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Old-growth forest fungus *Antrodiella citrinella* – distribution and ecology in the Czech Republic

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Localities and records of *Antrodiella citrinella* (Basidiomycota, *Polyporales*) in the Czech Republic are summarised and the ecology of the species is evaluated. The 31 localities are mostly situated in mountain regions, the highest number of records coming from elevations of 1200–1299 m. Less frequently, *A. citrinella* is found in highland regions, growing either on slopes of hills or on steep slopes and bottoms of deep river or stream valleys. Most records are from montane and supramontane spruce forests and submontane to montane mixed forests dominated by beech, spruce and fir. The fungus also occurs in waterlogged spruce forests and ravine forests. Most of the localities are protected as nature reserves or strictly protected zones of national parks. *Picea abies* is a preferred substrate, followed by *Abies alba*, *Fagus sylvatica*, and basidiomata of *Fomitopsis pinicola*. Almost all records are from fallen trunks 10–100 cm in diameter, rarely stumps or pieces of wood. The wood decay stage is 2–5, its peak in stage 3. The main fructification period is autumn, mainly October and November, and spring from March to the first half of June with the maximum in May. Summer records are rare. A distribution map for the Czech Republic is published and data on occurrence in other European countries are compiled and discussed. The Czech distribution data are confronted with the GIS map layer of the Czech natural forests databank containing exact data on naturalness of forest stands. This analysis shows that *A. citrinella* clearly prefers virgin, natural and near-natural forest stands, i.e. old-growth forests, therefore it can be used as an indicator of this habitat.

Key words: macrofungi, polypore, habitats, substrates, phenology, indicator fungus, forest naturalness, Europe.

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V článku jsou shrnuty lokality a nálezy druhu *Antrodiella citrinella* (Basidiomycota, *Polyporales*) v České republice, na jejichž základě je vyhodnocena jeho ekologie. Lokalit je 31 a většinou leží v horských oblastech, kde je maximum nálezů v rozmezí 1200–1299 m n. m. Druh je méně často nalézán v pahorkatině a podhůří, kde roste buď na mírnějších svazích kopců nebo na prudkých svazích a dnech zařízlých údolí řek nebo potoků. Většina nálezů pochází z montánních a supramontánních smrčin a smíšených lesů submontánního a montánního stupně, tvořených hlavně bukem, smrkem a jedlí. Druh dále roste v podmáčených smrčinách a suťových lesích. Většina lokalit je chráněna jako rezervace nebo první zóny národních parků. Houba preferuje dřevo smrku, dále jedle, buku, a roste také na starých plodnicích troudnatce pásovaného. Téměř všechny nálezy jsou na padlých kmenech o průměru 10–100 cm, vzácně na pahýlech nebo kusech dřeva na zemi. Dřevo je ve stadiu tlení 2–5, nejčastěji 3. Hlavním obdobím fruktifikace je podzim, zejména říjen a listopad, a dále jaro od poloviny března do první poloviny června s maximem v květnu. Nálezy z léta jsou vzácné. Je publikována mapa rozšíření druhu v ČR a údaje o rozšíření v dalších částech Evropy jsou shrnuty a diskutovány. Data o rozšíření v ČR jsou porovnána s mapovou vrstvou databanky přirozených lesů ČR, která obsahuje přesné údaje o přirozenosti konkrétních lesních porostů. Tato analýza prokázala, že *A. citrinella* skutečně preferuje pralesy, přírodní a přírodě blízké lesy, tedy souhrnně přirozené lesy, a může být využita jako jejich indikátor.

INTRODUCTION

Antrodiella citrinella Niemelä & Ryvarden [≡ *Flaviporus citrinellus* (Niemelä & Ryvarden) Ginns], a rare resupinate to narrowly effused-reflexed polypore with remarkably lemon to bright yellow pores, was described 35 years ago (Niemelä & Ryvarden 1983), based on material from Norway (holotype), Finland, Poland and Croatia. Currently it is also known from France (Pieri et al. 2000), Switzerland (Senn-Irlet et al. 2016), Austria (Dämon & Krisai-Greilhuber 2017), Germany, Sweden (e.g. Ryvarden & Gilbertson 1993, Wieners et al. 2016, Anonymus 1 on-line, Anonymus 3 on-line), Estonia (Anonymus 2 on-line), Latvia (Brūmelis et al. 2017), Czech Republic, Slovakia (Vlasák 1990), Russia (e.g. Niemelä et al. 2001, Viner et al. 2016), and Macedonia (Karadelev & Rusevska 2016). In most countries the fungus is included in Red Lists as a threatened species. The species is reported to occur in natural forests dominated by or intermixed with Norway spruce (*Picea abies*) (Ryvarden & Melo 2014). Recently, a massive spread of this polypore was observed in the Bavarian Forest National Park after natural disturbance of spruce forests by windfall and bark beetles (Bässler & Müller 2010). In addition to spruce, the species is known from silver fir (*Abies alba*) and beech (*Fagus sylvatica*). There is also a record from *Pinus nigra* (Karadelev & Rusevska 2016). It grows moreover on *Pinus sylvestris*, *Betula* sp., and *Populus tremula*, all with dead basidiomata of *Fomitopsis*

pinicola on them (Junninen, pers. comm.; observations from European boreal forests). Indeed, *Antrodiella citrinella* usually grows close to basidiomata of *F. pinicola* or directly on them. In the wood decay process, *F. pinicola* seems to be a predecessor of *A. citrinella* (Niemelä & Ryvarden 1983, Dai & Niemelä 1997, Piątek 2001). Co-occurrence of both species on *Picea abies* logs in permanent plots in the Czech Republic was reported by Pouska et al. (2013). Holmer et al. (1997) considered *A. citrinella* a secondary wood decomposer, but Wieners et al. (2016) elaborated the older idea that *A. citrinella* could be a parasite of *F. pinicola*.

In the Czech Republic, *A. citrinella* was first collected by J. Kubička in Boubínský prales virgin forest, Šumava Mts. in 1972 (Vampola 2011). Further records from the Šumava Mts. were published by Vlasák (1990), Holec & Pouzar (1999), Papoušek (2004), Lepšová & Pouska (2014) and Holec et al. (2015b). In other Bohemian mountains, the species is known from the Žofínský prales virgin forest in Novohradské hory Mts. (see e.g. Beran 1996, Papoušek 2004, Vlasák 2015), Jizerské hory Mts. (Slavíček 2015) and Krkonoše Mts. (Tejklová 2016, 2017). In addition to typical records from montane mixed and spruce forests also localities in deep river or stream valleys at low altitude are known (Běťák 2015, Vlasák 2015, Dvořák & Běťák 2017). Some records were published by Brom (2009, 2017) from submontane forests. Numerous records from the Czech Republic, mostly from its eastern part (Moravia), were recently published by Dvořák & Běťák (2017). In the Red List of Czech fungi it is classified as endangered (Kotlaba et al. 2006).

Even if published data on *A. citrinella* from the Czech Republic are rather rich, they are fragmented and lack general conclusions. This paper is focused on synthesis of all available data, both published and unpublished, with the aims 1) to evaluate the habitat and substrate requirements of *A. citrinella* and naturalness of its localities in the Czech Republic, 2) to publish complete distribution data from the country.

MATERIAL AND METHODS

For the basic dataset of the distribution of *A. citrinella*, we only used records with more or less detailed information available, both published (see Introduction) and unpublished (herbarium specimens and recent collections obtained during work on various projects, mostly in virgin forests and nature reserves). These records most probably cover all currently known localities of *A. citrinella* in the Czech Republic. They were obtained in two ways: 1) during an extensive field survey of some localities, 2) during an intensive fungal monitoring of selected fallen trunks at selected localities [virgin forests of Boubínský prales and

Žofínský prales, nature reserves of Kohoutov, Praděd (part named Eustaška) and Mionší] or inventories of fungi in permanent study plots or segments of localities (Trojmezná massif, Žofínský prales, Velký Špičák, localities in Krkonoše Mts.). The latter method usually earned more records. Records from Boubínský and Žofínský virgin forests presented in brief by Vlasák (1990, 2015) were not used due to a lack of some habitat and substrate data and the richness of our data from these forests. Localities were distinguished separately if they represented local geomorphological units (e.g. mountains, valleys) or different habitats distant at least 1 km from each other. Geomorphological units are according to http://geoportal.cuzk.cz/Geoprohlizec/default.aspx?wmcid=9590. Habitats were distinguished according to the Czech habitat catalogue (Chytrý et al. 2010). The scale of decay stages is according to Renvall (1995) for conifers and Heilmann-Clausen (2001) for broadleaved trees. Acronyms of public herbaria are from Index Herbariorum (http://sweetgum.nybg.org/science/ih/).

To avoid overestimation of some parameters, we cumulated replicated records as described below. For analysis of basidiomata phenology, repeated records on the same trunk in the same month and year were counted as one. For substrate species analysis, repeated records on the same trunk were counted as a single record. On the other hand, for analysis of substrate details (trunk diameter, stage of wood decay at the point of basidiomata occurrence), all records at different microsites of the same trunk were evaluated separately.

We used the GIS map layer of the Czech natural forests databank (http://naturalforests.cz/czech-natural-forests-databank) to analyse the relationship of *A. citrinella* to the degree of naturalness of the forest stands. For methods of forest naturalness evaluation in the Czech Republic and explanation of the terms virgin/natural/near-natural forest, see Adam et al. (2011), Holec et al. (2015a) and Vrška et al. (2018).

Results

Antrodiella citrinella Niemelä & Ryvarden, Karstenia 23(1): 26 (1983) Fig. 1
≡ *Flaviporus citrinellus* (Niemelä & Ryvarden) Ginns, Mycotaxon 21: 326 (1984)

Distribution

Antrodiella citrinella is known from 31 localities in the Czech Republic (Tab. 1, Fig. 2). They are situated in most mountain regions of this country (Český les, Šumava, Novohradské hory, Jizerské hory, Krkonoše, Králický Sněžník, Hrubý Jeseník, Moravskoslezské Beskydy). Their altitudinal range is 745–1335 m a.s.l., the highest number of records at 1200–1299 m (Fig. 3). Two localities from typical

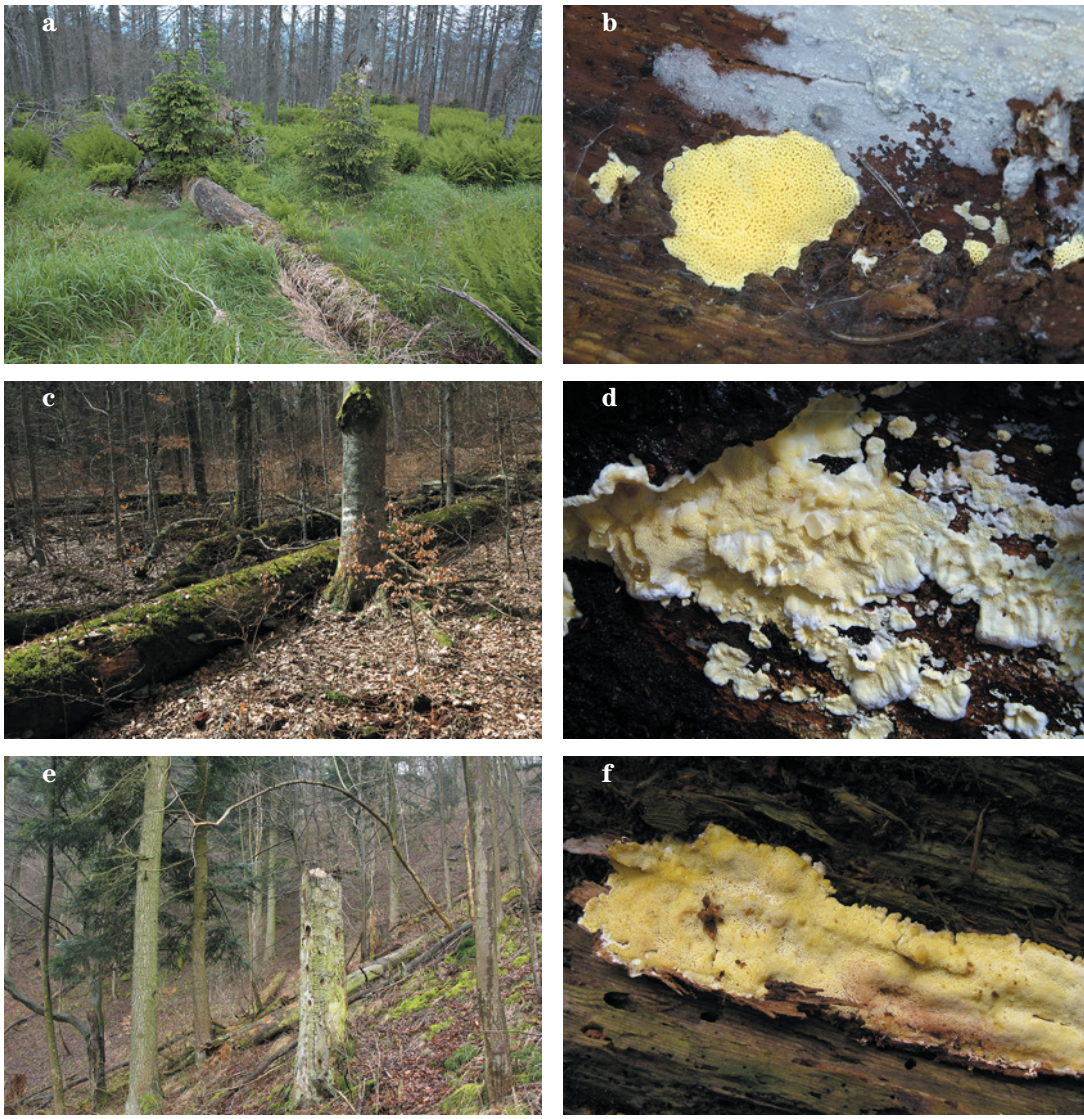

Fig. 1. *Antrodiella citrinella*, main habitats and basidiomata in situ. **a** – supramontane spruce forest (disturbed by bark beetles, now restoring), Trojmezná – 1st zone of Šumava National Park; **b** – Praděd National Nature Reserve, 30 May 2017 (priv. herb. L. Zíbarová 6788); **c** – virgin mixed forest composed of beech, spruce and fir, Boubínský prales National Nature Reserve; **d** – Boubínský prales National Nature Reserve, 9 October 2017 (PRM 946109); **e** – ravine forest at low altitude, U Doutné skály Nature Reserve; **f** – U Doutné skály Nature Reserve, 15 March 2015 (priv. herb. J. Běťák JB 15/01). Photographs by V. Pouska (a), L. Zíbarová (b), J. Holec (c, d), J. Běťák (e, f).

Tab. 1. Localities of *Antrodiella citrinella* in the Czech Republic. For details on all records, see Electronic supplement.
Abbreviations: n.g. – not given, NM – Nature Monument, NNR – National Nature Reserve (better preserved than Nature Reserve), NP: 1st zone – First (strictly protected) Zone of National Park, NR – Nature Reserve.

Locality	Protection	Nearest town or village	Geomorphological unit	Elevation (m)*	Habitat**	Dominant trees	Vegetation***	Naturalness****
Ostrůvek	NR	Lesná	Český les	745	mixed forest	*Fagus*, *Picea*	acidophilous beech forest	classified as non-natural
Čerchovské hvozdy	NNR	Capartice	Český les	950	mixed forest	n.g.	n.g.	classified as non-natural
Debrník: Medvědí jámy	NP: 1st zone	Železná Ruda	Šumava	800	mixed forest	*Fagus*, *Picea*, *Abies*	n.g.	near-natural
Ždanidla	NP: 1st zone	Prášily	Šumava	1210	mixed forest	*Fagus*, *Picea*, *Acer pseudoplatanus*	n.g.	near-natural
Prášilské jezero: Stará jímka	NP: 1st zone	Prášily	Šumava	1120	waterlogged spruce forest	*Picea*	*Mastigobryo-Piceetum*, *Sphagno-Piceetum*	natural
Křemelná river valley	NP: 1st zone	Srní	Šumava	715	spruce forest	*Picea*	n.g.	near-natural
Jilmová skála	NM	Lenora	Šumava	1000	ravine forest	*Acer*, *Ulmus*, *Fagus*, *Abies*	n.g.	near-natural
Boubínský prales	NNR	Lenora	Šumava	940–1065	mixed forest	*Fagus*, *Picea*, *Abies*	mostly *Dentario enneaphylli-Fagetum*	virgin
Mt. Vysoký hřeben	NP: 1st zone	Volary	Šumava	1265–1310	montane spruce forest	*Picea*	*Calamagrostio villosae-Piceetum*	natural
Mt. Trojmezná	NP: 1st zone	Volary	Šumava	1220–1335	montane spruce forest	*Picea*	*Calamagrostio villosae-Piceetum*	natural
Pod Trojmezím	not protected	Volary	Šumava	1150–1245	montane spruce forest	*Picea*	*Athyrio alpestris-Piceetum*	natural
Žofínský prales	NNR	Pohorská Ves	Novohradské hory	760–785	mixed forest	*Fagus*, *Picea*, *Abies*, *Acer pseudoplatanus*	mostly herb-rich beech forest	natural
Kohoutov	NNR	Ostrovec-Lhotka	Křivoklátská vrchovina	450	mixed forest	*Fagus*, *Picea*, *Betula*, *Tilia*	herb-rich beech forest	natural
Karvanice	NR	Hluboká n. Vltavou	Táborská vrchovina	390–415	ravine forest	*Fagus*, *Picea*	n.g.	near-natural
Libochovka	NR	Poněšice	Táborská vrchovina	400	mixed forest	*Fagus*, *Carpinus*, *Tilia*, *Picea*	n.g.	near-natural
V Klučí	NNR	Třešť	Křižanovská vrchovina	650	mixed forest	*Fagus*, *Picea*, *Abies*	*Dentario enneaphylli-Fagetum*	near-natural

Locality	Protection	Nearest town or village	Geomorphological unit	Elevation (m)*	Habitat**	Dominant trees	Vegetation***	Naturalness****
Velký Špičák	NNR	Třešť	Křižanovská vrchovina	660–700	mixed forest	*Fagus*, *Picea*, *Abies*	*Dentario enneaphylli-Fagetum*	near-natural
U doutné skály	NR	Bítov	Jevišovická pahorkatina	380	ravine forest	*Abies*, *Tilia*, *Carpinus*, *Picea*	n.g.	classified as non-natural
Rašeliniště Jizerky	NNR	Jizerka	Jizerské hory	870	spruce forest	*Picea*	bog spruce forest	near-natural
Labský důl	NP: 1st zone	Špindlerův Mlýn	Krkonoše	1030	montane spruce forest	*Picea*	*Athyrio-Piceetum*	classified as non-natural
Studniční hora: Modrý důl	NP: 1st zone	Pec pod Sněžkou	Krkonoše	1200	montane spruce forest	*Picea*	n.g.	natural
Zemská brána	NR	Klášterec n. Orlicí	Orlické hory	520	mixed forest	*Picea*, *Fagus*	n.g.	classified as non-natural
Kamenitý potok valley	not protected	Dolní Morava	Králický Sněžník	810	spruce/mixed forest	*Picea*	n.g.	classified as non-natural
Kozí hřbet ridge	not protected	Bělá	Hrubý Jeseník	740	spruce forest	*Picea*	production forest	classified as non-natural
Jelení bučina	NR	Ludvíkov	Hrubý Jeseník	840	mixed forest	*Fagus*, *Picea*	n.g.	near-natural
Praděd: Eustaška	NNR	Malá Morávka	Hrubý Jeseník	1230–1260	montane spruce forest	*Picea*	*Calamagrostio villosae-Piceetum*?	near-natural
Břidličná	NR	Vernířovice	Hrubý Jeseník	1120	montane spruce forest	*Picea*	*Calamagrostio villosae-Piceetum/Athyrio-Piceetum*	near-natural
Pod Jelení studánkou	NR	Malá Morávka	Hrubý Jeseník	1207	montane spruce forest	*Picea*	n.g.	near-natural
Rešovské vodopády	NNR	Rešov	Nízký Jeseník	485	spruce forest	*Picea*	n.g.	near-natural
Mazácký Grúnik	NR	Ostravice	Moravskoslezské Beskydy	± 700	mixed forest	*Fagus*, *Abies*, *Picea*	n.g.	natural
Mionší	NNR	Horní Lomná	Moravskoslezské Beskydy	820	mixed forest	*Fagus*, *Abies*	*Dentario enneaphylli-Fagetum*?	natural

* range of *A. citrinella* records at the locality
** prevailing habitat at the locality
*** given only when the collector of *A. citrinella* was certain of the identification, either using more general English terms according to Chytrý et al. (2010) or Latin names of exact vegetation units
**** according to the Czech natural forests databank (http://naturalforests.cz/czech-natural-forests-databank)

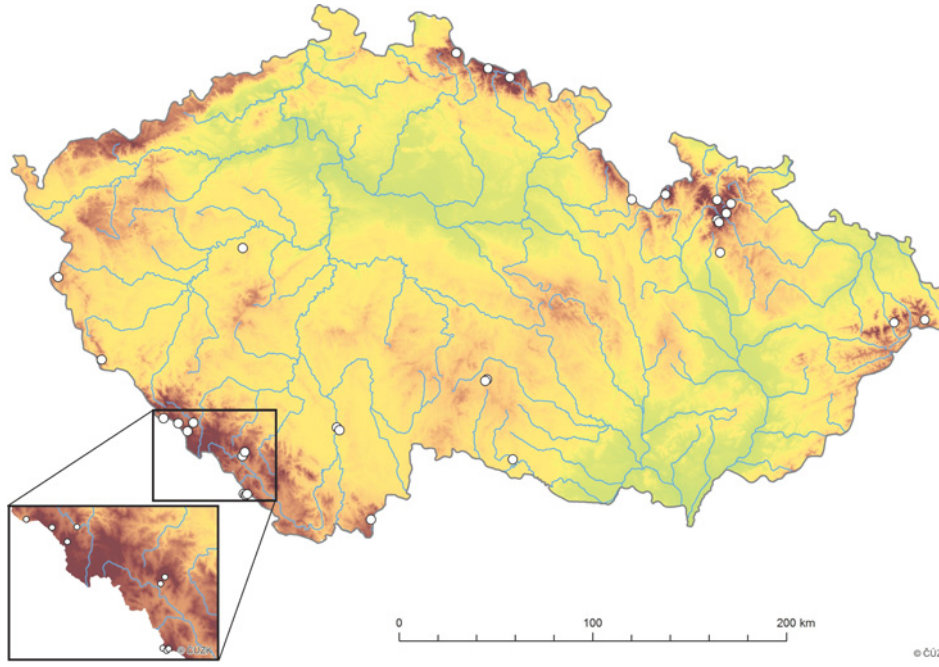

Fig. 2. Distribution of *Antrodiella citrinella* in the Czech Republic. Colours in the map indicate lowlands (green), highlands (yellow-brown), mountains (brown), and rivers (blue). At some localities more microlocalities were discovered (see Electronic supplement).

mountain regions (Šumava: Křemelná; Orlické hory: Zemská brána) are from deep river valleys (715 and 520 m a.s.l., respectively). Less frequently, *A. citrinella* is found in highland regions, growing on slopes of hills (Křižanovská vrchovina: 650–700 m a.s.l.; Kohoutov: 450 m) or on steep slopes and bottoms of deep river or stream valleys (Karvanice, Libochovka, U Doutné skály, Rešovské vodopády, and the already mentioned Zemská brána: 380–520 m a.s.l.).

At most localities, the basidiomata are rare (1–2 trunks), but there are also very rich localities, where basidiomata occur on many trunks (Boubínský prales, Trojmezná, Žofínský prales, Praděd: Eustaška). However, this is certainly connected with the intensive monitoring of these localities (see Material and methods). The other localities can also include more microlocalities, maybe not discovered during extensive surveys.

Habitats

Of the 62 records with an indicated habitat, a high number of records (25, i.e. 40%) are from more or less natural montane and supramontane spruce forests of the *Calamagrostio villosae-Piceetum* and *Athyrio alpestris-Piceetum* associations.

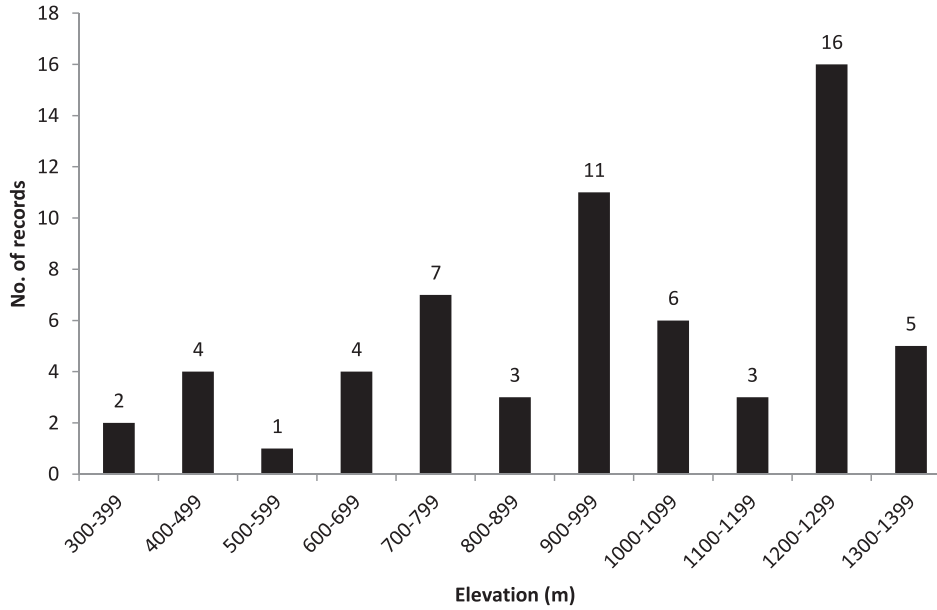

Fig. 3. Altitudinal distribution of *Antrodiella citrinella* in the Czech Republic.

The fungus also occurs in waterlogged spruce forests (5 records) of the *Sphagno-Piceetum* and *Bazzanio trilobatae-Piceetum* associations, and, exceptionally, in man-made or man-influenced spruce stands (2 records). There is also a high number of records (25) from submontane and montane mixed forests dominated by *Fagus*, *Abies* and *Picea*, representing various vegetation units of the *Fagion sylvaticae* alliance, mostly the *Dentario enneaphylli-Fagetum* association. The third main habitat (5 records) is represented by ravine forests (*Tilio-Acerion* alliance) of slopes, screes and ravines, where *A. citrinella* grows on steep slopes and bottoms, mostly in river and stream valleys. Such localities are located both in highlands and mountains (altitudinal range 380–1000 m).

Naturalness of localities

In most cases (24 out of 31, i.e. 77%), the localities of *A. citrinella* are situated in well-preserved forest habitats meeting the criteria of old-growth forests (Tab. 1). One locality (Boubínský prales) is situated in a virgin (i.e. original) forest, 9 localities can be classified as natural forests and 14 of them are near-natural forests. Although the remaining localities do not meet all criteria for natural forests, some of them should be re-evaluated due to the long time that has passed since the last assessment (nature reserves of U doutné skály and Ostrůvek). Others are situated in the close vicinity (0.4–4.8 km) of localities of old-growth

forests and/or in protected areas, therefore probably meeting at least some of the criteria of natural forests (e.g. Labský důl in Krkonoše Mts., Čerchovské hvozdy in Český les, Pod Trojmezím in Šumava Mts., Zemská brána in Orlické hory Mts., Kamenitý potok valley in Králický Sněžník Mts.). Only one record is from a forest considerably influenced by man (Kozí hřbet in Jeseníky Mts.).

Protection of localities

Most of the localities (28 out of 31, i.e. 90%) are protected as nature reserves or first (strictly protected) zones of national parks. Their land-use history as well as current conservation management vary from slight limitation to absolute exclusion of silvicultural interventions. Their common feature is that some (or the total) amount of dead wood is left at the site. The unprotected natural forest Pod Trojmezím in the Šumava Mts. is situated close to a protected and rich *A. citrinella* locality (Trojmezná) and is also rich in dead wood. The remaining unprotected localities are from the boundary between a man-made spruce stand and a near-natural mixed forest (valley of Kamenitý potok in Králický Sněžník Mts.), and from a man-made or man-influenced spruce stand (Kozí hřbet in Hrubý Jeseník Mts.).

It should be added that the spruce forests in the Trojmezná massif (localities Vysoký hřeben, Trojmezná and Pod Trojmezím) in the Šumava Mts. were earlier disturbed by wind and bark beetles, so that most of the canopy trees were dead by 2008. However, there is a new generation of juvenile trees under the dead ones, which were fortunately left at the site.

Substrate

Of the 71 records (see Electronic supplement) with reliably identified substrate, 61 (86%) are from wood of *Picea abies*, 5 from *Abies alba*, 2 from *Fagus sylvatica*, 2 from basidiomata of *Fomitopsis pinicola* growing on *Fagus*, and 1 from *F. pinicola* on *Picea*. Almost all records are from fallen trunks, either uprooted or broken, three of them on stumps and one on a piece of wood fallen off a trunk. The diameter of the trunks at the point of basidiomata occurrence varies from 10 to 100 cm, with a ± regular frequency of various thickness classes.

The wood decay stage at the point of basidiomata occurrence (including records on *F. pinicola*) is 2–5 with a peak in stage 3 (Fig. 4). Our data on the simultaneous presence/absence of *Fomitopsis pinicola* are incomplete and cannot be evaluated in detail. However, the presence of *F. pinicola* or its brown cubical rot was explicitly noted in about one third of the records. Observations in study plots in the Trojmezná massif showed that in 21 of a total of 24 records the two species were found together on the same piece of wood (trunks or their parts).

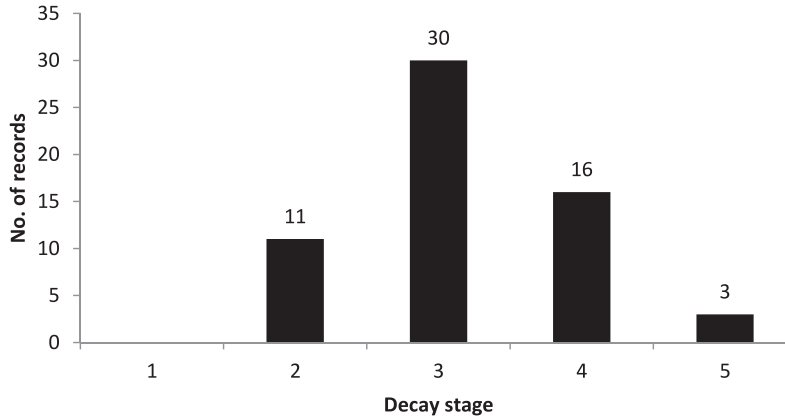

Fig. 4. Occurrence of *Antrodiella citrinella* basidiomata in relation to wood decay stages.

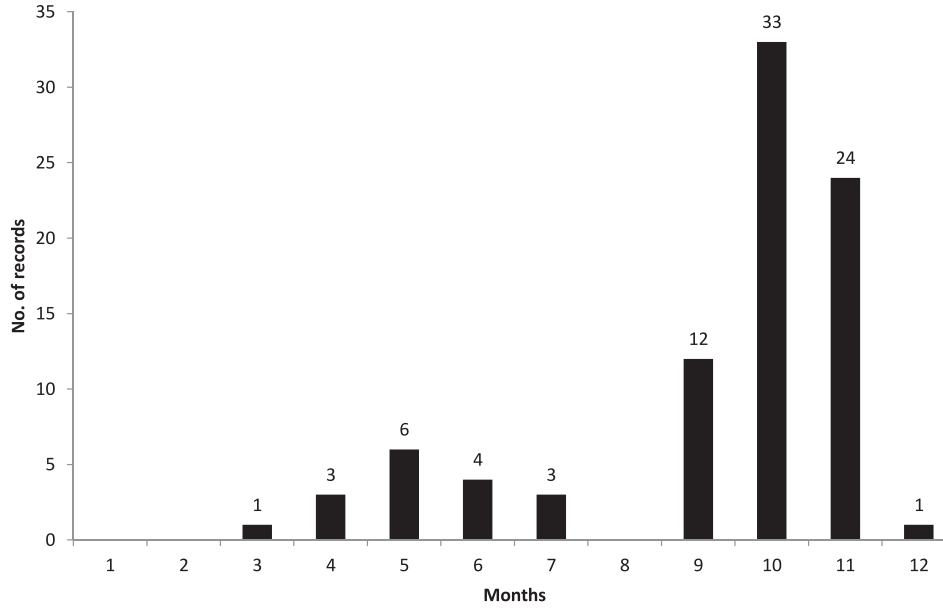

Fig. 5. Phenology of *Antrodiella citrinella* basidiomata production.

Phenology of basidiomata production

In total we have collected 87 records of *A. citrinella* in different months, some of them from the same trunk. The main fructification period in the Czech Republic (Fig. 5) is autumn (from September to 11th December, maximum in

October and November: 66% of records) and spring (from April to the first half of June, maximum in May). The four summer records (1 in late June, 3 in July) originate from montane regions (alt. 870–1065 m). No basidiomata were observed from the second half of December to the first half of March, but this is possibly related to the practical absence of field search in this period. We observed that basidiomata can persist over winter in some cases, but they are dead and difficult to identify in spring. The earliest record of fresh basidiomata is from March 15, from the locality with the lowest altitude (U Doutné skály: 380 m). In montane regions, fructification was observed as early as late April, just after the spring thaw (starting already below the snow cover?).

Discussion

The data collected here show that in the Czech Republic *Antrodiella citrinella* cannot be considered a very rare species but a fungus typical of old-growth forests, as 77% of its localities are classified as virgin, natural, or near-natural forest stands. In addition, most of the remaining localities are situated close to old-growth forests or should be re-classified as old-growth forests. There is only one record from a production stand. Our study is the first one where detailed distribution data of a fungus (coordinates of its records) are confronted with a GIS map layer containing exact data on naturalness of forest stands (see Material and methods).

In Central Europe, the Czech Republic probably hosts the highest number of localities of the species (compare e.g. Switzerland: Senn-Irlet et al. 2016; Germany: Bässler & Müller 2010, Wieners et al. 2016; Poland: Piątek 2001, Karasiński et al. 2009). The question is whether it was overlooked in the past, fructifies more intensively today, or is spreading recently (or if the last two factors are combined). Our data do not allow for answering this question exactly as most of our localities were not visited by mycologists before the year 2000 and so a comparison of time periods is impossible. However, some local data indicate that a recent spread or onset of fructification (maybe under changing environmental conditions) are possible. For example, J. Vlasák (pers. comm. 2018) observed the species in highland regions of southern Bohemia (around Hluboká nad Vltavou) as late as 2017 in spite of intensive search for polypores dated since the 1970s. Similarly, P. Vampola (pers. comm. 2018) did not find this species during a several year long mycological survey of the nature reserves of Velký Špičák and V Klučí (Bohemian-Moravian Highlands) in the early 1990s, although several finds are currently known from these localities (Brom 2009). We can only speculate that, for example, such a spread is enabled by spore dispersal from rich populations at localities like Boubínský prales, Trojmezná massif, Žofínský prales or Praděd,

where the species occurs on dozens of trunks, and, in the case of the first three localities, has occurred for decades. Changing interactions between various organisms on dead wood can also play a role, especially when a (still not experimentally proven) parasitic interaction (see e.g. Wieners et al. 2016) or successional relation with *Fomitopsis pinicola* (Niemelä & Ryvarden 1983, Dai & Niemelä 1997, Piątek 2001) is possible. Current forestry practices, in connection with bark beetle outbreaks, encourage a few species of polypores, of which *Fomitopsis pinicola* is one. Pouska et al. (2013) and Dvořák & Běťák (2017) observed frequent co-occurrence of *Camarops tubulina* and *Fomitopsis pinicola*. *Camarops tubulina* may have undergone a similar expansion in the Czech Republic as evidenced by its numerous recent localities (see e.g. Holec 2005) compared to the historical ones. However, we must admit that both *Antrodiella citrinella* and *Camarops tubulina* are easily overlooked in the field. Basidiomata of *Antrodiella citrinella* are usually small and often growing in hidden microhabitats, while stromata of *Camarops tubulina* are dark and irregular. It is well possible that these species have only recently gained more attention in the field.

Surprisingly, only one record of *A. citrinella* has been reported from Austria (Dämon & Krisai-Greilhuber 2017), a country neighbouring the Czech Republic and Switzerland, where records are more frequent (see above). On the other hand, a rather high number of localities is known from e.g. Estonia (Anonymus 2 on-line: 33 records).

We can also take into consideration the recent protection level of valuable forest stands where dead wood is left at the site in a higher amount than before. This increases the chance that new populations establish. It is encouraging to see that almost all montane regions of the Czech Republic host one or more populations of *A. citrinella* (Fig. 2). The localities in the stream or river valleys at elevations of 380–520 m can be considered as refugia for both Norway spruce and the fungus. Moreover, the occurrence of *A. citrinella* and/or other species preferring old-growth forests like *Fomitopsis rosea* and *Phellinus nigrolimitatus* may serve as supporting evidence for the natural extrazonal occurrence of Norway spruce at such sites (Kout & Vlasák 2009, Běťák 2015).

Comparable data from Switzerland (Senn-Irlet et al. 2016) show that the local habitat preferences of *A. citrinella* are rather different from those in the Czech Republic, where the species clearly prefers montane regions and old-growth forests dominated by or mixed with *Picea*, similarly to Germany (Bässler & Müller 2010, Wieners et al. 2016). In Switzerland, the fungus grows mainly at elevations below 600 m (foothills of the Alps) and there are no records above 1000 m. Most records are from *Fagus* or *Fagus-Abies* forests. Consequently, records on *Abies* are more frequent. However, these differences could be influenced by the limited Swiss dataset (13 records only), which may change in the future. On the other hand, the fructification pattern in both countries and also in Black Forest

National Park, Germany (Wieners et al. 2016) is very similar (early spring – July, September – December).

Karasiński et al. (2009) showed that all Polish records originate from primeval or natural and protected forests, mostly situated in national parks (Mt. Babia Góra, Góry Świętokrzyskie, Bieszczady Mts., Białowieża Forest). Almost all of our records document the same fact, which is also valid for German records from the Bavarian Forest (partly – there are also numerous records from formerly managed areas disturbed by bark beetle) and Black Forest National Park (Bässler & Müller 2010, Wieners et al. 2016). Slovak records known to us also originate from protected old-growth montane forests (at elevations of about 700–1320 m), either mixed (*Fagus*, *Abies*, *Picea*) or spruce stands: Badínsky virgin forest near Banská Bystrica, Poľana forest near Detva, Dobročský virgin forest near Čierny Balog, Latiborská hoľa in Nízke Tatry National Park, Stužica and Riaba Skala virgin forests in Poloniny National Park (Vlasák 1990, 2015), and Jánošíkova koľkáreň Nature Reserve in Veľká Fatra National Park, Pilsko massif in Horná Orava Protected Landscape Area, and Vajskovská dolina in Nízke Tatry National Park (authors' records, unpublished). Fennoscandian localities and the Croatian locality in Plitvička Jezera National Park are old-growth forests (Niemelä & Ryvarden 1983) as well. However, there is an exceptional record of *A. citrinella* from a man-made habitat, a *Pinus nigra* plantation in Macedonia (Karadelev & Rusevska 2016).

Based on data published here, especially the exact analysis of naturalness of localities, we agree with Wieners et al. (2016) that *A. citrinella* can be used as an indicator of old-growth forests.

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