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ORIGINAL RESEARCH PAPER

New locality of *Hymenochaete cruenta* in the Olbina nature reserve and revisiting of distribution of this fungus in Poland

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Abstract

Hymenochaete cruenta is a saprotrophic fungus, grown mainly on the bark of dead branches and trunks of *Abies* trees and thus the distribution of this fungus in Poland and other European countries is closely connected with natural range of silver fir. Despite its wide range, *H. cruenta* is considered as rare in the whole area of its occurrence. In this paper, we present a new locality of *H. cruenta*, discovered in May and September 2016 in the Olbina nature reserve (southern Wielkopolska Lowland, Kalisz Forest District). Ecological notes and macro- and microscopic feature of basidiocarps of this fungus are presented. Additionally, the current distribution of *H. cruenta* in Poland comprising 78 localities is provided. The rank of *H. cruenta* among threatened species categories in different European countries is discussed. It seems that the species is rare and threatened in Poland, and it should be still classified as “vulnerable” on the red list of macrofungi. The significance of *H. cruenta* for diversity of mycobiota and the necessity of further research on the dynamic of occurrence of *H. cruenta* inside and outside of the natural range of *A. alba* is underlined.

Keywords

Hymenochaetales; threatened macrofungi; ecology; *Abies alba*; silver fir; diagnostic features

Introduction

The widespread, but uncommon fungi of the genus *Hymenochaete* Lév. (Hymenochaetales, Basidiomycota) are represented worldwide by about 130 species. Most of them have been noted in tropical and subtropical regions, less frequently in the northern temperate areas. The species of this genus occur on dead wood, mostly of deciduous trees and shrubs, and less often on conifers. All species cause white fibrous or pocket rot [1–3].

Up to now, seven species of the genus *Hymenochaete* have been recorded in Poland: *H. carpatica* Pilát, *H. cinnamomea* (Pers.) Bres., *H. corrugate* (Fr.) Lév., *H. cruenta* (Pers.) Donk, *H. fuliginosa* (Pers) Bres, *H. rubiginosa* (Schrad.: Fr.) Lév., and *H. tabacina* (Sowerby) Lév [4]. Among them, *H. cruenta* is one of the rarest species in our country, but noted from various regions, e.g., from the Western Carpathians [5], the Lublin region [6], and the Świętokrzyskie Mts [7]. In Poland and other European countries, its distribution is associated with the natural range of silver fir (*Abies alba*).

The fungus *H. cruenta* is ranked as threatened and rare in Poland [8], the Czech Republic [9], Germany [10–14], and Switzerland [15].

The purpose of this paper is to present ecological notes and the current distribution of *H. cruenta* in Poland, supplemented with new locality of this species from the “Olbina” nature reserve, situated close to the northern border of natural occurrence of *A. alba*. Additionally macro- and microscopic features of basidiocarps of this fungus are presented.

Material and methods

Specimens of *H. cruenta* were collected in the Olbina Reserve in May and September 2016. The description of the basidiocarp morphology and ecological characteristics of this species are based on original material, accompanied by information from literature. The microscopic structure were observed and measured using Olympus BX53 light microscope (LM), supplied with an Olympus DP26 digital camera, and the scanning electron microscope Zeiss EVO LS10 (SEM). Spore, basidia, and setae sizes in the descriptions are based on 20–30 measurements. Size ranges of the microscopic features are given as follows: (minimum value–)first decile–ninth decile(–maximum value). SEM micrographs were taken in the Center for Molecular Biology and Biotechnology, Environmental Testing Laboratory, University of Szczecin (Poland). The specimens were identified by examining macroscopic and microscopic features, using monographs by Breitenbach and Kränzlin [16] and Bernicchia and Gorjón [17].

Distribution of *H. cruenta* in Poland is presented on the cartogram map according to the ATPOL grid square system as used by Wojewoda [18]. The cartogram map is based on our investigations and all available published and unpublished data. In order to illustrate the changes in the distribution of this species, we presented the localities in three different periods: before 1950, in years 1951–2002, and after 2002. The fungal nomenclature and its synonyms follows Index Fungorum database [19], and the names of vascular plants follows Mirek et al. [20]. The nomenclature of plant communities are given according to Matuszkiewicz [21]. The collected specimens of *H. cruenta* are deposited in the Herbarium of the Department of Botany and Nature Conservation, Szczecin University (SZUB), and in the Institute of Dendrology, Polish Academy of Sciences in Kórnik, (Poland).

Species description

Hymenochaete cruenta (Pers.) Donk, Persoonia 1(1): 51 (1959) – Hymenochaetaceae, Hymenochaetales, Agaricomycetes, Agaricomycotina, Basidiomycota, Fungi [1].

Syn.: *Corticium cruentum* (Pers.) J. Schröt., *Cytidia cruenta* (Pers.) Herter, *Hymenochaete mougeotii* (Fr.) Cooke, *Stereum mougeotii* (Fr.) Berk., *Thelephora cruenta* Pers., for other synonymies see Index Fungorum [19].

Basidiocarp annual, corticolous, resupinate to effuse-reflexed, adnate, coriaceous, soft when fresh, later hard and corky, with indistinct concentric zones, thick up to 0.5 mm; hymenophore smooth to slightly tuberculate, red to purple when fresh, later brown-red with a violet tint; margin brownish red (Fig. 1a–d); abhymenial surface brown. Hyphal system monomitic, hyphae simple septate, thin- to thick-walled (Fig. 2b), hyaline to yellowish brown. Setae subulate to fusiform, thick-walled, reddish brown (Fig. 1e and Fig. 2a,d), 50–80(–90) × 6–8(–10) μm. Cystidia absent. Dendrohyphidia hyaline, thin- to thick-walled, irregularly branched at the apex (Fig. 2c,d), 15–21 × 2.2–3 μm (according to Dai [22]). Basidia clavate, with four sterigmata, simple septate at the base, 20–25 × 4–5 μm (according to Bernicchia and Gorjón [17]). Basidiospores cylindrical, smooth, thick-walled, hyaline, slightly curved (Fig. 2c), (5–)6–8 × (1.4–)2–2.2 μm.

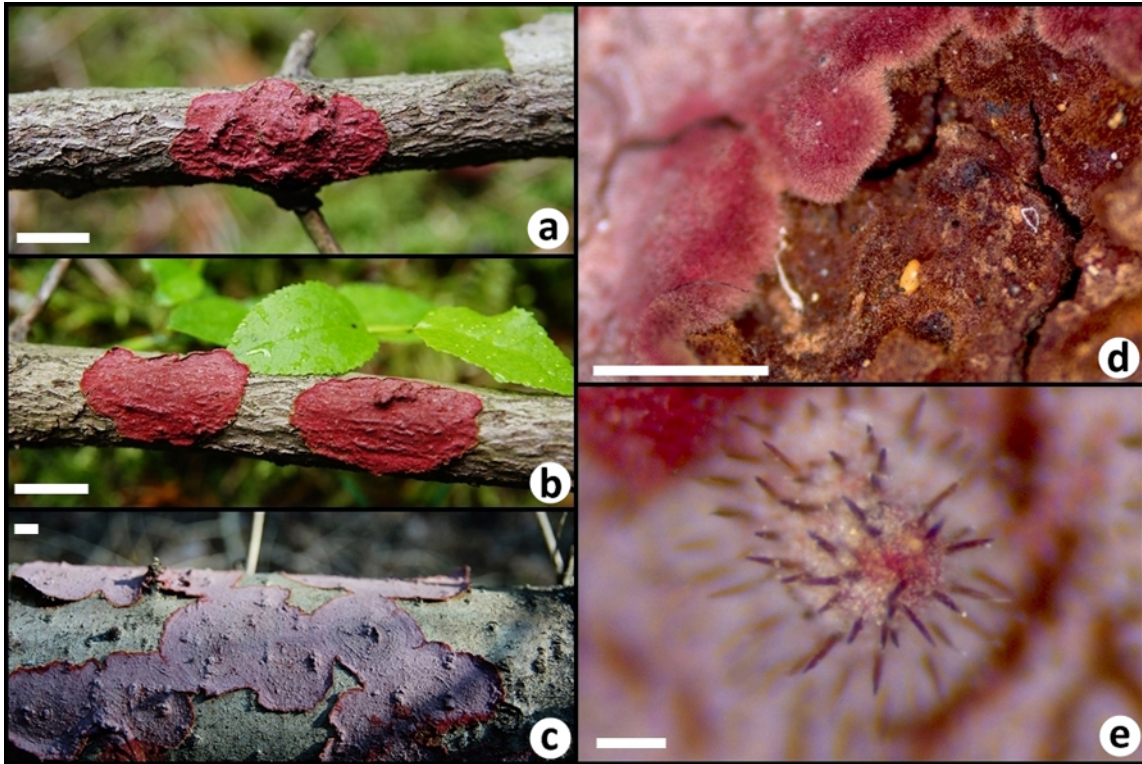


Fig. 1 Morphological features of *Hymenochaete cruenta* basidiocarps. **a–c** Plan view of basidiocarps growing on dead branches of *Abies alba*. **d** The edge of basidiocarps. **e** Setae on the surface of basidiocarp. Scale: **a–c** 1 cm; **d** 50 μ m; **e** 10 μ m. Photographs: T. Leski.

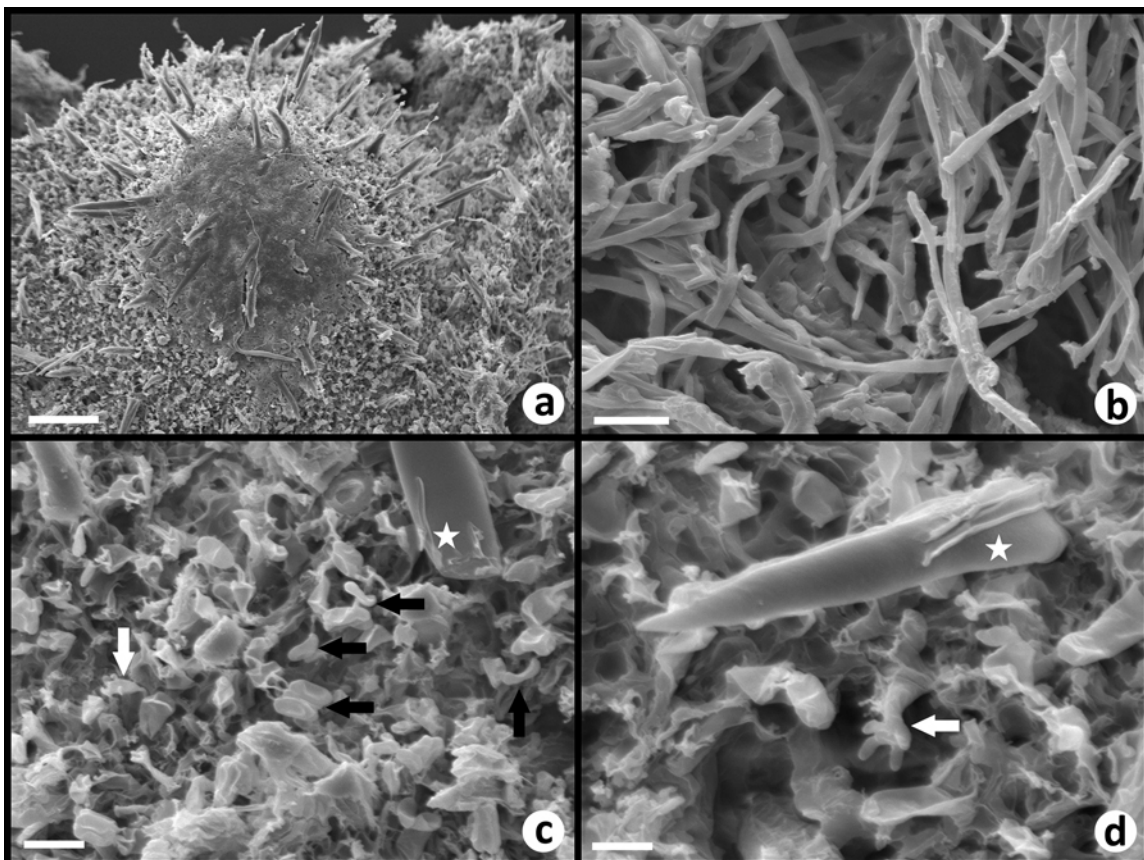


Fig. 2 Scanning electron micrographs of *Hymenochaete cruenta*. **a** Setae on the surface of basidiocarp. **b** Hyphae from subhymenium. **c,d** Different structures: white arrows – dendrohyphidium; black arrows – basidiospores; stars – setae. Scale: **a** 50 μ m; **b** 10 μ m; **c,d** 5 μ m. Photographs: M. Bihun and B. Bialecka.

Habitat and distribution

Hymenochaete cruenta is a saprotrophic fungus grows mostly on the bark of dead or dying branches and trunks of different tree species, mainly of the genus *Abies*, e.g., *A. alba*, *A. bolermuelleriana*, *A. holophylla*, *A. mayriana*, *A. nephrolepis*, *A. nordmanniana*, *A. sachalinensis*, and *A. sibirica* (e.g., [5,16,17,23,24]). Moreover, it has been reported from other coniferous trees: *Pinus* [25] and *Picea* (e.g., [26–28]), and angiosperm trees or shrubs, e.g., *Coriaria*, *Cyathodes*, *Dysoxylon*, *Hamamelis*, *Juglans*, *Neopanax*, *Quercus*, *Pittosporium*, *Pyrus*, and *Rhododendron* (e.g., [29–32]). According to Kotlaba [33], *H. cruenta* is an aeromycophyte fungus, usually growing on branches and stems in the crowns of old trees, often high above the ground in lowlands and uplands but mostly in the mountains (up to 1250 m a.s.l. in the Western Carpathians and up to 4100 m a.s.l. in the Laojun Mt).

Hymenochaete cruenta is a widespread fungus, known from Asia (China, Georgia, India, Japan, North Korea, Russia–Caucasus, and Turkey), South America (Argentina) and Europe (e.g., [23,24,32,34–36]). In Europe, where its distribution is associated with the natural range of *A. alba*, *H. cruenta* has been announced to occur in Austria [23,37], Bulgaria [17], Croatia [38], the Czech Republic [9,23], France [23,39], Germany [40–43], Great Britain [44], the Macedonia Republic [45], the Netherlands [25], Italy [17,46], Romania [47,48], Russia [23], Slovakia [49], Slovenia [50], Spain [51,52], Switzerland [16], and Ukraine [5]. In addition, it was reported from Australia and New Zealand [29,53,54].

In Poland, *H. cruenta* has been reported from various forests with *Abies alba*, e.g., *Abietetum polonicum* [55,56], *Abietetum polonicum* × *Dentario glandulosae*-*Fagetum* [55], *Abieti-Piceetum montanum* and *Bazzanio-Piceetum* [28], *Dentario enneaphylli-Fagetum* [5], *Dentario glandulosae-Fagetum* [5,55,57–60], *Quercus roboris-Pinetum* [5,57,61], *Quercus-Piceetum* [60], and *Tilio cordatae-Carpinetum betuli* [58,61]. In Croatia, this fungus was noted in *Abieti-Fagetum illyricum*, *Fagetum croaticum abietetosum*, and *Helleboro-Pinetum* [38,62]. In Poland, *H. cruenta* is rather rare species, recorded mainly in southern part of the country, e.g., in the Beskid Mts [63,64], on the Babia Góra Mt [28], in the Lublin region [6], the Gorce Mts [65], and the Świętokrzyskie Mts [7].

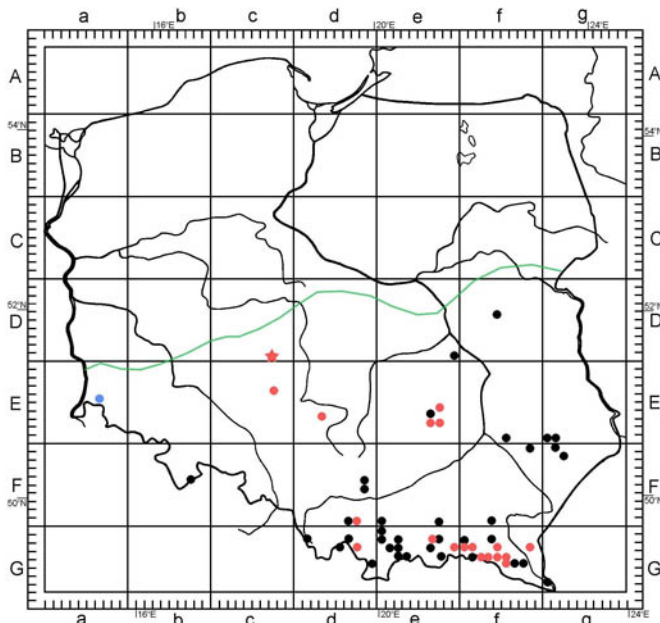


Fig. 3 Distribution of *Hymenochaete cruenta* in Poland. Blue point – locality before 1950; black points – localities reported between the years 1951–2002; red points – localities found after 2002; red star – new locality in the Olbina Reserve; green line – northern border of natural occurrence of *Abies alba* in Poland [80].

Localities in Poland

Until now, *H. cruenta* has been recorded in Poland at 78 localities. The oldest records come from the Sudetes (the Foothills Izerskie, near Lubań) from 1933 [33]. It is also the western-most stand in our country. In the years 1951–2002, this species was reported from 51 localities. A full list of localities and a distribution map are given by Wojewoda et al. [5]. After 2002, 26 new localities were found (Fig. 3).

A new locality of *H. cruenta* was discovered in the “Olbina” nature reserve (southern Wielkopolska Lowland: Kalisz Forest District, forest section No. 405, ATPOL grid square Cd-97; Fig. 3). The reserve was established in 1958, in order to “preserve a fir tree locality at its northern natural limit” [66]. According to Górski [67], the forest communities of this reserve belong to continental mixed forest *Festuco ovinae-Pinetum* (Juraszek 1928) Kobendza 1930, in variant with *A. alba*, and corresponding to Świętokrzyski-type fir forest. These phytocoenoses are composed by mature tree stands, predominated by *Pinus sylvestris* trees with a significant admixture of *A. alba* and *Picea abies*.

The specimens of *H. cruenta* in the Olbina Reserve were found for the first time in May 2016, in the middle-northern part of the reserve, in the community *Festuco ovinae-Pinetum*, and again in September 2016 in the southern part of reserve. On both places, basidiocarps of *H. cruenta* were observed on the bark of dead branches and trunks of *A. alba*, lying on the ground (Fig. 1a–c).

List of localities of *H. cruenta* in Poland¹

Cd-97 – Olbina res – Stasińska, Kujawska, Leski, Rudawska, Karliński 2016, SZUB and Institute of Dendrology, Polish Academy of Sciences in Kórnik, unpubl. **De-99** – Zagożdżon res [61]. **Df-44** – Jata res [61]. **Ea-46** – Izerskie Foothills: n Lubań [33]. **Ec-37** – (i) Koziołek [68]; (ii) Mieleszyn (1.3. km NE) – Zawada 2012, unpubl [69]. **Ed-63** – Broniszew Stary: Jodły Lemańskie – Kołodziejczyk 2013, unpubl [69]. **Ee-57** – n Starachowice – Kołodziejczyk 2010, unpubl [69]. **Ee-66** – (i) Czarny Las res [5]; (ii) Miejska Góra Mt (0.5 km SE of Podgórze) [5]. **Ee-76** – (i) Łysica Mt: Agata Mt (n Święta Katarzyna) [27]; (ii) Kakonin – Kołodziejczyk 2009, unpubl [69]; (iii) Świętokrzyski National Park: forest section No. 165h – Sobieraj, Łuszczynski 2009, KTCB 5451, unpubl. **Ee-77** – (i) Łysa Góra Mt (N slope) [5]; (ii) Łysa Góra Mt (Św. Krzyż Mt) [5]. **Ef-95** – (i) Imielty Ług res [56]; (ii) Łęka res [6]. **Eg-90** – n Panasówka [5]. **Eg-91** – (i) former Obroc res [55]; (ii) former Czerkies res [55]; (iii) Bukowa Góra Hill [27,55]. **Fb-47** – Wodospad Wilczki res in Międzygórze [5]. **Fd-48** – (i) bet Żłota Góra and Góra Zamkowa [57]; (ii) above Dolina Sąspowska [57]. **Fd-58** – (i) Ciasne Skalki (slope of Góra Chełmowa) [58]; (ii) Dolina Sąspowska n Jamki [58]; (iii) bet Wąwóz Pradła and Wąwóz Dziadkowiec [58]. **Fd-96** – Potrójna Mt [5]. **Fd-97** – Budzów – Czerniawski 2014, unpubl [69]. **Fe-90** – Łysina Mt [5]. **Fe-97** – Wąwóz Wodospad n Ciężkowice [5]. **Ff-08** – n Ciosmy [70]. **Ff-93** – Królewska Góra Mt [5]. **Fg-01** – Lasowe (1 km N) [5]. **Fg-12** – Czartowe Pole res [60]. **Gd-11** – Stożek Wielki Mt [5]. **Gd-16** – Knieja Czatożańska, below Czarna Hala [28]. **Gd-25** – Uszczawne Niżne Mt [5]. **Gd-27** – (i) Babia Góra Mt (S slope) [28]; (ii) Zubrzyca Górna (3.5 km W) [71]. **Gd-59** – (i) Grześkówki Mt [5]; (ii) Sarnia Skała (E slope of Grześkówki ridge) [5]; (iii) Sarnia Skała (Grześkówki slope) [5]. **Ge-00** – Lubogoszcz Mt [5]. **Ge-10** – Jaworzyna Ponicka Mt (NE slope) [5]. **Ge-12** – Cichoń Mt (Tokoń Mt) [5]. **Ge-16** – Cisy w Mogilnie res [72]. **Ge-17** – Maślana Góra Mt [59]. **Ge-21** – (i) n Polana Średnie [5]; (ii) Kudłoń Mt [65]. **Ge-22** – (i) Luboń Mt [27]; (ii) Runek Mt (N slope) [5]. **Ge-26** – Łabowiec res [73]. **Ge-29** – (i) Bartne [71]; (ii) Wołowiec (S Mareszka Mt) [71]. **Ge-32** – Flaki Mt [5]. **Ge-33** – (i) Pieniny Mts: below Białe Skały [74]; (ii) Pieniny Mts: below Sokolica Mt [5]. **Ge-37** – Mohnaczka Forest Inspectorate (bet Krynica and Tylicz) [75]. **Gf-10** – (i) Góra Magura Mt (N slope) [64]; (ii) n Jaworze – Hreczka 2015, unpubl [69]. **Gf-13** – Glorietta Mt n Iwonicz Zdrój [60]. **Gf-20** – Wołowiec (2 km SE) [71]. **Gf-21** – bet Mszana and Ropianka [76]. **Gf-24** – Ur. Wernejówka (2.5 km S of Puławy) [76]. **Gf-28** – Cisy w Serednicy res [77]. **Gf-31** – Góra Czerszla Mt [64]. **Gf-32** – Zyndranowa – Hreczka 2010, unpubl [69]. **Gf-33** – (i) Wola Niżna (3 km NE) [71]; (ii) n Wola Niżna [71]; (iii) n Jaśliska (S slope of Kamarka Mt) – Hreczka 2011, unpubl [69]. **Gf-34** – n Moszczaniec – Hreczka 2015, unpubl [69]. **Gf-35** – bet Wisłok Wielki and Czystogarb [71]. **Gf-45** – Komańcza [68]. **Gf-46** – Jawor Mt [78]. **Gf-47** – (i) n Baligród [63]; (ii) Żukra Stream valley [78]. **Gg-60** – Widelki Mt [63].

Discussion

Despite the fact that *H. cruenta* is a widespread fungus, mainly in Asia and Europe, our knowledge of geographical distribution and plants hosting this fungus is still incomplete. In terms of occurrence, *H. cruenta* is considered as very rare and rare

¹ bet – between; n – near; res – reserve; unpubl – unpublished; KTCB – Herbarium of Department of Botany, Jan Kochanowski University; SZUB – Herbarium of the University of Szczecin.

species, recorded in the mountains more frequently than in uplands or lowlands (e.g., [5,23,32,36]). According to Parmasto [23], *H. cruenta* grows especially on the bark of various species of the genus *Abies*, and its occurrence on *Picea* is doubtful. It has also been found on an angiosperm tree in Argentina [34] and on *Quercus leucotrichophora* in India [32]. Moreover, this species has been reported from some other angiosperm trees, like *Juglans*, *Neopanax*, *Pyrus*, and *Rhododendron*. According to Parmasto [23] and Dai and Niemelä [79] these findings rather belong to another species of *Hymenochaete*, i.e., *H. sphaericola*, characterized by similar basidiomata. *Hymenochaete sphaericola* differs from *H. cruenta* by longer setae and broader basidiospores, as well as by the hymenophore without a violet tint. These species have also different areas of distribution though they are partly overlapping in Asia (e.g., China, Japan, and Russian Far East) and Australia. Identification to the species level of some specimens of *Hymenochaete* is sometimes difficult because majority of specimens are sterile, or have deformed basidiospores and grows on wood, which are difficult to classify. Only on few specimens of *H. cruenta* found in the Olbina Reserve basidiospores were observed. It seems that this species can be more easily recognized in the field by its substrate preferences than by basidiospores characteristics.

The distribution of *H. cruenta* in Poland and other European countries is associated with the occurrence of *A. alba*. This is probably the main reason that *H. cruenta* is mostly reported from the southern part of our country, mainly from the mountains (Fig. 3), which are the most natural habitat for silver fir. The “Olbina” natural reserve, where the new locality of *H. cruenta* was discovered, is situated close to the northern border of natural occurrence of *A. alba* in Poland [80]. It is interesting that in Poland this European mountain tree species found also excellent conditions for growth and development 400 km north of its native range in the lowlands of Pomerania (northern Poland) [81]. However, despite extensive mycological surveys on this area, *H. cruenta* has not been found there until now. The reasons of absence of this species in Pomeranian fir forest remains an open question.

Another question is the rank of *H. cruenta* among threatened species categories. In some European countries, this fungus is regarded as an endangered and red-listed species. It has the status of “vulnerable” in Switzerland [15], “near threatened” – in the Czech Republic [9], and in Germany classified as threatened of varied threat categories in particular federal states [10–14]. In Poland, *H. cruenta* has been recognized as an endangered species not only on a regional scale but also countrywide. It is included on regional red lists of macrofungi in the Polish Carpathians (category “rare”, [82]) and the Świętokrzyskie Mts (category “rare” [83], category “near threatened” [7]). In the Polish red list of macrofungi it is placed into the category “vulnerable” [8]. It seems, based on the available published and unpublished data, that the species is rare and threatened in our country, and it should be still classified as “vulnerable” on the red list of macrofungi in Poland.

Hymenochaete cruenta is certainly an important element of diversity of mycobiota in Polish forests. In the context of recovery of growth of *A. alba* since the beginning of the 1980s after the decrease of SO₂ emissions and recent climate change, the dynamic of occurrence of *H. cruenta* inside and outside of the natural range of silver fir requires further research.

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