VILNIUS UNIVERSITY

TATJANA IZNOVA

DIVERSITY AND ECOLOGICAL PROPERTIES OF *DOTHIDEOMYCETES* AND *SORDARIOMYCETES* IN ALLUVIAL BLACK ALDER FORESTS AND PINE FOREST AFFECTED BY CORMORANTS

Summary of doctoral dissertation
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VILNIAUS UNIVERSITETAS

TATJANA IZNOVA

DOTIDĖJOMICETŲ (*DOTHIDEOMYCETES*) IR SORDARIJOMICETŲ (*SORDARIOMYCETES*) ĮVAIROVĖ BEI EKOLOGINĖS YPATYBĖS ALIUVINIUOSE JUODALKSNYNUOSE IR KORMORANŲ PAŽEISTAME PUŠYNE

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INTRODUCTION

Dothideomycetes and *Sordariomycetes* fungi (*Ascomycota*) are important components of forest ecosystems: they occur as endophytes in plants as well as parasites in animals and plants, live as symbiotrophs and saprotrophs (BARR, HUHNDORF, 2001; SAMUELS, BLACKWELL, 2001; KÜFFER, SENN-IRLET, 2005; KÜFFER et al., 2008).

Most of *Dothideomycetes* and *Sordariomycetes* are microscopic fungi, hard to notice with the naked eye, which makes it more difficult to collect and describe them. Therefore, it is not suprising that these fungi have not been investigated sufficiently not only globally (BARR, HUHNDORF, 2001; SAMUELS, BLACKWELL, 2001; KIRK et al., 2008) but also in Lithuania (IZNOVA, RUKŠĖNIENĖ, 2012). It is worth mentioning that the information about the environmental impact on the distribution of *Dothideomycetes* and *Sordariomycetes*, preference on certain substrates and host plants, therefore, the studies of these fungi are relevant and significant, enabling to enhance future knowledge on their biological and ecological properties.

Diverse data about *Dothideomycetes* and *Sordariomycetes* found in Lithuania has been published until now, however not many detailed studies have been made about the diversity and ecology of these fungi (CHLEBICKI, TREIGIENE, 1995; RUKŠĖNIENĖ, 1996; IRŠĖNAITĖ, TREIGIENĖ, 2001; RUKŠĖNIENĖ, IZNOVA, 2007; IZNOVA, RUKŠĖNIENĖ, 2011; KUTORGA et al., 2013). In most cases, the studies of the above-mentioned fungi were carried out in different forests but little attention was paid to the fungi in rare and protected habitats. The knowledge about diversity and distribution of *Dothideomycetes* and *Sordariomycetes* is important in order to find out more about the functionality and ecology of their habitats.

Alluvial forest habitats (91E0) significant on the European level are distinguished in Lithuania (RAŠOMAVIČIUS, 2012); however no data have been found about any mycological research carried out therein. Information is also lacking about the fungi in another important state protected territory, namely the Curonian Split National Park. The pine forest in this territory is the breeding-ground for the largest and one of the oldest Great Cormorant colonies known in Lithuania creating specific ecologic conditions, i. e. causing a strong hypertrophication effect, which encouraged making a scientific study in this forest (ADAMONYTĖ et al., 2013; KUTORGA et al., 2013; MOTIEJŪNAITĖ et al., 2014).

This study will enhance the knowledge about the diversity, functions, of woody and herbaceous plant fungi as well as the dependence of the communities dynamics on certain ecological conditions in the alluvial black alder forests and the pine forest affected by cormorants.

The aim of the study was to investigate the diversity and ecological properties of *Dothideomycetes* and *Sordariomycetes* in the alluvial black alder forests and the pine forest affected by cormorants.

Main tasks:

1. To define *Dothideomycetes* and *Sordariomycetes* species diversity in six alluvial black alder forests in different geographical locations of Lithuania and in the pine forest in the Curonian Spit.

2. To make the checklist of *Dothideomycetes* and *Sordariomycetes*, found and identified during the study, and describe the fungal species that are recorded for the first time to Lithuania.

3. To define the distribution, substrate preference of *Dothideomycetes* and *Sordariomycetes* and carry out the taxonomic and trophic analysis of these fungi.

4. To evaluate the influence of abiotic (physical-chemical properties of the soil and wood) and biotic (cormorant activity, amount and volume of woody debris) factors on *Dothideomycetes* and *Sordariomycetes* species diversity and distribution.

The defensive statements:

1. The species composition and distribution of *Dothideomycetes* and *Sordariomycetes* in the alluvial black alder forests depend on the abiotic and biotic factors, especially on the soil moisture regime and amount of woody debris.

2. The species composition and distribution of *Dothideomycetes* and *Sordariomycetes* in the pine forest affected by cormorants depend on the cormorant's activity.

3. *Dothideomycetes* and *Sordariomycetes* of woody plants are most frequently found on very fine woody debris at an early decay stage, while fungi of herbaceous plants are found on very fine dead stems.

Novelty of the study. For the first time in Lithuania, detailed investigations were carried out on the diversity and distribution of *Dothideomycetes* and *Sordariomycetes* in the alluvial black alder forests and the pine forest affected by cormorants. The checklist of the study fungi was compiled. 72 *Dothideomycetes* and *Sordariomycetes* species new to Lithuania were identified and original descriptions of their morphology were provided. The influence of abiotic factors on the diversity of woody and herbaceous plants fungi was evaluated for the first time in Lithuania.

Significance of the study. The results of the study provided new knowledge on the diversity and distribution of the Lithuanian *Dothideomycetes* and *Sordariomycetes*, therefore, this data could be used for the preparation of volumes of the editions "*Mycota Lithuaniae*". The obtained results provided new information about the biology of these fungi and revealed their ecological properties. The results of the study enhanced the knowledge about the distribution of *Dothideomycetes* and *Sordariomycetes* in the alluvial forests protected in Europe, which may be used to protect the biologic diversity of these habitats. The properties of the diversity and distribution of studied fungi in the pine forest affected by cormorants allow assessing the impact of the hypertrophication, caused by these birds on the pine forest mycobiota. Collected specimens of *Dothideomycetes* and *Sordariomycetes* are deposited in the Herbarium of Vilnius University (WI).

Presentation of the results. The results of the research were presented at four international and two regional scientific conferences: 1) XXIII Conference-Expedition of the Baltic Botanists (Haapsalu, Estonia, 2010); 2) International conference ,,Perspektivy razvitija i problemy sovremennoj botaniki“ (Novosibirsk, Russia, 2010); 3) XVIII Symposium of the Baltic Mycologists and Lichenologists and Nordic Lichen Society Meeting (Dubingiai, Lithuania, 2011); 4) Lithuanian Conference ,,Mokslas Gamtos mokslų fakultete“ (Vilnius, 2012); 5) Lithuanian Conference of Young Scientists ,,Bioateitis: gamtos ir gyvybės mokslų perspektyvos“ (Vilnius, 2012); 6) XIX Symposium of the Baltic Mycologists and Lichenologists (Šķēde, Latvia, 2014).

Volume and structure of the dissertation. The dissertation includes six chapters: Introduction, Abbreviations, Short glossary of terms, Literature review, Materials and methods, Results and discussion, Conclusions, References (258 literature sources), Appendix (4 tables, 47 figures). Volume of the dissertation is 199 pages (excluding appendix), and is illustrated with 16 tables and 63 figures. The dissertation is written in Lithuanian with the summary in English.

MATERIALS AND METHODS

The research was carried out in the alluvial black alder forests and in the pine forest affected by cormorants.

The material of alluvial forests was collected in April–May, June–July and September–November 2010–2012 (in total 98 expeditions) in six black alder forests: the northern part of Lake Ančia forest (Lazdijai district), Raistas forest (Zarasai district), Rinkotas forest (Lazdijai district), Spindžius forest (Trakai district), Šakeliškės meadows forest (Ignalina district) and Šveicarija forest (Vilnius district). All of the examined alluvial forests belong to European protected habitats.

In study forests were established three zones that were chosen considering by distance to water body (river, lake or waterlogged place):

- Zone I is a 6–12 m wide strip along the edge of water. During the spring flood about 60–80 % of this zone area is submerged.
- Zone II is within 10–17 m distance from water body and is 6–12 m wide. During the spring flood about 30–50 % of the zone area is submerged.
- Zone III is within 25–35 m distance from water body and is about 10 m wide. This zone is not submerged during the spring flood.

10 permanent circle study plots (100 m^2) were selected in each of three zones. The fungi were investigated by three methods in these zones:

Method A. Samples of woody and herbaceous plants with fungi were collected about 30 minutes in five study plots of each zone. It is noteworthy that the data collected by this method (151 species and 1737 number of records) was used for ecological analysis.

Method B. 100 differents samples of woody and herbaceous plants were collected in five study plots of each zone. These samples were observed at the plots and samples with fungi selected for further research. By this method were recorded 62 species and 629 number of records.

Method C. Samples of woody and herbaceous plants with fungi were collected by walking in each zone about 40 minutes. By this method were recorded 29 species and 459 number of records.

The material of pine forest was collected in Neringa, to the south of Juodkrantė in May and September 2012–2013 (in total 4 expeditions).

In studied forests were established six zones that were chosen considering by different activity of the cormorants (ADAMONYTĖ et al., 2013; KUTORGA et al., 2013; MOTIEJŪNAITĖ et al., 2014):

A – the oldest part of the colony in the dune hollow: formerly a pine and spruce forest on mesotrophic temporarily wet soil, coniferous trees are now dead. Cormorant nests are absent or very few, but birds fly over the area to feed in the Curonian Lagoon.

B – the oldest part of the colony on the dune terraces: no living trees, standing dead *Pinus sylvestris* trees are mostly barkless, large amounts of dead wood – laying and standing. Cormorant nests are absent or very few, but numerous birds roost and fly over the area.

C – the most active part of the colony in the former oligotrophic pine forest with the highest concentration of nests (>8 nests/100 m^2). Pine trees are dead or dying but still with bark.

D – an inner edge of the colony with the most recent and still rather few nests (<4,8 nests/100 m^2) in an oligotrophic pine forest on the upper part of dune, trees alive, but their vitality is reduced – crowns are thinner.

E – edge of the colony with very few, relatively undamaged by cormorants oligotrophic pine forest (association *Empetro nigri–Pinetum*).

G – control zone outside of colony, nests absent, closest nests are distanced approximately at 60 m. The stand is oligotrophic pine forest (association *Empetro nigri–Pinetum*) on the upper part of dune, undamaged by cormorants.

18 permanent rectangular study plots (100 m^2) for current investigation were established in these six zones (three plots in each zone). Samples of woody and herbaceous plants with fungi were collected about 30 minutes in study plots.

The amount and volume of woody debris were evaluated in studied alluvial black alder forests and pine forest affected by cormorants.

The physical-chemical properties of the soil and wood were analysed in order to evaluate the impact of cormorants' activity on the pine forest mycobiota (MOTIEJŪNAITĖ, 2012; ADAMONYTĖ et al., 2013; MOTIEJŪNAITĖ et al., 2014).

Each sample of woody and herbaceous plants with fungi is described according to the following features:

1. Substrate type;

2. Diameter class of debris (Küffer, Senn–Irlet, 2005; Abrego, Salcedo, 2013): very fine woody debris (<4.9 cm diameter, VFWD), fine woody debris (5–9.9 cm diameter, FWD) and coarse woody debris (>10 cm diameter, CWD). Diamteter class of overwintered stems belonged to three diameter classes: Isk (diameter of stems is <1 cm), IIsk (1–1.9 cm), IIIsk (2–4.9 cm);

3. Decay stage of woody debris (Renvall, 1995; Müller–Using, Bartsch, 2009; Abrego, Salcedo, 2011: early wood decay stage (DS1), medium wood decay stage (DS2) and late wood decay stage (DS3).

All samples were examined using Olympus CZ61 and Olympus SZX10 stereomicroscopes, Olympus CH–40 and Olympus BX51 light microscopes. The morphological features of studied fungi were microphotographed using Nikon Coolpix E 4500, Qimaging MicroPublisher 3.3 RTV and Qimaging MicroPublisher 5.0 RTV digital cameras. The fungal samples identified during the research were critically checked in Herbariums of the Swedish Museum of Natural History and The Komarov Botanical Institute of the Russian Academy of Sciences. The fungal material is deposited in the Herbarium of Vilnius University (WI).

The checklist of *Dothideomycetes* and *Sordariomycetes* was compiled. For each fungal species the information is given in the following order: scientific name, host plant, substrate type on which was found fungi, diameter and decay stage of this substrate, data on distribution, trophic group. New species for Lithuania were described in detail. The nomenclature of fungal taxa follows the Index Fungorum database (http://www.indexfungorum.org) and H. T. Lumbsch, S. M. Huhndorf (2010).

Data analysis was completed using PAST 2.17 software package (Hammer et al., 2001). The statistical data analysis was performed following the recommendations (Hammer et al., 2001; Zak, Willig, 2004; Čekanavičius, Murauskas, 2008; 2009). ANOSIM, Mantel tests and Shapiro-Wilk normality test, Sørensen index, ANOVA and cluster analysis, non-metric multidimensional scaling (nMDS) model were employed to analyse the data of research.

RESULTS AND DISCUSSION

Diversity and distribution of *Dothideomycetes* and *Sordariomycetes*

In total, 171 species from 114 genera, 55 families, 19 orders and two classes (*Dothideomycetes* and *Sordariomycetes*) have been recorded in studied forests: 151 species were recorded in the alluvial black alder forests and 38 species – in the pine forest affected by cormorants (Table 1). 72 species identified for the first time in Lithuania.

Table 1. Taxa of *Dothideomycetes* and *Sordariomycetes* in the alluvial black alder forests and the pine forest affected by cormorants

Taxon	Fungal species number			
	Alluvial black alder forests	Pine forest affected by coormorants	Total species in study forests	% of total species number in study forests
1	2	3	4	5
Dothideomycetes	**46**	**21**	**60**	**35**
Botryosphaeriales	**3**	**1**	**4**	**2,4**
Botryosphaeriaceae	**3**	**1**	**4**	**2,4**
Botryosphaeria	3	-	3	1,8
Sphaeropsis	-	1	1	0,6
Capnodiales	**3**	**-**	**3**	**1,8**
Mycosphaerellaceae	**3**	**-**	**3**	**1,8**
Mycosphaerella	3	-	3	1,8
Dothideales	**1**	**-**	**1**	**0,6**
Dothioraceae	**1**	**-**	**1**	**0,6**
Dothiora	1	-	1	0,6
Hysteriales	**4**	**2**	**5**	**3**
Hysteriaceae	**4**	**2**	**5**	**3**
Gloniella	1	-	1	0,6
Gloniopsis	1	-	1	0,6
Hysterium	2	2	3	1,8
Mytilinidiales	**-**	**2**	**2**	**1,2**
Mytilinidiaceae	**-**	**2**	**2**	**1,2**
Lophium	-	1	1	0,6
Mytilinidion	-	1	1	0,6
Pleosporales	**30**	**13**	**38**	**22**
Cucurbitariaceae	**2**	**1**	**3**	**1,8**
Cucurbitaria	2	-	2	1,2
Curreya	-	1	1	0,6
Didymosphaeriaceae	**1**	**-**	**1**	**0,6**
Didymosphaeria	1	-	1	0,6
Lentitheciaceae	**1**	**2**	**2**	**1,2**
Keissleriella	-	1	1	0,6
Lentithecium	1	1	1	0,6
Leptosphaeriaceae	**8**	**3**	**10**	**6**
Leptosphaeria	7	3	9	5,4
Plenodomus	1	-	1	0,6
Lophiostomataceae	**4**	**-**	**4**	**2,4**
Lophiostoma	4	-	4	2,4
Melanommataceae	**4**	**1**	**4**	**2,4**
Byssosphaeria	2	-	2	1,2
Herpotrichia	1	-	1	0,6
Melanomma	1	1	1	0,6
Montagnulaceae	**1**	**-**	**1**	**0,6**
Kalmusia	1	-	1	0,6
Phaeosphaeriaceae	**4**	**3**	**5**	**3**
Nodulosphaeria	1	-	1	0,6
Ophiobolus	2	2	2	1,2
Ophiosphaerella	1	-	1	0,6
Phaeosphaeria	-	1	1	0,6
Pleosporaceae	**1**	**1**	**2**	**1,2**
Pleospora	1	-	1	0,6
Lewia	-	1	1	0,6
Sporormiaceae	**-**	**1**	**1**	**0,6**
Sporormiella	-	1	1	0,6
Teichosporaceae	**2**	**-**	**2**	**1,2**
Immotthia	1	-	1	0,6
Teichospora	1	-	1	0,6
Testudinaceae	**-**	**1**	**1**	**0,6**
Testudina	-	1	1	0,6
Trematosphaeriaceae	**2**	**-**	**2**	**1,2**
Trematosphaeria	2	-	2	1,2
Strigulales	**-**	**1**	**1**	**0,6**
Strigulaceae	**-**	**1**	**1**	**0,6**
Oletheriostrigula	-	1	1	0,6
Tubeufiales	**1**	**-**	**1**	**0,6**
Tubeufiaceae	**1**	**-**	**1**	**0,6**
Tubeufia	1	-	1	0,6
Dothiodeomycetes incertae sedis	**4**	**2**	**5**	**3**
Astrosphaeriella	1	-	1	0,6
Fenestella	1	-	1	0,6
Kirschsteiniothelia	1	-	1	0,6
Leptospora	1	1	1	0,6
Mycothyridium	-	1	1	0,6
Sordariomycetes	**105**	**17**	**111**	**65**
Boliniales	**4**	**-**	**4**	**2,4**
Boliniaceae	**4**	**-**	**4**	**2,4**
Camaropella	1	-	1	0,6
Camarops	1	-	1	0,6
Endoxyla	1	-	1	0,6

Table 1 (continued)

1	2	3	4	5
Lentomitella	1	-	1	0,6
Calosphaeriales	**1**	**-**	**1**	**0,6**
Calosphaeriaceae	**1**	**-**	**1**	**0,6**
Calosphaeria	1	-	1	0,6
Chaetosphaeriales	**11**	**4**	**11**	**6,4**
Chaetosphaeriaceae	**11**	**4**	**11**	**6,4**
Chaetosphaerella	1	-	1	0,6
Chaetosphaeria	9	3	9	5,1
Lentomita	1	1	1	0,6
Coniochaetales	**2**	**3**	**3**	**1,8**
Coniochaetaceae	**2**	**3**	**3**	**1,8**
Coniochaeta	2	3	3	1,8
Coronophorales	**3**	**1**	**4**	**2,4**
Bertiaceae	**1**	**-**	**1**	**0,6**
Bertia	1	-	1	0,6
Nitschkiaceae	**2**	**1**	**3**	**1,8**
Acanthonitschkea	1	-	1	0,6
Nitschkia	1	1	2	1,2
Diaporthales	**27**	**2**	**28**	**16,3**
Diaporthaceae	**5**	**2**	**6**	**3,6**
Allantoporthe	1	-	1	0,6
Diaporthe	3	-	3	1,8
Phomopsis	1	2	2	1,2
Gnomoniaceae	**10**	**-**	**10**	**6**
Cryptodiaporthe	1	-	1	0,6
Cryptosporella	1	-	1	0,6
Ditopella	1	-	1	0,6
Gnomonia	3	-	3	1,8
Linospora	1	-	1	0,6
Ophiognomonia	1	-	1	0,6
Phragmoporthe	1	-	1	0,6
Plagiostoma	1	-	1	0,6
Melanconidaceae	**3**	**-**	**3**	**1,8**
Melanconis	2	-	2	1,2
Prosthecium	1	-	1	0,6
Pseudovalsaceae	**1**	**-**	**1**	**0,6**
Pseudovalsa	1	-	1	0,6
Sydowiellaceae	**2**	**-**	**2**	**1,2**
Sillia	1	-	1	0,6
Sydowiella	1	-	1	0,6
Togniniaceae	**1**	**-**	**1**	**0,6**
Phaeoacremonium	1	-	1	0,6
Valsaceae	**4**	**-**	**4**	**2,4**
Valsa	4	-	4	2,4
Incertae sedis	**1**	**-**	**1**	**0,6**
Apioporthe	1	-	1	0,6
Hypocreales	**12**	**4**	**14**	**8,2**
Hypocreaceae	**1**	**-**	**1**	**0,6**
Trichoderma	1	-	1	0,6
Nectriaceae	**8**	**4**	**10**	**6**
Dialonectria	1	-	1	0,6
Gibberella	1	2	2	1,2
Nectria	2	2	3	1,8

1	2	3	4	5
Neonectria	2	-	2	1,2
Pleonectria	1	-	1	0,6
Stylonectria	1	-	1	0,6
Niessliaceae	**3**	**-**	**3**	**1,8**
Melanopsamma	1	-	1	0,6
Trichosphaerella	2	-	2	1,2
Magnaporthales	**2**	**-**	**2**	**1,2**
Magnaporthaceae	**2**	**-**	**2**	**1,2**
Ceratosphaeria	2	-	2	1,2
Sordariales	**4**	**-**	**4**	**2,4**
Helminthospha eriaceae	**1**	**-**	**1**	**0,6**
Echinosphaeria	1	-	1	0,6
Lasiosphaeriaceae	**3**	**-**	**3**	**1,8**
Lasiosphaeria	2	-	2	1,2
Ruzenia	1	-	1	0,6
Trichosphaeriales	**3**	**1**	**3**	**1,8**
Trichosphaeriaceae	**3**	**1**	**3**	**1,8**
Eriosphaeria	1	1	1	0,6
Trichosphaeria	2	-	2	1,2
Xylariales	**32**	**1**	**32**	**18,7**
Amphisphaeriaceae	**1**	**-**	**1**	**0,6**
Ceriospora	1	-	1	0,6
Clypeosphaeriaceae	**1**	**-**	**1**	**0,6**
Pseudovalsaria	1	-	1	0,6
Diatrypaceae	**14**	**1**	**14**	**8,1**
Anthostoma	1	-	1	0,6
Diatrype	3	-	3	1,8
Diatrypella	2	1	2	1,2
Eutypa	5	-	5	3
Eutypella	3	-	3	1,8
Xylariaceae	**16**	**-**	**16**	**9,4**
Annulohypoxylon	2	-	2	1,2
Biscogniauxia	1	-	1	0,6
Daldinia	1	-	1	0,6
Entoleuca	1	-	1	0,6
Hypoxylon	4	-	4	2,4
Nemania	3	-	3	1,8
Rosellinia	2	-	2	1,2
Xylaria	2	-	2	1,2
Sordariomycetes incertae sedis	**4**	**1**	**5**	**3**
Hibberina	1	-	1	0,6
Melomastia	1	-	1	0,6
Phomatospora	1	1	2	1,2
Xylomelasma	1	-	1	0,6
In total: 2 classes, 19 orders, 55 families, 114 genera	**151**	**38**	**171**	**100**

Geographical distribution and frequency of *Dothideomycetes* and *Sordariomycetes* in Lithuania

The fungi identified during the research can be divided into five distribution classes of fungi based on the number of their geographical localities in Lithuania (by KUTORGA, 2000): very rare species (1–4 localities of these fungi were identified), rare (5–9), quite rare (10–19), quite common (20–29) and common (>30) (Fig. 1).

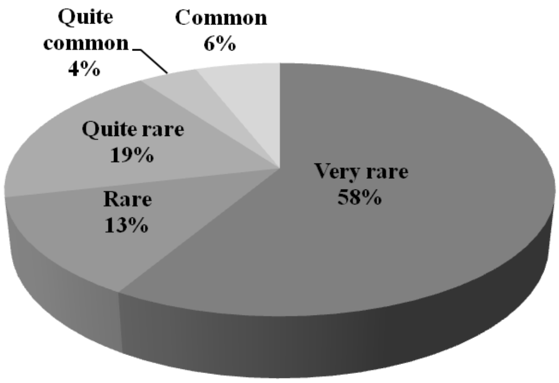

Fig. 1. Distribution of *Dothideomycetes* and *Sordariomycetes* identified during the research by distribution classes in Lithuania

More than half of the total fungi identified during the research in the alluvial black alder forests and the pine forest affected by cormorants are very rare (Fig. 1). It is noteworthy that 70 species out of them were identified for the first time in Lithuania, and 16 species were identified for the second time, therefore the distribution of these fungi in Lithuania has not been fully explored yet.

Analysis of *Dothideomycetes* and *Sordariomycetes* diversity and ecological properties in the alluvial black alder forests and the pine forest affected by cormorant

Characteristics of study zones of alluvial black alder forests

The flora in flooded woods certainly differs from that in non-flooded woods (KARAZIJA, 1988), therefore, Ellenberg's indicator values for soil humidity were used to highlight the differences between the studied alluvial black alder forests zones.

Non-metric multidimensional scaling (nMDS) method showed that Zone III formed separate group which is the farthest from the group of Zones I according to flora in studies zones (Fig. 2).

ANOSIM test showed that differences between three zones are statistically significant ($R = 0.2281$; $p < 0.05$) (Table 2). The groups of Zone I and III differ on the plants species composition ($R = 0.4045$). It is obvious that the soil moisture regime is varying in the examined zones, which is revealed by different identified flora composition.

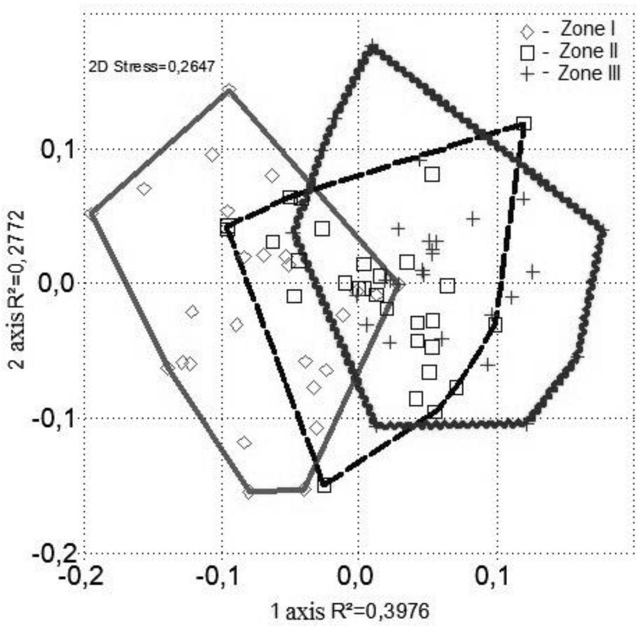

Fig. 2. Non-metric multidimensional scaling (nMDS) of the flora composition in three zones of the alluvial black alder forest (Euclidean's similarity index)
Description: — – indicates group of Zone I, --- – group of Zone II, ⁄\/\/\⁄ – group of Zone III

Table 2. Results of one-way ANOSIM test (based on the Euclidean's similarity index) for differences in groups of three zones of the black alder forest according to the flora (R – ANOSIM statistics, p – probability)

Zones	R	p
I and II	0.1944	0.0003
I and III	0.4045	0.0003
II and III	0.0895	0.003

According to the amount of woody debris in three zones of the alluvial black alder forests it was observed that the amount of this debris depends on the distance to water, i. e. the amount of woody debris decreases when getting closer to water (Fig. 3). Thus, Zone III in all of the studied alluvial black alder forest is characterised by the largest amount of woody debris.

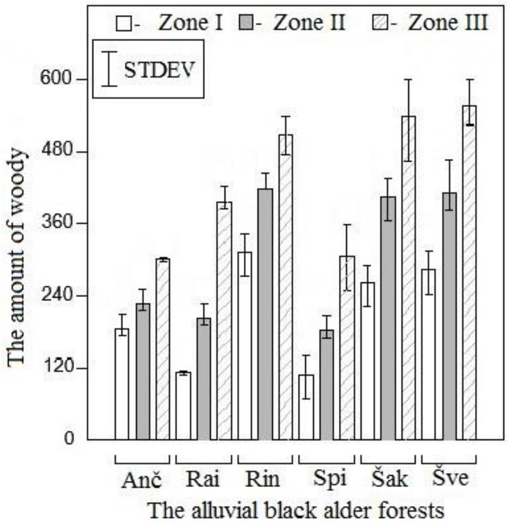

Fig. 3. The amount of woody debris compared in three zones of the alluvial black alder forests (in 100 m^2 plots)
Description: Anč – the northern part of Lake Ančia forest, Rai – Raistas forest, Rin – Rinkotas forest, Spi – Spindžius forest, Šak – Šakeliškės meadows forest, Šve – Šveicarija forest; STDEV – standard deviation

According to the amount of woody debris in Zones I, II and III of the alluvial black alder forests make up respective groups. The group of Zone III is the farthest from the group of Zone I (Fig. 4).

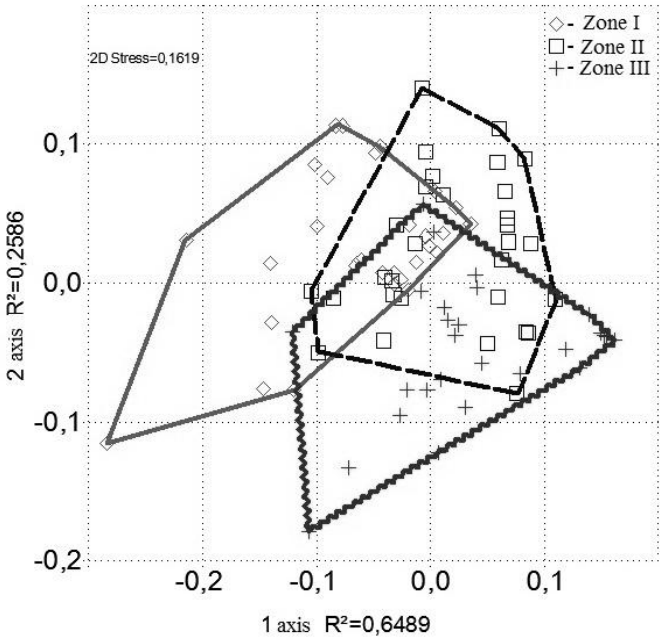

Fig. 4. Non-metric multidimensional scaling (nMDS) of the amount of woody debris composition in three zones of the alluvial black alder forest (Euclidean's similarity index)
Description of zones are the same as in Fig. 2

ANOSIM test showed that differences between three zones are statistically significant (R = 0.2136, p < 0.05) (Table 3). The groups of Zones I and III differ on the amount of woody debris composition (R=0.3688).

Table 3. Results of one-way ANOSIM test (based on the Euclidean's similarity index) for differences in groups of three zones of the alluvial black alder forest according to the amount of woody debris (R – ANOSIM statistics, p – probability)

Zones	R	p
I and II	0.1468	0.0009
I and III	0.3688	0.0003
II and III	0.1085	0.0033

The highest number of species of *Dothideomycetes* and *Sordariomycetes* was identified in the groups of Zone III: from 85 up to 100 % of all fungi were recorded in studied black alder forests. It should be noted that groups of this zone was the most similar by the flora composition and by the amount of wood remains.

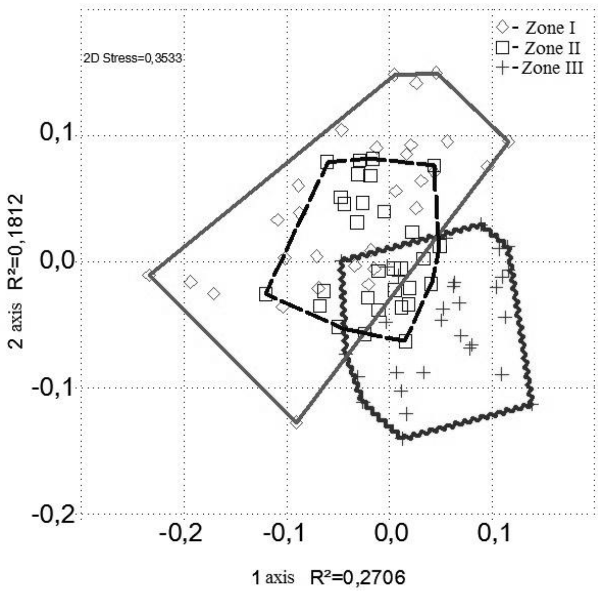

Fig. 5. Non-metric multidimensional scaling (nMDS) of fungal diversity in three zones of the alluvial black alder forest (Jaccard's similarity index)
Description of zones are the same as in Fig.2

nMDS analysis revealed that Zone III of black alder forests make one group which is distanced from other two groups of Zone I and Zone II (Fig. 5). The similarity of Zone III with Zone I and II is considerably lower (Sørensen index: 0.40–0.47). ANOSIM test showed that differences between three zones are statistically significant (R = 0.2227, p <

0.05) (Table 4). The groups of Zone I and III differ on the amount of woody debris composition (R = 0.3751).

Table 4. Results of one-way ANOSIM test (based on the Jaccard's similarity index) for differences in groups of three zones of the alluvial black alder forest according to the fungal diversity (R – ANOSIM statistics, p – probability)

Zones	**R**	**p**
I and II	0.1079	0.0008
I and III	0.3751	0.0001
II and III	0.1878	0.0001

Statistically reliable correlations ($p < 0.001$) of two matrixes: 1) fungal diversity and flora composition based on Ellenberg's indicator values for soil humidity (r_M = 0.1906), and 2) distribution of these fungi and the amount of wood debris in investigated zones (r_M = 0.1627) were obtained by Mantel test (Table 5).

The fungal diversity in the three zones of the alluvial black alder forests it is assumed to be dependent on the following two factors: 1) the soil moisture regime which is revealed by the flora composition based on Ellenberg's indicator values for soil humidity; 2) the amount of wood debris.

Table 5. Standartized (r_{AB}) and partial ($r_{AB.C}$) Mantel values between the three matrixes: the flora composition based on Ellenberg's indicator values for soil humidity (Plants), the amount of woody debris (Debris) and the fungal diversity (Fungi) (r_M – Mantel statistics, p – probability)

A	**B**	**C**	**r_M**	**p**
Fungi	Plants		0.1906	<0.001
Fungi	Debris		0.1627	<0.001
Plants	Debris		0.1157	0.0151
Fungi	Plants	Debris	0.1753	<0.001
Fungi	Debris	Plants	0.1442	<0.001

Characteristics of study zones of pine forest affected by cormorants

Zone B in the pine forest affected by cormorants was characterised by the highest FWD volume (51 m^3/ha), while Zones A and C have less of such debris (25 m^3/ha) (Fig. 6). The FWD volume was to be the lowest in Zones D, E and G (<10 m^3/ha). Zones A and B was characterised by the highest CWD volume (respectively 239 m^3/ha and 285 m^3/ha). The volume of such debris in other zones is below 19 m^3/ha.

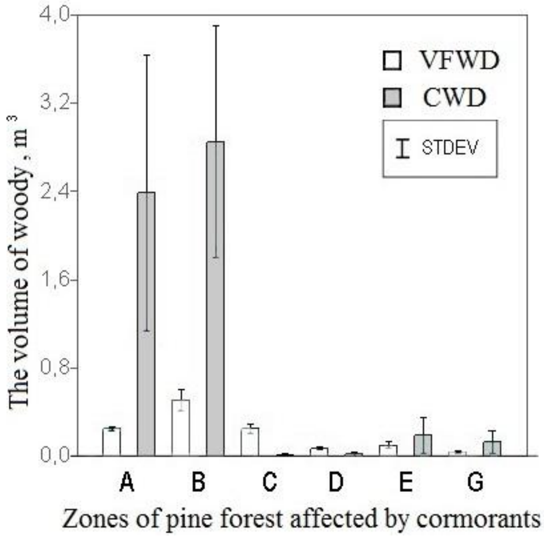

Fig. 6. The volume of woody debris compared in three zones of pine forest affected by cormorants (in 100 m^2 plots).
Description: FWD – fine woody debris, CWD – coarse woody debris. STDEV – standard deviation.

The soil in all of the investigated zones of pine forest affected by cormorants was characterised by high acidity (pH < 5) (Fig. 7).

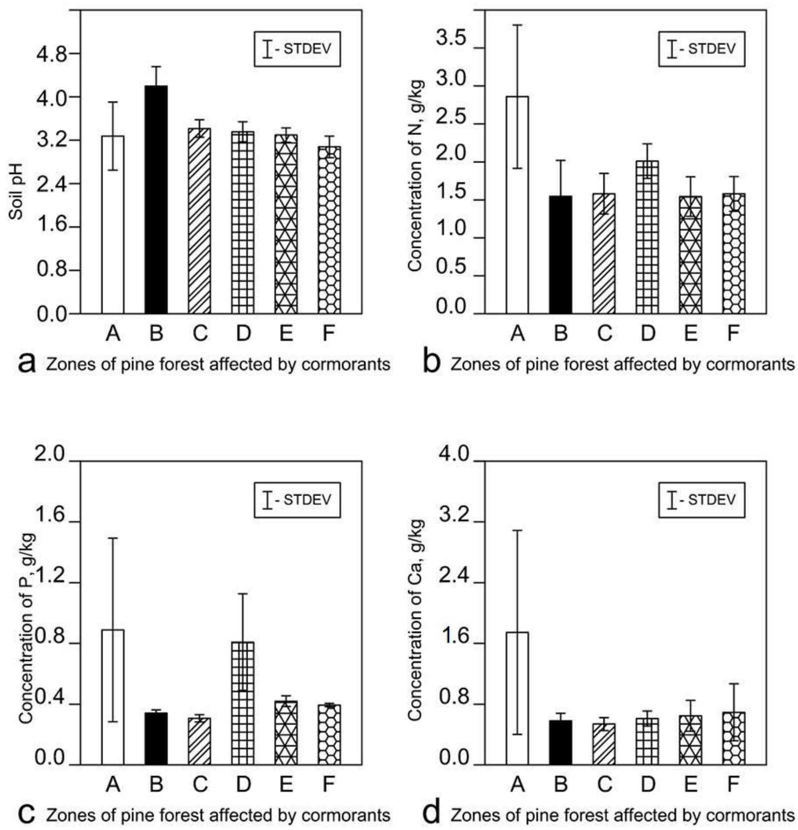

Fig. 7. The pH (a), and the amount of chemical elements N (b), P (c) and Ca (d) of soil in the six zones of the pine forest affected by cormorants
Description: STDEV – standard deviation

The highest amount of total N and P were found in Zones A and D, and also, the highest amount of Ca was also found in Zone A (Fig. 7). The amount of these elements in other pine forest zones slightly differ.

The pH of wood defined in the six zones of pine forest revealed a certain trend: the pH of wood in Zones B, C and D is higher than that in Zones A, E and G (Fig. 8). The highest amounts of total N, P and Ca in wood were found in Zone B, while in Zones A, C, D and E the amount of these elements was consistently decreasing with an increasing distance from the most activity of cormorants zone towards the periphery: the amount of these chemical elements was the lowest in the control Zone G.

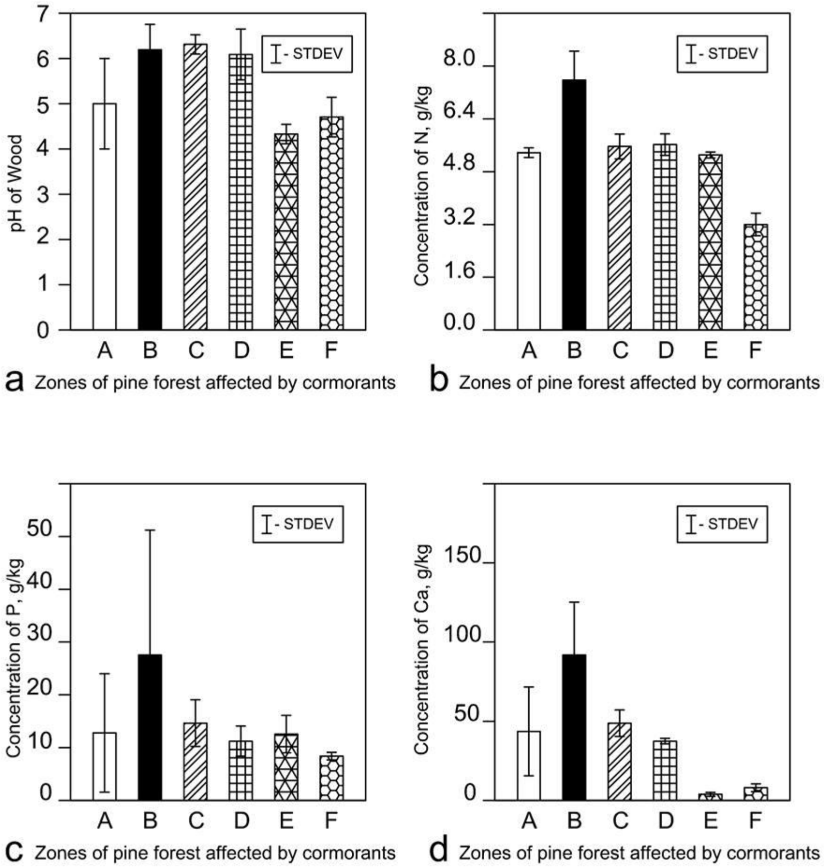

Fig. 8. The pH (a), and the amount of chemical elements N (b), P (c) and Ca (d) of wood in the six zones of the pine forest affected by cormorants
Description: STDEV – standard deviation

Nearly half (47 %) of the identified fungal species were found in Zone D. A similar number of species was defined in Zone A and E (respectively 42 % and 39.5 %). The lowest number of species was found in Zones C (26 %), G (18 %) and B (16 %). Species composition of these zones also show obvious differences from the little or not affected forest parts: the active cormorants zones (Zones A, B, C and D) were similar in the number of species identified therein (Sørensen index: 0.46–0.61). The species composition defined in Zones E and G, which are little affected or not affected by cormorants, it is completely different from Zones A, B, C and D (Sørensen index: 0.18–0.29). Meanwhile, Zones E and G are similar according to the species composition (SI = 0.45).

Sphaeropsis sapinea was one of the most frequently found fungi in all six zones of the studied pine forest. It is noteworthy that *Nectria cinnabarina* was the most frequently found fungi in the active cormorants' zones. It is a fact that mechanically damaged plants are attacked by various biotrophic fungi, for example, the above-mentioned fungi (KESSLER, 1990; ALEXOPOULOS et al., 1996; KUTORGA et al., 2013).

The dependence of *Dothideomycetes* and *Sordariomycetes* species composition on the physical-chemical values (the pH and the amount of N, P, Ca) of soil and wood in the defined colony impact zones is analysed by non-metric multidimensional scaling (Fig. 9).

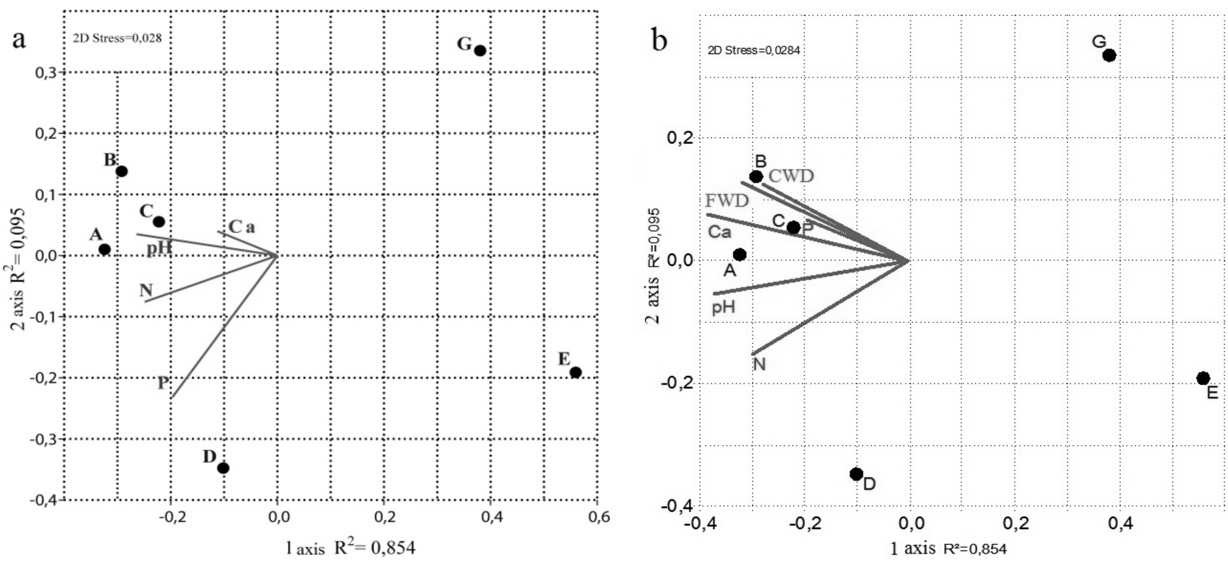

Fig. 9. Non-metric multidimensional scaling (nMDS) of fungal species composition and the physical-chemical values (the pH and the amount of N, P, Ca) of soil (a) and wood (b) and the volume of FWD and CWD (b) in six zones of the pine forest affected by cormorants (Jaccard's similarity index)
Description: FWD – fine woody debris, CWD – coarse woody debris

Zones E and G are the most distant from the others (joined in I group) – the fungal species composition identified therein differs from other zones (Fig. 9). According to the physical-chemical values of soil and wood and the amount of woody volume in Zones A, B and C consists of II group. D zone comes separately from the other zones (III group). ANOSIM test showed that the above-mentioned groups of zones have statistically reliable differences ($R = 0.8636$, $p < 0.05$).

Mantel test was not sufficient to define statistically reliable correlations between the fungal species composition and the physical-chemical values of the soil ($r_M = -0.1636$, $p > 0.05$), and between the fungal species composition and the wood volume ($r_M = -0.1665$, $p = 0.7748$). The statistically reliable correlation was obtained between the studied fungal species composition and the physical-chemical values of wood ($r_M = 0.3522$, ($p < 0.001$). Thus, a conclusion can be made that the fungal species composition in the pine forest affected zones depends on the physical-chemical values of the wood.

Table 6. Standartized (r_{AB}) and partial ($r_{AB.C}$) Mantel values between the three matrixes: flora composition based on the physical-chemical values of the wood (Chemistry), the amount of woody debris (Debris) and the fungal diversity (Fungi) (r_M – Mantel statistics, p – probability)

A	B	C	r_M	p
Fungi	Chemistry		0.3522	<0.001
Fungi	Debris		-0.1665	0.7748
Chemistry	Debris		0.4409	0.0621
Fungi	Chemistry	Debris	0.4809	<0.001
Fungi	Debris	Chemistry	-0.3831	0.9749

Trophic structure and relations with host plant of *Dothideomycetes* and *Sordariomycetes* in the alluvial black alder forests and the pine forest affected by cormorants

The identified fungi belong to two trophic groups: primary saprotrophs (facultative saprotrophs and facultative parasites) and secondary saprotrophs (including the fungi growing on dead debris and dead stromata of other fungi). Most of identified *Dothideomycetes* and *Sordariomycetes* (81 %) in the studied forests belong to secondary saprotrophs (in the alder forests – 78 %, in the pine forest – 95 %). According to some literature sources, *Dothideomycetes* and *Sordariomycetes* of these trophic groups are the most often found (ALEXOPOULOS et al., 1996; BARR, HUHNDORF, 2001; SAMUELS, BLACKWELL, 2001).

Primary saprotrophs often grow on mechanically damaged plants or on plants that are weakened for any reasons and afterwards continue their development on dead debris of these plants (CHLEBICKI, 1995; CHLEBICKI et al., 1996; CANNONN, SUTTON, 2004). The number of these fungi (19 %) in the studied forests was defined to be several times lower than that of secondary saprotrophs.

Dothideomycetes and *Sordariomycetes* of the alluvial black alder forests and pine forest affected by cormorants were found on 31 species of host plants that belong to 21 plant families (in the alder forest the identified fungi were found on 27 host plants species belonging to 18 plant families, in the pine forest – on six host plants species belonging to six families).

The greatest number of the fungi (67 %) was identified on *Betulaceae* host plants. J. RUKŠĖNIENĖ (1992) also revealed that the highest number of *Dothideomycetes* and *Sordariomycetes* is found on *Betulaceae* host plants. 19 % of the fungi are identified on *Corylaceae* plants. It is noteworthy that in the pine forest fungi were absent on woody plants of *Betulaceae* and *Corylaceae*. 58 % of the identified fungi in this forest were found on *Pinaceae* trees.

Preference for substrate type of *Dothideomycetes* and *Sordariomycetes* in the alluvial black alder forests and the pine forest affected by cormorants

In the alluvial black alder forests and the pine forest affected by cormorants *Dothideomycetes* and *Sordariomycetes* fungi were identified on 16 types of substrata.

The greatest number of fungal species (63 %) was identified on dead lying branches. One fourth of the studied fungi were identified on dead lying twigs. The results of the research correspond to the literature data: the greatest number of fungi is found on the above-mentioned branches and twigs (CHLEBICKI et al., 1996; RUKŠĖNIENĖ, 1996; IRŠĖNAITĖ, TREIGIENĖ, 2001; IZNOVA, RUKŠĖNIENĖ, 2012).

A cluster analysis was performed in order to identify the fungal species composition on a certain substrata (Fig. 10). Seven groups of the studied fungi were distinguished by types of substrata: 1) alive twigs and branches, dry twigs and branches, 2) dead lying twigs and branches, 3) alive trunks, dead lying trunks and stumps, 4) overwintered stems and leaves, 5) cones and needles, 6) roots and 7) old fungal stromata.

The analysis supports the above discussed trend: fungi of *Dothideomycetes* and *Sordariomycetes* are distinguished by their preference for substrata. It was identified that the species composition of dead lying twigs and branches is similar (Bray Curtis index, BCI = 20 %).

The group of alive trunks, dead lying trunks and stumps is important as it combines the mycobiota of coarse woody debris. It should be noted that the fungal species composition of dead lying and standing trunks is the most similar (BCI = 53 %) (Fig. 10).

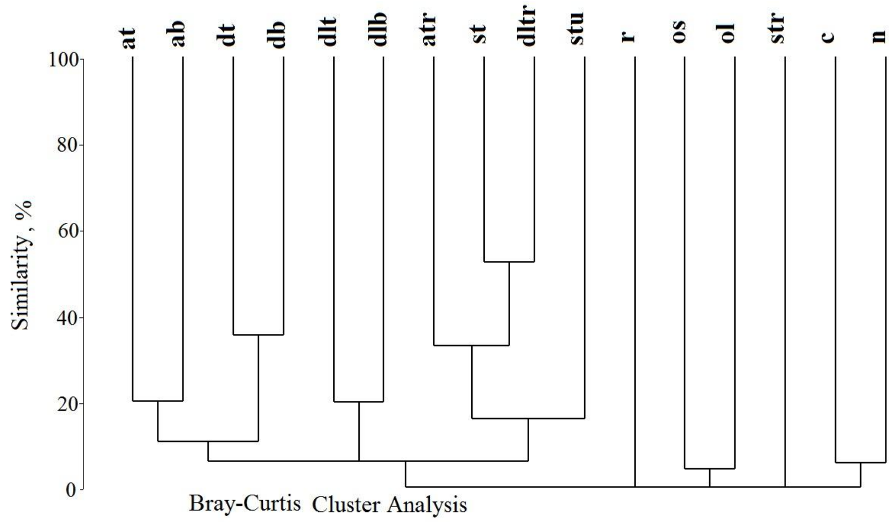

Fig. 10. Dendrogram of fungal species composition and their distribution on substrata type
Description: at – alive twig, ab – alive branch, dt – dry twig, db – dry branch, dlt – dead lying twigs, dlb – dead lying branch, atr – alive trunk, dltr – dead lying trunks, st – stumps, os – overwintered stems, ol – overwintered leaves, c – cones, n –needles, r – roots, str – old fungal stromata

In the alluvial black alder forests and the pine forest affected by cormorants fungi of *Dothideomycetes* and *Sordariomycetes* were found on bark and wood (relatively 43 % and 40 %). The fungal species composition of bark and wood is very similar (Sørensen index = 0.81). The results of the alder forests study revealed that the most of identified fungi were found on wood (62 %). On the contrary, the following trend was observed in the pine forest: the most of fungi were found on bark (62 %).

According to literature data, the diameter of woody plant debris is relevant to the fungal diversity and distribution (HEILMANN-CLAUSEN, CHRISTENSEN, 2004; ABREGO, SALCEDO, 2011).

Dothideomycetes and *Sordariomycetes* fungi of the alluvial black alder forests and the pine forest affected by cormorants were identified on very fine woody debris (VFWD), fine woody debris (FWD) and coarse woody debris (CWD) (Fig. 11).

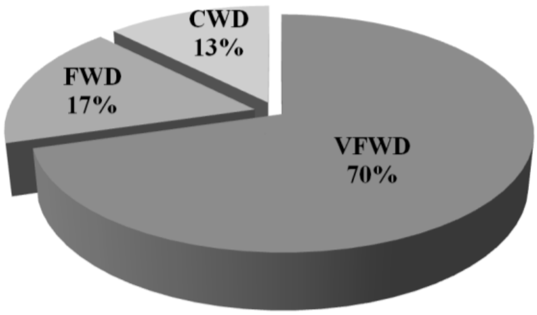

Fig. 11. The number of *Dothideomycetes* and *Sordariomycetes* species in the alluvial black alder forests and the pine forest affected by cormorants according to the diameter classes of woody debris
Description: VFWD – very fine woody debris, FWD – fine woody debris, CWD – coarse woody debris

70 % of all fungi of woody plants were found on very fine woody debris (in the alder forests – 75 %, in the pine forest – 71 %). These results are also supported by the data of other studies (RUKŠĖNIENĖ, 1991; NORDÉN et al., 1997; NORDÉN et al., 2004; IZNOVA, RUKŠĖNIENĖ, 2011). Certainly, very fine woody debris undergo constant microclimate variations, namely moisture and temperature, however fungi of *Dothideomycetes* and *Sordariomycetes* developed adaptations that help them to survive these extreme conditions (BODDY, HEILMANN-CLAUSEN, 2008).

Most similar mycobiota was recorded on fine woody debris and coarse woody debris (BCI = 59 %) (Fig. 12).

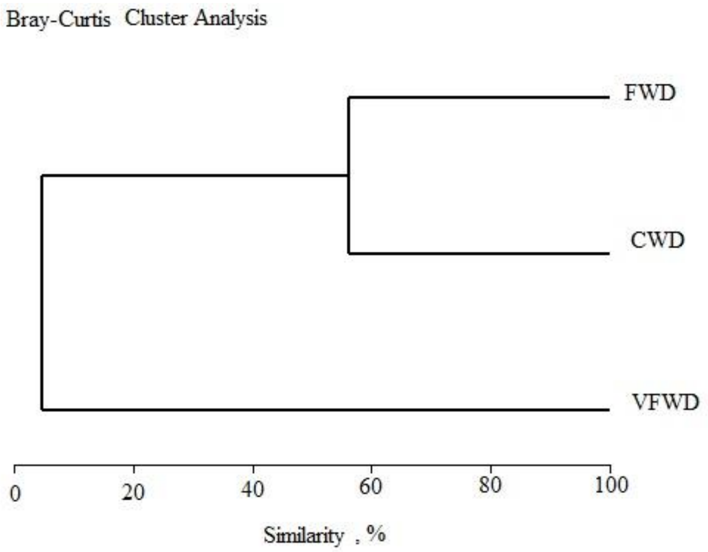

Fig. 12. Dendrogram of fungal species composition and their distribution on different diameter class of woody debris
Description: VFWD – very fine woody debris, FWD – fine woody debris, CWD – coarse woody debris

According to our data, fungal species grow on overwintered stems, which are varying in diameter. These stems belonged to three diameter classes: Isk (diameter of stems is <1 cm), IIsk (1–1.9 cm), IIIsk (2–4.9 cm) (Fig. 13).

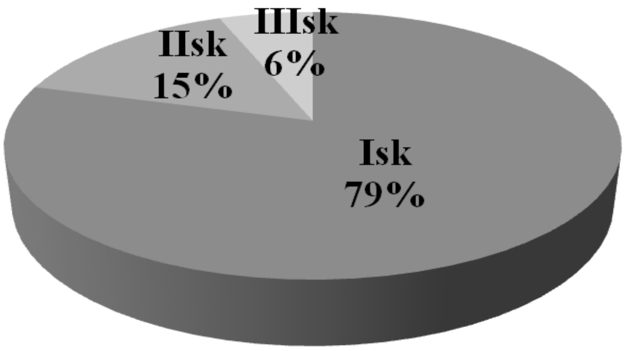

Fig. 13. The number of *Dothideomycetes* and *Sordariomycetes* species in the alluvial black alder forests and the pine forest affected by cormorants according to the diameter classes of owerwintered stems

The greatest number of *Dothideomycetes* and *Sordariomycetes* species (79 %) in the alluvial black alder forests and the pine forest affected by cormorants were found on Isk stems. The smallest number of these fungi was identified on stems of IIsk diameter class (15 %) and on IIIsk (6 %).

Fungi of *Dothideomycetes* and *Sordariomycetes* of the alluvial black alder forests and the pine forest affected by cormorants were identified on various decay stage woody debris (RENVALL, 1995; MÜLLER–USING, BARTSCH, 2009; ABREGO, SALCEDO, 2011): early wood decay stage (DS1), medium wood decay stage (DS2) and late wood decay stage (DS3) (Fig. 14).

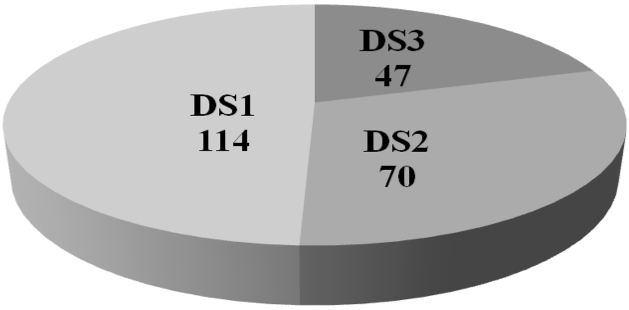

Fig. 14. The number of *Dothideomycetes* and *Sordariomycetes* species in the alluvial black alder forests and the pine forest affected by cormorants according to the decay stage of woody debris
Description: DS1 – early wood decay stage woody debris, DS2 – medium wood decay stage, DS3 – late wood decay stage

The greatest number of *Dothideomycetes* and *Sordariomycetes* species in the alluvial black alder forests (63 %) and the pine forest affected by cormorants (62 %) was identified on early decay stage woody debris. Thus it can be stated that with the increasing wood decay degree, the diversity of fungi is decreasing.

According to B. NORDÉN et al. (1997), most of the recorded fungi were found on medium decay stage woody debris. The works performed by other scientists (RUKŠĖNIENĖ, 1991; ABREGO, SALCEDO, 2011) also support the research data, i. e. the fungi are mostly established on early decay stages woody debris, while very few fungi are found on late decay stage debris.

The most similar mycobiota was recorded on medium and late decay stage wody debris (BCI = 54 %) (Fig. 15).

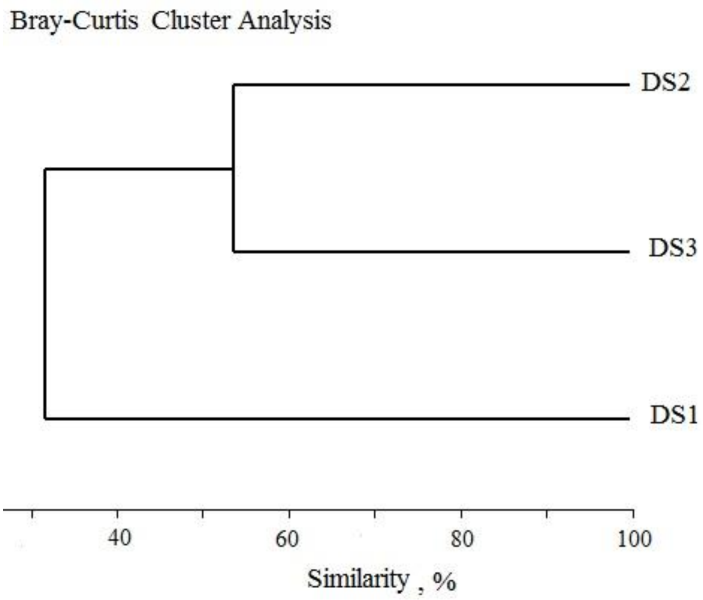

Fig. 15. Dendrogram of fungal species composition and their distribution on different decay stage of woody debris
Description: DS1 – early wood decay stage woody debris, DS2 – medium wood decay stage, DS3 – late wood decay stage

The results of the research showed that specific mycobiota establishes on debris of different decay stages (Fig. 15).

CONCLUSIONS

1. A total of 171 *Dothideomycetes* and *Sordariomycetes* species were identified in the alluvial black alder forests (151 species) and in the pine forest affected by cormorants (38 species). These fungi belong to 104 genera, 55 families, 19 orders. The greatest number of fungal species was recorded in *Sordariomycetes* (111 species) class, the lowest – in *Dothideomycetes* (60). 72 fungal species were identified for the first time in Lithuania.

2. The distribution of *Dothideomycetes* and *Sordariomycetes* species identified in Lithuania varied: 58 % of all identified species of fungi belong to very rare fungi groups, 19 % are quite rare, 13 % – rare, 6 % – common and 4 % – quite common groups.

3. The species composition of *Dothideomycetes* and *Sordariomycetes* in the alluvial black alder forests statistically significant depends on the soil moisture regime and on the amount of wood debris.

4. The species composition of *Dothideomycetes* and *Sordariomycetes* and their distribution in the pine forest affected by cormorants depends on the cormorant activity. Most diversity (47 %) of these fungi was recorded in strongly cormorant affected zones. Different species composition of the study fungi is formed in different cormorant activity zones.

5. The species composition of *Dothideomycetes* and *Sordariomycetes* in the pine forest affected by cormorants' zones depends on the physical-chemical properties of the wood (the total amount of N, P and Ca). Statistically significant influence of the physical-chemical properties of the soil and of the volume of woody debris to identified fungal species composition was not detected.

6. *Dothideomycetes* and *Sordariomycetes* fungi are important saprotrophs in the alluvial black alder forests and in the pine forest affected by cormorants: the greatest number of fungal species (in the alder forests – 78 %, in the pine forest – 95 %) belong to secondary saprotrophs, the lowest – belong to primary saprotrophs. It was identified that the cormorant activity determined the distribution of some fungi: on various wood and herbaceous plant debris was identified coprotrophic *Sporormiella leporina* and biotrophs *Sphaeropsis sapinea* and *Nectria cinnabarina* were recorded in strongly cormorant affected zones.

7. The diversity and distribution of *Dothideomycetes* and *Sordariomycetes* fungi depends on the type and diameter of substrata. Most similar mycobiota was of dead lying twigs and branches, and also, these substrata were the most relevant to the distribution of the fungi. The greatest number of fungal species (in the alder forests – 75 %, in the pine forest – 71 %) was found on very fine woody debris (the diameter <4.9 cm). Most similar mycobiota was recorded on fine woody debris and coarse woody debris. The fungi of herbaceous plants are found on very fine dead stems.

8. The early wood decay stage debris are the most important to *Dothideomycetes* and *Sordariomycetes* – on these woody debris was registered the greatest number of fungal species (in the alder forests – 63 %, in the pine forest – 62 %). Most similar mycobiota was recorded on medium and late wood decay stage debris.

LIST OF PUBLICATIONS

IZNOVA T., RUKŠĖNIENĖ J., 2012: Ascomycete species new to Lithuania. – Botanica Lithuanica, **18(1)**: 35–39.

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SANTRAUKA

Aukšliagrybūnų (*Ascomycota*) skyriui priklausantys dotidėjomicetų (*Dothideomycetes*) ir sordarijomicetų (*Sordariomycetes*) klasių grybai yra svarbūs miškų ekosistemų komponentai, dalyvauja įvairiuose ekologiniuose procesuose. Jie yra įvairių augalų endofitai, gyvūnų bei augalų parazitai, simbiotrofai ir saprotrofai (BARR, HUHNDORF, 2001; SAMUELS, BLACKWELL, 2001; KÜFFER, SENN-IRLET, 2005; KÜFFER et al., 2008).

Dotidėjomicetai ir sordarijomicetai pasižymi didele substratų įvairove: jie įsikuria ant sumedėjusių ir žolinių augalų įvairių dalių, gyvūnų ekskrementų gali būti tiesiogiai ar netiesiogiai susiję su kitais gyvais organizmais, pavyzdžiui, gyvūnais ir grybais.

Dauguma dotidėjomicetų ir sordarijomicetų yra mikroskopiniai ir sunkiai plika akimi pastebimi grybai, todėl nenuostabu, kad jie yra nepakankamai ištirti ne tik pasaulyje (BARR, HUHNDORF, 2001; SAMUELS, BLACKWELL, 2001) bet ir Lietuvoje (Iznova, Rukšėnienė, 2012).

Literatūroje paskelbta įvairių duomenų apie Lietuvoje aptiktus dotidėjomicetus ir sordarijomicetus (CHLEBICKI, TREIGIENE, 1995; RUKŠĖNIENĖ, 1996; IRŠĖNAITĖ, TREIGIENĖ, 2001; RUKŠĖNIENĖ, IZNOVA, 2007; IZNOVA, RUKŠĖNIENĖ, 2011 ir kiti), tačiau iki 2011 m. nėra atlikta išsamių mikosociologinių tyrimų, skirtų išaiškinti šių grybų rūšių paplitimo priklausomybę nuo aplinkos veiksnių. Be to, retų ir saugomų buveinių grybams skirta mažai dėmesio. Žinios apie grybų rūšių įvairovę ir paplitimo dėsningumus yra svarbios norint geriau suprasti šių buveinių funkcionavimą bei siekiant efektyviau organizuoti jų apsaugą.

Lietuvoje nustatytos Europos mastu svarbios saugomos aliuvinių miškų (91E0) buveinės (RAŠOMAVIČIUS, 2012), tačiau duomenų apie jose atliktus mikologinius tyrimus nėra. Apie kitos svarbios Valstybės saugomos teritorijos, būtent Kuršių nerijos nacionalinio parko, dotidėjomicetus ir sordarijomicetus taipogi trūksta mokslinės informacijos. Kuršių nerijos sename pušyne ties Juodkrante įsikūrusi didžiausia ir viena seniausių Lietuvoje didžiųjų kormoranų kolonija, kuri sukeldama stiprų hipertrofikacijos poveikį pažeidė pušyno gyvybingumą ir sudarė specifines ekologines sąlygas kitų organizmų vystymuisi šiame miške (ADAMONYTĖ et al., 2013; KUTORGA et al., 2013; MOTIEJŪNAITĖ et al., 2014).

Šiuo darbu siekta pagilinti žinias apie aliuvinių miškų bei kormoranų pažeisto pušyno sumedėjusių ir žolinių augalų dotidėjomicetų ir sordarijomicetų įvairovę, funkcijas, paplitimą bei jų bendrijų dinamikos priklausomybę nuo kai kurių ekologinių veiksnių.

Darbo tikslas – ištirti dotidėjomicetų (*Dothideomycetes*) ir sordarijomicetų (*Sordariomycetes*) įvairovę bei ekologines ypatybes aliuviniuose juodalksnynuose ir kormoranų pažeistame pušyne.

Darbo uždaviniai:

1. Nustatyti dotidėjomicetų ir sordarijomicetų rūšių įvairovę skirtingų Lietuvos geografinių vietų aliuviniuose juodalksnynuose bei Kuršių nerijos kormoranų pažeistame pušyne.
2. Sudaryti tyrimų metu aptiktų ir identifikuotų dotidėjomicetų ir sordarijomicetų sąvadą bei aprašyti naujas Lietuvai grybų rūšis.
3. Nustatyti dotidėjomicetų ir sordarijomicetų paplitimo dažnį, prieraišumą substratui bei atlikti šių grybų rūšinės sudėties taksonominę ir trofinę analizes.
4. Įvertinti abiotinių (dirvožemio ir medienos fizikinės-cheminės savybės) ir biotinių (kormoranų veiklos aktyvumas, medienos liekanų kiekis ir tūris) veiksnių įtaką dotidėjomicetų ir sordarijomicetų rūšių įvairovei bei paplitimui.

Ginami teiginiai:

1. Aliuviniuose juodalksnynuose dotidėjomicetų ir sordarijomicetų rūšinė sudėtis bei paplitimas priklauso nuo abiotinių ir biotinių veiksnių, ypač nuo dirvožemio drėgmės režimo bei medienos liekanų kiekio.
2. Kormoranų pažeisto pušyno dotidėjomicetų ir sordarijomicetų rūšinė sudėtis bei paplitimas priklauso nuo kormoranų veiklos aktyvumo.
3. Sumedėjusių augalų dotidėjomicetams ir sordarijomicetams svarbiausios yra ankstyvosios suirimo stadijos labai smulkios medienos liekanos, o žolinių augalų tirtiems grybams – labai smulkūs pernykščiai stiebai.

Darbo naujumas. Darbe pirmą kartą detaliai ištirta Lietuvos aliuvinių juodalksnynų ir kormoranų pažeisto pušyno dotidėjomicetų ir sordarijomicetų rūšių įvairovė bei paplitimas. Sudarytas tirtuose miškuose aptiktų dotidėjomicetų ir sordariomicetų sąvadas. Išaiškintos 72 naujos Lietuvai grybų rūšys, pateikti jų originalūs aprašymai. Pirmą kartą Lietuvoje įvertinta aplinkos veiksnių įtaka sumedėjusių bei žolinių augalų dotidėjomicetų ir sordarijomicetų įvairovei.

Mokslinė ir praktinė darbo reikšmė. Tyrimų rezultatai papildė žinias apie Lietuvos dotidėjomicetų ir sordarijomicetų įvairovę bei paplitimą, todėl šie duomenys gali būti panaudoti rengiant daugiatomį leidinį „Lietuvos grybai". Gauti rezultatai suteikė naujos informacijos apie šių aukšliagrybūnų biologiją, atskleidė jų ekologijos ypatumus. Darbo rezultatai pagilino žinias apie dotidėjomicetų ir sordarijomicetų paplitimo dėsningumus Europoje saugomuose aliuviniuose miškuose, kas yra svarbu šių buveinių biologinės įvairovės išsaugojimui. Kormoranų pažeistame pušyne nustatyti tirtų grybų rūšinės sudėties ir paplitimo ypatumai leidžia įvertinti paukščių sukeliamos hipertrofikacijos poveikį pušyno mikobiotai. Tyrimų metu surinkta nemaža dotidėjomicetų ir sordarijomicetų pavyzdžių kolekcija, kuri saugoma Vilniaus universiteto herbariume (WI).

Išvados

Tyrimų metu nustatyta 171 dotidėjomicetų (*Dothideomycetes*) ir sordarijomicetų (*Sordariomycetes*) klasių rūšis: šešiuose aliuviniuose juodalksnynuose identifikuota 151 rūšis, o kormoranų pažeistame pušyne – 38 rūšys. Šios grybų rūšys priklauso 104 gentims, 55 šeimoms ir 19 eilių. Daugiausia grybų rūšių (111 rūšių) priklauso sordarijomicetams, o beveik dvigubai mažiau (60) – dotidėjomicetams. Pirmą kartą Lietuvoje nustatytos 72 grybų rūšys.

Identifikuotų dotidėjomicetų ir sordarijomicetų rūšių dažnumas Lietuvoje skyrėsi: 58 % visų nustatytų rūšių priklauso labai retų, 19 % – gana retų, 13 % – retų, 6 % – dažnų ir 4 % – gana dažnų grybų grupėms.

Dotidėjomicetų ir sordarijomicetų rūšinė sudėtis tirtuose aliuviniuose juodalksnynuose statistiškai reikšmingai priklauso nuo dirvožemio drėgmės režimo bei medienos liekanų kiekio.

Dotidėjomicetų ir sordarijomicetų rūšių bei jų radimo atvejų skaičius kormoranų pažeistame pušyne priklauso nuo kormoranų veiklos aktyvumo. Labiausiai pažeistose pušyno zonose nustatyta didžiausia (47 %) šių grybų įvairovė. Skirtingose kormoranų veiklos aktyvumo zonose formuojasi skirtinga grybų rūšinė sudėtis.

Dotidėjomicetų ir sordarijomicetų rūšinė sudėtis kormoranų pažeisto pušyno zonose priklauso nuo medienos fizikinių-cheminių savybių (bendrųjų azoto (N) ir fosforo (P) bei kalcio (Ca) kiekio). Dirvožemio fizikinės-cheminės savybės ir medienos liekanų tūris grybų sudėčiai statistiškai reikšmingos įtakos neturėjo.

Dotidėjomicetai ir sordarijomicetai yra svarbūs saprotrofai aliuviniuose juodalksnynuose ir kormoranų pažeistame pušyne: didžiausia identifikuotų grybų dalis (juodalksnynuose – 78 %, pušyne – 95 %) priklauso antriniams saprotrofams, o žymiai mažesnė – pirminiams saprotrofams. Kormoranų veikla sąlygoja tam tikrų grybų paplitimą: kormoranų kolonijos aktyvios veiklos zonose ant įvairių sumedėjusių ir žolinių augalų liekanų buvo aptinkamas koprotrofas *Sporormiella leporina* bei labai dažnai aptinkami parazitiniai grybai *Sphaeropsis sapinea* ir *Nectria cinnabarina*, nustatomi ant pažeistų augalų.

Nustatyta dotidėjomicetų ir sordarijomicetų rūšių įvairovės bei paplitimo priklausomybė nuo substrato tipo ir jo skersmens. Labiausiai tarpusavyje panaši nukritusių šakelių ir tokių pačių šakų grybų rūšinė sudėtis, be to, šie substrato tipai buvo svarbiausi tirtų grybų paplitimui. Aliuviniuose juodalksnynuose ir kormoranų pažeistame pušyne didžiausia dalis grybų (juodalksnynuose – 75 %, pušyne – 71 %) nustatyta ant labai smulkių medienos liekanų (skersmuo yra iki 4,9 cm). Smulkių ir stambių medienos liekanų grybų rūšinė sudėtis buvo panaši. Žolinių augalų dotidėjomicetai ir sordarijomicetai dažniausiai buvo aptinkami ant stiebų, kurių skersmuo yra mažesnis nei 1 cm.

Dotidėjomicetams ir sordarijomicetams svarbiausios ankstyvosios suirimo klasės liekanos – ant jų nustatyta daugiausiai tirtų grybų (juodalksnynuose – 63 %, pušyne – 62 %). Šios suirimo klasės liekanų grybų rūšinė sudėtis skiriasi nuo tarpinės ir vėlyvosios suirimo klasių liekanų, kurių mikobiota buvo panaši.