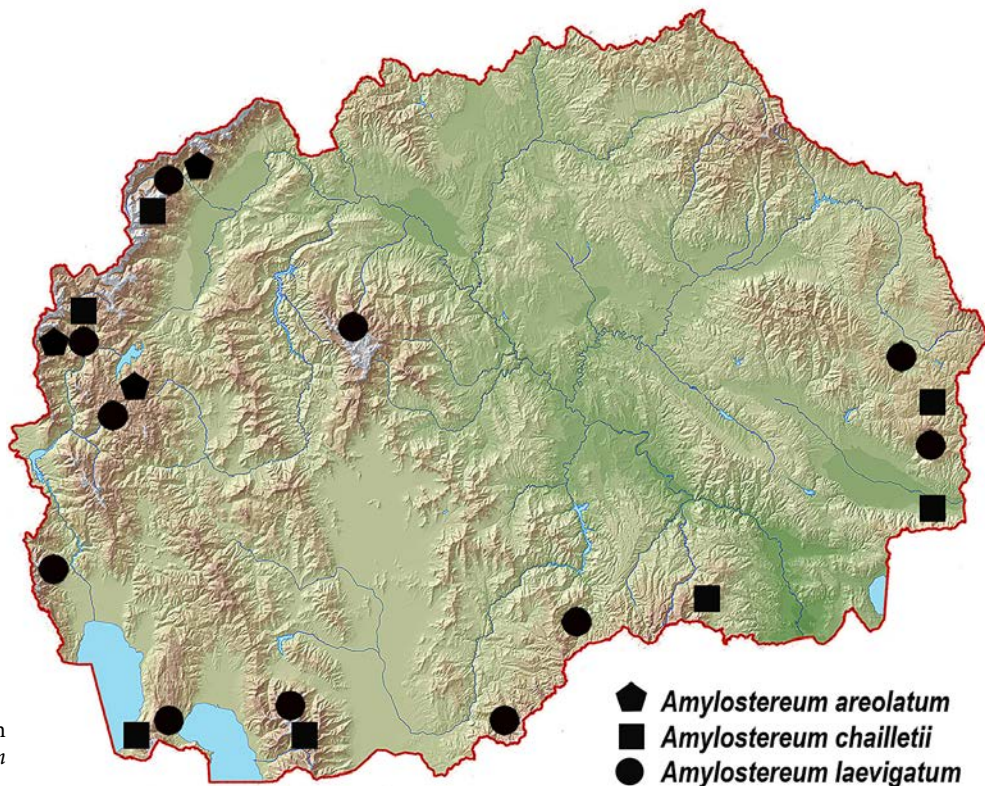


Fig. 1. Species distribution map of genus *Amylostereum* in North Macedonia.

PRM – National Museum in Prague

exs. – collections in which the dried material (exsiccatum) is deposited

vill. – village

Results and discussion

Amylostereum areolatum (Chaillat : Fr.) Boidin,
Revue Mycol., Paris 23(3): 345, 1958.

≡ *Thelephora areolata* Chaillat ex Fr., Elench. Funga.
(Greifswald) 1:190, 1828. (Fig. 2)

References: Pilát (1937); Tortić (1988a, b); Karadelev (1999b, 2000a); Karadelev & Rusevska (2013); Perić & al. (2001), Karadelev & al. (2018).

Collections: MCF, CNF.

Basidiome effuse-reflexed to pileate, upper sterile surface with an adpressed brown tomentum, margin undulate, hymenial surface smooth, pale brown contrasting with the paler upper surface. *Hyphal system* dimitic, generative hyphae with clamps, thin-walled, 1.5–3 µm, skeletal hyphae brownish, thick-walled, 2–4 µm wide. *Cystidia* cylindrical with tapering apex, 50–80 × 5–6 µm, brownish, thick-walled, rare and thin encrustation in the apical part 15–20 µm, very numerous in hymenium and context, skeletal hyphal ends with typically undulate walls. *Basidia* clavate, 15–20 × 3–6 µm, thin-walled, with 4-sterigmata and with a basal clamp. *Basidiospores* cylindrical to fusiform, 6.5–7.5 × 2.5–3 µm, thin-walled, smooth and amyloid.

Habitat. *A. areolatum* is a very rare species known only as a saprotroph on fallen trunks and on stumps of spruce (*Picea abies*).

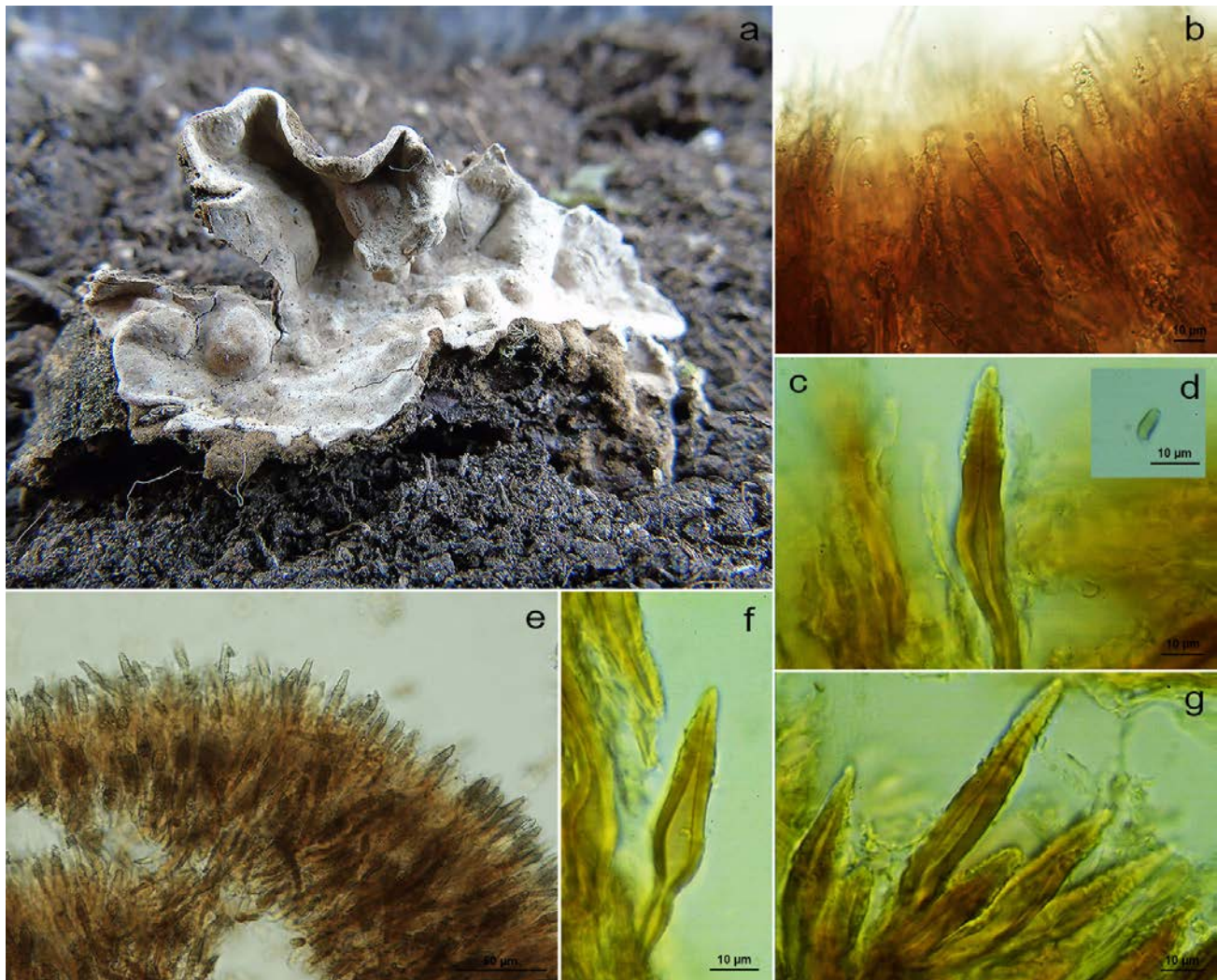


Fig. 2. a) Macroscopic view of basidiome of *Amylostereum areolatum*; b-g) Microscopical features of *A. areolatum*: b, e – section of basidiome, presence of numerous encrusted cystidia and basidia, f – young cystidia, c, g – encrusted cystidia, d – basidiospore.

Material examined. Bistra: Mavrovo National Park, on planted *P. abies*, exs. (CNF); Korab: Adjina Reka, Mavrovo National Park, ass. *Abieti-Piceetum scardicum*, on *P. abies*, 1400 m, 24.IX.1975, exs. (CNF); Shar Planina: Jelak, ass. *Abieti-Piceetum scardicum*, on *P. abies*, 1700–1800 m, 14.VI.2007, exs. (MCF 07/7229).

Remarks. *A. areolatum* occurs on dead spruce wood commonly in the mountain coniferous forests, on fallen trunks and on stumps. This species causes a dry white rot of the wood before and after the death of the tree (King 1966). It is a common and widespread species in Europe and mainly occurs on *Picea abies*, rarely on deciduous wood of *Fagus sylvatica* and *Robinia pseudoacacia* (Bernicchia & Gorjón 2010). In Macedonia, considering the data published by Tortić (1988b), the species has not been registered on deciduous trees, which indicates that it has been first collected in Former Yugoslavia (Slovenia, Croatia, Bosnia and Herzegovina, including Macedonia), where it occurred on dead wood of *Picea abies*, mostly on stumps, occasionally on logs and prostrate branches. In Bosnia and Herzegovina, the species were reported to have been collected on *Abies alba*, which is a possible, although a rare host, but there was no trace of wood on the specimen to verify this assumption. The localities cited in Macedonia are the southernmost for *A. areolatum* within Yugoslavia, since its main host, spruce, reaches its southern borders of distribution there.

In Macedonia, it is a rare species known only from three localities in the northwestern part of the country: the mountains of Bistra, Korab and Shar Planina; the last one is a recently discovered locality for this species. The species has been registered only on *Picea* spp. In terms of vertical distribution, it is found between 1400–1800 m a.s.l. According to the existing data, it is not a very common species. *A. areolatum* (Vulnerable, VU) is included in the *Macedonian Red List of Fungi* (Karadelev & Rusevska 2013).

Amylostereum chailletii (Pers. : Fr.) Boidin, *Revue Mycol.*, Paris 23(3): 345, 1958

≡ *Thelephora chailletii* Pers., *Mycol. Eur.* (Erlanga) 1:125, 1822. (Fig. 3)

References: Pilát & Lindtner (1938); Tortić (1988a) as *Stereum chailletii* (Pers.) Fr.; Tortić (1988b); Karadelev (1993, 1994, 1995b, 1998, 1999a); Karadelev & Rusevska (2000); Karadelev & al. (2003a, 2008, 2018).

Collections: MCF, BEO, PRM, CNF

Basidiome resupinate to effuse-reflexed, pale brown coloured, hymenical surface even. *Hyphal system* dimitic, generative hyphae with clamps, thin-to-thick-walled, 2–5 µm, skeletal hyphae brownish, thick-walled, 3–4 µm wide. *Cystidia* yellowish brown, cylindrical with tapering apex, 60–80 × 5–6 µm, thick-walled and apically encrusted 15–20 µm, very numerous in hymenium and context, young cystidia subulate, thin-walled, not encrusted and smooth. *Basidia* clavate, 15–20 × 4–6 µm, thin-walled, with 4-sterigmata and with a basal clamp. *Basidiospores* cylindrical to fusiform, 6–8 × 2.5–3 µm, thin-walled, smooth and amyloid.

Habitat. *A. chailletii* is a more common species registered mainly on fallen branches of fir.

Material examined. Belasitsa: Sredno Bilo, ass. *Abieti-Fagetum*, on *Abies borisii-regis*, 1500 m, 03.IV.1995, exs. (MCF 95/5625); Galichitsa: Volko Legalo, ass. *Abieti-Fagetum*, on *A. borisii-regis*, 1500 m, notes M. Karadelev; Korab: above Strezimir Watchtower, ass. *Abieti-Fagetum*, on *Abies alba*, 1500 m, 19.VII.2003, exs. (MCF 03/13854); Nichpur, ass. *Abieti-Fagetum*, on *A. alba*, 1400 m, VII. 1937, exs. (PRM); Kozhuf: Matushmitsa, ass. *Fago-Abietetum meridionale*, on *A. borisii-regis*, 950 m, VIII.1984, notes M. Karadelev; Ograzhden: ass. *Fago-Pinetum sylvestris*, on *Pinus sylvestris*, 800–1200 m, 01.V.1990, exs. (MCF 90/2151); Pelister: between Kopanki chalet and Palisnopje, ass. *Digitali viridiflorae-Pinetum peuces*, on *Abies* sp., 1540–1640 m, 11.V.2003, exs. (MCF 03/9481); around river Rotinska, ass. *Digitali viridiflorae-Pinetum peuces*, on *Pinus peuce*, 1500–1600 m, 11.VII.2001; exs. (MCF 01/431); and on *P. peuce*, exs. (MCF 01/438); Begova Cheshma, ass. *Digitali viridiflorae-Pinetum peuces*, on *P. peuce* and *Abies* sp., 1400 m, 20.IX.1983, exs. (CNF); Kopanki, *Digitalis viridiflorae-Pinetum peuces*, on *Abies* sp., 1700 m, 12.VII.1989, exs. (MCF 89/825) and ass. *Gentiano luteae-Pinetum peuces*, on *A. borisii-regis*, 1700–1800 m, 12.VII.1989; Palisnopje, ass. *Digitali viridiflorae-Pinetum peuces*, on *Abies* sp., 1600 m, 07.X.2000, exs. (MCF 00/4582); Shar Planina: Jelak, ass. *Abieti-Piceetum scardicum*, on *Abies* sp., 1700–1800 m, 16.X.2000, exs. (MCF 00/2729) and on *A. alba*, 04.VII.1993, exs. (MCF 93/4554); Leshnica, ass. *Fago-Abietetum meridionale*, on *A. alba*, 16.VII.2009, exs. (MCF 09/11026).

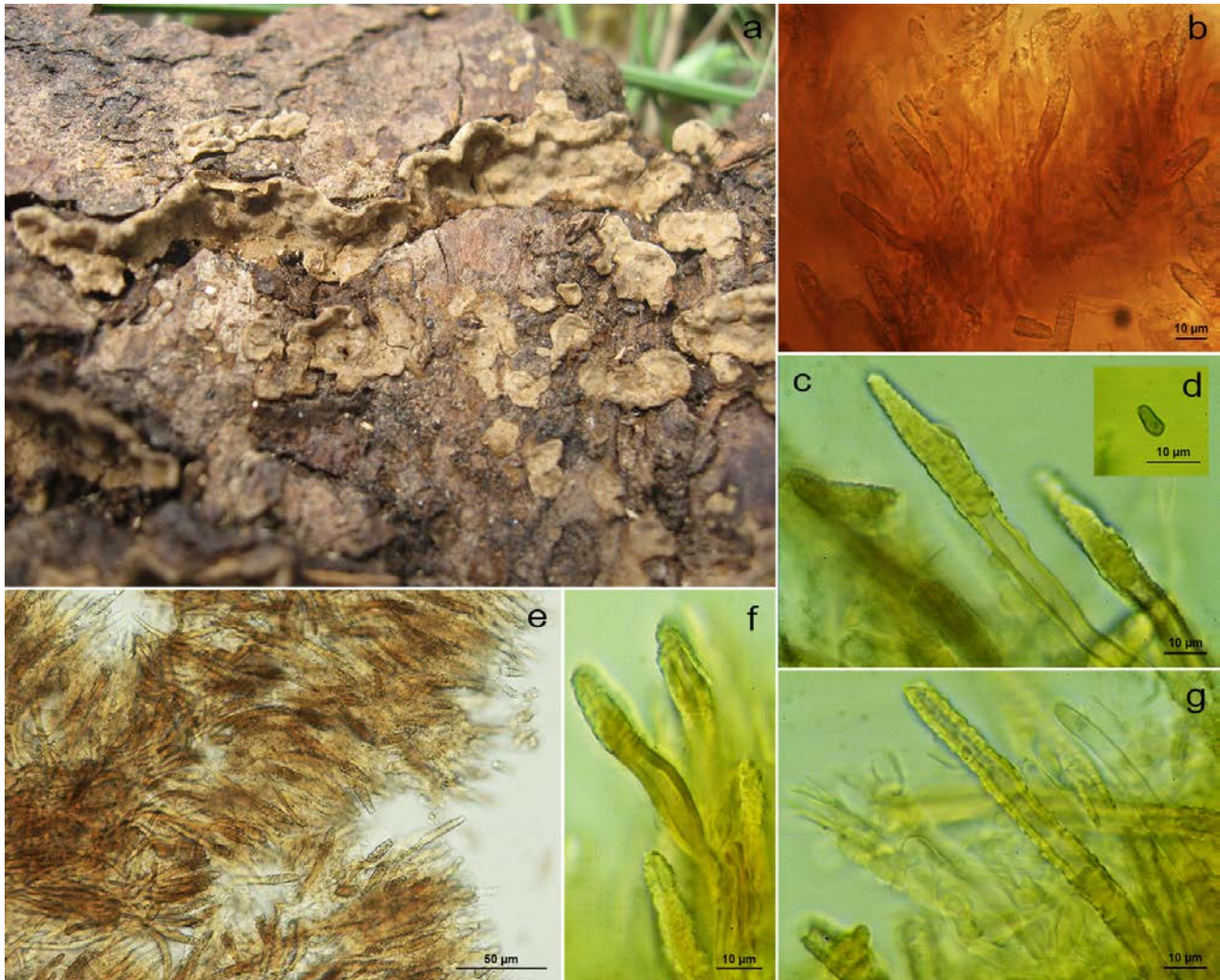


Fig. 3. a) Macroscopic view of basidiome of *Amylostereum chailletii*; b-g) Microscopical features of *A. chailletii*: b, e – section of basidiome, presence of numerous incrustated cystidia, c, f, g – incrustated cystidia and presence of basidia, d – basidiospore.

Remarks. *A. chailletii* grows mainly on dead wood, branches, stumps and logs, mainly on fir, and rarely on spruce and pine. Eriksson & Ryvar den (1973) reported that in North Europe this species follows the distribution of spruce. According to Eriksson & Ryvar den (1973), the hymenium in *A. areolatum* is darker than in *A. chailletii* and basidiome is usually thicker, about 2–3 mm. Cystidia of this species are more encrusted than in *A. areolatum*, where are rare and thin encrustation in the apical part (Bernicchia & Gorjón 2010). Our research has confirmed most of the published data on the macro- and microscopical characteristics of the species, except for the shape and size of spores, i.e. the shape of the spores is ovoid oblong, and the size of the spores is somewhat larger, as noted

by Boidin & Lanquetin (1984). According to the published data by Tortić (1988b), this species has been collected on the territory of Former Yugoslavia on different substrates: on fir and spruce (Slovenia, Bosnia and Herzegovina), on larch (Slovenia), on Macedonian pine and Bulgarian fir (Macedonia).

In Macedonia, it has been found on fallen trunks, rotten wood, logs, and fallen branches of fir and pine. It is known from seven localities, and the following are new for Macedonia: the mountains of Belasitsa, Ograzhden and Shar Planina. This species has been registered at 800–1800 m a.s.l. in different associations: *Abieti-Fagetum*, *Abieti-Piceetum scardicum*, *Digitali viridiflorae-Pinetum peuces*, *Fago-Abietetum meridionale*, *Fago-Pinetum sylvestris*, and *Gentiano luteae-Pinetum peuces*. It causes white rot on conifers.

Amylostereum laevigatum (Fr.) Boidin, Revue Mycol., Paris 23(3):345, 1958.

≡ *Thelephora laevigata* Fr., Elench. Fung. (Greifswald) 1:224, 1828. (Fig. 4)

References: Pilát & Lindtner (1938); Tortić (1988a) as *Peniophora laevigata* (Fr.) Bres.; Tortić (1988b); Karadelev (1993, 1994, 1995a, 1998, 1999c, 2000b, 2000c, 2000d, 2001); Karadelev & al. (2002, 2003b, 2018).

Collections: MCF, BEO, PRM.

Basidiome resupinate, effused, brownish, hymenial surface even. **Hyphal system** monomitic, hyphae with clamps, thin-to-thick-walled, 1.5–3 µm. **Cystidia** cylindrical, yellowish brown, with tapering apex, 40–60 × 7–8 µm, thick-walled and apically encrusted 15–25 µm, very numerous in hymenium and subiculum,

young cystidia thin-walled, not encrusted. **Basidia** clavate, 15–20 × 4–6 µm, thin-walled, with 4-sterigmata and with a basal clamp. **Basidiospores** cylindrical to fusiform, 7–12 × 3–4 µm, thin-walled, smooth and amyloid.

Habitat. *A. laevigatum* is known from several localities on different juniper species. It grows usually on dead fallen branches of juniper trees.

Material examined. Bistra: Lazaropole vill., path to Sokolica, beech forest, on *Juniperus communis*, 1350 m, 12.VIII.2012, exs. (MCF 12/13960); Tresonche vill. (above), oak forest, on *Juniperus oxycedrus*, 1100 m, 12.VII.2003, exs. (MCF 03/3422); Galichitsa: Stenje vill., oak forest, on *Juniperus excelsa*, 900–1000 m; oak forest, on *J. oxycedrus*, notes M. Karadelev; ass. *Juniperion excelsae-foetidissimae*,



Fig. 4. a) Macroscopic view of basidiome of *Amylostereum laevigatum*; b-g) Microscopical features of *A. laevigatum*: b, e – section of basidiome, presence of numerous encrusted cystidia, c, f, g – encrusted cystidia and presence of basidia with sterigmata and basal clamp, d – basidiospores.

on *Juniperus foetidissima*; Jablanitsa: Jankov Kamen (between Gorna Belica vill. and Vevchani vill.), beech forest, on *J. communis*, 1300 m, 11.VII.2006, exs. (MCF 06/5805); Kajmakchalan (Nidzhe Mountain): Suv Dol, mixed forest, on *J. communis*, 1550–1640 m, 17.VII.2002, exs. (MCF 02/5650); Karadzica (Mokra Planina): Jurudzhica, pine forest, on *J. communis*, 13.VII.2011, exs. MCF (11/13449); river Kadina, below Karadzica chalet, beech forest, on *J. communis*, 1270–1500 m, 25.VII.1997, notes M. Karadelev; Mumdzhica, beech forest, on *J. communis*, 1500 m, 24.VII.1997, exs. (MCF 97/4416); near Policiski Kukji, mountain pasture, on *J. communis*, 1445–1800 m, 27.VII.1997, exs. (MCF 97/4422); Shashkovića, alpine pasture, on *J. communis* ssp. *nana*, 1750 m, 27.VII.1997, exs. (MCF 97/4461); Kozhuf: Majdan vill., oak forest, on *J. communis*, 800 m, 22.IV.1998; Korab: Nichpur, alpine pasture, on *J. communis* ssp. *nana*, 1400 m, VII. 1937, exs. (PRM); Maleshevski Planini: artificial lake Ratevo, mixed beech and pine forest, on *J. communis*, 18.IX.2001, exs. (MCF 01/898); Shaban, near the dam, mixed beech and pine forest, on *J. communis*, 1000 m, 15.VII.2000, exs. (MCF 00/1587); Ograzhden: Ezovo Brdo, mixed beech and pine forest, on *J. communis*, 1100–1300 m, VII.2000; Pelister: Begova Cheshma, 1200 m, Molika pine forest, on *J. communis*, 02.V.2007, exs. (MCF 07/6824); Kazhani vill., oak forest, on *J. communis*, 1000 m, 19.IV.2002, exs. (MCF 02/2614); the way to Molika Hotel, pasture, on *J. communis*, 1100 m, 26.IV.2002, exs. (MCF 02/10296); Kopanki, mixed Molika pine and fir forest, on *J. communis*, exs. (MCF 02/3833); Shar Planina: Brodec vill., fir forest, on *J. communis*, 12.X.2012, exs. (MCF 12/14253); (MCF 12/14287); Jelovce vill., oak forest, on *J. oxycedrus*, 1000 m, 15.VII.1998, exs. (MCF 98/1692); Ljuboten, alpine pasture, on *J. communis* ssp. *nana*, 1500–1800 m, VII.1937, exs. (PRM, BEO); Popova Shapka, alpine pasture, on *J. communis* ssp. *nana*, 1800 m, 29.IX.1990, exs. (MCF 99/2246); Vrben vill. (above), fir forest, on *J. communis*, 1350 m, 13.V.2010, exs. (MCF 10/11908).

Remarks. *A. laevigatum* is a resupinate, corticioid species, which mainly grows on dry branches of living trees. It grows exclusively on juniper species, where it is common, especially on *Juniperus communis*. Among the *Amylostereum* species, it is characterized by the monomitic hyphal system and resupinate basidiome (Bernicchia & Gorjón 2010). It

is widespread and common in most parts of Scandinavia, but rare in Norway (Eriksson & Ryvar den 1973). However, it is not very common on *J. excelsa*, although it was found in most localities that were investigated (Karadelev 2000c). It also grows on *Taxus baccata*, but rarely. In Sweden, it was also identified on *Thuja occidentalis* (Eriksson, Hjortstam & Ryvar den 1981). Eriksson & Ryvar den (1973) stated that the form growing on *Taxus baccata* has larger spores than the one on *Juniperus*.

According to Tortić (1988b), the species has been registered on *Taxus baccata* from three localities in Former Yugoslavia (Serbia and Croatia); however, due to complete absence of spores, it was not possible to determine the spore size. The presence of *A. laevigatum* on *T. baccata* in the neighboring regions of Macedonia, especially in Serbia, is a good indication that further research of the species associated with *T. baccata* is required, in order to confirm or reject the presence of *A. laevigatum* on *T. baccata* in Macedonia, as well as to provide insight on its distribution and ecology in that country.

In Macedonia, it has been registered on different *Juniperus* species (*J. communis*, *J. excelsa*, *J. foetidissima*, *J. communis* ssp. *nana* and *J. oxycedrus*). For Macedonia, there are only five published data which refer to the following localities: Galichitsa, Kozhuf, Korab, Ograzhden and Shar Planina. The following localities are identified as recently discovered: Bistra, Jablanitsa, Kajmakchalan (Mt Nidzhe), Karadzica (Mokra Planina), Maleshevski Planini, and Pelister. It is a common and widely distributed species within the altitude range from 900 to 1800 m a.s.l., found exclusively in conifer associations.

Key to the species of genus *Amylostereum*

1. Basidiome effuse-reflexed, hyphal system dimitic, spores $6-8 \times 2.5-3 \mu\text{m}$, often on *Pinaceae*, rarely on deciduous wood 2
1. Basidiome resupinate to effuse-reflexed, hyphal system monomitic, spores $7-12 \times 3-4 \mu\text{m}$, on *Cupressaceae* and *Taxaceae* *A. laevigatum* (Fr.) Boidin
2. Basidiome usually less than 1 mm thick, cystidia more encrusted in the apical part *A. chailletii* (Pers.) Boidin
2. Basidiome usually thicker about 2–3 mm, cystidia rare and with thin encrustation in the apical part *A. areolatum* (Chaillet ex Fr.) Boidin

Acknowledgements. The first author would like to express her deep gratitude to her family for their unconditional support, especially to her mother and father. To her mother, for the sincere and moral support, inexhaustible energy, patience and love. This article was drafted in loving memory of the father of the first author, who always supported, encouraged and motivated her to keep up with the scientific work in the field of mycology. The authors are grateful to Boyan Manchev for precious linguistic corrections.

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