



*Tomasz Dobies, Anna Wierzbicka, Andrzej M. Jagodziński, Cezary K. Urbanowski, Izabela Kałucka, Marek Kasprowicz, Maria Wojterska, Małgorzata Sławska, Andrzej Łabędzki, Mirosław Nowiński, Stanisław Małek, Piotr Karolewski, Jacek Oleksyn, Piotr Banaszcak, Maciej Skorupski\**

## Diversity of plants, fungi, and invertebrates of yellow birch (*Betula alleghaniensis* Britton) experimental stands in Rogów Arboretum (Poland)

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**Abstract:** *Betula alleghaniensis* Britton, commonly known as yellow birch, occurs naturally in northeastern North America, particularly in the Appalachian and Great Lakes regions, where it is considered one of the most valuable hardwood species. In this study, conducted between 2007 and 2010, we assessed the diversity of vascular plants, mosses and liverworts, fungi, and invertebrates in two experimental stands of *B. alleghaniensis* established in the Rogów Arboretum (Poland), outside the species' natural range. A total of 54 taxa of vascular plants, mosses, and liverworts, 39 taxa of fungi, and 108 taxa of invertebrates were recorded. The richest groups were insects (Collembola and Coleoptera), followed by nematodes and mites. Compared to reference oak-hornbeam forests (*Tilio-Carpinetum*), *B. alleghaniensis* stands hosted a slightly higher number of vascular plants and mosses (+4%), but substantially fewer fungi (−42%) and invertebrates (−33%). These results indicate that *B. alleghaniensis* supports distinct but less diverse soil and litter biota than native broadleaves tree species. The findings highlight the importance of tree species identity in shaping biodiversity patterns and provide a reference for future studies on non-native tree introductions in Central Europe.

**Keywords:** yellow birch, biodiversity, tree species effect, non-native trees, soil fauna, fungi, vascular plants

**Addresses:** T. Dobies, A. Wierzbicka, A. M. Jagodziński, C. K. Urbanowski, A. Łabędzki, M. Nowiński, M. Skorupski, Poznań University of Life Sciences, Department of Game Management and Forest Protection, Wojska Polskiego 71C, 60-625 Poznań, Poland; e-mail: [maskorup@up.poznan.pl](mailto:maskorup@up.poznan.pl)

A. M. Jagodziński, P. Karolewski, J. Oleksyn, Institute of Dendrology, Polish Academy of Sciences, Parkowa 5, 62-035 Kórnik, Poland

I. Kałucka, University of Lodz, Department of Mycology, Banacha 12/16, 90-237 Łódź

M. Kasprowicz, M. Wojterska, Adam Mickiewicz University, Department of Plant Ecology and Environmental Protection, Faculty of Biology, Umultowska 89, 61-614 Poznań

M. Sławska, Warsaw University of Life Sciences, Department of Forest Protection and Ecology, Nowoursynowska 159, 02-776 Warszawa

S. Małek, University of Agriculture in Krakow, Department of Ecology, 29 Listopada 46, 31-425 Kraków

P. Banaszcak, Warsaw University of Life Sciences, Rogów Arboretum, Akademicka 20, 95-063 Rogów

\* corresponding author

## Introduction

Tree species have a fundamental influence on forest biodiversity and ecosystem functioning. Through differences in canopy structure, leaf litter quality, decomposition rate, root exudates, and associated mycorrhizal fungi, tree species create distinct microhabitats that shape the diversity and abundance of plants, fungi, and soil fauna (e.g., Hobbie et al., 2006; Horodecki et al., 2019; Mueller et al., 2016). Tree species modify abiotic conditions such as light intensity, soil pH, and moisture, which in turn determine the composition and trophic interactions of various organism groups inhabiting forest ecosystems (e.g. Kamczyc et al., 2021). It has been documented that tree species may affect vegetation diversity and species composition but the impact on soil fauna were limited mainly to community composition rather than overall diversity Slabejová et al. (2024). Therefore comprehensive multi-taxon studies covering vascular plants, fungi, and invertebrates under different tree species are still greatly needed, although such integrative assessments require extensive fieldwork and taxonomic expertise. Moreover, there are only a few studies that provide complete data-sets of taxa across multiple biological groups (Jagodziński et al., 2010; Kałucka et al., 2013; Skorupski et al., 2011), but they do not cover the relation to the native tree species in the same habitat.

In this study we focused on yellow birch (*Betula alleghaniensis* Britton), which is important and profitable hardwood species in northeastern North America forests. This species is native for northern Appalachians and Great Lakes region, growing up to 1050 m asl. It prefers cool habitats with high rainfall (from 640 mm in its western limit to 1270 mm in the East) and the growing season ca. 120 days (60–150 days) (Gilbert, 1965). Yellow birch tolerates extreme temperatures from  $-40^{\circ}\text{C}$  to  $38^{\circ}\text{C}$  and its northern limits coincides with a  $+2^{\circ}\text{C}$  average annual temperature isotherm (Dansereau & Pageau, 1966; Gilbert, 1965). This tree grows best on well-drained, fertile loams and moderately well-drained sandy loams of uplands and, mountain ravines, along streams and swampy forests (Gilbert, 1965). Additionally, it grows in mixtures with other tree species (Eyre, 1980) in old-growth and unmanaged second-growth northern hardwood forests (Erdmann, 1990; Erdmann & Oberg, 1973), and can reach an age of 300 years, but probably their physiological maturity is about half that time (Hicks, 1998).

Yellow birch is classified as an early to mid-successional tree species that is displaced by late successional species as a stand matures (Flaccus, 1959). The trees begin producing seeds abundantly every 2–4 year from the age of 40 which fall in October and the seeds germinate abundantly in habitats as

mossy logs, decayed wood, and rotten stumps and windthrown hummocks, where there is a lack of a thick leaf litter layer at warm temperatures in early July (Clausen, 1973; Erdmann, 1990; Gilbert, 1965; Houle & Payette, 1990). The mortality of seedlings is usually very high. Natural regeneration of yellow birch is usually limited to edges of skidroads (Tubbs, 1969). The optimum light conditions for the growth and development of seedlings up to 5 years old is ca. 50% of full sunlight (Filip, 1969). Yellow birch is more tolerant to shade, but requires considerable space for crown expansion, and suitable soil moisture (Gilbert, 1965). Trees growing in dense stands have good natural pruning of lower limbs. Yellow birch trees develop epicormic branching when thinnings are too heavy (Hicks, 1998). To ensure successful natural regeneration in young stands where the sapling density of trees is low, it is strongly recommended to control of competing vegetation (Bouffard et al., 2007).

Currently, there is a lack of data on species richness in pure yellow birch stands because this species occurs mainly in parks and gardens, therefore the aim of the study was to assess the diversity of major taxonomic groups of vascular plants, fungi, and invertebrates occurring under the canopy of *B. alleghaniensis* stands established outside the species' natural distribution and to compare them with those recorded in reference oak-hornbeam forests (*Tilio-Carpinetum*) growing under similar habitat conditions. Additionally, we hypothesized that *B. alleghaniensis* stands would host members of the same taxonomic groups as oak-hornbeam forests, but their species richness would be lower due to differences in litter properties, soil microclimate, and mycorrhizal associations.

## Materials and Methods

The study was conducted in two yellow birch (*Betula alleghaniensis* Britton) stands (A and B) with ages of 39 years (Figs 1 and 2) in the Rogów Arboretum of the Warsaw University of Life Sciences (SGGW), Poland ( $51^{\circ}49'\text{N}$ ,  $19^{\circ}53'\text{E}$ ). The study plots (A and B) were located in the western part of the Arboretum, placed next to each other (Table 1).

According to long-term meteorological observations (55 years) from the closest meteorological station in Strzelna, mean annual temperature is  $7.2^{\circ}\text{C}$  (January:  $-3.2^{\circ}\text{C}$ , July:  $17.3^{\circ}\text{C}$ ), mean annual precipitation is 596 mm (404–832 mm, ca. 70% of annual precipitation is in the growing season), and mean growing season length (calculated as the number of days with mean temperature  $\geq 5^{\circ}\text{C}$ ) is 212 days (Bednarek, 1993; Jagodziński & Banaszczak, 2010). The study plots are located on flat terrain ca. 189 m a.s.l. The soils were developed on a postglacial



Fig. 1. *Betula alleghaniensis* tree stand



Fig. 2. *Betula alleghaniensis* – leaved twig

Table 1. The characteristics of *Betula alleghaniensis* experimental plots (Hotała, 2010)

Characteristics	Study site A	Study site B
Year of stand establishment	1970	1970
Number of specimens	86	86
Area of experimental plot	0.02 ha	0.02 ha
Seed origin	Ottawa Cent. Exp. Farm, Canada	Washtenaw Co., Marquette Co., Michigan, USA
Stand density (trees ha <sup>-1</sup> )	1151	1151
Stand age	36	36

formation in the region of a ground moraine. The soils are rich, mesic, with the groundwater level beyond the reach of tree roots (Człepińska-Kamińska et al., 1991; Jagodziński & Banaszczak, 2010).

Soil unit is haplic luvisol. Soil texture in the A horizon was sandy silt. Fraction content in plot A – sand fraction 59%, silt fraction 39%, clay fraction 2%; in plot B – sand fraction 58%, silt fraction 38%, clay fraction 4%. Soil pH measured in M KCl in particular horizons was as follows: plot A – Oll 4.52, Ol 4.84, Ofh 4.58, and A 3.28; plot B – Oll 4.30, Ol 5.00, Ofh 4.90, and A 3.22. Total acidity was respectively: plot A – Oll 39.36 cmol(+) / kg, Ol 34.40 cmol(+) / kg, Ofh 40.82 cmol(+) / kg and A 21.74 cmol(+) / kg; plot B – Oll 47.31 cmol(+) / kg, Ol 32.79 cmol(+) / kg, Ofh 31.68 cmol(+) / kg and A 9.60 cmol(+) / kg.

Mycological observations were conducted during two full growing seasons (from June to November), on average once a month. A total of 10 observations were made on each of the plot. Each time, the abundance of fruiting bodies or substrates of individual fungal species representing different ecological groups was recorded. Geobotanical studies were conducted over three consecutive growing seasons, from 2007 to 2009, and covered vascular plants, mosses and liverworts, as well as vegetation. A phytosociological photograph was taken on each area, determining the quantitative share of plants according to the modified 8-point Braun-Blanquet scale. In order to study the soil fauna of selected groups of invertebrates, soil samples were collected three times, twice in spring and once in autumn (2008/2009). The analysis covered all groups of invertebrates studied. Nematodes were identified in experimental plots in mineral soil and litter. Fifteen samples per plot were taken from these microenvironments using a soil sampler (3 cm in diameter and 15 cm in length). Samples were taken from the soil and separately from the litter and then mixed. Approximately 1,500 cm<sup>3</sup> of material was collected from each study area. Mites were flushed out using Tullgren funnels. Using a 20 cm<sup>2</sup> sampler, 10 soil samples were collected from each plot, from between trees and from reference areas in stands located next to the Arboretum. These samples were collected to a depth of 5 cm in mineral soil and also contained litter with humus. A total of 30 soil samples were collected from each

plot. To capture epigeic-soil springtails, a method commonly used in studies of this group was adopted, consisting of collecting litter-soil samples with an intact structure. The samples were collected using a metal soil corer with a diameter of 5 cm and a length of 15 cm. The surface area of one such sample is approximately 20 cm<sup>2</sup>. The remaining soil insects were surveyed on the basis of litter sieve samples collected from each plot. Litter was collected from an area of 0.5 m<sup>2</sup> in three replicates on each plot. In total, the sifting of litter and topsoil covered an area of 1.5 m<sup>2</sup>. Fungal nomenclature follows Index Fungorum (access 30 Oct 2025). The number of described species was finally compared with the values described for the control area by Kasprowicz et al. (2011; Table 2). The identification of nematodes was adopted according to Brzeski (1998). The data presented in the manuscript are cumulative over three years.

Table 2. Comparison of the number of taxa described in the *Betula alleghaniensis* stand and in the control plot (*Tilio-Carpinetum*)

	<i>Betula alleghaniensis</i>	<i>Tilio-Carpinetum</i> *
Spontaneous vascular plants and mosses	54	52
Fungi	39	67
Invertebrates	108	162

\* – data based on Kasprowicz et al. (2011).

## Study limitations

Our study suffers from a lack of replicability—each stand type was represented only by two study plots, with no possibility of subsampling or extending sample size. Nevertheless, studied stands of yellow birch represent only two large-scale plots, where the studied species is able to form its own stand, affecting forest functioning beneath its canopy. This system has been not replicated else in the country (or presumably even in Europe). Forest ecology advanced also due to numerous studies using only one or two study sites, often providing unique outcomes, essential for the further studies, e.g. in phenology, dendroclimatology, understory productivity, or forest spatial structures (Anderson-Teixeira et al., 2015; Czapiewska et al., 2019; McMahon & Parker, 2015; Parker et al., 2004).

## Results

During the three-year study (2007–2010) 54 taxa of vascular plants (48) and mosses (6) were found. 39 taxa of fungi were identified: 23 mycorrhizal and 16 saprotrophic or parasitic fungi. The presence of 108 taxa of invertebrates was recorded: Nematoda – 19, Oribatida – 16, Mesostigmata – 13, Collembola – 33, Coleoptera – 25, other – 2.

### Vascular plants cultivated in the Arboretum, spontaneously occurring in the investigated plots

*Amelanchier* sp., *Acer pennsylvanicum* L., *Betula alleghaniensis* Britton, *Castanea sativa* Mill., *Crataegus* sp., *Pinus* sp., *Pseudotsuga menziesii* (Mirb.) Franco, *Prunus virginiana* L., *Quercus cerris* L., *Quercus rubra* L., *Robinia pseudoacacia* L., *Robinia pseudoacacia* var. *unifoliola*, *Sorbus* sp., *Taxus baccata* L.

### Spontaneous vascular plants

*Agrostis capillaris* L., *Anemone nemorosa* L., *Carex digitata* L., *Carex pilulifera* L., *Carpinus betulus* L., *Cerasus avium* (L.) Moench, *Corylus avellana* L., *Dryopteris carthusiana* (Vill.) H. P. Fuchs, *Dryopteris filix-mas* (L.) Schott, *Euonymus verrucosa* Scop., *Fagus sylvatica* L., *Frangula alnus* Mill., *Hieracium sabaudum* L., *Holcus mollis* L., *Hypericum perforatum* L., *Lonicera xylosteum* L., *Lupinus polyphyllus* L., *Luzula pilosa* (L.) Willd., *Maianthemum bifolium* (L.) F. W. Schmidt, *Melampyrum pratense* L., *Melica nutans* L., *Padus serotina* (Ehrh.) Borkh., *Poa nemoralis* L., *Populus tremula* L., *Prunus spinosa* L., *Quercus petraea* (Matt.) Liebl., *Q. robur* L., *Rubus idaeus* L., *R. cfr. corylifolius* Sm. agg., *Rubus* sp., *Solidago virgaurea* L. s.s., *Sorbus aucuparia* L., *Stellaria holostea* L., *Viola riviniana* Rchb.

### Mosses

*Atrichum undulatum* (Hedw.) P. Beauv., *Brachythecium velutinum* (Hedw.) Schimp., *Polytrichastrum formosum* (Hedw.) G.L. Sm., *Polytrichastrum longisetum* (Sw. ex Brid.) G.L.Sm., *Polytrichum commune* Hedw., *Sciurohypnum oedipodium* Mitt.

### Mycorrhizal fungi

*Amanita citrina* Pers., *Amanita muscaria* (L.) Lam., *Amanita porphyria* Alb. & Schwein., *Amanita rubescens* Pers., *Boletus edulis* Bull., *Cortinarius cf. alboviolaceus* (Pers.) Zaw., *Cortinarius* sp. 5, *Cortinarius* sp. 6, *Cortinarius* sp. 7, *Cortinarius* sp. 8, *Cortinarius* sp. 9, *Lactarius tabidus* Fr., *Lactarius torminosus* (Schaeff.) Pers., *Lactarius necator* (Bull.) Fr., *Lactarius vietus* (Fr.) Fr.,

*Paxillus involutus* (Batsch) Fr., *Russula cf. brunneoviolacea* Crawshay, *Russula pseudo-olivascens* Kärcher, *Russula fragilis* Fr., *Russula vesca* Fr., *Russula* sp. 3, *Russula* sp. 4

### Saprotrophic and parasitic fungi

*Armillaria* sp., *Bjerkandera adusta* (Willd.) P. Karst., *Daedaleopsis confragosa* (Bolton) J. Schröt., *Entoloma* spp., *Gymnopilus penetrans* (Fr.) Murrill, *Collybiopsis peronata* (Bolton) R.H. Petersen, *Heterobasidion annosum* (Fr.) Bref., *Hypholoma lateritium* (Schaeff.) P. Kumm., *Lentinus substrictus* (Bolton) Zmitr. & Kovalenko, *Mycena zephyrus* (Fr.) P. Kumm., *Mycena* spp., *Pholiota lenta* (Pers.) Singer, *Pluteus cervinus* (Schaeff.) P. Kumm., *Rhodocollybia asema* (Fr.) Bendiksen & Dima, *Stereum hirsutum* (Willd.) Pers., *Trametes versicolor* (L.) Lloyd, *Trametes ochracea* (Pers.) Gilb. & Ryvarden

### Nematodes

*Aglenchus agricola* (de Man) Meyl, *Aphelenchina* spp., *Cephalenchus hexalineatus* (Geraert) Geraert et Goodey, *Coslenchus costatus* (de Man) Siddiqi, *Ditylenchus* spp., *Filenchus misellus* (Andrássy) Raski et Geraert, *Filenchus discrepans* (Andrássy) Raski et Geraert, *Filenchus vulgaris* (Brzeski) Lownsbery et Lownsbery, *Helicotylenchus pseudorobustus* (Steiner) Golden, *Lelenchus leptosoma* (de Man) Mezl, *Malenchus acarayensis* Andrásy, *Mesocriconema sphaerocephalum* (Taylor) Loof et De Grisse, *Paratylenchus straeleni* (de Coninck) Oostenbrink, *Paratylenchus projectus* Jenkins, *Rhabditida* spp., *Rotylenchus robustus* (de Man) Filipjev, *Tylenchus arcuatus* Siddiqi, *Tylenchus elegans* de Man, *Xenocrinone-mella macrodora* (Taylor) De Grisse et Loof

### Acari (Oribatida)

*Achipteria coleoptrata* (Linnaeus), *Carabodes areolatus* Berlese, *Carabodes coriaceus* Koch, *Chamobates (Xiphobates) voigtsi* (Oudemans), *Cultroribula bicultrata* (Berlese), *Dissorhina ornata* (Oudemans), *Galumna lanceata* (Oudemans), Juv., *Lauropia falcata* (Paoli), *Metabelba pulverulenta* (Koch), *Nothrus silvestris* Nicolet, *Oppiella nova* (Oudemans), *Oribatula tibialis* (Nicolet), *Scheloribates laevigatus* (Koch), *Suctobelbidae* sp., *Tectocephus velatus* (Michael)

### Acari (Mesostigmata)

*Holoparasitus* sp., *Leptogamasus suecicus* Trägårdh, *Olodiscus*, *Pachylaelaps bellicosus* Berlese, *Prozercon kochi* Sellnick, *Prozercon traegardhi* (Halbert), *Rhodacarus coronatus* Berlese, *Rhodacarus reconditus* Athias-Henriot, *Trachytes aegrota* (C. L. Koch), *Trichouropoda obscura* (C. L. Koch), *Uropoda minima* Kramer, *Veigaia nemorensis*

(C. L. Koch), *Zercon peltatus* C. L. Koch, *Zercon triangularis* C. L. Koch

## Insects (Collembola)

*Allacma fusca* (Linnaeus), *Arrhopalites secundarius* Gisin, *Arrhopalites* sp. juv., *Ceratophysella denticulata* (Bagnall), *Ceratophysella* sp. juv., *Desoria germanica* (Huther & Winter), *D. tigrina* (Tullberg), *Desoria* sp. juv., *Entomobrya muscorum* (Nicolet), Entomobyidae juv., *Friesea truncata* Cassagnau, *Folsomia penicula* Bagnall, *Isotomiella minor* (Schaffer), *Lepidocyrtus lanuginosus* (Gmelin), *L. lignorum* (Fabricius), *L. violacea* gr juv., *L. lignorum* gr juv., *Lipotrix lubbocki* (Tullberg), *Megalothorax minimus* Willem, *Mesaphorura hylophila* Rusek, *M. macrochaeta* Rusek, *M. yosii* Rusek, *Pariotoma notabilis* (Schaffer), *Pogonognatellus flavescens* (Tullberg), *Proisotoma minima* (Tullberg), *Pseudachorutes dubius* Krausbauer, *Pseudosinella alba* (Packard), *Schoetella ununguiculata* (Tullberg), *Sphaeridia pumilis* (Krausbauer), *Sminthurinus* sp. juv., Symphypleona juv., (Tullberg), *Tomocerus minor* (Lubbock), Tomoceridae juv.

## Insects (Coleoptera)

*Brosicus cephalotes* (L.), *Byctiscus betulae*, *Calathus ambiguus* (Payk.), *Calathus melanocephalus* (L.), *Cantharis fusca* L., *Carabus violaceus* L., Cerambycidae spp., *Clivina fossor* (L.), *Coccinella septempunctata*, *Curculio glandium* Marsh., *Deporaus betulae* L., *Ectobius sylvestris*, *Endromis versicolora* L., *Hypera* sp., *Lema melanopus* L., *Lochmaea caprea* L., *Phyllobius argentatus* L., *Propylea quatuordecimpunctata*, *Pterostichus cupreus* (L.), *Rhagonycha fulva* Scop., *Selatosomus aeneus* L., *Sitona* sp., Staphylinidae spp., *Strophosoma capitata*, Tipulidae spp.

## Other insects

Heteroptera spp., Homoptera spp.

The richest groups were insects (Collembola and Coleoptera), followed by nematodes and mites (Mesostigmata and Oribatida). Compared to reference oak-hornbeam forests (Table 2), *B. alleghaniensis* forests had 4% more vascular plants and mosses, 42% less fungi, and 33% less invertebrates.

## Discussion

Vascular plants and mosses recorded on the *B. alleghaniensis* surfaces are commonly found in the natural conditions of the region or cultivated in the Rogów Arboretum. Their diversity was probably mainly due to the availability of light, because the *B. alleghaniensis* surfaces were characterized by the

highest average relative intensity of photosynthetically active radiation (RPAR; %) at the height of 0.5 m (21.82% ±0.99) among the studied tree species. The species composition of vascular plants covers both forest specialists, as well as generalists, occurring mostly in forest edges or in gaps (Rosaceae trees and shrubs, natural regeneration of pine and birch), supporting that claim.

*Betula alleghaniensis* engages in complex and diverse interactions with ectomycorrhizal (ECM) fungi that are crucial for its growth, health, and adaptability in diverse forest ecosystems. The roots of yellow birch are known to be highly colonized already in seedling stage (DeBellis et al., 2002). Mycorrhizal fungi reported in stands of *B. alleghaniensis* mainly belong to the genera of *Cortinarius*, *Hebeloma*, *Lactarius*, *Tomentella* and *Russula*; *Paxillus involutus*, *Scleroderma citrinum*, *Piloderma fallax* and *Cenococcum geophilum* were also observed (Massicotte et al., 1990; Poznaniuk et al., 2015). In our study, we found the following ECM taxa: *Cortinarius* cf. *alboviolaceus* and other five *Cortinarius* species, *Lactarius necator*, *L. tabidus*, *L. torminosus*, *L. vietus*, *Russula fragilis*, *R. pseudo-olivascens*, *R. vesca*, and other two *Russula* species. The above data show that yellow birch ECM associates outside its natural range of occurrence represent the similar taxonomic diversity.

Among parasitic macrofungi, the presence of *Heterobasidion annosum* and *Armillaria* sp. fungi was detected. These fungi can cause extensive white rot and can pose a threat to leaving trees. They were found also in *B. alleghaniensis* stands within its natural range of occurrence; root rot caused by *Armillaria mellea* s.l. is the most important factor causing the decay of yellow birch roots. *Pholiota limonella* (Peck) Sacc., *P. aurivella* (Batsch) P. Kumm, *Trametes versicolor* (L.) Lloyd, *Daldinia concentrica* (Bolton) Ces. & De Not. and *Hypoxylon* spp. have also been reported among wood decay fungi. *Cystostereum murrayi* (Berk. & M.A. Curtis) Pouzar causes fibrous trunk rot of yellow birch. *Fomitopsis betulina* (Bull.) B.K. Cui, M.L. Han & Y.C. Dai, *Fomitopsis pinicola* (Sw.) P. Karst also are also among the primary decayers of dead yellow birch wood, but they may extend into centers of living trees (Burns & Honcala, 1990). However, in our study, no other than *Heterobasidion* and *Armillaria* pathogenic macrofungi were observed. The remaining saprotrophes are wood and litter decomposers.

After a more thorough analysis of available sources, no scientific publications were found that directly examine interactions between *B. alleghaniensis* and nematodes from the Nematoda group. There is a lack of detailed data on the impact of nematodes on the health, growth, or development of yellow birch. There are general studies in the literature on plant-nematode interactions in forest ecosystems, but they do not refer directly to *Betula alleghaniensis*. Therefore,

to obtain more detailed information on potential interactions between yellow birch and nematodes, it is recommended to conduct dedicated field and laboratory studies. For example, *Cephalenchus hexalineatus*, *Filenchus misellus*, *Filenchus discrepans* are species commonly found in forest soils where different tree species grow and in different climatic zones, and we also recorded them in our studies.

Among the various components of forest ecosystems, the soil mesofauna, including oribatid mites, mesostigmatid mites, and springtails, is an important group of organisms that influence soil processes such as decomposition, nutrient cycling, and maintenance of soil structure (Koehler & Melecis, 2010). Species composition, spatial and age structure of stands significantly affect assemblages of those soil taxa, influencing their diversity, abundance, and functionality (Urbanowski et al., 2021). Among the soil mesofauna recorded, 33, 16, and 13 taxa of springtails, moss mites, and mesostigmata mites were found, respectively. As the dominant groups of soil mesofauna in the topsoil (Menta, 2012), they significantly influence the breakdown of dead organic matter and the cycling of micro- and macroelements in the upper soil layer. Moreover, the diversity and species richness of soil mesofauna are significantly shaped by soil processes, including soil-forming processes (Erdmann et al., 2012; Koehler, 1997; Urbanowski et al., 2022; Wang & Ruan, 2011). For example, Burtis et al. (2024) examined the distribution of yellow birch litter in relation to soil mesofauna communities (Collembola, Mesostigmata, Oribatida) and revealed that the ability of examined soil arthropods to predict changes in biochemical properties of litter was inversely correlated with hemicellulose (ability of Oribatida) and acid-unhydrolyzable residues (ability of Collembola and Oribatida).

Different tree species shape different habitats and soil conditions, which in turn shape the communities of soil fauna (Horodecki et al., 2019; Mueller et al., 2016). Stand type, structure, and age, directly influence the structure and diversity of understorey vegetation by, among others, shaping specific temperature and moisture conditions (Rawlik et al., 2018a, 2018b). The influence of tree species on soil fauna depends on, among others, factors such as litter quality and quantity, soil pH, and organic matter content (Fujii & Takeda, 2017; Gergócs & Hufnagel, 2016; Urbanowski et al., 2022). Trees release root secretions containing organic compounds that affect, among others, the microbial composition and, therefore, soil mesofauna. Some tree species promote mutualistic relationships with arbuscular mycorrhizal fungi, while others may release allelopathic compounds that suppress certain soil organisms (Peng et al., 2022; Wohlgemuth et al., 2022). The mycelium provides a food source for many fungivorous species

of oribatid mites, or springtails. It also determines the occurrence of prey (e.g. nematodes) for soil predators such as Mesostigmata (Koehler, 1997; Siepel & Ruiter-Dijkman, 1993; Sławska, 2007). It should be noted that there are species within Mesostigmata that have a parasitic lifestyle (Błoszyk, 2008; Skorupski, 2008).

In the studied stands, most of the species shown belonging to Mesostigmata are in the family Zerconidae (31% of the total taxa shown). Zerconidae occur throughout the entire Holarctic (Sikora, 2014). It is a family of mites that feeds primarily on arthropod eggs, enchytraeids, nematodes, as well as insect larvae (Seniczak et al., 2018). Interestingly, some studies show that the trophic preferences of selected soil mesofauna species are different than previously thought. In the present study, the species *Opiella nova*, which is widespread in forest litter. Previous studies have shown that Oribatida are fungivorous and strongly associated with dead organic matter of plant origin. However, studies using stable element isotopes (carbon ( $^{12}\text{C}$  and  $^{13}\text{C}$ ) and nitrogen ( $^{15}\text{N}$ )) indicate that *Opiella nova*, a member of the family Oppiidae, is a predatory species at a higher trophic level in the soil food web (Lu et al., 2022; Schneider, 2005). The occurrence of 16 taxa of oribatid mites and 13 mesostigmatid mites (main soil predators) from different families may indicate that suitable conditions are forming in the yellow birch stands studied for the soil trophic webs.

Studies focusing on the influence of yellow birch in shaping the habitat conditions of soil mesofauna are limited. Burtis et al. (2024) studied the effects of yellow birch leaf decomposition on soil mesofauna assemblages. They revealed that yellow birch litter had the lowest C/N ratio compared to litter of other studied tree species, native to North America. Furthermore, yellow birch had the greatest loss of initial haemicellulose and bound proteins. They also indicated that the larger-sized soil fauna was less common on yellow birch litter than on the other tree species litter. Furthermore, the soil mesofauna inhabiting the litter of yellow birch stands was studied by Young et al. (2024). Their study showed that soil mesofauna may have a decisive influence on the rate of organic matter decomposition, which shapes the biological, chemical, and physical properties of the forest topsoil. Forest stands exert a key influence on soil mesofauna by shaping soil conditions (Eisenhauer et al., 2017; Mueller et al., 2016; Reich et al., 2005).

## Conclusions

According to our study, forests dominated by *Betula alleghaniensis* contained more vascular plants and

mosses, but fewer fungi and invertebrates compared to the oak-hornbeam stands. It seems that yellow birch stands are characterised by unique biodiversity, distinguishing them from reference oak-hornbeam stands (control area) due to various environmental factors, including light availability or accumulation of organic matter. Tree species composition and structural diversity of stands shape the abundance and diversity of soil mites and insects, ultimately influencing soil health and sustainability of the forest ecosystem. Understanding these interactions is crucial for sustainable forest management practices, maintaining biodiversity and ecological balance.

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