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FUNGI OCCURRING IN ACORN OF *QUERCUS ROBUR* L. INFESTED BY INSECTS

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Abstract. The paper presents the results of the isolation and identification of fungi from *Quercus robur* L. acorns infested by acorn major pests: *Curculio glandium* Marsh. and *Kenneliola* spp., and larvae of these insects. Acorns were collected in 2003, in three locations in Poland from the forest floor and from the nets suspended above the forest floor. The most frequently fungi isolated from acorns colonized by *C. glandium* was *Alternaria alternata* (Fr.) Keissl., and colonized by *Kenneliola* spp. were yeasts and *A. alternata.* Acorns collected from the nets were more often infected by *A. alternata*, *Lecythophora* sp., *Pezicula cinnamomea* (DC.) Sacc., *Aspergillus* and *Cladosporium* species, while acorns from the forest floor were often colonized by *Ciboria batschiana* (Zopf) N.F. Buchw. and species from *Penicillium* and *Fusarium* genera. The most frequently isolated fungi from *C. glandium* larvae were: *Fusarium sporotrichioides* Sherb., *F. stilboides* Wollenw., *Penicillium* spp. and *Pestalotia clavispora* Atk. and from *Kenneliola* spp. larvae were: *A. alternata*, *F. sporotrichioides*, *Penicillium* spp. and *P. clavispora.*

Key words: acorn, *Curculio glandium*, fungi, *Kenneliola* spp., *Quercus robur*

INTRODUCTION

There are several abiotic and biotic factors responsible for damage of oak acorns in Europe. Among the biotic factors, insects are the most important. They can affect seed- or seedling-based artificial regeneration as well as natural regeneration [Xiao et al. 2007]. The most common acorn insects are weevils, totricidae moths and cynipids [Kapuściński 1966, Křistek and Skrzypczyńska 1992, Michalski and Mazur 2006]. Among them, *Curculio glandium* Marsh. – acorn weevil and *Kenneliola splendana* Hbn. – acorn moth cause the most damage to *Quercus robur* acorns. The females of these insects lay their eggs in early stages of acorn development. Acorns are colonized while still on trees, but insects development continues after their fall and lying on the ground. Larvae feed within acorns before they leave through a small hole in the wall and burrow into the soil.

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Besides insects, also fungi may infest acorns. *Ciboria batschiana* (Zopf) N.F. Buchw., *Diaporthe insularis* Nitschke, *Apiognomonia quercina* (Kleb.) Höhn., *Schizophyllum commune* Fr., *Stereum hirsutum* (Willd.) Pers., *Phomopsis quercella* (Sacc. & Roum.) Died. and *Ophiostoma* species are the most important pathogens of oak acorns [Kozłowska 1970, Procházková 1991, 1995, Kowalski and Kowalczyk 1997, Stocka 1998, Przybył 2006]. Kwaśna [1997] reported that also *Phomopsis glandicola* (Lev.) Grove and *Cystodendron dryophilum* (Passs.) Bubak contribute to formation of brown spots and mummification symptoms on oak seeds in Poland. These pathogens colonized the acorns lying on the forest floor as well as stored ones. However, there is no information about the fungi colonizing the acorns of *Q. robur* after infection by insects.

In this study, species composition and frequency of individual fungi in acorns of *Q. robur* infested by *C. glandium* and *Kenneliola* spp. collected from forest floor and nets were investigated.

MATERIAL AND METHODS

Acorns of *Q. robur* were collected in 2003 from three study plots: Rewal (54°05´32˝ N, 15°03´23˝ E); Babimost (52°09´14˝ N, 15°50´23˝ E) and Krzyszkowice forest near Cracow (50°00´06˝ N, 20°00´33˝ E). In Rewal and Babimost acorns were collected in oak-Scots pine stands. In contrast, in Krzyszkowice the acorns were collected in a broadleaved forest, where English oak and European hornbeam were the dominant species.

Acorns were collected either directly from forest floor or from the nets suspended below tree crowns, in first two weeks of September 2003. Only acorns with extensive external damage by insects were collected. To quantify the percentage of acorns infested by insects, 122-215 acorns from each site were carefully opened in laboratory and examined, under binocular microscope, for the presence of insects. The larvae were collected with sterilized tweezers and put and then stored individually in sterile microtubes (1.5 ml). In total, 194 larvae were picked up from acorns. The insects present in the acorns represented mostly two species: *C. glandium*, which occurred in 71, 74 and 90% of the infested acorns in three analyzed plots and *K. splendana* (Table 1).

Table 1. Insects species abundance in acorns of *Quercus robur* at three study plots
Tabela 1. Częstość występowania owadów w żołędziach *Quercus robur* na trzech powierzchniach badawczych

Species of insect Gatunek owada	Number and percentage (in brackets) of acorns infested Liczba i procent (w nawiasie) żołędzi zasiedlonych		
	Rewal	Babimost	Kraków
Curculio glandium Marsh.	100(90.2)	114(74.0)	153(71.2)
Kenneliola splendana Hbn.	10(8.2)	39(25.3)	57(26.5)
Kenneliola amplana Hbn.		1(0.6)	5(2.3)
Pammene fasciana L.	2(1.6)		
Number of acorns analysed Liczba analizowanych żołędzi	122	154	215

Fungal isolations were made from the larvae colonizing acorns and acorn tissues with visible symptoms of damage. Each larvae was surface washed in sterile water for 30 seconds. After drying on a sterile blotting paper, the larvae were crushed on a microscopic slide and evenly spread on the surface of medium, with a sterile scalpel. In case of acorns tissues, the isolation of fungal taxa was made separately for the pericaps and cotyledons, except for acorns collected from forest floor where isolation was made only from cotyledons. The pericaps and cotyledons were surface – sterilized with 96% ethanol (1 min), 4% sodium hypochlorite (3 min) and again in 96% ethanol (30 s). After drying on a sterile blotting paper, 4-6 pieces from each acorn were studied. Isolation of fungi was made on the 2% malt agar supplemented with 200 mg/l of tetracycline. Acorns fragments were taken from insects galleries and from discoloured areas around these galleries. Plates were incubated at room temperature, at natural day/night light cycle, for 10 weeks. In total 1692 pieces from 491 acorns were studied.

RESULTS

Fungal isolations from larvae

The 194 larvae sampled from *Q. robur* acorns yielded a total of 316 fungal isolates (261 from *C. glandium* and 55 from *Kenneliola* spp.), representing 41 taxa. Only 22 genera were identified to species level (Table 2).

Table 2. Fungi isolated from the larvae of *Curculio glandium* (*C. g.*) and *Kenneliola* spp. (*K.* spp.) taken from *Quercus robur* acorns

Tabela 2. Grzyby wyizolowane z larw *Curculio glandium* (*C. g.*) i *Kenneliola* spp. (*K.* spp.) pobranych z żołędzi *Quercus robur*

Species Gatunek	Number of isolates and percentage of frequency (in brackets) isolated from the larvae collected Liczba i procent częstości (w nawiasie) izolatów wyizolowanych z larw zebranych				Total Ogółem	
	from nets z pędów		from forest floor z ziemi			
	C. g.	*K.* spp.	*C. g.*	*K.* spp.	*C. g.*	*K.* spp.
1	2	3	4	5	6	7
Acremonium spp. (two species – dwa gatunki)	7(9.2)	1(4.5)	5(2.7)	2(6.1)	12(4.6)	3(5.5)
Acremonium zeae W. Gams & D.R. Sumner			6(3.2)	2(6.1)	6(2.3)	2(3.6)
Alternaria alternata (Fr.) Keissl.	5(6.6)	5(22.7)	3(1.6)	2(6.1)	8(3.1)	7(12.7)
Alternaria raphani J.W. Groves & Skolko			1(0.5)		1(0.4)	
Apiospora montagnei Sacc.		1(4.5)				1(1.8)
Aspergillus niger Tiegh.	4(5.2)	2(9.1)			4(1.5)	2(3.6)
Aspergillus sp.			1(0.5)	1(3.0)	1(0.4)	1(1.8)

Table 2 – cont.

1	2	3	4	5	6	7
Aureobasidium pullulans (de Bary) G. Arnaud	6(7.9)				6(2.3)	
Botrytis cinerea Pers.			2(1.1)	1(3.0)	2(0.8)	1(1.8)
Ciboria batschiana (Zopf) N.F. Buchw.			4(2.2)		4(1.5)	
Cladosporium cladosporioides (Fresen.) G.A. de Vries	1(1.3)	4(18.2)	4(2.2)		5(1.9)	4(7.3)
Cladosporium herbarum (Pers.) Link			2(1.1)		2(0.8)	
Epicoccum nigrum Link	1(1.3)				1(0.4)	
Fusarium avenaceum (Fr.) Sacc.						
Fusarium oxysporum var. *redolens* (Wollenw.) W.L. Gordon			1(0.5)		1(0.4)	
Fusarium poae (Peck) Wollenw.			6(3.2)		6(2.3)	
Fusarium sporotrichioides Sherb.	4(5.2)	1(4.5)	36(19.5)	5(15.2)	40(15.3)	6(10.9)
Fusarium stilboides Wollenw.			24(13.0)	1(3.0)	24(9.2)	1(1.8)
Fusarium torulosum (Berk. & M.A. Curtis) Nirenberg	1(1.3)	1(4.5)	19(10.3)	3(9.7)	20(7.7)	4(7.3)
Geotrichum candidum Link			1(0.5)		1(0.4)	
Lecythophora sp.			2(1.1)	1(3.0)	2(0.8)	1(1.8)
Mucor sp.			5(2.7)		5(1.9)	
Paecilomyces farinosus (Holmsk.) A.H.S. Br. & G. Sm.				3(9.1)		3(5.5)
Papulaspora sp.			2(1.1)		2(0.8)	
Penicillium spp. (two species – dwa gatunki)	38(50.0)	5(22.7)	25(13.5)	3(9.1)	63(24.1)	8(14.5)
Pestalotia clavispora Atk.			21(11.4)	9(27.3)	21(8.0)	9(16.4)
Phialophora sp.	2(2.6)		5(2.7)		7(2.7)	
Rhizoctonia sp.			2(1.1)		2(0.8)	
Stachybotrys atra Corda	1(1.3)				1(0.4)	
Verticillium lecanii (Zimm.) Viégas			2(1.1)		2(0.8)	
Yeats – Drożdżaki			6(3.2)		6(2.3)	
Not sporulating or not identified (eight species) Niezarodnikujące lub niezidentyfikowane (osiem gatunków)	6(7.9)	2(9.1)			6(2.3)	2(3.6)
Total isolates Ogółem izolaty	76	22	185	33	261	55
Number and percentage (in brackets) of larvae which did not yield fungi Liczba i procent (w nawiasie) larw, z których nie wyizolowano grzybów	1(2.2)	11(42.3)	7(7.0)	6(27.3)	8(5.5)	17(35.4)
Number of examined larvae Liczba badanych larw	46	26	100	22	146	48

The most frequently isolated fungi from *C. glandium* larvae were: *Fusarium sporotrichioides* Sherb., *F. stilboides* Wollenw., *Penicillium* spp. and *Pestalotia clavispora* Atk. They amounted to > 8% of the total number of isolates. The most frequently isolated fungi from *Kenneliola* spp. were *Alternaria alternata* (Fr.) Keissl., *F. sporotrichioides*, *Penicillium* spp. and *P. clavispora.*

As far as *C. glandium* larvae are concerned, fungi were found mostly in those which were from acorns collected on forest floor. *Curculio glandium* larvae inhabiting acorns collected from nets yielded only 76 isolates, from 14 species (Table 2). *Acremonium* sp., *A. alternata*, *Aureobasidium pullulans* (de Bary) G. Arnaud and *Penicillium* species were usually more frequent in larvae inhabiting acorns collected from nets. *Fusarium* species and *P. clavispora* were more frequent in the larvae inhabiting acorns collected from forest floor (Table 2). Similar relationship was observed in *Kenneliola* spp. larvae. *Alternaria alternata*, *C. cladosporioides* and *Penicillium* species were more commonly found in larvae inhabiting acorns from nets, whereas *Fusarium* species and *P. clavispora* were found more often in larvae from acorns collected from forest floor (Table 2).

Fungal isolations from acorns infested by *Curculio glandium* and *Kenneliola* spp.

From the 1060 fragments of acorns infested by *C. glandium* and 632 fragments of acorns infested by *Kenneliola* spp., 429 (Table 3) and 178 (Table 4) isolates of fungi were obtained, respectively. A total of 42 and 26 species were isolated from acorn

Table 3. Fungi isolated from acorns of *Quercus robur* infested by *Curculio glandium*
Tabela 3. Grzyby wyizolowane z żołędzi zasiedlonych przez *Curculio glandium*

Species Gatunek	Number of isolates and percentage of frequency (in brackets) isolated from acorns collected Liczba i procent częstości (w nawiasie) izolatów wyizolowanych z żołędzi zebranych			Total Ogółem
	from nets z pędów		from forest floor z ziemi	
	pericarps owocnie	cotyledons liścienie	cotyledons liścienie	
1	2	3	4	5
Acremonium bacillisporum (Onions & G.L. Barron) W. Gams			2(1.2)	2(0.5)
Acremonium charticola (J. Lindau) W. Gams	1(0.7)			1(0.2)
Acremonium sp.	5(3.4)	2(1.7)	3(1.8)	10(2.3)
Acremonium strictum W. Gams	1(0.7)			1(0.2)
Alternaria alternata (Fr.) Keissl.	54(36.7)	39(33.6)	11(6.6)	104(24.2)
Alternaria raphani J.W. Groves & Skolko			1(0.6)	1(0.2)
Alternaria tenuissima (Kunze) Wiltshire	1(0.7)			1(0.2)
Aposphaeria sp.	6(4.1)	2(1.7)		8(1.9)

Table 3 – cont.

1	2	3	4	5
Aspergillus niger Tiegh.	2(1.4)	1(0.9)		3(0.7)
Aspergillus sp.	4(2.7)	4(3.4)		8(1.9)
Aureobasidium pullulans (de Bary) G. Arnaud	8(5.4)			8(1.9)
Chaetomium indicum Corda	2(1,3)	2(1.7)		4(0.9)
Chrysosporium sp.	1(0.7)			1(0.2)
Ciboria batschiana (Zopf) N.F. Buchw.			26(15.7)	26(6.1)
Cladosporium cladosporioides (Fresen.) G.A. de Vries	3(2.0)		5(3.0)	8(1.9)
Cladosporium herbarum (Pers.) Link			3(1.8)	3(0.7)
Cladosporium sphaerospermum Penz.	3(2.0)			3(0.7)
Coniothyrium quercinum (Bonord.) Sacc.	1(0.7)			1(0.2)
Fusarium anthophilum (A. Braun) Wollenw.			9(5.4)	9(2.1)
Fusarium avenaceum (Fr.) Sacc.			2(1.2)	2(0.5)
Fusarium poae (Peck) Wollenw.			2(1.2)	2(0.5)
Fusarium sporotrichioides Sherb.			26(15.7)	26(6.1)
Fusarium stilboides Wollenw.			4(2.4)	4(0.9)
Fusarium torulosum (Berk. & M.A. Curtis) Nirenberg	1(0.7)		3(1.8)	4(0.9)
Fusidium sp.	1(0.7)			1(0.2)
Lecythophora sp.	9(6.1)	15(12.9)	6(3.6)	30(7.0)
Mucor sp.			1(0.6)	1(0.2)
Papulaspora sp.			2(1.2)	2(0.5)
Penicillium spp. (two species)	1(0.7)	10(8.6)	29(17.5)	40(9.3)
Pezicula cinnamomea (DC.) Sacc.	11(7.5)	2(1.7)		13(3.0)
Phialophora sp.	9(6.1)	4(3.4)	1(0.6)	14(3.3)
Phoma sp.			14(8.4)	14(3.3)
Phomopsis quercella Died.	3(2.0)			3(0.7)
Rhizoctonia sp.	2(1.4)	3(2.6)	4(2.4)	9(2.1)
Trichoderma viride Pers.		1(0.9)		1(0.2)
Yeats – Drożdżaki		23(19.8)	12(7.2)	35(8.2)
Not sporulating or not identified (seven species) Niezarodnikujące lub niezidentyfikowane (siedem gatunków)	18(12.2)	8(6.9)		26(6.1)
Total isolates Ogółem izolaty	147	116	166	429
Number and percentage (in brackets) of fragments which did not yield fungi Liczba i procent (w nawiasie) fragmentów, z których nie wyizolowano grzybów	204(68.0)	318(77.6)	176(50.3)	698(65.8)
Number of examined fragments Liczba badanych fragmentów	300	410	350	1 060

Table 4. Fungi isolated from acorns of *Quercus robur* infested by *Kenneliola* spp.
Tabela 4. Grzyby wyizolowane z żołędzi zasiedlonych przez *Kenneliola* spp.

Species Gatunek	Number of isolates and percentage of frequency (in brackets) isolated from acorns collected Liczba i procent częstości (w nawiasie) izolatów wyizolowanych z żołędzi zebranych			Total Ogółem
	from nets z pędów		from forest floor z ziemi	
	pericarps owocnie	cotyledons liścienie	cotyledons liścienie	
Acremonium kiliense Grütz	1(1.7)	2(2.7)		3(1.7)
Acremonium sp.		3(4.1)	1(2.1)	4(2.2)
Acremonium zeae			1(2.1)	1(0.6)
Alternaria alternata	26(44.8)	16(21.9)	4(8.5)	46(25.8)
Aposphaeria sp.		1(1.4)		1(0.6)
Ascotricha sp.		1(1.4)		1(0.6)
Chaetomium indicum	2(3.4)			2(1.1)
Cladosporium cladosporioides	2(3.4)	4(5.5)	1(2.1)	7(3.9)
Cladosporium sphaerospermum	1(1.7)	1(1.4)		2(1.1)
Epicoccum nigrum	2(3.4)			2(1.1)
Fusarium anthophilum			4(8.5)	4(2.2)
Fusarium sporotrichioides			3(6.4)	3(1.7)
Fusarium torulosum (Berk. & M.A. Curtis) Nirenberg	1(1.7)		2(4.3)	3(1.7)
Lecythophora sp.	2(3.4)	2(2.7)		4(2.2)
Paecilomyces farinosus (Holmsk.) A.H.S. Br. & G. Sm.			1(2.1)	1(0.6)
Penicillium spp. (two species)		3(4.1)	6(12.8)	9(5.1)
Pestalotia clavispora			2(4.3)	2(1.1)
Phoma sp.		2(2.7)		2(1.1)
Rhizoctonia sp.			2(4.3)	2(1.1)
Torula sp.	3(5.2)	1(1.4)		4(2.2)
Yeats – Drożdżaki	5(8.6)	22(30.1)	20(42.5)	47(26.4)
Not sporulating or not identified (five species) Niezarodnikujące lub niezidentyfikowane (pięć gatunków)	13(22.4)	15(20.5)		28(15.7)
Total isolates Ogółem izolaty	58	73	47	178
Number and percentage (in brackets) of fragments which did not yield fungi Liczba i procent (w nawiasie) fragmentów, z których nie wyizolowano grzybów	150(76.5)	217(75.9)	120(62.8)	487(77.1)
Number of examined fragments Liczba badanych fragmentów	196	286	150	632

infested by *C. glandium*, and *Kenneliola* spp., respectively. *Alternaria alternata* was the most commonly isolated fungus (over 24% isolates) from acorns colonized by *C. glandium*. Other species were isolated less frequently. *Penicillium* spp., yeasts, *Lecythophora* sp., *C. batschiana* and *F. sporotrichioides* were isolated from 9.3, 8.2, 7.0, 6.1 and 6.1% of samples, respectively (Table 3). Yeasts (26.4%) and *A. alternata* (25.8%) were the most commonly isolated from tissues of acorns infested by *Kenneliola* spp. (Table 4). *Acremonium* sp., *C. cladosporioides*, *F. anthopilum*, *Lecythophora* sp. and *Penicillium* spp. were less frequent (isolated from 2.2-5.1% of samples; Table 4).

There were relatively large quantitative and qualitative differences in the composition of acorns mycobiota depending on conditions of microhabitat after falling. Generally, acorns from the nets were more often infected by *A. alternata, Lecythophora* sp., *Pezicula cinnamomea* (DC.) Sacc., *Aspergillus* and *Cladosporium* species, while acorns from the forest floor were more often colonized by *C. batschiana* and *Penicillium* and *Fusarium* species (Table 3, 4).

The frequency of a few fungi isolated from acorns from nets depended on the type of tissue. In acorns infested by *C. glandium*, *A. alternata*, *Aureobasidium pullulans*, *P. eucrita* and *Phialophora* sp. were particularly abundant on the pericaps, whereas *Lecythophora* sp., *Penicillium* spp. and yeasts were more frequent on cotyledons (Table 3). The similar relationship was observed in acorns infested by *Kenneliola* spp. (Table 4).

DISCUSSION

This study demonstrates a great diversity of fungi associated with oak acorns infested by weevils and totricidae moths in Poland. *Alternaria alternata*, *Penicillium* spp. *Fusarium* spp. and yeasts were the most common fungal associates. A similar spectrum of fungi has been found on oak acorns in Europe [Potlajczuk 1953, Uroševič 1957, Łukomski 1961, Kozłowska 1970, Procházková 1991, 1995, Kowalski and Kowalczyk 1997, Kwaśna 1997, Procházková et al. 2005]. However, a few fungi including *Apiognomonia quercina*, *Cytospora intermedia* Sacc., *Cystodendron dryophilum* and *Phomopsis glandicola* that had been reported in Poland were not recorded in this study [Kowalski and Kowalczyk 1997, Kwaśna 1997]. Various reasons might have been responsible for this fact. Among these, the type of acorns used in these studies could be very important. Kowalski and Kowalczyk [1997] and Kwaśna [1997] isolated fungi from acorns with spots and mummification symptoms, while in this study the isolations of fungi were made from acorns infested by insects. The various character of samples studied makes the comparison of mycobiota more difficult.

Four species, indicated by the presented study, e.g. *Ciboria batschiana*, *Phomopsis quercella* and *Fusarium* spp. are considered as serious pathogens of oak acorns [Procházková 1991, 1995, Kowalski and Kowalczyk 1997]. The most important, *Ciboria batschiana* causes “black rot-mummification” and can destroy a high percentage of stored acorns [Kowalski 1999]. For the first time pathogen was recorded in 1961 [Łukomski 1961]. The fungus was observed also by Kozłowska [1970], Siwecki [1994], Kowalski and Kowalczyk [1997]. Stocka [1994] and Procházková et al. [2005] claimed *C. batschiana* may infect acorns that are still on trees. This study does not confirm these observations. *Ciboria batschiana* was reported only from acorns collected from forest floor, what would suggest that they were infected while being in contact with a ground.

In Procházková et al. [2005] studies, *C. batschiana* occurred more often in acorns collected from the forest floor than from nets and this supports the supposition that *C. batschiana* infects acorns mainly during contact on the forest floor. The new observation in studies on *C. batschiana* ecology, is that pathogen was found in acorns infested by *C. glandium* and in their larvae. This would suggest that *C. glandium* may be considered as a potential vector of *C. batschiana.* Similar suggestion was made by Vettraino et al. [2005] who confirmed that in chestnut orchards in central Italy other species from *Curculio* genus – *Curculio propinquus* (Desbr.) carries and spreads *C. batschiana*. In the Italian studies, *C. batshiana* was detected in adults collected from ground and from trees suggesting the *C. propinquus* ability to infect chestnut seeds on nets.

The number of fungi isolated from the acorns infested by *C. glandium* was markedly higher than of those from the acorns attacked by *Kenneliola* spp. This could be due to the different biology of both insects. In the spring, overwintering *C. glandium* adults emerge from hibernation and feed on oak leaves. After mating, females began to lay eggs in the holes drilled in acorns. In contrast, acorn moth females start laying egg on the upper surface of the leaves 24 hours after emergence and continue at intervals over about 10 days. Besides, *Curculio glandium* in the adult state lives 1 year while *Kenneliola* spp. lives only 20-40 days [Kapuściński 1966]. Considering the biology of both genera of insects, it seems that 'long-living' weevil may be more effective in spread of *C. batschiana* infection than 'short-living' moth. To confirm this, however, further studies on the fungal mycobiota of overwintering and newly emerging adults of both genera insects are necessary.

Most of the fungi found on weevils and moths, and acorns colonized by them are widely distributed in nature, and some of them have been isolated from other insects. For example, different species of *Alternaria*, *Aspergillus*, *Cladosporium*, *Fusarium*, *Paecilomyces* and *Penicillium* were found in association with the bark beetles [Kirschner 2001, Pérez et al. 2003, Jankowiak 2005, Jankowiak and Bilański 2007, Jankowiak et al. 2007] and bees [Gilliman and Prest 1977] and the moth *Spodoptera litoralis* (Boisdoval) [Ismail and Abdel-Sater 1993]. These fungi are commonly isolated from plants, soil, food, and air.

The study showed that the damaged acorns located at a height of 1.5 m above ground were more often infected by *Alternaria* and *Aspergillus* species, and acorns lying on the forest floor were more often infected by *Mucor* sp., *Fusarium* and *Penicillium.* This is due to the ecology of these fungi; *Alternaria* and *Aspergillus* are typical airborne species while *Fusarium* occurs mainly in litter and soil [Dix and Webster 1995].

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GRZYBY WYSTĘPUJĄCE NA ZAATAKOWANYCH PRZEZ OWADY ŻOŁĘDZIACH *QUERCUS ROBUR* L.

Streszczenie. W pracy przedstawiono wyniki badań nad izolacją i identyfikacją grzybów zasiedlających zaatakowane przez owady żołędzie *Quercus robur* L. Izolacje grzybów były wykonywane z żołędzi uszkodzonych przez dwa główne szkodniki żołędzi: *Curculio glandium* Marsh. i *Kenneliola* spp. oraz z larw tych owadów. Żołędzie były zbierane w 2003 roku, z ziemi oraz z pędów znajdujących się nad ziemią, z trzech powierzchni usytuowanych w Polsce. *Alternaria alternata* (Fr.) Keissl. był gatunkiem najczęściej izolowanym z żołędzi zaatakowanych przez *C. glandium*, natomiast drożdżaki i *A. alternata* najczęściej były stwierdzane w żołędziach uszkodzonych przez owady z rodzaju *Kenneliola*. Żołędzie zebrane z pędów wyróżniały się silnym skolonizowaniem przez następujące grzyby: *Alternaria alternata*, *Lecythophora* sp., *Pezicula cinnamomea* (DC.) Sacc., *Aspergillus* i *Cladosporium* spp. Natomiast na żołędziach zebranych z ziemi stwierdzono liczną obecność grzyba *Ciboria batschiana* (Zopf) N.F. Buchw. oraz grzybów z rodzajów *Fusarium* i *Penicillium*. Z larw *C. glandium* najczęściej izolowano następujące gatunki i rodzaje grzybów: *Fusarium sporotrichioides* Sherb., *F. stilboides* Wollenw., *Penicillium* spp. i *Pestalotia clavispora* Atk., a larwy *Kenneliola* spp. najliczniej były zasiedlone przez: *Alternaria alternata*, *Fusarium sporotrichioides*, *Penicillium* spp. i *Pestalotia clavispora*.

Słowa kluczowe: *Curculio glandium*, grzyby, *Kenneliola* spp., *Quercus robur*

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