Acta Mycologica

DOI: 10.5586/am.1067

Publication history
Received: 2015-11-03
Accepted: 2016-01-08
Published: 2016-01-29

Handling editor
Tomasz Leski, Institute of Dendrology of the Polish Academy of Sciences, Poland

Authors' contributions
All authors: collecting and identification of the materials; MRM, MWr, JP, CT, JS: writing the manuscript; MRM, MWr, JP: designing the study; MWi: text proofreading and identification of selected materials

Funding
The works in Biele Suchowolskie fen in 2008/2009 were carried out as a part of a grant from the Polish Ministry of Science and Higher Education (No. NN305433933). The study was also partially supported by the University of Łódź (grant No. 506/1144 in 2015). Funding from EU through the European Social Fund, contract number UDA-POKL.04.01.01-00-072/09-00 to MWi is acknowledged.

Competing interests
No competing interests have been declared.

Citation
Ruszkiewicz-Michalska M, Bałazy S, Chełkowski J, Dynowska M, Pawłowska J, Sucharzewska E, et al. Preliminary studies of fungi in the Biebrza National Park (NE Poland). Part III. Micromycetes – new data. Acta Mycol. 2015;50(2):1067. http://dx.doi.org/10.5586/am.1067

ORIGINAL RESEARCH PAPER

Preliminary studies of fungi in the Biebrza National Park (NE Poland). Part III. Micromycetes – new data

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Abstract
Ecological information concerning 292 fungal taxa is reported as a result of two surverys in the Biebrza National Park. Most data presented come from the 5-day all-fungi inventory of the Polish Mycological Society in 2013, and 47 species were recorded during studies in the Biele Suchowolskie fen in 2008/2009. In total, 27 species of zygomycetes, 232 ascomycetes (including anamorphs) and 27 basidiomycetes (mainly Pucciniales). Additionaly some representatives of fungi-like organisms from Stramenopiles (4 species) and Dictyostelia (2) were identified. Fungal groups included were the same as in the previous survey in 2012: 190 taxa associated with plants, 15 with animals, 8 with fungi and 71 isolated from soil, plant debris and animal excrements. The most numerous were anamorphic ascomycetes (159 species). Nineteen species have not been previously known from Poland and 31 species are rare (1–3 localities). For the Biebrza National Park 197 species (67.5%) are new.

Keywords
all-species inventory; micromycetes; plant parasites; arthropod pathogens; soil fungi; fungal ecology; protected area

This paper is dedicated to Professor Maria Lisiewska and Professor Anna Bujakiewicz on the occasion of their 80th and 75th birthday, respectively.

Introduction

The all-fungi inventory carried out by the Polish Mycological Society (PMS) was organized in the Biebrza National Park (BbNP) in 2012 and 2013. The results of the first year of study as well as general state of knowledge about BbNP natural environment were presented in 2012 [1,2]. Although the studies in 2013 were continuation of the

first inventory, they were focused on new, previously unexplored areas. The aim of this paper is to present new data on micromycetes associated with plants, fungi and animals. Most of them were collected in 2013 during the second survey of PMS in the BbNP. Some additional materials from 2012, previously unpublished, are also included here. These data are supplemented with unpublished results of the earlier study (2008/2009) devoted to soil- and litter-inhabiting micromycetes of burnt and unburnt areas of the Biele Suchowolskie fen [3].

A synopsis of macromycetes collected during the same survey in 2013 is given in the paper by Kujawa and co-workers in this issue [4].

Material and methods

The materials were collected on 26–31 Aug. 2013 during all-fungi inventory of the PMS in 5 protective units (Brzeziny, Grzędy, Kapice, Osowiec, Werykle) and on 20 Jun. 2008 and 15 Oct. 2009 at the Biele Suchowolskie fen (Kopytkowo protective unit). Six localities (Fig. 1) and seven habitats were screened: *Caricion nigrae* alliance, continental swamp/bog pine forest (*Vaccinio uliginosi-Pinetum*), *Filipendulion alliance* with *Deschampsia cespitosa* (L.) Beauv., Middle-European alder fen forest (*Carici elongatae-Alnetum*), moderately moist, wet meadow with *Festuca rubra* L., *Salicetum pentandro-cinereae* in association with *Urtica dioica* L., subatlantic swamp birch forest (*Vaccinio uliginosi-Betuletum pubescentis*), subcontinental lime-oak-hornbeam forest (*Tilio-Carpinetum*). The characteristics of particular sites including plant community

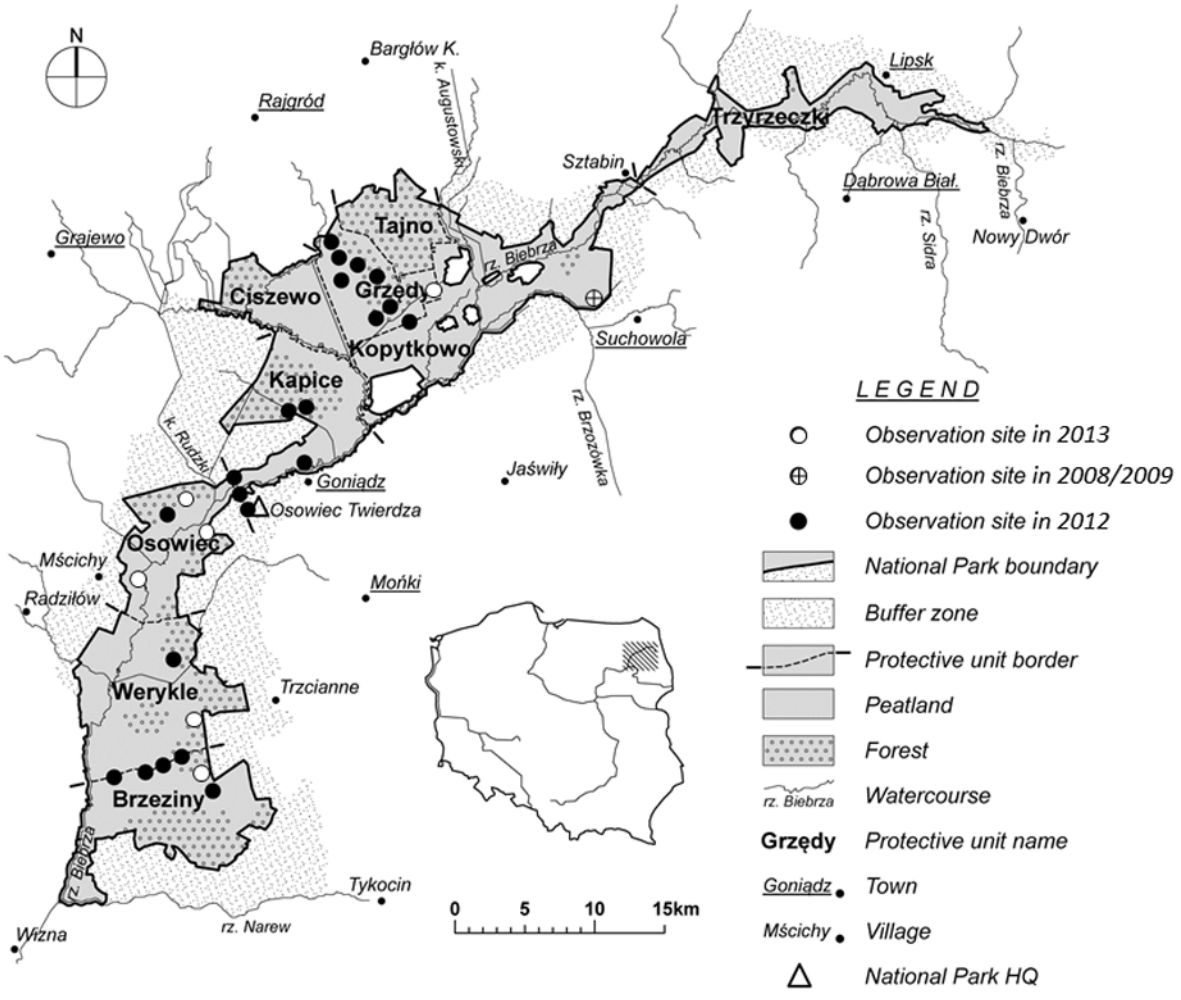

Fig. 1 Localization of observation sites in the Biebrza National Park ([2], modified).

information (if available) is given in detailed part of the "Results" chapter. Fungi were also collected in deciduous and mixed forests (without determination of their syntaxonomic affinity) and from other habitats, including forest edges, causeways, roadsides, pathways, meadows, etc. More detailed characteristics of sites from Kopytkowo protected unit were provided by several authors [3,5–7].

Fungi were collected and identified according to taxon-specific methods [8–26]; for details see first part of the inventory in BbNP [1]. Host plant species were determined using the key by Rutkowski [27]. Taxonomic system of fungi and fungus-like organisms of Adl et al. [28] and Hibbett et al. [29] is adopted, while nomenclature follows Keller [30], Humber [31], Mułenko et al. [32], and Index Fungorum [33]. Names of plants and arthropods are given after Mirek et al. [34] and Schaefer [35], respectively, while syntaxonomic nomenclature follows Matuszkiewicz [36].

The specimens documenting research are deposited in the Herbarium of the Faculty of Biology, University of Warsaw (WA), in the Fungal Collection of the Herbarium Universitatis Lodziensis (LOD), as well as in Fungal Collection of Department of Plant Protection and Breeding of the Siedlce University of Natural Sciences and Humanities, and in the Fungal collection in Department of Mycology of the Warmia and Mazury University in Olsztyn.

The following abbreviations and symbols are used in the list of species: BPU – Brzeziny protective unit; GPU – Grzędy protective unit; KPU – Kapice protective unit; KoPU – Kopytkowo protective unit; OPU – Osowiec protective unit; WPU – Werykle protective unit; Ce-A – *Carici elongatae-Alnetum*; FDc – *Filipendulion* alliance with *Deschampsia cespitosa*; M-A – wet meadow with *Festuca rubra*; S-cn – *Caricion nigrae*; Sp-c – *Salicetum pentandro-cinereae* in association with *Urtica dioica*; T-C – *Tilio-Carpinetum*; Vu-B – *Vaccinio uliginosi-Betuletum pubescentis*; Vu-P – *Vaccinio uliginosi-Pinetum*; (a) – anamorphic stage; (t) – teleomorphic stage; (0, I, II, III) – stages of rust fungi; ** – taxon new to Poland; * – taxon new to BbNP; # – species very rare in Poland (1–3 localities). Initials of the names are given to denote collecting and/or identifying person, namely: AB – Abiba Boulahdjel, CT – Cezary Tkaczuk, ES – Ewa Sucharzewska, JC – Jerzy Chełkowski, JS – Jarosław Szkodzik, MD – Maria Dynowska, MRM – Małgorzata Ruszkiewicz-Michalska, MW – Marta Wrzosek, MWK – Mateusz Wilk, SB – Stanisław Bałazy.

Results

List of 292 species of fungi and fungi-like organisms reported here consists of 245 species collected during 5-day survey of PMS, and 47 species obtained from studies at the Biele Suchowolskie fen in 2008–2009. The predominant group were ascomycetes (232 species), recorded mainly in anamorphic state (159 species). Zygomycetes and basidiomycetes were less numerous – 27 species each (Tab. 1, Tab. 2). Fungi-like organisms were represented by four stramenopilean species (Peronosporales) and two dictyosteloid species. The most numerous group were plant-associated fungi and stramenopilean fungi-like organisms (190 taxa), followed by 15 species of arthropod (insects, spiders) pathogens and 8 species inhabiting other fungi. Second numerous group (71 species) constitute fungi and Dictyostelia isolated from soil and remnants of plants and animal excrements. Nineteen species reported here were found in Poland for the first time and about 67% (197 species) of the fungi recorded are new for the Biebrza National Park. Thirty-one species are rarely recorded in Poland – in that group only taxa with 1–3 known localities are classified.

Plant-associated fungi

Among 190 taxa found in association with plants predominate ascomycetous anamorphs (105 species, 55%), with Capnodiales (59 species), Pleosporales (14) and Xylariales (11) as the most numerous groups. Basidiomycetes and fungi-like species were represented mainly by Pucciniales (25) and Peronosporales (4), respectively. Ascomycetes and their anamorphs were recorded mostly from leaves and only 19 species

Tab. 1 Numbers of species of fungi and fungus-like organisms collected at the study area.

Taxon	No.
anamorphic fungi*	159
Capnodiales	2
Chaetosphaeriales	1
Coronophorales	1
Diaporthales	1
Dictyostelia	2
Dothideales	1
Entomophthorales	8
Erysiphales	30
Exobasidiales	2
Helotiales	1
Hypocreales	5
Mortierellales	1
Mucorales	12
Neozygitales	2
Peronosporales	4
Pleosporales	4
Pucciniales	25
Rhytismatales	1
Sordariales	3
Venturiales	1
Xylariales	22
Zoopagales	4
In total	**292**

* Species recorded in anamorphic state, with known or unknown/uncertain anamorph–teleomorph connections.

Tab. 2 Affinity of fungi taxa (according to [33]) collected/identified in anamorphic state.

Taxon	No.
Botryosphaeriales	3
Capnodiales	59
Diaporthales	7
Eurotiales	13
Helotiales	4
Hypocreales	31
Incertae sedis, Dothideomycetes	5
Incertae sedis, Pezizomycotina	3
Incertae sedis, Sordariomycetes	6
Microascales	3
Pleosporales	13
Rhytismatales	1
Sordariales	1
Xylariales	10
In total	**159**

inhabiting dead wood (branches, logs, stumps) of deciduous trees and Scots pines were collected. They belonged predominantly to Xylariales as well as to Chaetosphaeriales, Coronophorales, Diaporthales, Hypocreales and Sordariales.

Fourteen species are reported from Poland for the first time, including *Daldinia decipiens*, five *Discosia* species, *Mycosphaerella osborniae*, *Nemania aenea*, *Phaeosphaeria inclusa*, *Phomopsis amygdaliana*, *Seimatosporium foliicola* and *Sphaceloma viburni* which have been very rarely reported worldwide [20,37]. Twenty-five species, mainy ascomycetous anamorphs, are known in Poland from 1–3 localities [32,38]. Among them three species have been sporadically reported in Poland: *Helminthosphaeria clavariarum* (on *Clavulina* sp.) recorded for the first time in 2013 [39], as well as *Hypomyces rosellus* (on deciduous wood) and *Stephanoma strigosum* (on *Humaria hemisphaerica*), with the last localities known from 1908 and 1936, respectively [32,38].

****Alternaria alternata*** (Fr.) Keissl. s. l., (a), on *Alliaria petiolata* (Bieb.) Cavara & Grande, OPU, Góra Skobla, deciduous forest edge, 27 Aug. 2013, leg. ES, det. MD & ES.

Alternaria sp., (a), on *Filipendula ulmaria* (L.) Maxim, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES; on *Plantago lanceolata* L., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. ES, det. MD & ES.

Ampelomyces quisqualis Ces. s. l., (a), on *Erysiphe alphitoides* (on *Quercus robur*), GPU, Vu-P, 29 Aug. 2012, leg. & det. MRM; on *Erysiphe cynoglossi* (on *Pulmonaria officinalis*), BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM; on *Erysiphe friesii* (on *Rhamnus cathartica*), OPU, Sośnia, mixed forest near dune, 28 Aug. 2013, leg. MW, det. MRM; on *Erysiphe heraclei* (on *Heracleum sphondylium*), BPU, Grobla Honczarowska causeway, 26 Aug. 2013, leg. & det. MRM; (on *Peucedanum cervaria*), GPU, deciduous thicket, small glade, 27 Aug. 2013, leg. &

det. MRM; on *Erysiphe* sp. (on *Syringa vulgaris*), OPU, Sośnia, village, near a house, 28 Aug. 2013, leg. MW, det. MRM; on *Golovinomyces sordidus*, (on *Plantago major*), OPU, Góra Skobla, deciduous thicket, 27 Aug. 2013, leg. MD, det. MD & ES; on *Podosphaera fusca* (on *Melampyrum nemorosum*), BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

Annulohypoxylon multiforme (Fr.) Y.M. Ju, J.D. Rogers & H.M. Hsieh, (t), on *Betula pendula* Roth log, GPU, deciduous thicket, 27 Aug. 2013, leg. & det. JS.

Apiognomonia errabunda (Roberge ex Desm.) Höhn. [= *Discula umbrinella* (Berk. & Broome) Morelet], (a), on *Tilia cordata* Mill., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. ES, det. MRM.

*#***Ascochyta equiseti*** (Desm.) Grove, (a), on *Equisetum palustre* L., BPU, Długa Luka overpass, sedge patch, 26 Aug. 2013, leg. & det. MRM.

****Asteroma frondicola*** (Fr.) M. Morelet, (a), on *Populus nigra* L., BPU, Grobla Honczarowska causeway, 26 Aug. 2013, leg. & det. MRM; on *Populus tremula* L., GPU, deciduous thicket, 27 Aug. 2013, leg. & det. MRM.

#***Asteroma padi*** DC., (a), on *Cerasus avium* (L.) Moench, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES, rev. MRM; same locality and date, leg. & det. MRM; OPU, Carska Droga, catwalk, 26 Aug. 2013, leg. & det. MRM.

****Asteromella ludwigii*** Petr., (a), on *Chamaenerion angustifolium* (L.) Scop., WPU, Carska Droga near Grobla Honczarowska causeway, roadside, 26 Aug. 2013, leg. & det. MRM.

#***Asteromella pruni-mahaleb*** (Pass.) Bedlan [= *Phyllosticta passerinii* Berl. & Voglino], (a), on *Cerasus avium* (L.) Moench, OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES, rev. MRM.

Asteromella sp., (a), on *Alliaria petiolata* (M. Bieb.) Cavara & Grande, KPU, T-C, 28 Aug. 2012, leg. MRM, det. MWK & MRM; on *Filipendula ulmaria* (L.) Maxim, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM; on *Peucedanum oreoselinum* (L.) Moench, GPU, edge of dune, 30 Aug. 2012, leg. MRM, det. MRM & MWK; on *Peucedanum cervaria* (L.) Lapeyr., GPU, deciduous thicket, small glade, 27 Aug. 2013, leg. & det. MRM.

Notes. No *Asteromella* species were described on *Alliaria*, *Filipendula* and *Peucedanum* species [40].

Asteromella tiliicola (Oudem.) Arx, (a), on *Tilia cordata* Mill., OPU, Biały Grąd, deciduous forest, 27 Aug. 2013, leg. ES, det. MRM.

Asteromella trautmanniana (Moesz) Moesz, (a), on *Sorbus aucuparia* L. emend. Hedl., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM; GPU, deciduous thicket, 27 Aug. 2013, leg. & det. MRM; Vu-P, 29 Aug. 2012, leg. & det. MRM; OPU, Sośnia, dune, 27 Aug. 2013, leg. & det. MRM.

****Bertia moriformis*** (Tode) De Not., (t), on *Pinus sylvestris* L. wood, GPU, mixed forest, 28 Aug. 2013, leg. & det. JS.

****Botrytis cinerea*** Pers., (a), on *Potentilla argentea* L. (det. J. Kołodziejek), KPU, T-C, glade, 28 Aug. 2012, leg. & det. MRM.

Cercospora armoraciae Sacc., (a), on *Berteroa incana* (L.) DC., GPU, dune, 29 Aug. 2013, leg. & det. MRM.

Notes. Notes. The fungus already reported from BbNP as *Cercospora berteroae* Hollós [1], recently synonymized with *C. armoraciae* [41].

Cercospora mercurialis Pass., (a), on *Mercurialis perennis* L., GPU, mixed forest, 29 Aug. 2012, leg. MRM, det. MWK; deciduous forest, 27 Aug. 2013, leg. & det. MRM.

****Cercospora zebrina*** Pass., (a), on *Trifolium alpestre* L., GPU, edge of dune and deciduous forest, 27 Aug.2013, leg. & det. MRM; on *Trifolium arvense* L., GPU, dune, 27 Aug. 2013, leg. & det. MRM.

*****Cercosporella lindaviana*** (Jaap) U. Braun, (a), on *Vicia cracca* L., GPU, dune, 30 Aug. 2012, leg. & det. MRM.

****Cercosporella virgaureae*** (Thüm.) Allesch., (a), on *Conyza canadensis* (L.) Cronquist, GPU, dune, 30 Aug. 2012, leg. & det. MRM.

****Chaetosphaeria myriocarpa*** (Fr.) C. Booth, (t), on old stromata of *Hypoxylon fuscum* (on *Corylus avellana* log), GPU, deciduous thicket, 27 Aug. 2013, leg. & det. JS.

Cladosporium herbarum (Pers.) Link s. l., (a), on *Quercus robur* L., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. ES, det. MD & ES; on *Salix* sp., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. MD, det. MD & ES; on *Silene vulgaris* (Moench) Garcke, OPU, Sośnia, mixed forest edge, 28 Aug. 2013, leg. MD, det. MD & ES.

Cladosporium sp., (a), on *Acer pseudoplatanus* L., OPU, Góra Skobla, deciduous thicket, 27 Aug. 2013, leg. ES, det. MD & ES; on *Corylus avellana* L., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. ES, det. MD & ES; on *Plantago lanceolata* L., Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. MD, det. MD & ES.

Coleosporium tussilaginis (Pers.) Lév. s. l., (III, III), on *Campanula trachelium* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES; GPU, mixed forest, path, 29 Aug. 2012, leg. & det. MRM; on *Melampyrum polonicum* (P.B.) Soó, GPU, deciduous forest edge, 30 Aug. 2012, leg. & det. MRM; on *Melampyrum nemorosum* L., OPU, Sośnia, Scots pine forest, roadside, 28 Aug. 2013, leg. & det. MRM.

*#***Colletotrichum circinans*** (Berk.) Voglino, (a), on *Paris quadrifolia* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES.

Colletotrichum dematium (Pers.) Grove, (a), on *Convallaria majalis* L., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES.

Colletotrichum sp., (a), on *Acer negundo* L., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES; on *Paris quadrifolia* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES.

*****Colletotrichum veratrina*** (Ellis & Everh.) Treigiene, (a), on *Geranium palustre* L., KPU, T-C, 28 Aug. 2012, leg. MRM, det. MWK.

Coniothyrium olivaceum Bonord. [= *Microsphaeropsis olivacea* (Bonord.) Höhn.], (a), on *Cerasus avium* (L.) Moench, OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES, rev. MRM; on *Corylus avellana* L., GPU, mixed forest, 29 Aug. 2012, leg. & det. MRM; on *Dianthus carthusianorum* L., GPU, dune, 27 Aug. 2013, leg. MRM, det. MWK; on *Peucedanum cervaria* (L.) Lapeyr., GPU, deciduous thicket, small glade, 27 Aug. 2013, leg. & det. MRM.

***Daldinia concentrica** (Bolton) Ces. & De Not. s. l., (t), on *Alnus glutinosa* (L.) Gaertn. log, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. JS.

****Daldinia decipiens** Wollw. & M. Stadler, (t), on *Alnus glutinosa* (L.) Gaertn. log, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. Tomasz Leski, det. JS.

***Diatrype bullata** (Hoffm.) Fr., (t), on *Corylus avellana* L. branch, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. JS; on Salix sp. branch, OPU, Sośnia, Ce-A, 28 Aug. 2013, leg. & det. JS.

Diatrype stigma (Hoffm.) Fr., (t), on *Alnus glutinosa* (L.) Gaertn. branch, OPU, Sośnia, Ce-A, 28 Aug. 2013, leg. & det. JS; on *Corylus avellana* L. branch, GPU, T-C, 27 Aug. 2013, leg. & det. JS.

Diatrypella favacea (Fr.) Ces. & de Not., (t), on *Betula pendula* Roth branch, GPU, Vu-B, 27 Aug. 2013, leg. & det. JS; same locality and date, leg. & det. Małgorzata Stasińska; OPU, Sośnia, deciduous thicket, 28 Aug. 2013, leg. & det. JS; on *Corylus avellana* L. fallen branch, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. JS.

Diatrypella quercina (Pers.) Cooke, (t), on *Quercus robur* L. branch, GPU, T-C, 27 Aug. 2013, leg. & det. JS.

***Diplocarpon earlianum** (Ellis & Everh.) F.A. Wolf [= *Marssonina fragariae* (Lib.) Kleb.], (a), on *Comarum palustre* L., GPU, willow thicket, 29 Aug. 2012, leg. MRM, det. MWK.

Discosia artocreas (Tode) Fr., (a), on *Lysimachia thyrsiflora* L., GPU, willow thicket, 29 Aug. 2012, leg. & det. MRM; on *Oenothera biennis* L. s. l., GPU, deciduous thicket, small glade, 27 Aug. 2013; on *Peucedanum cervaria* (L.) Lapeyr., GPU, deciduous thicket, small glade, 27 Aug. 2013, leg. & det. MRM; on *Populus tremula* L., GPU, mixed forest, 29 Aug. 2012, leg. & det. MRM; on *Quercus robur* L., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. & det. ES.

****Discosia fitzpatrickii** Vanev, (a), on *Quercus robur* L., GPU, Vu-P, 29 Aug. 2012, leg. & det. MRM.

****Discosia kabati** Vanev, (a), on *Sorbus aucuparia* L. emend. Hedl., GPU, dune edge, poor grassland, 30 Aug. 2012, leg. & det. MRM.

#***Discosia minuta*** Ces., (a), on *Vaccinium myrtillus* L., GPU, Vu-P, 29 Aug. 2012, leg. MRM, det. MRM & MWK; on *Vaccinium uliginosum* L., GPU, Vu-P, 29 Aug. 2012, leg. MRM, det. MWK; on *Vaccinium vitis-idaea* L., GPU, Vu-P, 29 Aug. 2012, leg. & det. MRM.

****Discosia potentillae** Tehon, (a), on *Filipendula ulmaria* (L.) Maxim., GPU, willow thicket near catwalk, 29 Aug. 2012, leg. & det. MRM.

****Discosia pulmonariae** Vanev, (a), on *Pulmonaria officinalis* L., GPU, deciduous forest, 29 Aug. 2012, leg. & det. MRM.

****Discosia quercicola** de Not., (a), on *Corylus avellana* L., GPU, mixed forest, 29 Aug. 2012, leg. & det. MRM.

Discosia sp., (a), on *Epilobium adnatum* Griseb., OPU, Góra Skobla, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES.

*#***Discostroma callistemonis** (H.J. Swart) Sivan. [= *Seimatosporium kriegerianum* (Bres.) Morgan-Jones & B. Sutton], (a), on *Chamaenerion angustifolium* (L.) Scop., WPU, Carska Droga near Grobla Honczarowska, roadside, 26 Aug. 2013, leg. & det. MRM; on *Epilobium adnatum* Griseb., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES.

*#***Discula campestris** (Pass.) Arx, (a), on *Acer platanoides* L., OPU, Sośnia, village, 29 Aug. 2013, leg. MW, det. MRM.

Epicoccum nigrum Link, (a), on *Acer pseudoplatanus* L., OPU, Góra Skobla, deciduous forest, 26 Aug. 2013, leg. ES, det. MD & ES; on *Humulus lupulus* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES; on *Salix* sp., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. MD, det. MD & ES.

Erysiphe adunca (Wallr.) Fr., (t), on *Salix aurita* L., GPU, willow thicket, 29 Aug. 2012, leg. & det. MRM.

Erysiphe alphitoides (Griffon & Maubl.) U. Braun & S. Takam., (a,t), on *Quercus robur* L., GPU, Vu-P, 29 Aug. 2012, leg. & det. MRM; OPU, Biały Grąd, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES; Góra Skobla, mixed forest, 27 Aug. 2013, leg. ES, det. MD & ES; on *Quercus rubra* L., (a), OPU, Carska Droga, catwalk, 26 Aug. 2013, leg. MRM & Natalia Michalska, det. MRM.

Erysiphe aquilegiae var. ***ranunculi*** (Grev.) R.Y. Zheng & G.Q. Chen, (a), on *Ranunculus repens* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM; on *Ranunculus* sp., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES; on *Thalictrum aquilegiifolium* L., OPU, Biały Grąd, edge of causeway, 27 Aug. 2013, leg. MD, det. MD & ES.

Erysiphe berberidis* DC., (a), on *Berberis vulgaris* L., OPU, Góra Skobla, deciduous forest edge, 27 Aug. 2013, leg. MD, det. MD & ES.

Erysiphe cynoglossi* (Wallr.) U. Braun, (a), on *Pulmonaria officinalis* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

Erysiphe divaricata (Wallr.) Schltdl., (t), on *Frangula alnus* Mill., GPU, deciduous thicket, 27 Aug. 2013, leg. & det. MRM; OPU, Biały Grąd, thicket close to mineral island ("grądzik"), 27 Aug. 2013, leg. MW, det. MRM.

Erysiphe euonymi DC., (t), on *Euonymus europaea* L., OPU, Sośnia, edge of ash-alder forest (*Fraxino-Alnetum*), close to dune, 28 Aug. 2013, leg. & det. MRM; OPU, Sośnia, Ce-A, close to dune, 29 Aug. 2013, leg. & det. MRM.

Erysiphe friesii* (Lév.) U. Braun & S. Takam., (t), on *Rhamnus cathartica* L., OPU, Sośnia, mixed forest near dune, 28 Aug. 2013, leg. MW, det. MRM.

Erysiphe heraclei DC., (a), on *Heracleum sphondylium* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES; same locality and date, (t), leg. & det. MRM; on *Peucedanum cervaria* (L.) Lapeyr., (t), GPU, deciduous thicket, small glade, 28 Aug. 2013, leg. & det. MRM.

Erysiphe howeana U. Braun, (a), on *Oenothera biennis* L. s. l., GPU, dune, 27 Aug. 2013, leg. & det. MRM.

Erysiphe ornata var. ***europaea*** (U. Braun) U. Braun & S. Takam., (t), on *Betula pendula* Roth, GPU, Vu-P, 29 Aug. 2012, leg. & det. MRM; on *Betula pubescens* Ehrh., GPU, Vu-P, 29 Aug. 2012, leg. & det. MRM; OPU, Sośnia, Scots pine forest, 28 Aug. 2013, leg. & det. MRM; same locality and date, leg. ES, det. MD & ES.

****Erysiphe polygoni*** DC., (a), on *Rumex acetosella* L., GPU, dune, 27 Aug. 2013, leg. & det. MRM.

****Erysiphe*** sp., (a), on *Syringa vulgaris* L., OPU, Sośnia, village, near house, 28 Aug. 2013, leg. & det. MRM.

Erysiphe tortilis (Wallr.) Link, (t), on *Cornus* sp., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. ES, det. MD & ES.

****Erysiphe trifolii*** Grev., (a), on *Melilotus officinalis* (L.) Pall., BPU, Grobla Honczarowska causeway, 26 Aug. 2013, leg. MD, det. MD & ES.

****Erysiphe urticae*** (Wallr.) S. Blumer on *Urtica dioica* L., OPU, Sośnia, mixed forest edge, 28 Aug. 2013, leg. MD, det. MD & ES.

****Erysiphe vanbruntiana*** (W.R. Gerard) U. Braun & S. Takam., (a), on *Sambucus racemosa* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES; OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES.

****Erysiphe viburni*** Duby [= *Microsphaera sparsa* Howe], (t), on *Viburnum opulus* L., OPU, Sośnia, deciduous forest near dune, 28 Aug. 2013, leg. & det. MRM.

****Eutypella cerviculata*** (Fr.) Sacc., (t), on *Alnus glutinosa* (L.) Gaertn. branch, OPU, Sośnia, Ce-A, 28 Aug. 2013, leg. & det. JS.

*#***Exobasidium pachysporum*** Nannf., (t), on *Vaccinium uliginosum* L., BbPN buffer zone, 2 km SW Osowiec-Twierdza village, transitional bog, Vu-B, 28 Aug. 2013, leg. Małgorzata Stasińska, det. MRM.

****Exobasidium vaccinii*** (Fuckel) Woronin, (t), on *Vaccinium vitis-idaea* L., OPU, Dziegciorka, close to road 668 (from Osowiec to Sośnia), mixed forest, 28 Aug. 2013, leg. MW, det. MRM.

*#***Fusicladium betulae*** Aderh., (a), on *Betula pendula* Roth, GPU, catwalk, 27 Aug. 2013, leg. & det. MRM.

****Gloeosporium*** sp., (a), on *Acer negundo* L., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES; on *Quercus robur* L., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES.

****Gnomoniopsis comari*** (P. Karst.) Sogonov [= *Zythia fragariae* Laib.], (a), on *Potentilla argentea* L. (det. dr. Jeremi Kołodziejek), KPU, T-C, glade, 28 Aug. 2012, leg. & det. MRM.

Golovinomyces sordidus (L. Junell) V.P. Heluta, (t), on *Plantago major* L., OPU, Góra Skobla, deciduous forest edge, 27 Aug. 2013, leg. MD, det. MD & ES.

Gymnosporangium cornutum Arthur ex F. Kern, (0, I), on *Sorbus aucuparia* L. emend. Hedl., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES; Sośnia, dune, 28 Aug. 2013, leg. Natalia Michalska, det. MRM; same locality and date, leg. MD, det. MD & ES.

****Gymnosporangium sabinae*** (Dicks.) G. Winter, (0, I), on *Pyrus communis* L., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. ES, det. MD & ES.

****Helminthosphaeria clavariarum*** (Desm.) Fuckel, (t), on *Clavulina* sp., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. Błażej Gierczyk.

*#***Hendersonia viciae-fabae** Savelli, (a), on *Vicia* sp., GPU, edge of dune, 27 Aug. 2013, leg. & det. MRM.

*#***Hyaloperonospora niessliana** (Berl.) Constant. [= *Peronospora niessliana* Berl.], (a), on *Alliaria petiolata* (M. Bieb.) Cavara & Grande, KPU, T-C, 28 Aug. 2012, leg. MRM, det. MWK; OPU, Góra Skobla, deciduous forest edge, 27 Aug. 2013, leg. ES, det. MD & ES.

*#***Hypomyces rosellus** (Alb. & Schwein.) Tul. & C. Tul., (t), on wood of deciduous tree, OPU, Sośnia, mixed forest, 28 Aug. 2013, leg. Marcin Pietras, det. Anna Kujawa, Błażej Gierczyk & JS.

*#***Hypoxylon fragiforme** (Pers.) J. Kickx, (t), on *Alnus glutinosa* (L.) Gaertn. branch, OPU, Sośnia, Ce-A, 28 Aug. 2013, leg. & det. JS.

***Hypoxylon fuscum** (Pers.) Fr., (t), on branches of *Acer platanoides* L. and *Tilia cordata* Mill., GPU, T-C, 27 Aug. 2013, leg. & det. JS; on *Alnus glutinosa* (L.) Gaertn. branch, GPU, Ce-A, 27 Aug. 2013,leg. & det. JS.

*#***Hypoxylon howeanum** Peck., (t), on *Corylus avellana* L. fallen branch, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. JS.

*#***Lasiosphaeris hirsuta** (Fr.) A.N. Mill. & Huhndorf, (t), on *Alnus glutinosa* (L.) Gaertn. rotten branch, OPU, Sośnia, Ce-A, 28 Aug. 2013, leg. & det. JS.

***Leptosphaeria** sp., (t), on *Acer pseudoplatanus* L., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES.

*#***Leptotrochila ranunculi** (Fr.) Schüepp, (t), on *Ranunculus acris* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES; same locality and date, leg. MRM & Natalia Michalska, det. MRM.

*#***Leveillula helichrysi** V.P. Heluta & Simonyan, (t), on *Helichrysum arenarium* (L.) Moench, GPU, dune, 27 Aug. 2013, leg. & det. MRM.

Notes. The species reported at the same locality in BbNP in 2013 as *Leveillula taurica* (Lév.) Arnaud [1]. Also reports of Majewski from Świnoujście, Drezdenko, Zgłowiączka near Włocławek, listed by Sałata [42] as *L. taurica*, most probably belong to the same species.

*#***Lophodermium pinastri** (Schrad.) Chevall., (t), on *Juniperus communis* L., OPU, Sośnia, mixed forest, 28 Aug. 2013, leg. ES, det. MD & ES.

***Melampsora epitea** Thüm., (II), on *Salix aurita* L., GPU, willow thicket, 29 Aug. 2012, leg. & det. MRM.

*#***Melampsora laricis-pentandrae** Kleb., (II), on *Salix* sp., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES.

***Melampsora populnea** (Pers.) P. Karst., (II, III), on *Populus nigra* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES; same locality and date, leg. & det. MRM; on *Populus tremula* L., GPU, Vu-P, 29 Aug. 2012, leg. & det. MRM; same host, deciduous thicket, 27 Aug. 2013, leg. & det. MRM.

***Melampsoridium betulinum** (Pers.) Kleb., (II), on *Betula pendula* Roth, GPU, Vu-P, 29 Aug. 2012, leg. & det. MRM.

*#***Monilinia padi** (Woronin) Honey [= *Monilia linhartiana* Sacc.], (a), on *Cerasus avium* (L.) Moench, OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det.

MD & ES, rev. MRM; on *Padus serotina* (Ehrh.) Borkh., OPU, Sośnia, Scots pine forest with *Padus serotina* thicket, 28 Aug. 2013, leg. & det. MRM.

****Monochaetia monochaeta*** (Desm.) Allesch., (a), on *Quercus robur* L., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES.

Mycosphaerella millegrana (Cooke) J. Schröt. [= *Passalora microsora* (Sacc.) U. Braun], (a), on *Tilia cordata* Mill., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. ES, det. MRM.

*****Mycosphaerella osborniae*** D. Hawksw. & Sivanesan, (t), on *Artemisia vulgaris*, KPU, T-C, road edge, 28 Aug. 2012, leg. & det. MRM.

****Naohidemyces vaccinii*** (Jørst.) S. Sato, Katsuya & Y. Hirats. ex Vanderweyen & Fraiture [= *Pucciniastrum vaccinii* Jørst.], (II), on *Vaccinium uliginosum* L., BbPN buffer zone, 2 km SW Osowiec-Twierdza village, transitional bog, Vu-B, 28 Aug. 2013, leg. Małgorzata Stasińska, det. MRM.

Nectria cinnabarina (Tode) Fr., (t), on *Betula pendula* Roth branches, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. JS.

*****Nemania aenea*** (Nitschke) Pouzar, (t), on rotten branch of *Salix fragilis* L. submerged in stagnant water, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. JS.

Nemania serpens (Pers.) Gray, (t), on *Carpinus betulus* L. log, GPU, T-C, 27 Aug. 2013, leg. & det. JS.

Neoerysiphe galeopsidis (DC.) U. Braun, (a), on *Galeobdolon luteum* Huds., GPU, T-C, 27 Aug. 2013, leg. & det. MRM; on *Galeopsis tetrahit* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES; OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES.

****Oidium*** sp., (a), on Vicia sp., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES.

Ophiognomonia intermedia (Rehm) Sogonov [= *Discula betulina* (Westend.) Arx], (a), on *Betula pendula* Roth, GPU, Vu-P, 29 Aug. 2012, leg. & det. MRM; catwalk, 27 Aug. 2013, leg. & det. MRM; on *Betula pubescens* Ehrh., GPU, catwalk, 27 Aug. 2013, leg. & det. MRM.

****Passalora ariae*** (Fuckel) U. Braun & Crous, (a), on *Sorbus aucuparia* L. emend. Hedl., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

****Passalora comari*** (Peck) U. Braun [= *Cercospora comari* Peck], (a), on *Comarum palustre* L., GPU, willow thicket, 29 Aug. 2012, leg. MRM, det. MWK.

Passalora ferruginea (Fuckel) U. Braun & Crous, (a), on *Artemisia vulgaris* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM; KPU, T-C, edge of the road, 28 Aug. 2012, leg. & det. MRM; OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. MD, det. MD & ES.

*#***Passalora heterospora*** (Höhn.) Höhn., (a), on *Epilobium roseum* Schreb., WPU, Carska Droga near Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

*#***Passalora minutissima*** (Desm.) U. Braun & Crous, (a), on *Geranium palustre* L., OPU, Góra Skobla, deciduous forest edge, 26 Aug. 2013, leg. ES, det. MD & ES, rev. MRM.

***Passalora murina** (Ellis & Kellerm.) U. Braun & Crous, (a), on *Viola* sp., GPU, mixed forest, 29 Aug. 2012, leg. MRM, det. MWK.

***Periconia byssoides** Pers., (a), on *Lonicera xylosteum* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. MD & ES; OPU, Góra Skobla, deciduous forest edge, 27 Aug. MD, det. MD & ES; on *Viburnum opulus* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES.

***Periconia cookei** Mason & M.B. Ellis, (a), on *Polygonatum odoratum* (Mill.) Druce, GPU, T-C, 27 Aug. 2013, leg. & det. MRM.

*#***Peronospora agrimoniae*** Syd., (a), on *Agrimonia eupatoria* L. s. l., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

***Peronospora knautiae** Fuckel, (a), on *Knautia arvensis* (L.) J.M. Coult., OPU, Sośnia, deciduous forest edge, 28 Aug. 2013, leg. & det. ES & MD.

Peronospora sordida Berk., (a), on *Scrophularia nodosa* L., GPU, deciduous thicket, 27 Aug. 2013, leg. & det. MRM.

***Phaeobotryosphaeria visci** (Kalchbr.) A.J.L. Phillips & Crous [= *Sphaeropsis visci* (Alb. & Schwein.) Sacc.], (a), on *Viscum album* L., GPU, catwalk, 27 Aug. 2013, leg. & det. MRM.

****Phaeosphaeria inclusa** Shoemaker & C.E. Babc., (t), on *Polygonatum odoratum* (Mill.) Druce, GPU, T-C, 27 Aug. 2013, leg. & det. MRM.

Phaeosphaeria sp., (t), on *Thelypteris palustris* Schott, BPU, Długa Luka overpass, sedge patch, 26 Aug. 2013, leg. & det. MRM.

***Phloeospora aceris** (Lib.) Sacc., (a), on *Acer platanoides* L., OPU, Sośnia, village, 29 Aug. 2013, leg. MW, det. MRM; on *Acer pseudoplatanus* L., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES.

Phoma** cf. ***macrostoma Mont., (a), on *Fraxinus excelsior* L., GPU, mixed forest, 29 Aug. 2012, leg. & det. MRM.

Phoma glomerata (Corda) Wollenw. & Hochapfel, (a), on *Erysiphe euonymi* (on *Euonymus europaea*), OPU, Sośnia, Ce-A, close to dune, 29 Aug. 2013, leg. MW, det. MRM; on *Erysiphe divaricata* (on *Frangula alnus*), GPU, deciduous thicket, 27 Aug. 2013, leg. & det. MRM.

Phoma** sect. ***Heterospora Boerema, Gruyter & Noordel., (a), on *Dianthus carthusianorum* L., GPU, dune, 27 Aug. 2013, leg. MRM, det. MWK.

***Phomatospora dinemasporium** J. Webster [= *Dinemasporium strigosum* (Pers.) Sacc.], (a), on *Corynephorus canescens* (L.) P. Beauv., GPU, dune, 20 Aug. 2012, leg. MRM, det. MWK & MRM.

****Phomopsis amygdaliana** Canonaco, (a), on *Padus serotina* (Ehrh.) Borkh., OPU, Sośnia, Scots pine forest with *Padus serotina* thicket, 28 Aug. 2013, leg. & det. MRM.

Phragmidium potentillae (Pers.) P. Karst., (II, III), on *Potentilla argentea* L., GPU, dune, 27 Aug. 2013, leg. MRM, det. MWK.

***Phragmidium tuberculatum** Jul. Müll., (II, III), on *Rosa canina* L., OPU, Sośnia, mixed forest edge, 28 Aug., leg. ES, det. MD & ES.

Phyllactinia guttata (Wallr.) Lév. s. l., (a,t), on *Betula pendula* Roth, GPU, catwalk, 27 Aug. 2013, leg. & det. MRM; on *Corylus avellana* L., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. ES, det. MD & ES.

*#***Phyllosticta pyrolae*** Ell. & Everh., (a), on *Orthilia secunda* (L.) House, OPU, Sośnia, Scots pine forest, near dune, 28 Aug. 2013, leg. & det. MRM.

****Phyllosticta tambowiensis*** Bubák & Serebrian., (a), on *Acer negundo* L., OPU, Sośnia, mixed forest, 28 Aug. 2013, leg. ES, det. MD & ES.

*#***Pilidium concavum*** (Desm.) Höhn., (a), on *Epilobium adnatum* Griseb., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES.

*#***Plenodomus visci*** (Sacc.) Gruyter, Aveskamp & Verkley [= *Plectophomella visci* (Sacc.) Moesz], (a), on *Viscum album* L., GPU, catwalk, 27 Aug. 2013, leg. & det. MRM.

****Podosphaera aphanis*** (Wallr.) U. Braun & S. Takam. [= *Sphaerotheca alchemillae* (J. Steiner) Erikss.], (a,t), on *Alchemilla* sp., OPU, Biały Grąd, edge of causeway, 27 Aug. 2013, leg. & det. ES; on *Filipendula ulmaria* (L.) Maxim., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES.

Podosphaera balsaminae (Wallr.) U. Braun & S. Takam., (a), on *Impatiens noli-tangere* L., BPU, Grobla Honczarowska causeway, 26 Aug. 2013, leg. ES, det. MD & ES; same locality and date, leg. & det. MRM.

****Podosphaera fusca*** (Fr.) U. Braun & Shishkoff, (a,t), on *Conyza canadensis* (L.) Cronquist, GPU, dune, 27 Aug. 2013, leg. & det. MRM; on *Erigeron annuus* (L.) Pers., OPU, Sośnia, mixed forest edge, 28 Aug. 2013, leg. & det. ES; on *Melampyrum nemorosum* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM; on *Melampyrum* sp., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES; on *Taraxacum officinale* F.H. Wigg., OPU, Biały Grąd, edge of causeway, 27 Aug. 2013, leg. ES, det. MD & ES; Sośnia, mixed forest edge, 28 Aug. 2013, leg. & det. ES.

Podosphaera major (Juel) S. Blumer [= *P. myrtillina* Kunze var. major Juel], (t), on *Vaccinium uliginosum* L., GPU, Vu-P, 29 Aug. 2012, leg. MRM, det. MWK; BbPN buffer zone, 2 km SW Osowiec-Twierdza village, transitional bog, Vu-B, 28 Aug. 2013, leg. Małgorzata Stasińska, det. MRM.

****Podosphaera myrtillina*** Kunze, (t), on Vaccinium myrtillus L., GPU, Vu-P, 29 Aug. 2012, leg. MRM, det. MWK.

Puccinia arenariae (Schumach.) J. Schröt., (II, III), on *Melandrium album* (Mill.) Garcke, OPU, Góra Skobla, deciduous forest edge, 27 Aug. 2013, leg. MD, det. MD & ES; BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES; on *Moehringia trinervia* (L.) Clairv., GPU, mixed forest, 29 Aug. 2012, leg. & det. MRM; KPU, T-C, 28 Aug. 2012, leg. Natalia Michalska, det. MRM; on *Stellaria holostea* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES.

Puccinia argentata (Schultz) G. Winter [= *P. impatientis* Ficinus & C. Schubad], (II, III), on *Impatiens noli-tangere* L., BPU, Grobla Honczarowska causeway, 26 Aug. 2013, leg. ES, det. MD & ES; same locality and date, leg. & det. MRM.

Puccinia chaerophylli Purton, (II, III), on *Chaerophyllum temulum* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

***Puccinia hieracii** (Röhl.) H. Mart., (II), on *Taraxacum officinale* F.H. Wigg., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. ES, det. MD & ES.

***Puccinia menthae** Pers., (I, II), on *Mentha arvensis* L., OPU, Biały Grąd, edge of causeway, 27 Aug. 2013, leg. ES, det. MD & ES.

***Puccinia oreoselini** (F. Strauss) Körn., (III), on *Peucedanum cervaria* (L.) Lapeyr., GPU, deciduous forest edge, 27 Aug. 2013, leg. & det. MRM.

***Puccinia phragmitis** Tul. [= *P. phragmitis* (Schumach.) Körn]., (II, III), on *Phragmites australis* (Cav.) Trin. ex Steud., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES.

Puccinia polygoni-amphibii Pers. [= *P. polygoni* Alb. & Schwein.], (II, III), on *Fallopia convolvulus* (L.) Á. Löve, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MD & ES; GPU, mixed forest, 29 Aug. 2012, leg. MRM, det. MRM & MWK; dune, 27 Aug. 2013, leg. & det. MRM; OPU, Biały Grąd, edge of causeway, 27 Aug. 2013, leg. MD, det. MD & ES.

Puccinia punctata Link, (II, III), on *Galium schultesii* Vest, GPU, deciduous thicket, 27 Aug. 2013, leg. & det. MRM; on *Galium* sp., OPU, Sośnia, mixed forest edge, 28 Aug. 2013, leg. MD, det. MD & ES.

***Puccinia punctiformis** (F. Strauss) Röhl., (II, III), on *Cirsium oleraceum* (L.) Scop., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES.

Puccinia tanaceti DC. s. l., (II,III), on *Artemisia vulgaris* L., KPU, T-C, road edge, 28 Aug. 2012, leg. & det. MRM; OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. MD, det. MD & ES; Sośnia, mixed forest edge, 28 Aug. 2013, leg. MD, det. MD & ES.

***Pyrenochaeta** sp., (a), on *Vaccinium vitis-idaea* L., GPU, Vu-P, 29 Aug. 2012, leg. MRM, det. MWK.

***Ramularia agrestis** Sacc., (a), on *Viola arvensis* Murray, GPU, dune, 27 Aug. 2013, leg. & det. MRM.

***Ramularia aromatica** (Sacc.) Höhn., (a), on *Acorus calamus* L., OPU, Biały Grąd, edge of causeway, ditch, 27 Aug. 2013, leg. ES, det. MD & ES.

***Ramularia carneola** (Sacc.) Nannf. [= *R. scrophulariae* Fautrey & Roum.], (a), on *Scrophularia nodosa* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES; same locality and date, leg. & det. MRM; GPU, deciduous thicket, 27 Aug. 2013, leg. & det. MRM.

***Ramularia chaerophylli** Ferraris, (a), on *Chaerophyllum temulum* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

Ramularia chamaedryos (Lindr.) Gunnerb., (a), on *Veronica chamaedrys* L., BPU, Grobla Honczarowska causeway,deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

Ramularia geranii** (Westend.) Fuckel var. ***geranii, (a), on *Geranium palustre* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

Ramularia grevilleana (Tul.) Jørst. var. ***grevilleana***, (a), on *Potentilla argentea* L. (det. dr Jeremi Kołodziejek), GPU, edge of dune, 27 Aug. 2013, leg. & det. MRM.

Ramularia inaequalis (Preuss) U. Braun, (a), on *Cichorium intybus* L., OPU, Sośnia, mixed forest edge, 28 Aug. 2013, leg. ES, det. MD & ES.

****Ramularia lysimachiae*** Thüm., (a), on *Lysimachia thyrsiflora* L., GPU, Vu-P, 29 Aug. 2012, leg. & det. MRM.

****Ramularia moehringiae*** Lindr., (a), on *Moehringia trinervia* (L.) Clairv., GPU, mixed forest, 29 Aug. 2012, leg. & det. MRM.

****Ramularia rhabdospora*** (Berk. & Broome) Nannf., (a), on *Plantago lanceolata* L., OPU, Biały Grąd, edge of causeway, 27 Aug. 2013, leg. ES, det. MD & ES.

*#***Ramularia rhaetica*** (Sacc. & G. Winter) Jaap, (a), on *Peucedanum cervaria* (L.) Lapeyr., GPU, deciduous thicket, small glade, 27 Aug. 2013, leg. & det. MRM.

****Ramularia simplex*** Pass., (a), on *Ranunculus repens* L., BPU, Grobla Honczarowska, deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

Ramularia urticae Ces., (a), on *Urtica dioica* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES; OPU, Biały Grąd, edge of causeway, 27 Aug. 2013, leg. MD, det. MD & ES.

Ramularia variabilis Fuckel, (a), on *Verbascum nigrum* L., GPU, dune, 27 Aug. 2013, leg. & det. MRM.

Rhytisma acerinum (Pers.) Fr. [= *Melasmia acerina* Lév.], (a), on *Acer platanoides* L., OPU, Osowiec-Twierdza village, near the headquarters of BbNP, 28 Aug. 2013, leg. & det. JC; Sośnia, village, 29 Aug. 2013, leg. MW, det. MRM; on *Acer pseudoplatanus* L., OPU, Góra Skobla, 27 Aug. 2013, leg. ES, det. MD & ES.

*#***Sarcopodium circinatum*** Ehrenb., (a), on *Geranium robertianum* L., GPU, mixed forest, 29 Aug. 2012, leg. MRM, det. MWK; on *Mercurialis perennis* L., GPU, mixed forest, 29 Aug. 2012, leg. MRM, det. MWK.

****Sawadaea bicornis*** (Wallr.) Homma, (t), on *Acer pseudoplatanus* L., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. ES, det. MD & ES.

****Sawadaea tulasnei*** (Fuckel) Homma, (t), on *Acer pseudoplatanus* L., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. & det. MD & ES.

*****Seimatosporium foliicola*** (Berk.) Shoemaker, (a), on *Crataegus monogyna* Jacq., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. MD, det. MD & ES.

Septoria aegopodii Desm., (a), on *Aegopodium podagraria* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM; GPU, catwalk, 27 Aug. 2013, leg. Natalia Michalska, det. MRM; KPU, T-C, 28 Aug. 2012, leg. & det. MRM; on *Peucedanum oreoselinum* (L.) Moench, GPU, edge of dune, 30 Aug. 2012, leg. MRM, det. MWK.

*#***Septoria alni*** Sacc., (a), on *Alnus glutinosa* (L.) Gaertn., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

****Septoria brissaceana*** Sacc. & Letell., (a), on *Lythrum salicaria* L., OPU, Biały Grąd, edge of causeway, 27 Aug. 2013, leg. MD, det. MD & ES.

****Septoria capraeae*** Westend., (a), on *Salix* sp., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. ES, det. MD & ES.

Septoria chelidonii Desm., (a), on *Chelidonium majus* L., OPU, Biały Grąd, edge of causeway, 27 Aug. 2013, leg. MD, det. MD & ES; Góra Skobla, deciduous thicket, 27 Aug. 2013, leg. MD, det. MD & ES.

****Septoria convolvuli*** Desm., (a), on *Convolvulus arvensis* L., GPU, dune slope, 30 Aug. 2012, leg. & det. MRM.

****Septoria epilobii*** Westend., (a), on *Epilobium roseum* Schreb., WPU, Carska Droga near Grobla Honczarowska causeway, deciduous thickets, 26 Aug. 2013, leg. & det. MRM; associated with immature *Mycosphaerella* sp. *ascomata*.

****Septoria galeopsidis*** Westend., (a), on *Galeopsis tetrahit* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES; OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. MD, det. MD & ES.

*#***Septoria jasiones*** (Bres.) Grove, (a), on *Jasione montana* L., GPU, dune, 27 Aug. 2013, leg. & det. MRM.

Septoria lychnidis Desm. [= *Caryophylloseptoria lychnidis* (Desm.) Verkley, Quaedvlieg & Crous], (a), on *Melandrium album* (Mill.) Garcke, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES; OPU, Sośnia, mixed forest edge, 28 Aug. 2013, leg. MD, det. MD & ES.

****Septoria lysimachiae*** Westend., (a), on *Lysimachia thyrsiflora* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES; same locality and date, leg. & det. MRM; GPU, willow thicket, 29 Aug. 2012, leg. & det. MRM; OPU, Sośnia, mixed forest near dune, 28 Aug. 2013, leg. & det. MRM.

Septoria oenotherae Westend., (a), on *Oenothera biennis* L. s. l., GPU, deciduous thicket, small glade, 27 Aug. 2013, leg. & det. MRM; same locality, dune, 27 Aug. 2013, leg. Natalia Michalska, det. MRM; Sośnia, roadside, 28 Aug. 2013, leg. MD, det. MD & ES.

****Septoria oreoselini*** (Lasch) Sacc., (a), on *Peucedanum cervaria* (L.) Lapeyr., GPU, deciduous thicket, small glade, 27 Aug. 2013, leg. & det. MRM.

Septoria polygonorum Desm., (a), on *Polygonum persicaria* L., OPU, Biały Grąd, edge of causeway, 27 Aug. 2013, leg. ES, det. MD & ES.

Septoria pyricola Desm., (a), on *Pyrus communis* L., OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. ES, det. MD & ES.

****Septoria scabiosicola*** Desm., (a), on *Knautia arvensis* (L.) J.M. Coult., OPU, Sośnia, mixed forest edge, 28 Aug. 2013, leg. ES, det. MD & ES; GPU, egde of dune, 29 Aug. 2013, leg. & det. MRM.

*#***Septoria tabacina*** Died., (a), on *Artemisia vulgaris* L., KPU, T-C, edge of forest road, 28 Aug. 2012, leg. & det. MRM.

Septoria virgaureae (Lib.) Desm., (a), on *Solidago virgaurea* L., GPU, edge of dune, 30 Aug. 2012, leg. & det. MRM.

*****Sphaceloma viburni*** Jenkins & Bitanc., (a), on *Viburnum opulus* L., OPU, Sośnia, deciduous forest near dune, 28 Aug. 2013, leg. & det. MRM.

Sphaerellopsis filum (Biv.) B. Sutton, (a), on *Melampsora epitea* (on *Salix autira*), GPU, willow thicket, 29 Aug. 2012, leg. & det. MRM; on *Puccinia arenariae* (on *Melandrium album*), BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES, rev. MRM; on *Puccinia argentata* (on *Impatiens noli-tangere*), BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES,

det. MD & ES; on *Puccinia menthae* (on *Mentha arvensis*), OPU, Biały Grąd, edge of causeway, 27 Aug. 2013, leg. ES, det. MD & ES; on *Puccinia phragmitis* (on *Phragmites australis*), BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES; on *Puccinia punctiformis* (on *Cirsium oleraceum*), BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. ES, det. MD & ES; on *Uromyces geranii* (on *Geranium palustre*), BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

****Sphaerulina*** sp., (t), on *Euonymus europaea* L., OPU, Sośnia, Ce-A, close to edge of dune, 29 Aug. 2013, leg. & det. MRM; on *Scrophularia nodosa* L., GPU, deciduous thicket, 27 Aug. 2013, leg. & det. MRM, associated with *Ramularia carneola*.

*#***Stephanoma strigosum*** Wallr., (a), on *Humaria hemisphaerica* (F.H. Wigg.) Fuckel, OPU, Sośnia, mixed forest (*Pinus sylvestris*, *Juniperus communis*, *Populus tremula*), 28 Aug. 2013, leg. Grażyna Domian, det. MRM.

Notes. This species is known in Poland only from four records in the early twenty-first-century papers listed by Mułenko et al. [32] as *Stephanoma strigosum* and *Hypomyces strigosus* (Wallr.) Schroeter. However, the species seems to be very common on the host throughout the country (M. Ruszkiewicz-Michalska, unpblished).

*#***Thedgonia bellocensis*** (C. Massal. & Sacc.) U. Braun, (a), on *Verbascum nigrum* L., GPU, Vu-B, close to edge of dune, 27 Aug. 2013, leg. & det. MRM.

*#***Thedgonia ligustrina*** (Boerema) B. Sutton, (a), BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. MRM.

****Trichothecium roseum*** (Pers.) Link, (a), on *Acer negundo* L., OPU, Góra Skobla, deciduous forest, 27 Aug. 2013, leg. & det. ES.

****Trichothecium*** sp., (a), on *Alliaria petiolata* (M. Bieb.) Cavara & Grande, KPU, T-C, 28 Aug. 2012, leg. MRM, det. MWK; on *Vaccinium myrtillus* L., GPU, Vu-P, 29 Aug. 2012, leg. MRM, det. MWK.

Triphragmium ulmariae (DC.) Link (II, III) on *Filipendula almaria* (L.) Maxim., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES; same locality and date, leg. & det. MRM.

****Uromyces geranii*** (DC.) G.H. Otth & Wartm. (III) on *Geranium palustre* L., BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. MD, det. MD & ES; same date, leg. & det. MRM.

****Uromyces rumicis*** (Schumach.) G. Winter (III) on *Rumex hydrolapathum* Huds., OPU, Biały Grąd,edge of causeway, 27 Aug. 2013, leg. & det. ES.

****Uromyces viciae-fabae*** (Pers.) J. Schröt. (II, III) on *Vicia cracca* L., GPU, dune, 30 Aug. 2012, leg. & det. MRM.

****Valsa pini*** (Alb. & Schwein.) Fr., (t), on *Pinus sylvestris* L. branch, GPU, dune, 27 Aug. 2013, leg. & det. JS.

****Venturia potentillae*** (Wallr.) Cooke [= *Coleroa potentillae* (Wallr.) G. Winter], (a), on *Comarum palustre* L., BPU, Długa Luka overpass, sedge patch, 26 Aug. 2013, leg. MRM, det. MWK; GPU, willow thicket, 29 Aug. 2012, leg. MRM, det. MWK.

Fungi associated with arthropods

In total 16 species of entomopathogenic fungi were found as pathogens of different arthropods and 6 species were isolated from forest or meadow soil by means of the

Galleria bait method or Warcup dilution. Nine entomophthoralean fungal species representing phylum Entomophthoromycota were isolated in total, among them seven were identified as pathogens of insects, one (*Neozygites floridana*) was isolated from spider mite and *Conidiobolus coronatus* was detected from meadow soil by means of the bait method and from plant debris by dilution method. From among seven species of anamorphic Hypocreales (Ascomycota) affecting arthropods in investigated parts of the BbNP in 2013, two have been recognized as pathogens of spiders (*Gibellula leiopus* and *G. pulchra*), two (*Beauveria bassiana* and *Isaria farinosa*) were isolated from different unidentified insects in forest litter and three were pathogenic to mites (*Hirsutella danubiensis*, *H. kirchneri*, *H. thompsonii*). In addition, from forest or meadow soil the entomopathogenic fungi *Isaria farinosa*, *I. fumosorosea*, *Lecanicillium lecanii*, *Lecanicillium* sp. and *Metarhizium anisopliae* were isolated by means of the Galleria bait or dilution method.

Thirteen fungal species associated with arthropods recorded for the first time in BbNP are marked with asterisk. Especially interesting is a record of mycoses in hope aphid (*Phorodon humuli*) population, caused simultaneously by three entomophthoralean fungal species: *Entomophthora planchoniana*, *Pandora neoaphidis* and *Zoophthora aphidis*.

There were very limited possibilities to enter deeper into wet meadows because of both-side digs filled with water along the paths and roads. Some accessible insects on dig-border plants appeared healthy, including even big aphid colonies on *Salix cinerea* leaves, entirely free of fungal pathogens.

Beauveria bassiana (Bals.-Criv.) Vuill. on unidentified bug (Heteroptera), OPU, Sośnia, in the litter of deciduous forest, 28 Aug. 2013, leg. & det. CT; BPU, Grobla Honczarowska; OPU, Biały Grąd, and in some surrounding forests, common in the forest litter and in sub-cortical insects feeding sites on adult bark beetles and accompanying them small predacious larvae and adults, as well as in the coniferous and mixed forest litter mostly on chrysomelid, curculionid and staphylinid beetles, leg. & det. SB.

****Cladosporium*** sp. (thick-walled, smooth spores) on exuvia of aphids feeding on *Alnus glutinosa* (L.) Gaertn. and on *Verbascum nigrum* L., OPU, Sośnia, village path, 28 Aug. 2013, leg. Natalia Michalska, det. MRM.

****Conidiobolus coronatus*** (Costantin) A. Batko, plant debris, dilution method, KoPU, Biele Suchowolskie fen, Sp-c, 15 Oct. 2009, leg. AB, det. MW; meadow soil, Galleria bait method, OPU, Biały Grąd, pasture, 27 Aug. 2013, leg. & det. CT.

****Entomophthora muscae*** (Cohn) Fresen. on unidentified fly (Diptera) attached to the *Mentha* sp. leaves, OPU, Biały Grąd, pasture, 27 Aug. 2013, leg. & det. CT.

****Entomophthora planchoniana*** Cornu on hope aphids (*Phorodon humuli* Schrank) feeding on *Humulus lupulus* L. leaves, OPU, Sośnia, mixed forest edge, 28 Aug., leg. & det. CT & SB.

Gibellula leiopus (Vuill. ex Maubl.) Mains on a spider on underside of *Corylus avellana* L. leaf, OPU, Biały Grąd, deciduous thicket, 27 Aug. 2013, leg. & det. SB.

Gibellula pulchra Cavara on spider from the family Thomisidae, BPU, Grobla Honczarowska causeway, deciduous thicket, 26 Aug. 2013, leg. & det. SB & CT.

Hirsutella danubiensis Tkaczuk, Bałazy & Wegenst. on spider mite *Neotetranychus rubi* (Träg) feeding on *Rubus* sp., OPU, Biały Grąd, deciduous forest, 27 Aug. 2013, leg. & det. CT.

Hirsutella kirchneri (Rostrup) Minter, Brady & Hall on eriophyid mites (*Abacarus* sp.) feeding on grass leaves, OPU, Góra Skobla, mid-forest clearing, 28 Aug. 2013, leg. & det. CT.

****Hirsutella thompsonii*** F.E. Fisher on eriophyid mites (*Abacarus* sp.) feeding on grass leaves, OPU, Góra Skobla, mid-forest clearing, 28 Aug. 2013, leg. & det. CT.

Isaria farinosa (Holm) Brown & Smith, soil, Warcup method, KoPU, Biele Suchowolskie fen, FDc, S-cn, Sp-c, 20 Jun. 2008, leg. AB, det. MW; FDc, 15 Oct. 2009, leg. AB, det. MW; forest soil, Galleria bait method, OPU, Biały Grąd, mixed forest edge, 27 Aug. 2013, leg. & det. CT; in forest litter on caterpillars and some small beetles, single specimens in all investigated localities, leg. & det. SB.

Isaria fumosorosea Wize, forest soil, Galleria bait method, OPU, Biały Grąd, mixed forest edge, 27 Aug. 2013, leg. & det. CT.

****Lecanicillium lecani*** (Zimm.) Zare & W. Gams, soil, dilution method, KoPU, Biele Suchowolskie fen, FDc, Sp-c, 20 Jun. 2008, leg. AB, det. MW; M-A, 15 Oct. 2009, leg. AB, det. MW.

****Lecanicillium*** sp., forest soil, Galleria bait method, OPU, Biały Grąd, pasture, 27 Aug. 2013, leg. & det. CT.

Metarhizium anisopliae (Metschn.) Sorokin s. l., soil, dilution method, KoPU, Biele Suchowolskie fen, S-cn, 20 Jun. 2008, leg. AB, det. MW; forest soil, Galleria bait method, OPU, Biały Grąd, mixed forest edge, 27 Aug. 2013, leg. & det. CT.

Neozygites floridana (J. Weiser & Muma) Remaud. & Keller on spider mites *Neotetranychus rubi* feeding on *Rubus* sp., OPU, Biały Grąd, deciduous forest, 27 Aug. 2013, leg. & det. CT.

****Neozygites parvispora*** (D.M. MacLeod & K.P. Carl) Remaud. & S. Keller on unidentified thrips feeding on *Solanum* sp. leaves, OPU, Biały Grąd, pastures, 27 Aug. 2013, leg. & det. CT.

****Pandora neoaphidis*** (Remaud. & Hennebert) Humber on hope aphids *Phorodon humuli* Schrank feeding on *Humulus lupulus* leaves, OPU, Sośnia, deciduous forest, 28 Aug. 2013, leg. & det. CT & SB.

****Verticillium*** sp. on a relatively big plant-hopper (Auchenorrhyncha), partly destroyed, OPU, Sośnia, mid-forest marsh, on aquatic vegetation, 28 Aug. 2013, leg. & det. SB; contamined secondarily by *Cladosporium herbarum* (Pers.) Link s. l.

****Zoophthora aphidis*** (Hoffm. ex Fresen.) A. Batko on hope aphids *Phorodon humuli* feeding on *Humulus lupulus* leaves, OPU, Sośnia, deciduous forest, 28 Aug. 2013, leg. & det. CT & SB.

****Zoophthora ichneumonis*** Bałazy on unidentified adults of Hymenoptera from the family Ichneumonidae, attached to the leaves of different deciduous trees, mid-meadow loose afforestation, Biały Grąd, 27 Aug. 2013, leg. & det. CT & SB.

****Zoophthora*** sp. on unidentified beetle (Coleoptera) feeding on *Corylus avellana* leaves, BPU, Grobla Honczarowska, wooded dike, 26 Aug.2013, leg. & det. CT.

Fungi and Dictyostelia isolated from soil and associated with plant debris and excrements

In total 61 species belonging to Kickxellomycotina, Mortierellomycotina, Mucoromycotina, Zoopagomycotina and ascomycetous anamorphs (41 taxa) were isolated. Additionally two cellular slime moulds (Amebozoa, Dictyostelia) were found. 48 taxa reported here were not recorded during the first inventory in BbNP.

Among isolated fungi five taxa were found for the first time in Poland. *Candelabrum spinulosum* – very distinctive species growing among *Sphagnum* was recorded

in the same year in peat bog "Torfy" near Warsaw (unpublished data). One of the most interesting among recorded species was *Piptocephalis fimbriata* that has not been recorded from Poland to date [32]. It is known from Japan, Taiwan, UK and USA [43]. The genus *Helicocephalum* comprises parasites of nematodes eggs. Until now in Poland *Helicocephalum* species was recorded only once, on wet, decayed wood [32]. However, the studies dealing with Helicocephalidaceae were not conducted in Poland and there is no precise information about rarity of the genus. Our specimen was non-culturable and its affinity to the species remained unresolved. Also one Spororomiaceae strain remained unidentified. Several taxa from this family are rare in Poland and the number of known records is limited [32,38,44]. *Trichoderma aggressivum*, known as fungal pathogen [45], was previously recorded from Poland from mushroom compost [46]. Two other taxa: *Talaromyces funiculosus* and *T. rugulosus* were not listed in the Polish checklist of Micromycetes [32] but they are certainly quite common in our country [47,48]. *Piptocephalis lepidula* and *Syncephalis* species with single known records in Poland [32,49], seem to be relatively common on dung of mice, rats and boars (M. Wrzosek, unpublished).

Absidia glauca Hagem, soil, damp chamber, OPU, Biały Grąd, meadow, 27 Aug. 2013, leg. & det. MW.

****Acremoniella atra*** (Corda) Sacc., (a), soil, Warcup method, KoPU, Biele Suchowolskie fen, FDc, Sp-c, 15 Oct. 2009, leg. & det. MW.

****Aspergillus flavus*** Link, (a), soil, dilution method, KoPU, Biele Suchowolskie fen, M-A, 20 Jun. 2008, leg. & det. MW.

****Aspergillus niger*** Tiegh., (a), soil, dilution method, KoPU, Biele Suchowolskie fen, FDc, M-A, S-cn, Sp-c, 20 Jun. 2008, leg. & det. MW.

Bionectria solani (Reinke & Berthold) Schroers [= *Gliocladium solani* (Harting) Petch], (a), soil, dilution method, KoPU, Biele Suchowolskie fen, FDc, 20 Jun. 2008, leg. AB, det. MW.

*****Candelabrum spinulosum*** Beverw., plant debris from peatbog, OPU, Osowiec, birch forest, 27 Aug. 2013, leg. & det. MW.

*****Cephalotrichum nanum*** (Ehrenb.) S. Hughes [= *Doratomyces nanus* (Ehrenb.) F.J. Morton & G. Sm.], (a), soil, Warcup method, KoPU, Biele Suchowolskie fen, M-A, 20 Jun. 2008, leg. AB, det. MW.

****Cephalotrichum stemonitis*** (Pers.) Nees [= *Doratomyces stemonitis* (Pers.) F.J. Morton & G. Sm.], (a), soil, Warcup method, KoPU, Biele Suchowolskie fen, Sp-c, 15 Oct. 2009, leg. AB, det. MW.

Cladosporium cladosporioides (Fresen.) G.A. de Vries, (a), soil, Warcup and dilution methods, KoPU, Biele Suchowolskie fen, M-A, 20 Jun. 2008, leg. AB, det. MW; M-A, S-cn, Sp-c, 15 Oct. 2009, leg. & det. MW.

****Cladosporium herbarum*** (Pers.) Link, (a), soil, Warcup and dilution methods, KoPU, Biele Suchowolskie fen, FDc, M-A, Sp-c, 20 Jun. 2008, leg. & det. MW; S-cn, 15 Oct. 2009, leg. & det. MW.

Dictyostelium mucoroides Bref., soil, dilution method, KoPU, Biele Suchowolskie fen, M-A, 20 Jun. 2008 and 15 Oct. 2009, leg. AB, det. MW.

****Fusarium arthrosporioides*** Sherb., (a), soil and plant debris, Warcup method, OPU, Biały Grąd, meadow, 27 Aug. 2013, leg. & det. MW.

****Fusarium chlamydosporum*** Wollenw. & Reinking [= *Fusarium fusarioides* (Gonz. Frag. & Cif.) C. Booth], (a), soil, dilution and Warcup methods, KoPU, Biele Suchowolskie fen, M-A, 15 Oct. 2009, leg. AB, det. MW.

****Fusarium oxysporum*** Schltdl., (a), soil, dilution and Warcup methods, KoPU, Biele Suchowolskie fen, M-A, 20 Jun. 2008, leg. AB, det. MW; Sp-c, 15 Oct. 2009, leg. AB, det. MW.

****Fusarium sporotrichioides*** Sherb., (a), soil, dilution and Warcup methods, KoPU, Biele Suchowolskie fen, M-A, S-cn, 20 Jun. 2008, leg. AB, det. MW; M-A, 15 Oct. 2009, leg. AB, det. MW.

****Gilmaniella*** sp., (a), soil, Warcup method, KoPU, Biele Suchowolskie fen, M-A, 15 Oct. 2009, leg. AB, det. MW.

*****Helicocephalum*** sp., (a), on wet spruce wood, non-culturable, OPU, Carska Droga, edge of road, 31 Aug. 2013, leg. & det. MW.

****Hirsutella rhossiliensis*** Minter & B.L. Brady, (a), soil, Warcup method, KoPU, Biele Suchowolskie fen, M-A, 15 Oct. 2009, leg. AB, det. MW.

****Humicola fuscoatra*** Traaen, (a), soil, Warcup method, KoPU, Biele Suchowolskie fen, M-A, S-cn, 20 Jun. 2008, leg. AB, det. MW; same plant communities, 15 Oct. 2009, leg. AB, det. MW.

****Microascus brevicaulis*** S.P. Abbott [= *Scopulariopsis brevicaulis* (Sacc.) Bainier], (a), soil, dilution method, KoPU, Biele Suchowolskie fen, FDc, 15 Oct. 2009, leg. & det. MW.

Mortierella bisporalis (Thaxt.) Björl., soil, damp chamber, OPU, Sośnia, Ce-A, edge of dune, 29 Aug. 2013, leg. & det. MW.

****Mucor circinelloides*** Tiegh., soil, dilution method, OPU, Sośnia, path in village, 28 Aug. 2013, leg. & det. MW.

Mucor hiemalis Wehmer, soil, Warcup and dilution methods, OPU, Góra Skobla, dune, 27 Aug. 2013, leg. & det. MW; Sośnia, Ce-A, close to edge of dune, 29 Aug. 2013, leg. & det. MW.

****Mucor moelleri*** (Vuill.) Lendn. [= *Zygorhynchus moelleri* Vuill.], mineral soil, dilution method, OPU, Sośnia, dune, 29 Aug. 2013, leg. & det. MW.

****Mucor piriformis*** A. Fisch., soil and plant debris, damp chamber method, OPU, Sośnia, path in village, 28 Aug. 2013, leg. & det. MW.

****Mucor racemosus*** Fresen., soil, Warcup and dilution methods, OPU, Góra Skobla, dune, 27 Aug. 2013, leg. & det. MW; Sośnia, Ce-A close to edge of dune, 29 Aug. 2013, leg. & det. MW.

****Mucor ramosissimus*** Samouts., soil, dilution method, OPU, Sośnia, dune, 29 Aug. 2013, leg. & det. MW.

****Paecilomyces carneus*** (Duché & R. Heim) A.H.S. Br. & G. Sm., (a), soil, dilution method, KoPU, Biele Suchowolskie fen, M-A, 15 Oct. 2009, leg. AB, det. MW.

****Paecilomyces*** sp., (a), soil, dilution and Warcup methods, KoPU, Biele Suchowolskie fen, FDc, Sp-c, 20 Jun. 2008, leg. AB, det. MW; FDc, M-A, Sp-c, 15 Oct. 2009, leg. AB, det. MW.

****Paecilomyces variotii*** Bainier, (a), soil, Warcup method, KoPU, Biele Suchowolskie fen, M-A, 20 Jun. 2008, leg. & det. MW.

****Penicillium aurantiogriseum*** Dierckx, (a), soil, dilution method, KoPU, Biele Suchowolskie fen, S-cn, 20 Jun. 2008, leg. & det. MW; Sp-c, 15 Oct. 2009, leg. & det. MW.

****Penicillium brevicompactum*** Dierckx, (a), soil, dilution method, KoPU, Biele Suchowolskie fen, S-cn, Sp-c, 15 ct. 2009, leg. & det. MW.

****Penicillium chrysogenum*** var. ***chrysogenum*** Thom, (a), soil, dilution and Warcup methods, KoPU, Biele Suchowolskie fen, FDc, M-A, S-cn, Sp-c, 20 Jun. 2008, leg. AB, det. MW.

****Penicillium decumbens*** Thom, (a), soil, dilution method, KoPU, Biele Suchowolskie fen, Sp-c, 20 Jun. 2008, leg. AB, det. MW; M-A, Sp-c, 15 Oct. 2009, leg. AB, det. MW.

****Penicillium miczynskii*** K.M. Zaleski [= *Penicillium soppi* K.M. Zaleski], (a), soil, dilution method, KoPU, Biele Suchowolskie fen, FDc, M-A, S-cn, Sp-c, 20 Jun. 2008, leg. AB, det. MW; M-A, Sp-c, 15 Oct. 2009, leg. AB, det. MW.

****Penicillium oxalicum*** Currie & Thom, (a), soil, dilution method, KoPU, Biele Suchowolskie fen, S-cn, 20 Jun. 2008, leg. AB, det. MW; M-A, S-cn, 15 Oct. 2009, leg. AB, det. MW.

Pilobolus crystallinus (F.H. Wigg.) Tode, on boar dung, OPU, Sośnia, Ce-A close to edge of dune, 29 Aug. 2013, leg. & det. MW.

*****Pilobolus nanus*** Tiegh., on boar dung, OPU, Sośnia, Ce-A close to edge of dune, 29 Aug. 2013, leg. & det. MW.

\#***Piptocephalis lepidula*** (Marchal) P. Syd., on boar dung, OPU, Sośnia, Ce-A close to edge of dune, 29 Aug. 2013, leg. & det. MW.

*****Piptocephalis fimbriata*** M.J. Richardson & Leadbeater, on boar dung, OPU, Sośnia, Ce-A close to edge of dune, 29 Aug. 2013, leg. & det. MW.

****Polysphondylium*** sp., soil, dilution method, KoPU, Biele Suchowolskie fen, Sp-c, 20 Jun. 2008, leg. AB, det. MW; M-A, Sp-c, 15 Oct. 2009, leg. AB, det. MW.

Rhizopus arrhizus Went & Prins. Geerl. [= *Rhizopus oryzae* Went & Prins. Geerl.], soil and plant debris, damp chamber method, OPU, Biały Grąd, meadow, 27 Aug. 2013, leg. & det. MW.

Rhizopus stolonifer (Ehrenb.) Vuill., plant debris, damp chamber method, BbNP buffer zone, Osowiec village, Carska Droga, roaside, 30 Aug. 2013, leg. & det. MW.

****Rhopalomyces elegans*** Corda, soil and plant debris, Warcup method, KoPU, Biele Suchowolskie fen, FDc, 20 Jun. 2008, leg. & det. MW; S-cn, 15 Oct. 2009, leg. & det. MW.

****Sarocladium kiliense*** (Grütz) Summerb. [= *Acremonium kiliense* Grütz], (a), soil, Warcup and dilution methods, KoPU, Biele Suchowolskie fen, S-cn, 20 Jun. 2008, leg. AB, det. MW; M-A, 15 Oct. 2009, leg. AB, det. MW.

****Sarocladium strictum*** (W. Gams) Summerb. [= *Acremonium strictum* W. Gams], (a), soil, Warcup and dilution methods, KoPU, Biele Suchowolskie fen, M-A, Sp-c, 20 Jun. 2008, leg. AB, det. MW; 27 Aug. 2013 leg. & det. MW.

****Sordaria fimicola*** (Roberge ex Desm.) Ces. & De Not., (t), plant debris, KoPU, Biele Suchowolskie fen, Sp-c, 15 Oct. 2009, leg. AB, det. MW.

***unidentified Sporormiaceae**, (t), soil, Warcup method, KoPU, Biele Suchowolskie fen, Sp-c, 15 Oct. 2009, leg. AB, det. MW.

****Syncephalis nodosa*** Tiegh., soil on mucoralean hyphae, KoPU, Biele Suchowolskie fen, FDc, 15 Oct. 2009, leg. AB, det. MW.

Syncephalis sphaerica Tiegh., soil on mucoralean hyphae, KoPU, Biele Suchowolskie fen, M-A, 20 Jun. 2008, leg. AB, det. MW; M-A, Sp-c, 15 Oct. 2009, leg. AB, det. MW.

Syncephalis tenuis Thaxt., soil, dump chamber, OPU, Biały Grąd, meadow, 27 Aug. 2013, leg. & det. MW.

****Syzygites megalocarpus*** Ehrenb., on *Humaria hemisphaerica* fruitbody, OPU, Sośnia, mixed forest, 28 Aug. 2013, leg. & det. MW.

*#***Talaromyces funiculosus*** (Thom) Samson, N. Yilmaz, Frisvad & Seifert [= *Penicillium funiculosum* Thom.], (a), soil, dilution method, KoPU, Biele Suchowolskie fen, FDc, M-A, S-cn, 20 Jun. 2008, leg. AB, det. MW; Sp-c, 15 Oct. 2009, leg. AB, det. MW.

*#***Talaromyces rugulosus*** (Thom) Samson, N. Yilmaz, Frisvad & Seifert [= *Penicillium rugulosum* Thom], (a), soil, dilution method, KoPU, Biele Suchowolskie fen, M-A, Sp-c, 20 Jun. 2008, leg. AB, det. MW; M-A, S-cn, 15 Oct. 2009, leg. AB, det. MW.

****Trichocladium asperum*** Harz, (a), soil, Warcup and dilution methods, KoPU, Biele Suchowolskie fen, Sp-c, 20 Jun. 2008 and 15 Oct. 2009, leg. AB, det. MW.

*#***Trichoderma aggressivum*** Samuels & W. Gams, (a), on hoof fungus *Fomes fomentarius* fruitbody, OPU, Biały Grąd, solitary tree trunk on meadow, 27 Aug. 2013, leg. & det. MW.

****Trichoderma deliquescens*** (Sopp) Jaklitsch [= *Gliocladium viride* Matr.], (a), soil, dilution method, KoPU, Biele Suchowolskie fen, M-A, 15 Oct. 2009, leg. AB, det. MW.

****Trichoderma hamatum*** (Bonord.) Bainier, (a), soil by dilution and Warcup methods, KoPU, Biele Suchowolskie fen, FDc, M-A, S-cn, Sp-c, 20 Jun. 2008, leg. AB, det. MW; Sp-c, 15 Oct. 2009, leg. AB, det. MW.

****Trichoderma harzianum*** Rifai, (a), soil, dilution and Warcup methods, KoPU, Biele Suchowolskie fen, FDc, S-cn, 20 Jun. 2008, leg. AB, det. MW; S-cn, 15 Oct. 2009, leg. AB, det. MW.

Trichoderma koningii Oudem., (a), soil, dilution and Warcup methods, KoPU, Biele Suchowolskie fen, S-cn, 20 Jun. 2008, leg. AB, det. MW; M-A, S-cn, 15 Oct. 2009, leg. AB, det. MW.

****Trichoderma polysporum*** (Link) Rifai, (a), soil, dilution and Warcup methods, KoPU, Biele Suchowolskie fen, FDc, Sp-c, 20 Jun. 2008, leg. AB, det. MW; M-A, Sp-c, 15 Oct. 2009, leg. AB, det. MW.

Trichoderma viride Pers., (a), soil, dilution method, KoPU, Biele Suchowolskie fen, FDc, M-A, S-cn, Sp-c, 20 Jun. 2008, leg. AB, det. MW; M-A, S-cn, Sp-c, 15 Oct. 2009, leg. AB, det. MW.

****Verticillium*** sp., (a), soil, dilution method, KoPU, Biele Suchowolskie fen, FDc, S-cn, Sp-c, 20 Jun. 2008, leg. AB, det. MW; M-A, 15 Oct. 2009, leg. AB, det. MW.

Discussion

Although the data presented in this paper are preliminary, the results of the second few-days-inventory carried out by PMS, supplemented with limited data from the Biele Suchowolskie fen (two samples from each plant community) are promising for the future mycological studies in BbNP. The list of microfungal species is relatively extensive and includes taxa very rare or recorded for the first time in Poland. In addition, about a half of the species from the current list was not observed during the previous PMS survey in 2012 [1]. Worth noting is also the ecological spectrum of the fungi presented in our paper, as the data on entomopathogens and soil fungi are very scarce in case of other mycologically studied Polish national parks [50]. It concerns also most thoroughly studied Białowieża National Park [51] and Tatra National Park [52]. Due to that lack of specific data and short-term research in BbNP the possibility to compare our results with other studies is greatly limited. The only practicable comparison concerns plant-associated species as this group of microfungi was extensively studied in nine of 23 Polish national parks. The number of species recorded in BbNP in 2013 (190) accounts for more than one third of the number of species recorded in Ojcowski, Pieniński, and Poleski National Parks during several years' studies using a route method (cf. [53]). Surprisingly, current number of taxa from BbNP constitutes about a half of the number of species listed from long-term project CRYPTO in the Białowieża National Park [51] and the projected Jurassic National Park [54] where permanent observation plots were used, but less than one third of taxa collected in the Słowiński National Park [55] using the same method. The currently reported number of plant-associated microfungi is however greater than that recorded using route method during systematic studies carried out in the Lubelska Upland and Bug River Valley (cf. [53]). The available data concerning arthropod associated fungi indicate that the number recorded in BbNP in 2013 (22 species) accounts for a little more than one third of the number of species recorded in Białowieża NP [56,57] and less than one quarter of taxa noted in Wielkopolski National Park [56].

The diversity of methods used for isolation and identification of soil fungi is another reason for limited comparison of the present results with literature data. For example, the methods used to study soil fungi vary strongly from one research to another. The most commonly used dilution method [58,59] was deeply criticized by Warcup [60]. His soil-plate method is still widely used in a direct way or with modifications [61–63]. Since the beginning of twenty-first century new method of a cultivation-independent analysis and direct DNA extraction and sequencing were implemented [64,65] to study soil fungal communities.

The results of traditional and molecular studies are incomparable, and the lists of microfungal species found in soil are difficult to interpret. The dilution method favors fungi producing phialospores while fungi that are not sporulating readily on agar media could be detected by direct sequencing [64]. Yeasts such as *Trichosporon* spp. are identified in soils more often in molecular studies than when using other techniques [66–68]. Some quite rare, specialized fungi could be also isolated from soil using trap method [69]. These fungi often remain unidentified in molecular studies due to the lack of reference sequences.

The majority of investigations of soil fungal communities fall into one of three categories: systematic studies, biochemical research and phytopathology. Most of them is focused on plant rhizosphere – a microecological zone in direct proximity of plant roots. Symbiotic and pathogenic fungi could significantly affect the yield, and studies are restricted to economically important plants. The general ecological investigations of soil fungi are still very rare [70] and assignment of any taxa to specific habitats is impossible yet. Our present studies are preliminary and should be supplemented with taxa identified by pyrosequencing. The studies by Buée and collaborators [65] and Lim and collaborators [71] indicate that the richness of fungi in soils is much bigger than expected. Finally, one should note that only holistic approach could lead us to understanding of the specificity of soil mycocoenoses.

Key outcomes

- Nineteen taxa were found for the first time in Poland: *Candelabrum spinulosum*, *Cephalotrichum nanum*, *Cercosporella lindaviana*, *Colletotrichum veratrina*, *Daldinia decipiens*, *Discosia fitzpatrickii*, *D. kabati*, *D. potentillae*, *D. pulmonariae*, *D. quercicola*, *Helicocephalum* sp., *Nemania aenea*, *Mycosphaerella osborniae*, *Phaeosphaeria inclusa*, *Phomopsis amygdaliana*, *Pilobolus nanus*, *Piptocephalis fimbriata*, *Seimatosporium foliicola*, and *Sphaceloma viburni*.
- Thirty-one taxa that may be considered as rare, including plant-inhabiting fungi (*Ascochyta equiseti*, *Asteromella pruni-mahaleb*, *Discosia minuta*, *Fusicladium betulae*, *Hypomyces rosellus*, *Helminthosphaeria clavariarum*, *Leveillula helichrysi*, *Monilinia padi*, *Peronospora agrimoniae*, *Phyllosticta pyrolae*, *Septoria jasiones*, *Septoria tabacina*, *Stephanoma strigosum*), and four isolated from soil (*Talaromyces funiculosus*, *Talaromyces rugulosus*, *Piptocephalis lepidula*, *Trichoderma aggressivum*).
- 165 species are reported as new to the area of the Biebrza National Park.

Although some taxa are recorded in Poland for the first time, one should note that the knowledge about occurrence and distribution of microfungi without economical impact is still very limited. Thus all final conclusions basing on available data should be treated with caution.

Acknowledgments

We are deeply grateful to Mr. Roman Skąpski (director of BbNP) as well as to Ms. Agnieszka Henel, Mr. Cezary Werpachowski and Mr. Krzysztof Frąckiel, and other employees of the Biebrza National Park for collecting fungi, offering their facilities, helping in the implementation of our research and creating the very friendly atmosphere during our visit. We are grateful to the following persons for permission to use their materials in our paper: Abiba Boulahdjel (University of Warsaw), Grażyna Domian (Regional Directorate for Environmental Protection in Szczecin), Błażej Gierczyk (Adam Mickiewicz University in Poznań), Tomasz Leski and Marcin Pietras (Institute of Dendrology, Polish Academy of Sciences, Kórnik), Małgorzata Stasińska (University of Szczecin), and Natalia Michalska (Łódź). We thank also Błażej Gierczyk and Anna Kujawa (Institute for Agricultural and Forest Environment) for identification of *Helminthosphaeria clavariarum* and *Hypomyces rosellus* and Jeremi Kołodziejek (University of Łódź) for identification of *Potentilla* species. Thanks are also to Kamil Kędra (University of Agriculture in Krakow) for providing digital version of BbNP map.

References

1. Ruszkiewicz-Michalska M, Tkaczuk C, Dynowska M, Sucharzewska E, Szkodzik J, Wrzosek M. Preliminary studies of fungi in the Biebrza National Park (NE Poland). I. Micromycetes. Acta Mycol. 2012;47(2):213–234. http://dx.doi.org/10.5586/am.2012.026
2. Kujawa A, Wrzosek M, Domian G, Kędra K, Szkodzik J, Rudawska M, et al. Preliminary studies of fungi in the Biebrza National Park (NE Poland). II. Macromycetes. Acta Mycol. 2012;47(2):235–264. http://dx.doi.org/10.5586/am.2012.027
3. Boulahdjel A. Microscopic soil fungi from partially burnt Biele Suchowolskie fen in Biebrza National Park [MSc thesis]. Warsaw: University of Warsaw; 2010.
4. Kujawa A, Gierczyk B, Domian G, Wrzosek M, Stasińska M, Szkodzik J, et al. Preliminary studies of fungi in the Biebrza National Park. IV. Macromycetes – new data and the synthesis. Acta Mycol. 2015;50(2):1070. http://dx.doi.org/10.5586/am.1070
5. Budziszewska J, Boulahdjel A, Wilk M, Wrzosek M. Soil zygomycetous fungi in Biebrza National Park (northeast Poland). Pol Bot J. 2010;55(2):391–407.
6. Kania J, Malawska M, Gutry P, Kamiński J, Wiłkomirski B. Zmiany przyrodnicze torfowiska niskiego spowodowane pożarem wgłębnym. Woda, Środowisko i Obszary Wiejskie. 2006;6(2):155–173.
7. Mętrak M, Malawska M, Kamiński J, Błocka A, Wiłkomirski B. Plant secondary succession patterns after 2002 wildfire in the Biebrza National Park. Phytopedon (Bratislava). 2008;7:109–114.

8. Braun U. The powdery mildews (Erysiphales) of Europe. Jena: G. Fisher Verlag; 1995.
9. Braun U. A monograph of *Cercosporella*, *Ramularia* and allied genera (phytopathogenic hyphomycetes). Eching: IHW; 1995. (vol 1).
10. Braun U. A monograph of *Cercosporella*, *Ramularia* and allied genera (phytopathogenic hyphomycetes). Eching: IHW; 1998. (vol 2).
11. Domsch KH, Gams W, Anderson TH. Compendium of soil fungi. Bransweig: IHW; 1993.
12. Hoffmann K, Pawłowska J, Walther G, Wrzosek M, de Hoog GS, Benny GL, et al. The family structure of the Mucorales: a synoptic revision based on comprehensive multigene-genealogies. Persoonia. 2013;30:57–76. http://dx.doi.org/10.3767/003158513X666259
13. Ignatavičiutė M, Treigienė A. Mycota Lithuaniae. IX. Melanconiales. Vilnius: UAB, Valstiečių Laikraštis; 1998.
14. Kochman J, Majewski T. Glonowce (Phycomycetes), wroślikowe (Peronosporales). Warszawa: Państwowe Wydawnictwo Naukowe; 1970. [Flora Polska. Rośliny Zarodnikowe Polski i Ziem Ościennych. Grzyby (Mycota); vol 4].
15. Majewski T. Podstawczaki (Basidiomycetes), rdzawnikowe (Uredinales) I. Warszawa: Państwowe Wydawnictwo Naukowe; 1977. [Flora Polska. Rośliny Zarodnikowe Polski i Ziem Ościennych. Grzyby (Mycota); vol 9].
16. Majewski T. Podstawczaki (Basidiomycetes), rdzawnikowe (Uredinales) II. Warszawa: Państwowe Wydawnictwo Naukowe; 1979. [Flora Polska. Rośliny Zarodnikowe Polski i Ziem Ościennych. Grzyby (Mycota); vol 11].
17. Nannfeldt JA. *Exobasidium*, a taxonomic reassessment applied to the European species. Symb Bot Ups. 1981;23(2):1–72.
18. Schubert K, Ritschel A, Braun U. A monograph of *Fusicladium* s. lat. (Hyphomycetes). Schlechtendalia. 2003;9:1–132.
19. Skirgiełło A, Zadara M. Glonowce (Phycomycetes), pleśniakowe (Mucorales). Warszawa: Państwowe Wydawnictwo Naukowe; 1979. [Flora Polska. Rośliny Zarodnikowe Polski i Ziem Ościennych. Grzyby (Mycota); vol 10].
20. Vanev SG, Sameva EF, Bakalova GG. Fungi Bulgaricae. 3 tomus, Ordo Sphaeropsidales. Sofia: Pensoft; 1997.
21. Wołczańska A. The *Ramularia* species in Poland. Łódź: Polish Botanical Society; 2005. (Monographiae Botanicae; vol 95). http://dx.doi.org/10.5586/mb.2005.002
22. Wołczańska A. Septoria in Poland. Lublin: Maria Curie-Skłodowska University; 2013.
23. Ellis MB, Ellis JP. Microfungi on lands plants. An identyfication handbook. Enlarged edition. Slough: The Richmond Publishing; 1997.
24. Rappaz F. Taxonomie et nomenclature des Diatrypacees à asques octospores. Mycologia Helvetica. 1987;2(3):285–648.
25. Stadler M, Baumgartner M, Wollweber H, Rogers JD, Ju YM. *Daldinia decipiens* sp. nov. and notes on some other European *Daldinia* spp. inhabiting Betulaceae. Mycotaxon. 2001;80:167–177.
26. Ju YM, Rogers JD. The genus *Nemania* (Xylariaceae). Nova Hedwigia. 2002;74(1–2):75–120. http://dx.doi.org/10.1127/0029-5035/2002/0074-0075
27. Rutkowski L. Klucz do oznaczania roślin naczyniowych Polski niżowej. Warszawa: Wydawnictwo Naukowe PWN; 2004.
28. Adl SM, Simpson AG, Lane CE, Lukeš J, Bass D, Bowser SS, et al. The revised classification of Eukaryotes. J Eukaryot Microbiol. 2012;59(5):429–493. http://dx.doi.org/10.1111/j.1550-7408.2012.00644.x
29. Hibbett DS, Binder M, Bischoff JF, Blackwell M, Cannon PF, Eriksson OE, et al. A higher-level phylogenetic classification of the Fungi. Mycol Res. 2007;111:509–547. http://dx.doi.org/10.1016/j.mycres.2007.03.004
30. Keller S. Systematics, taxonomy and identification. In: Keller S, editor. Arthropod-pathogenic Entomophthorales: biology, ecology, identification. Luxembourg: COST Office; 2007. p. 111–126.
31. Humber R. Entomophthoromycota: a new phylum and reclassification for entomophthoroid fungi. Mycotaxon. 2012;120:477–492. http://dx.doi.org/10.5248/120.477
32. Mułenko W, Majewski T, Ruszkiewicz-Michalska M, editors. A preliminary checklist of micromycetes in Poland. Kraków: W. Szafer Institute of Botany, Polish Academy of Sciences; 2008. (Biodiversity of Poland; vol 9).

33. Index Fungorum [Internet]. 2015 [cited 2015 Oct 10]. Available from: http://www.indexfungorum.org
34. Mirek Z, Piękoś-Mirkowa H, Zając A, Zając M, editors. Flowering plants and pteridophytes of Poland – a checklist. Kraków: W. Szafer Institute of Botany, Polish Academy of Sciences; 2002. (Biodiversity of Poland; vol 1).
35. Schaefer M. Brohmer-Fauna von Deutschland. Wiebelsheim: Quelle und Meyer; 2010.
36. Matuszkiewicz W. Przewodnik do oznaczania zbiorowisk roślinnych Polski. Warszawa: Wydawnictwo Naukowe PWN; 2006.
37. Farr DF, Rossman AY. Fungal databases [Internet]. 2015 [cited 2015 Oct 10]. Available from: http://nt.ars-grin.gov/fungaldatabases
38. Kujawa A. Grzyby makroskopijne Polski w literaturze mykologicznej [Internet]. 2015 [cited 2015 Oct 10]. Available from: http://www.grzyby.pl/grzyby-makroskopijne-Polski-w-literaturze-mikologicznej.htm
39. Gierczyk B, Szczepkowski A, Kujawa A. The XVIII Fungi Exposition of the Białowieża Forest. Parki Narodowe i Rezerwaty Przyrody. 2013;32(2):88–112.
40. Vanev SG, van der Aa HA. An annotated list of the published names in *Asteromella*. Persoonia. 1998;17(1):47–67.
41. Groenewald JZ, Nakashima C, Nishikawa J, Shin HD, Park JH, Jama AN, et al. Species concepts in *Cercospora*: spotting the weeds among the roses. Stud Mycol. 2012;75:115–170. http://dx.doi.org/10.3114/sim0012
42. Sałata B. Workowce (Ascomycetes), mączniakowe (Erysiphales). Warszawa: Państwowe Wydawnictwo Naukowe; 1985. [Flora Polska. Rośliny Zarodnikowe Polski i Ziem Ościennych. Grzyby (Mycota); vol 15].
43. Ho HM. The merosporangiferous fungi from Taiwan (VI): two new records of *Piptocephalis* (Piptocephalidaceae, Zoopagales, Zygomycetes). Taiwania. 2006;51(3):210–213.
44. Schroeter J. Kryptogamen-Flora von Schlesien: Die Pilze Schleziens. Breslau: J.U. Kern's Verlag; 1908. (vol 2).
45. Samuels GJ, Dodd SL, Gams W, Castlebury LA, Petrini O. *Trichoderma* species associated with the green mold epidemic of commercially grown *Agaricus bisporus*. Mycologia. 2002;94(1):146–170. http://dx.doi.org/10.2307/3761854
46. Błaszczyk L, Popiel D, Chełkowski J, Koczyk G, Samuels GJ, Sobieralski K, et al. Species diversity of *Trichoderma* in Poland. J Appl Genet. 2011;52(2):233–243. http://dx.doi.org/10.1007/s13353-011-0039-z
47. Werner M, Frużyńska-Jóźwiak D, Andrzejak R. Oddziaływanie *Trichoderma* spp. i *Penicillium funiculosum* na rozwój fuzariozy naczyniowej na goździku szklarniowym i gipsówce wiechowatej. Roczniki Akademii Rolniczej w Poznaniu, Ogrodnictwo. 1998;26:105–112.
48. Szwedek-Trzaska A, Głowacka A. Seeking ways to eradicate potentially pathogenic fungi isolated from soil. Pol J Environ Stud. 2011;20(5):1313–1318.
49. Bebłowska M. Four noteworthy coprophilic Mucorales from eastern Poland. Acta Mycol. 1992;27(2):271–276. http://dx.doi.org/10.5586/am.1992.026
50. Ławrynowicz M, Bujakiewicz A, Mułenko W. Mycocoenological studies in Poland. 1952–2002. Łódź: Polish Botanical Society; 2004. (Monographiae Botanicae; vol 93). http://dx.doi.org/10.5586/mb.2004.001
51. Faliński JB, Mułenko W, editors. Cryptogamous plants in the forest communities of Białowieża National Park. Ecological atlas (Project CRYPTO 4). Supplementum Cartographiae Geobotanicae. 1997;7:1–522.
52. Mułenko W, Kozłowska M, Sałata B. Microfungi of the Tatra National Park. A checklist. Biodiversity of the Tatra National Park. 2004;1:1–72.
53. Mułenko W. Phytopathogenic microfungi in the structure of natural forest communities. Lublin: Maria Curie-Skłodowska University; 1998.
54. Ruszkiewicz-Michalska M. Mikroskopijne grzyby pasożytnicze w zbiorowiskach roślinnych Wyżyny Częstochowskiej. Łódź: Polish Botanical Society; 2006. (Monographiae Botanicae; vol 96). http://dx.doi.org/10.5586/mb.2006.001
55. Adamska I. Zróżnicowanie zbiorowisk grzybów mikroskopijnych w odniesieniu do zróżnicowania zbiorowisk roślinnych w Słowińskim Parku Narodowym. Szczecin: Zachodniopomorski Uniwersytet Technologiczny; 2013.
56. Bałazy S. Significance of protected areas for the preservation of entomopathogenic fungi. Kosmos. 2004;53(1):5–16.

57. Sosnowska D, Bałazy S, Prishchepa L, Mikulskaya N. Biodiversity of arthropod pathogens in the Białowieża Forest. J Plant Prot Res. 2004;44(4):313–121.
58. Mehrotra BR, Kakkar RK. Rhizosphere soil fungi of some vegetable plants. Mycopathol Mycol Appl. 1972;46(4):379–385. http://dx.doi.org/10.1007/BF02052135
59. Jeyanthi R, Dhanalakshmi V, Sharmila S, Susithra G, Kumar S, Bala S. Isolation, identification and characterization of fungi from rhizosphere soil of *Barleria cristata*. International Journal of Horticultural and Crop Science Research. 2012;2(1):1–6.
60. Warcup JH. Soil fungi. In: Burges A, Raw F, editors. Soil biology. London: Academic Press; 1967. p. 51–109. http://dx.doi.org/10.1016/b978-0-12-395699-6.50007-9
61. Johnson LF, Mańka K. A modification of Warcup's soil-plate method for isolating soil fungi. Soil Sci. 1961;92:79–84. http://dx.doi.org/10.1097/00010694-196108000-00001
62. Mańka K. Próby dalszego udoskonalenia zmodyfikowanej metody Warcupa izolowania grzybów z gleby. Prace Komisji Nauk Rolniczych i Komomisji Nauk Leśnych. 1964;17:29–45.
63. Mańka K, Salmanowicz B. Udoskonalenie niektórych technik zmodyfikowanej metody płytek glebowych do izolowania grzybów z gleby z punktu widzenia mikologii. Rocz Nauk Rol. 1987;E(17):35–46.
64. Gomes NC, Fagbola O, Costa R, Rumjanek N, Buchner A, Mendona-Hagler L, et al. Dynamics of fungal communities in bulk and maize rhizosphere soil in the tropics. Appl Environ Microbiol. 2003;69(7):3758–3766. http://dx.doi.org/10.1128/AEM.69.7.3758-3766.2003
65. Buée M, Reich M, Murat C, Morin E, Nilsson RH, Uroz S, et al. 454 pyrosequencing analyses of forest soils reveal an unexpectedly high fungal diversity. New Phytol. 2009;184(2):449–456. http://dx.doi.org/10.1111/j.1469-8137.2009.03003.x
66. Middelhoven WJ, Scorzetti G, Fell JW. *Trichosporon guehoae* sp. nov., an anamorphic basidiomycetous yeast. Can J Microbiol. 1999;45:686–690. http://dx.doi.org/10.1139/w99-055
67. Middelhoven WJ, Scorzetti G, Fell JW. *Trichosporon porosum* comb. nov., an anamorphic basidiomycetous yeast inhabiting soil, related to the loubieri/laibachii group of species that assimilate hemicelluloses and phenolic compounds. FEMS Yeast Res. 2001;1:15–22. http://dx.doi.org/10.1016/S1567-1356(00)00002-7
68. Middelhoven WJ, Scorzetti G, Fell JW. Systematics of the anamorphic basidiomycetous yeast genus *Trichosporon* Behrend with the description of five novel species: *Trichosporon vadense*, *T. smithiae*, *T. dehoogii*, *T. scarabaeorum* and *T. gamsii*. Int J Syst Evol Microbiol. 2004;54(3):975–986. http://dx.doi.org/10.1099/ijs.0.02859-0
69. Dhingra O, Sinclair J. Basic plant pathology methods. Boca Raton, FL: Lewis Publishers; 1995.
70. Badurowa M, Badura L, Further investigations on the relationships between soil fungi and macroflora. Acta Soc Bot Pol. 1967;36(3):515–529. http://dx.doi.org/10.5586/asbp.1967.049
71. Lim YW, Kim BK, Kim C, Jung HS, Kim BS, Lee JH, et al. Assessment of soil fungal communities using pyrosequencing. J Microbiol. 2010;48(3):284–289. http://dx.doi.org/10.1007/s12275-010-9369-5