

# Buglossoporus Quercinus, a Rare Wood-inhabiting Fungus on Ancient Oak Trees in Poland: Ecology, Distribution and Extinction Risk Assessment

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Szczepkowski, A., Gierczyk, B. and Kujawa, A. 2019. *Buglossoporus Quercinus*, a Rare Wood-inhabiting Fungus on Ancient Oak Trees in Poland: Ecology, Distribution and Extinction Risk Assessment. *Baltic Forestry* 25(2): 178–186.

## Abstract

*Buglossoporus quercinus* is widely distributed across Europe, within the range of *Quercus robur*. Throughout the area in which it appears, it is rare or very rare. *B. quercinus* is associated with large old oaks (*Quercus*, usually *Q. robur*), whose numbers are decreasing due to ongoing changes in the environment. It was added to the Red Lists of fungi in a number of countries, along with awaiting inclusion in the IUCN Red List. In this study we have critically analysed the existing data about the occurrence of *B. quercinus* in Poland. We have presented two new localities of the species in Poland, as well as new records in the Białowieża National Park, the only place where this species had been previously recorded in Poland. Selected trees and logs inhabited by *B. quercinus* have been characterized. We have indicated the number of observed basidiomata, their phenology, and the sizes of the largest specimens. We have identified eight fungal species (*Bisporella citrina*, *Daedalea quercina*, *Hapalopilus croceus*, *Hymenochaete rubiginosa*, *Laetiporus sulphureus*, *Mycena galericulata*, *M. inclinata*, *Xylobolus frustulatus*) that coexist with *B. quercinus*. Based on the new distribution data for *B. quercinus* in Poland, according to IUCN Red List criteria this species should be classified as Endangered (EN) according to the IUCN Red List criteria.

**Keywords:** wood-decay fungi, rare species, fungi protection, Red List, Central Europe, oak

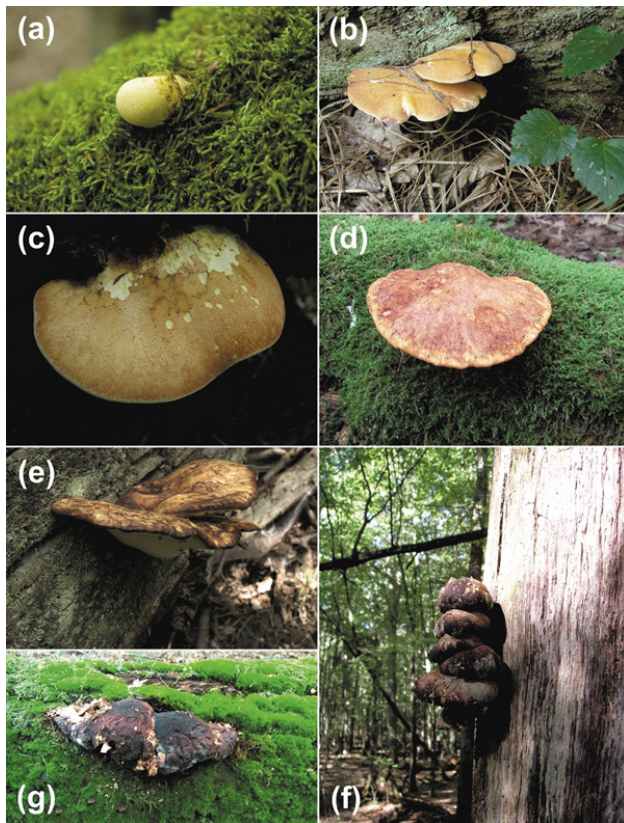
## Introduction

*Buglossoporus quercinus* (Schrad.) Kotl. & Pouzar (Kotlaba and Pouzar 1966) [synonym: *Buglossoporus pulvinus* (Pers.) Donk (Index Fungorum 2019)] has often referred to as *Piptoporus quercinus* (Schrad.) P. Karst, but its correct placement should be in *Buglossoporus* Kotl. et Pouzar, as shown by molecular data (Binder et al. 2013, Han et al. 2016). In MycoBank (2019) *Buglossoporus pulvinus* is listed as the current name (Robert et al. 2005). The first scientific description of the species appeared in *Spicilegium Florae Germanicae* published by Heinrich Adolph Schrader in 1794 (Schrader 1794). He named it *Boletus quercinus* Schrad. A few years later, Persoon (1799) described this taxon under the name *Boletus pulvinus* Pers. The epithet “quercinus” has been published earlier than “pulvinus”, so it should have priority and it is valid. *B. quercinus* lives exclusively on oaks. It usually forms basidiomata on mature trees older

than 250 years. In stable populations, this species can also grow on younger trees (Crockatt 2008). It has been recorded on: *Quercus robur*, *Q. petraea* and *Q. cerris* (Kotlaba 1984). It causes brown rot on heartwood in living and dead trees; after the death of a tree, it lives saprotrophically on logs and timber, occasionally even on structural beams in mines (Pilát 1936-1942, Tortić and Jelić 1969).

This species is known to be a sporadic fruiter, sometimes with long gaps between fruiting periods. Its basidiomata are annual, pileate, applanate to slightly convex, dimidiate or broadly tongue-shaped with a base that forms a short stripe, medium or large in size (they usually reach 15 cm in length and width, 1-5 cm thick), upper surface velutinous at first later glabrous and smooth, initially off-white or ochre-yellow but later turning reddish to brown; context fleshy and soft when fresh, hard but friable when dry, white, slightly greyish-rose to light brown; with a porous hymenophore that is always light-

er in colour than the surface of the cap and that darkens in damaged areas (Figure 1a-g) (Domański et al. 1967, 1973, Ryvarden and Gilbertson 1994, Bernicchia 2005, Overall 2010, Ryvarden and Melo 2014).



**Figure 1.** Basidiomata of *Buglossoporus quercinus* at various stages of development

*B. quercinus* is widespread in the Northern Hemisphere; it occurs in North America, Asia and Europe. In Europe, it has been recorded in Austria, Croatia, the Czech Republic, Denmark, France, Germany, Hungary, Lithuania, Norway, Poland, Portugal, the Russian Federation, Slovakia, Spain, Sweden and the United Kingdom (Kotlaba 1984, Ryvarden and Gilbertson 1994, Sunhede and Vasiliauskas 1996, 2003, Calonge et al. 2003, Tkalčec et al. 2008, Gorjón and Bernicchia 2013, Anonymous 2019).

*B. quercinus* is very rare in the entire range of its occurrence. According to the Global Fungal Red List Initiative (Anonymous 2019), it has the preliminary extinction risk category of Vulnerable – VU C2a (i) and is a species awaiting inclusion in the IUCN Red List. It is included in the red lists of a few countries, among them Austria: Critically Endangered (CR) – in a particularly and extremely critical state (Dämon and Krisai-Greilhuber 2017); England: Vulnerable (VU) D1 – high risk of

unnatural (human-caused) extinction without further human intervention (Smith et al. 2016); Slovakia: Endangered (EN) – very high risk of extinction in the wild (Lizoń 2001); Norway: EN C2a(i) (Brandrud et al. 2010); Sweden: EN C2a(i) (Westling 2015); the Czech Republic: VU (Holec and Beran 2006); Germany: CR (Dämmrich et al. 2016); and Croatia: EN (Tkalčec et al. 2008).

In Poland, *B. quercinus* has been a strictly protected species since 2014 (Anonymous 2014). Since 1986, it had been included in successive editions of the red list of fungi under the category Endangered (E) (Wojewoda and Ławrynowicz 1986, 1992, 2006).

The first data about the occurrence of *B. quercinus* in Poland were presented by Domański (1967) and Domański et al. (1967, 1973) from the Białowieża National Park (BPN). However, none of these studies indicated its exact locations. Two other locations of *B. quercinus* outside of the BPN were reported by Wojewoda (2003) in the Checklist of Polish Larger Basidiomycetes, where he referred to the study of Domański (1997): The Świętokrzyskie Mountains and Łazy (near Wyszaków) in the Łochowskie Forests in Mazovia. During the inventorying of fungi carried out in connection with preparation of the BPN Protection Plan in the years 2009-2010, occurrences of *B. quercinus* were recorded in 18 sites localized in 14 sub-compartments of 12 compartments of the BPN (256A, 257Dk, 314Af, 315Aa, 315Bg, 316Bf, 318Dh, 346D, 369Ah, 373Da, 373Db, 374C, 374Cf, 374Df, 374Dh, 375B, 375Bc, 402Aa) (Karasiński et al. 2010). These data were partially repeated in the study of Karasiński and Wołkowycki (2015).

The aim of this work is to: (i) present current data on the occurrence and distribution of *B. quercinus* in Poland; (ii) describe the ecological preferences of this species based on the data from Poland; and (iii) define the extinction risk of this species in Poland.

## Materials and Methods

Our data were collected in the years 2009-2018. The specimens collected were identified by standard methods used in fungal taxonomy, i.e. determination of micro- and macrocharacters using a binocular or optical microscopy. Standard staining techniques, including 10% KOH in water, Congo Red in ammonia and Melzer's reagent, were used. Specimens were identified using the following keys: Bernicchia (2005), Knudsen and Vesterholt (2012), and Ryvarden and Melo (2014). The collected specimens were deposited in the Fungarium of the Division of Mycology and Forest Phytopathology of the Warsaw University of Life Sciences – SGGW (WAML). The names of fungi are cited according to Robert et al. (2005). The names of macroregions were given according to Solon et al. (2018), forest division

into compartments according to Forest Data Bank (Anonymous 2018), and plant names according to Mirek et al. (2002). The length and diameter of logs and fallen trees were measured with tape. The diameters of the trunks of growing trees were measured at the height of 1.3 m, and the diameters of the fallen trees and logs were measured at their thicker end. Assessment of the state of threat *B. quercinus* in Poland was carried out based on the IUCN criteria (Anonymous 2016) and recommendations of Dahlberg and Mueller (2011).

## Results

### Localities in Poland

Two new sites of *B. quercinus* were identified in recent years in nature reserves located in the northwestern and northeastern parts of the country. Currently, this species is known in three macro-regions of Poland (Szczecin Coastland, Masurian Lakeland, and Northern Podlasie Plain) and in three provinces (*pol.* województwo) (West Pomerania, Warmia-Masuria, and Podlasie) (Figure 2, Table 1). We identified three new localities of *B. quercinus* within the BPN, in three sub-compartments of the Park (344 A/B, 318 C, 373 C), where it had not been found before. We also found new specimens of oak trees and logs inhabited by *B. quercinus* in compartments where it already had been recorded by Karasiński et al. (2010) and Karasiński and Wołkowycki (2015) e.g. in compartments: 314, 346, 374 C.

### New localities

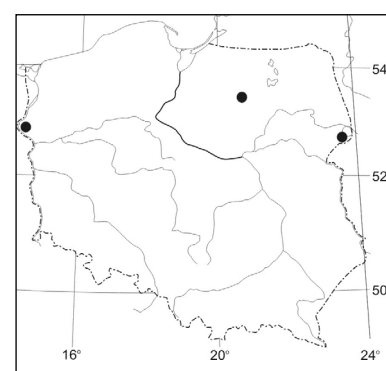
- Szczecin Coastland, Bielinek at the Oder nature reserve (Cedynia municipality, Gryfino county, West Pomerania Province), forest compartment 39 p, thermophilous oak forest (*Quercetum pubescenti-petraeae*) with *Quercus pubescens*, *Q. robur*, *Q. petraea*, *Acer campestre*, *Crataegus monogyna*, *Pyrus pyraster*, *Rhamnus cathartica*, *Sorbus torminalis*, *Ulmus minor*, on the trunk of an overturned *Quercus* sp. resting across a forest road, three basidiomata in the company of *Daedalea quercina* (L.) Pers., 17 Aug 2016, 19 July 2017, *leg./det.* B. Gierczyk; on a broken trunk of *Quercus* sp. resting on a slope, three basidiomata in the company of *Xylobolus frustulatus* (Pers.) Boidin, 19 July 2017, *leg./det.* B. Gierczyk; forest compartment 39 g, at the base of the trunk of a dead *Quercus* sp., on a steep slope, four basidiomata, 27 July 2017, *leg./det.* G. Domian (Table 1).

- Masurian Lakeland, Koniuszanka II nature reserve (Nidzica municipality, Nidzica county, Warmia-Masuria Province), forest compartment 190 or 189, in the vicinity of an educational trail, in oak-hornbeam forest (*Tilio-Carpinetum*) with *Quercus robur*, *Carpinus betulus*, *Betula pendula*, *Pinus sylvestris* and *Picea abies*, on a very thick and decomposed log of *Quercus* sp., three

basidiomata, 28 June 2013, *leg./det.* A. Szczepkowski (Table 1).

- Northern Podlasie Plain, Białowieża National Park (Białowieża municipality, Hajnówka county, Podlaska Province), forest compartment 344 A/B, in oak-hornbeam forest (*Tilio-Carpinetum*) with *Quercus robur*, *Carpinus betulus*, *Tilia cordata* and *Picea abies*, on an overturned trunk of *Q. robur*, three basidiomata, 8 June 2010, *leg.* J. Ostapski, A. Szczepkowski, *det.* A. Szczepkowski, WAML 699; forest compartment 318 C, on the bough of an overturned *Q. robur*, one basidioma, 8 June 2010, *leg./det.* A. Szczepkowski, WAML 700; forest compartment 373 C, on an overturned trunk of *Q. robur*, a few basidiomata, 1 July 2015, *leg./det.* B. Gierczyk (Table 1).

**Figure 2.** Distribution of *Buglossoporus quercinus* in Poland (black circles – new locations, white circles – locations known from the literature, from left: Bielinek on the Oder nature reserve, Koniuszanka II nature reserve, Białowieża National Park (BPN)



### Characteristics of trees inhabited by *B. quercinus*

Basidiomata of *B. quercinus* were found on the trunks of two standing dead oak trees, on 11 trunks and one bough of overturned trees and on one fragment of a log. The diameter of the trunks and logs ranged from 0.3 to 1.3 m. The height of the standing trees and length of resting logs ranged from 1.2 and 25.0 m (Table 1).

### Characteristics and phenology of basidiomata

Basidiomata of *B. quercinus* were found in the localities identified by the authors in June (3 records), July (8 records), August (1 record) and September (3 records). The earliest date when basidiomata were found, was the 8th June in 2010 in the BPN, and the latest was the 14th-15th September in 2016, 2017 and 2018, also in the BPN. The basidiomata found in June were very young and in the process of growth (Figure 1a), while those found in September were mature, with some partially decomposing (Figure 1f, g). With the exception of one locality in the BPN where we only found one basidioma, in most cases there were a few basidiomata, usually 3-4, on each tree or log (Table 1). The maximum number of basidiomata found on one trunk of overturned oaks in the BPN was 15. The sizes of the largest basidiomata were 17.0 × 23.0 × 5.0 cm and 14.0 × 21.0 × 5.0 cm. (Table 1). Basidi-

**Table 1.** Characteristics of selected oak trees inhabited by *Buglossoporus quercinus* in Poland

Location	Forest compartment <sup>1</sup>	Trunk/log dimensions: Length [m] × diameter [m];	Number of basidiomata (and dimensions of the largest one)	Coexisting species of fungi	Date (y-m-d)	Source of data
Koniuszanka II nature reserve	189 or 190	TO – 10 × 1.3	3	–	2013.06.28	This study
Bielinek on the Oder nature reserve	39p	TO – 12 × 0.8-0.9	3 (15 × 20 × 4 cm, 13 × 18 × 4 cm)	<i>Daedalea quercina</i>	2016.08.17 2017.07.19	This study
	39p	L – 10 × 0.5	3 (concrecence, 20-23 × 25-27 × 5 cm)	<i>Xylobolus frustulatus</i>	2017.07.19	This study
	39g	T – 9 × 0.5-0.6	4 (concrecence, 12-23 × 15-25 × 4-5 cm)	–	2017.07.27	This study
BPN	344 A/B	TO – 20 × 0.6	3	<i>Hapalopilus croceus</i>	2010.06.08	This study
BPN	318C	BO – 23 × 0.8	1	–	2010.06.08	This study
BPN	373C	TO	Several	–	2015.07.01	This study
BPN	256A	TO – 12 × 0.75	15 (17.0 × 23.0 × 5.0 cm)	–	2009.07.29	Karasiński et al. 2010 <sup>2</sup>
BPN	346D	L – 1.2 × 0.7	2	<i>Hymenochaete rubiginosa</i>	2009.07.27	Karasiński et al. 2010 <sup>2</sup>
BPN	374C	TO – 14 × 0.3	5 3	<i>H. rubiginosa</i> ,	2009.07.31	Karasiński et al. 2010 <sup>2</sup>
				<i>Mycena inclinata</i>	2017.09.15	and this study
BPN	374C	TO – 20 × 0.45	11 (14.0 × 21.0 × 5.0 cm)	<i>H. rubiginosa</i>	2009.07.28	Karasiński et al. 2010 <sup>2</sup>
				–	–	Karasiński and Wołkowycy 2015 <sup>2</sup>
BPN	374C	TO – 23 × 1.25	4	–	2009.07.28	Karasiński et al. 2010 <sup>2</sup>
BPN	374C	T – 10.0 × 0.4	7	<i>M. inclinata</i>	2016.09.15	This study
				<i>Laetiporus sulphureus</i>	2018.09.14	This study
BPN	374C	TO – 25 × 40	3	<i>H. rubiginosa</i>	–	–
				<i>M. inclinata</i>	–	–
BPN	375B	TO – 15 × 0.8	2	<i>M. galericulata</i>	–	–
				<i>Bisporella citrina</i>	–	–
BPN	375B	TO – 15 × 0.8	2	<i>Hapalopilus croceus</i>	2009.07.27	Karasiński et al. 2010 <sup>2</sup>
BPN	375B	TO – 15 × 0.8	2	<i>Hapalopilus croceus</i>	2009.07.27	Karasiński and Wołkowycy 2015 <sup>2</sup>

Note: BPN – Białowieża National Park, L – log, T – trunk of a dead tree, TO – trunk of overturned tree, BO – bough of overturned tree,

<sup>1</sup> – The numbers of forest compartments were given according Forest Data Bank (Anonymous 2018),

<sup>2</sup> – Only the localities - without detailed data - were given by the cited authors (Karaśński et al. 2010, Karasiński and Wołkowycy 2015)

omata were growing at a height of 1.5-3.5 m above ground on the barkless trunk of the *Quercus* found in section 374 C (Figure 1f).

#### Other fungal species growing on trees inhabited by *B. quercinus*

We confirm the coexistence of eight other species of fungi growing on the examined trees inhabited by *B. quercinus*: *Bisporella citrina* (Batsch) Korf & S.E. Carp., *Daedalea quercina*, *Hapalopilus croceus* (Pers.) Bondartsev & Singer, *Hymenochaete rubiginosa* (Dicks.) Lév., *Laetiporus sulphureus* (Bull.) Murrill, *Mycena galericulata* (Scop.) Gray, *M. inclinata* (Fr.) Quél., and *Xylobolus frustulatus*. The species found most often (3 times) as coexisting with *B. quercinus* was *Hymenochaete rubiginosa*, while *Hapalopilus croceus* and *M. inclinata* were found twice each, and *B. citrina*, *D. quercina*, *L.*

*sulphureus*, *M. galericulata* and *X. frustulatus* were each recorded once (Table 1).

#### Assessment of the state of threat to *B. quercinus* in Poland

Taking into account the recommendations of Dahlberg and Mueller (2011), we have determined that:

1. In recent years, we have not observed a decrease in the size of the population of *B. quercinus* (criterion A).

2. The available data do not indicate a potential decrease in the size of the population of this species in the future (criterion A).

3. The range of *B. quercinus* in Poland (criterion B) can be approximated by drawing a triangle between Białowieża, the Koniuszanka II nature reserve and the Bielinek nature reserve (the three known locations), of around 35.000 km<sup>2</sup>. On the other hand, the areas in which

it occurs total ca. 500 km<sup>2</sup> [5 ATPOL squares of 10 × 10 km – basic fungi mapping unit in Poland – Wojewoda (2000)]. Despite the clearly island-like character of the occurrence of *B. quercinus*, we do not foresee negative changes in the size of its population or in the available substrate.

4. The actual size of the population of this species is hard to estimate (criterion C, D). Taking into account the concept of Dahlberg and Mueller (2011), who propose acceptance of the principle that in the case of arboreal fungi one is dealing with 2-10 “mature specimens” on a single tree, and being guided with the acceptance by Smith et al. (2016) of the figure of three specimens on a single log, we can estimate the size of the population of the species in question in Poland as 75 “mature specimens”. Since estimating the potential size of a population is recommended when evaluating the actual size of the population, taking into consideration the availability of substrates (oaks over 200-250 years), it can be presumed that the actual size of the population is larger and that there are no grounds for predicting its decrease.

Taking into account the above analyses of extinction risk, *B. quercinus* can be classified as Endangered in Poland (category EN) based on criterion D (a very small population with the number of mature specimens below 250).

## Discussion

### *Distribution of B. quercinus in Poland*

Previously, *B. quercinus* was known in Poland only from its localities in the BPN. Two occurrences of *B. quercinus* listed by Zbigniew Domański (Domański 1997, 2001) outside of the BPN and cited by Wojewoda (2003) and Łuszczynski (2007, 2008) ought to be treated as artefacts. Our revision of herbarium specimens by Domański (WA 0000017503 (old classification 034423), WA 0000017504 and WA 0000017505 (there is no information about the place where the latter two were gathered) revealed the misidentification. These records represent *Laetiporus sulphureus* (rev. A. Szczepkowski). Currently, three sites of occurrence of *B. quercinus* are known in Poland. All of them are situated in forest areas under the highest levels of nature protection in Poland – one in a BPN and two in nature reserves (Bielinek on the Oder, and Koniuszanka II). *B. quercinus* has been found in mesophytic and thermophilous deciduous forests with living as well as dying or dead several-hundred-year-old oaks. In the United Kingdom, the species is usually found in ancient oak forests, deer parks and woodland pastures where large numbers of veteran trees are present (Evans 2001, 2006). In the former Yugoslavia, Tortić and Jelić (1969) indicated nature reserves and urban parks as actual and potential places for the appearance of *B. quercinus*. In Czechia, it is

found mainly in dry thermophilous oak forests, lowland floodplain forests and man-made plantations, particularly on the earthworks used to dam commercial fishponds (Kotłaba 1984, Dvořák and Bět'ák 2017).

In the BPN, *B. quercinus* was found on at least 23 trees located in 17 forest sub-compartments that form part of 13 compartments. Due to its long history of protection (Okolów 2009) and a density of large old oaks (Grzywacz et al. 2017, 2018) (left after dying to undergo complete decomposition) that is rarely encountered in other European forests, the BPN constitutes the richest and most valuable refuge for this rare species in Poland and probably one of the richest in the whole of Europe. In Europe, the countries with the greatest number of recordings of this species are Sweden and Great Britain. Probably the most numerous European population of this species is found in England in the former royal hunting forest Windsor Crown Estate, where 100 oaks were found in 1998 to be inhabited by *B. quercinus* (Crockatt 2008, Anonymous 2018). A relatively large population of this species is found in the Czech Republic (Kotłaba 1984, Dvořák and Bět'ák 2017); in the former Czechoslovakia, it was found on 56 oaks (Kotłaba 1984).

### *The number and categories of trees and logs inhabited by B. quercinus*

The data in the literature indicate that *B. quercinus* occurs only on living oak specimens (Bernicchia 2005, Ryvardeen and Melo 2014); on living and, more rarely, on dead oaks (Domański et al. 1967); on living and recently deceased ones (Ryvardeen and Gilbertson 1994); or on living, dying, or dead trunks and old stumps (Kotłaba and Pouzar 1966, Dvořák and Bět'ák 2017). In the UK, this species grows on both living and dead standing trees but can also fruit regularly on fallen trunks, branches and even quite small fragments splintered from suitable disintegrating veterans (Evans 2001, 2006, Crockatt 2008). The Polish data diverge slightly from these statements. Out of 26 Polish records of this species, only two were found on the trunks of living oaks and two on standing dead ones. The first record of *B. quercinus* in Poland comes from the trunk of a living oak (Domański 1967, Domański et al. 1967, 1973). Combining the data from the studies of the BPN Protection Plan (Karasiński et al. 2010) and Karasiński and Wołkowycki (2015) with those analysed in this study (from the years 2009-2018), basidiomata of *B. quercinus* were found on at least 26 trees: mostly on fallen trunks or their fragments or on logs (20); on the trunks of two standing living trees and two standing dead oaks; on one bough of an overturned oak and on one branch lying on the ground. A similar conclusion, i.e., about the prevailing frequency of fruiting of *B. quercinus* in Poland on dead timber, can be found in the work by Karasiński and Wołkowycki (2015).

### Phenology

In Poland, the basidiomata of *B. quercinus* have been recorded between June and September. They were found most frequently in July (15 records, i.e., over 50% of all records) and noticeably less in August (5, i.e., 20% of all records). The fewest recordings come from September (4) and June (3). The cited dates of fructification of this species are confirmed by data from the literature. In Europe, *B. quercinus* forms basidiomata during summer and autumn, mainly in July and August and less frequently in June, September and October (Kotlaba 1984, Evans 2001, 2006, Wald et al. 2004, Ryvarden and Melo 2014, Dvořák and Běťák 2017); sometimes dried ones can remain until the following year (Evans 2006).

### Fungi co-occurring with *B. quercinus*

The basidiomata of *B. quercinus* were found in co-occurrence of eight species (Table 1), among which five belong to the group of fungi being found exclusively or almost exclusively on oak wood (Wojewoda 2003, Stasińska 2008). The species of fungi found during the study to coexist with *B. quercinus* represent two of the causes of brown rot in wood (*Daedalea quercina*, *Lae-tiporus sulphureus*), one of white rot (*Hapalopilus croceus*), and two of white pocket rot (*Hymenochaete rubiginosa*, *Xylobolus frustulatus*). Six species (*Bis-porella citrina*, *Mycena galericulata*, *M. inclinata*, *H. rubiginosa*, *D. quercina*, *L. sulphureus*) are very common fungi in Poland (Wojewoda 2003, Chmiel 2006). On the other hand, *Hapalopilus croceus* is rare in Poland, is subject to species protection and is found on the red list with category E (Wojewoda and Ławrynowicz 2006, Anonymous 2014). *X. frustulatus* is also not a common species in Poland (Wojewoda 2003, Stasińska 2008); it is listed on the red list of fungi with category V (Wojewoda and Ławrynowicz 2006). Simultaneous co-occurrence of the basidiomata of the two rare fungal species (*H. croceus* and *X. frustulatus*) mentioned above in the company of *B. quercinus* on the trunk of a fallen oak was also noted in France (Rivoire et al. 2017).

### Assessment of the state of threat to *B. quercinus* in Poland

In the forests of Poland (managed forests and national parks), oaks of 200 years and older have been catalogued in about 7,000 forest subareas covering almost 22,000 hectares. In the case of 250-year-old and older oaks, such trees have been recorded in almost 1,700 forest subareas of a total area of almost 5,500 hectares (Anonymous 2018). It should be kept in mind that the share of such old oaks in particular subareas varies significantly; however, it is usually not high. In Poland, oaks (along with lindens) belong to the trees most frequently recognized as natural monuments, and their

number is ca. 28,500 specimens (Grzywacz and Pietrzak 2013). Moreover, old oaks occur in the stands of a significant portion of almost 10,000 parks and historic gardens that together possess an area of almost 35,000 hectares and are located on urban and rural terrain (Domańska et al. 2018). Despite such a large potential substrate and basis for substrate appropriate for *B. quercinus*, this species is still very rare in Poland. To date, it has been recorded exclusively in forest areas with special protection (national parks and nature reserves). For instance, in the former strict nature reserve of the BPN, where are localities of *B. quercinus*, over 2,000 oak specimens with monumental sizes were inventoried across an area of ca 4,600 hectares (Grzywacz et al. 2017, 2018). A large proportion of old oaks that provide a potential base for the growth of *B. quercinus* offers good prospects for maintaining a stable population of this species in the BPN. It is worth stressing that localities of *B. quercinus* in the Białowieża Primeval Forest were found only within the boundaries of the BPN, which occupies ca. 1/6 of the Polish part of the whole Forest. Although very old oaks grow also in other parts of the Forest, so far there are no records of this fungus outside of the BPN (e.g. Bujakiewicz and Kujawa 2010, Jaworski et al. 2016, Kujawa et al. 2018b). On the other hand, in the Las Bielański nature reserve in Warsaw – where over 1,000 old oaks were inventoried, some of which reached the age of over 300 years, and where species of fungi associated with oaks and characteristic of well-preserved forests are found (*Hapalopilus croceus*, *Hericium erinaceus* (Bull.) Pers., *Fistulina hepatica* (Schaeff.) With., *Xylobolus frustulatus*) (Szczepkowski and Sierota 2013) – despite searches, *B. quercinus* has so far not been found. Searches for this fungus – thus far unsuccessful – were also conducted in other nature reserves of Central Poland (e.g. Szczepkowski 2008, Szczepkowski and Sierota 2013) and in the Kampinos National Park near Warsaw (e.g. Karasiński et al. 2015, Gierczyk et al. 2017, 2019a, b). We also have not found it in 1,136 examined old oaks growing in the agricultural landscape of central Greater Poland (Kujawa et al. 2018a).

### Conclusions

*Buglossoporus quercinus* – a very rare polypore in Poland – has been recorded exclusively in forest areas under special protection. The results of our studies on *B. quercinus* showed three locations: Białowieża National Park, nature reserve Bielinek on the Oder, and Koniuszanka II in NE Poland. This species seems to be associated with mesophytic and thermophilous deciduous forests with very old oaks. Basidiomata of *B. quercinus* appear mainly on trunks of an overturned trees and more decayed logs as well as – less frequently – on trunks of



standing dead oaks. In couple of cases *B. quercinus* coexisted on one log or trunk with fungi causing both white and brown rot of wood. The Białowieża National Park constitutes the richest and most valuable refuge of this rare species in Poland and probably one of the richest in the whole of Europe. It could be beneficial to check the potential habitats of *B. quercinus* throughout Poland. *B. quercinus* should be classified as Endangered (EN), according to the IUCN Red List criteria, based on the provided distribution data for this species in Poland.

### Acknowledgments

*The authors would like to express their gratitude to Ms. Grażyna Domian and Mr. Jerzy Ostapski for participating in searches for Buglossoporus quercinus, and to Dr. Andrzej Talarczyk from the Board of the Bureau for Forest Management and Geodesy for preparing and making accessible the data about the share of oaks over 200 years old in the National Forests and national parks of Poland and two anonymous referees for their valuable comments.*

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