

Overview of ant species collected in the Białowieża Forest in Poland: the importance of long-term monitoring for the detection of new species

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Abstract: Knowledge of ant distribution in Poland remains incomplete, despite a recent increase in faunistic and ecological studies. The Białowieża Forest, one of Europe's most valuable natural forest complexes, has been the subject of long-term invertebrate monitoring, yet its myrmecofauna has not been comprehensively updated for almost decade. This study synthesises data collected between 2003 and 2015 from permanent monitoring plots located in both the strictly protected zone of Białowieża National Park and the managed part of the forest. Ants were sampled using Moericke, Barber, and IBL-2bis traps in two forest habitat types: fresh mixed coniferous forest (*Calamagrostio-Piceetum*) and fresh deciduous forest (*Tilio-Carpinetum*). A total of 28 species were recorded. Four species – *Lasius distinguendus* (Emery, 1916), *Camponotus fallax* (Nylander, 1856), *Formica rufibarbis* Fabricius, 1793 and *Leptothorax gredleri* Mayr, 1855 – were documented for the first time in the Białowieża Forest. One species – *Formica pressilabris* Nylander, 1846 – was documented for the first time in the Polish part of the Białowieża Forest. The highest numbers of recorded species and collected individuals were observed in mixed coniferous forest plots within the National Park; however, comparisons between habitat types should be interpreted cautiously because sampling intensity differed between plots. The most frequently recorded species were *Myrmica ruginodis* Nylander, 1846, *Formica fusca* Linnaeus, 1758, *Camponotus herculeanus* (Linnaeus, 1758), *Lasius platythorax* Seifert, 1991, and *F. sanguinea* Latreille, 1798. Currently, 50 ant species are known from the Białowieża Forest as a whole, including 50 recorded from the Polish part and 33 from the Belarusian part, which primarily reflects differences in the intensity and extent of myrmecological research between the two areas rather than actual faunal disparities. The results provide an updated overview of the Białowieża Forest myrmecofauna and highlight the importance of long-term monitoring in detecting rare and newly recorded species, as well as in understanding habitat-related differences in ant assemblages within this ancient forest ecosystem.

Key words: ants, faunistic, coniferous forest, oak-hornbeam deciduous forest

INTRODUCTION

Knowledge of ant distribution in Poland remains limited. For many years, faunal research was largely overlooked, and hence, even common species have yet to be documented in some regions (Czechowski et al. 2002, 2012). Recently, there has been a resurgence of research, with a growing number of researchers focusing on ants, driven by renewed faunistic interest, improved sampling methods, and more intensive and geographically comprehensive survey efforts. Previously unexplored areas are now being investigated, numerous publications on this subject are appearing, and new species for Poland are being discovered (Borowiec 2007, 2009, 2011; Suchocka et al. 2008; Salata & Borowiec 2011, 2014, 2016; Czechowski et al. 2012; Borowiec & Borowiec 2013; Witek et al. 2013; Michlewicz 2014, 2022; Salata et al. 2015, 2018a, 2018b; Kaszyca et al. 2017; Borowiec & Salata 2018; Zięba et al. 2019; Borowiec & Waleński

2020; Radchenko & Aleksandrowicz 2020; Trigos-Peral et al. 2020a, 2020b; Adamski & Wendzonka 2021; Zięba & Zięba 2021; Żurawlew & Salata 2021; Gierłasiński & Rutkowski 2022; Kadej et al. 2022; Pawluk et al. 2022a, 2022b; Zięcina & Salata 2022; Zięba 2023; Zięba & Michalczyk 2023; Sondej & Domisch 2024a; Stępień & Salata 2024; Czechowski et al. 2025; Lewek et al. 2025; Trigos-Peral & Czechowski 2025). Currently, 112 Formicidae species are known from Poland, including 11 alien species introduced from warmer regions of the world (Trigos-Peral & Czechowski 2025).

The Białowieża Forest (BF) is one of the most renowned faunal regions in the world (Jaroszewicz et al. 2019). It is renowned for its well-preserved natural and near-natural forests and for its high species richness, particularly of insects and fungi (Gutowski & Jaroszewicz 2001; Gutowski et al. 2009; Jaroszewicz et al. 2019). It is widely regarded as a model forest, with the strictly protected area of Białowieża National Park (BNP) serving

as a particularly important reference site for ecological observations and research on temperate deciduous and mixed forests in Europe. Many species that have already become extinct or have drastically declined in other parts of Europe can still be found in the BF, underscoring its importance as refuge for many relict European forest species and highlighting its role as a unique forest gene bank (Gutowski & Jaroszewicz 2004; Gutowski et al. 2009; Jaroszewicz et al. 2019). Moreover, BNP plays a key role in the study and understanding of natural processes and species, including invertebrate communities. The forest has existed for approximately 10,000 years since the retreat of the last glacier (Dąbrowski 1959), and many natural ecological processes have remained largely uninterrupted. This ecological continuity makes the area particularly valuable for long-term studies of invertebrates, including ants.

For over a century, ants from BF have been the focus of a wide variety of myrmecological studies, including those by Bischoff (1925), Karpiński (1956), Pisarski (1961, 1962), Dlussky & Pisarski (1971), Gutowski & Krzysztofak (1988), Czechowski et al. (1995, 1997, 1998, 1999), Radchenko et al. (1997, 1999), and Czechowski & Czechowska (1999), Mazur (2001, 2006), Maziarz et al. (2020, 2026); among others. The Belarusian part of the Białowieża Forest has also been subject of different studies on ants, including those conducted by Arnol'di (1970), Dyachenko (1975, 1997, 2017), Kazulka & Makovetskaya (2017) and Makovetskaya & Kazulka (2017). At the beginning of the twenty-first century, knowledge of the Formicidae of this transboundary natural site was summarised in the Catalogue of the fauna of Białowieża Primeval Forest (Czechowski & Dyachenko 2001). At that time, 44 species were recorded in the BF, including 43 in the Polish part and 18 in the Belarusian part (Czechowski & Dyachenko 2001). Later, studies increased these numbers to 45 species in the Polish part of the forest (Czechowski et al. 2002, 2012; Mazur 2002, 2006) and 33 ant species in the Belarusian part (Makovetskaya & Kazulka 2017); a discrepancy most likely resulting from historically uneven sampling effort and the later intensification and expansion of faunistic surveys in the Belarusian part of the forest (see Makovetskaya & Kazulka 2017; Czechowski et al. 2012).

In recent years, although additional faunistic studies have included ants (i.e. Floren et al. 2014, Maziarz et al. 2026), myrmecological research in BF have mainly focused on the ecological aspects of red wood ants in this forest (Sondej et al. 2018, 2021; Maák et al. 2021; Sondej & Domisch 2022, 2024b, 2025).

The aim of this study is to compile available information on the family Formicidae in the BF and to update the species list using newly collected material from the Polish part of the forest.

STUDY AREA

The BF, located in a mixed forest zone, is influenced by both oceanic and continental climates, as well as bo-

real and southern elements. The dynamic character of the Białowieża Forest's fauna and flora also results from the absence of natural geographical barriers (such as mountain ranges or water bodies) that would limit the migration of living organisms into this area (Jaroszewicz et al. 2019). The BF is a large, continuous forest complex situated on the border between Poland and Belarus, covering approximately 1,500 km² (Fig. 1). Of this, 623 km² lies within Poland, the remaining area is situated in Belarus. The entire Belarusian part is protected as a national park. On the Polish side, the national park covers only 16.6% of the western part of the BF (about 105 km²). Approximately 57 km² on the Polish side and about 300 km² on the Belarusian side are strictly protected (Jaroszewicz et al. 2019). More than 1,000 vascular plant species occur in the BF, including 25 native tree species (plus 17 artificially introduced) and 55 shrub species. Dominant tree and shrub species include: *Pinus sylvestris* L., *Picea abies* (L.) H. Karst., *Carpinus betulus* L., *Tilia cordata* Mill., *Quercus robur* L., *Fraxinus excelsior* L., *Acer platanoides* L., *Alnus glutinosa* (L.) Gaert., *Populus tremula* L., *Betula pendula* Roth, *B. pubescens* Ehrhart, *Prunus padus* L., *Corylus avellana* L., and *Salix cinerea* L. (Miścicki et al. 2022).

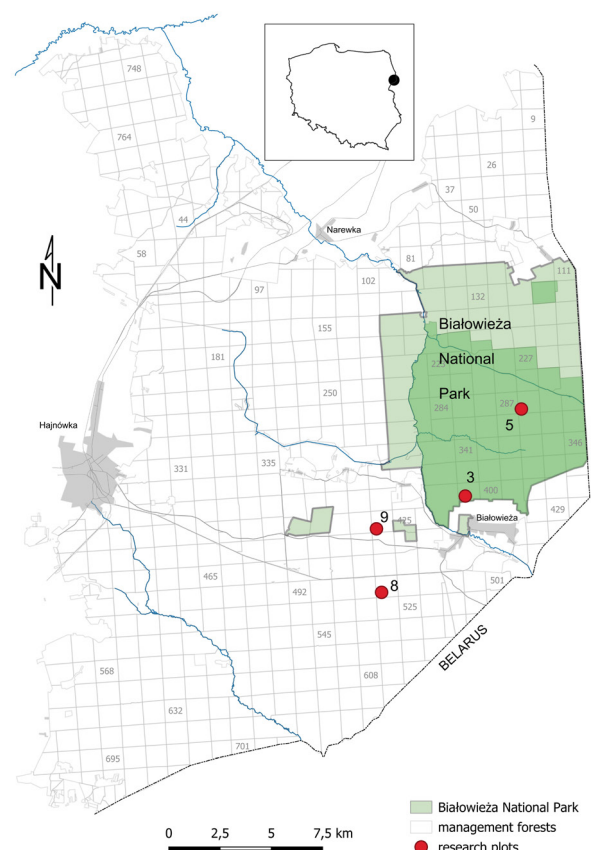


Figure 1. Location of the research plots in the Białowieża Forest: plot 3 and 9 located in a fresh deciduous forest and plots 5 and 8 located in fresh mixed coniferous forests. The numbers refer to the numbering system used for the research plots. Numbers shown on the map in a small font indicate selected forest compartment numbers. They are arranged sequentially from left to right and from top to bottom.

Overall, a total of 143 plant communities at the rank of association have been identified in the forest, including 27 forest and 3 shrub communities, while the remaining units comprise mainly meadow, peat bog, marsh, aquatic, and synanthropic vegetation (Sokołowski 2004; see also Białowieża National Park data).

MATERIALS AND METHODS

Ant samples were collected as part of the BF invertebrate monitoring programme, which involved collecting ants from permanent plots using standardised methods from 1988 to 2015 (Gutowski & Krzysztowiak 1995a, 1995b; Gutowski 2004). Part of the material used in this study was collected between 2003 and 2015 in two main study plots located in naturally mature forest stands within the strictly protected area of BNP: plot 3, forest compartment 399C (UTM: FD94), a fresh deciduous forest (*Tilio-Carpinetum stachyetosum*) (Figs. 1 and 2); and plot 5, forest compartment 288C/318A (FD94), a fresh mixed coniferous forest (*Calamagrostio-Piceetum*) (Figs. 1 and 3). From 2011 to 2015, additional invertebrates, including ants, were collected from two similar plots in the managed part of the Białowieża Forest District: plot 8, compartment 494C (FD84), a fresh mixed coniferous forest (*Calamagrostio-Piceetum*); and plot 9, compartment 424C (FD84), a fresh deciduous forest (*Tilio-Carpinetum*) (Fig. 1).

Moericke traps (nine per plot, suspended at 1 m), Barber pitfall traps (10 per plot), and IBL-2bis screen traps (two per plot, Fig. 4) (Gutowski et al. 2024) were installed on all plots and were operated from April to September, with content collected at 14-days intervals. In the fresh mixed coniferous forest plots (5 and 8), traps were set annually, and in the fresh deciduous forest plots (3 and 9), every three years. Ants were identified at the Laboratory of Social and Myrmecophilous Insects (MIZ PAS) using a Leica MZ16 stereomicroscope and following the identification keys in Radchenko & Elmes (2010), Czechowski et al. (2012) and Seifert (2018). The specimens are housed at the Department of Natural Forests of the FRI in Białowieża.

RESULTS

A total of 8325 Formicidae individuals, representing 28 species, were collected (Table 1). Among them, four species are new records for the myrmecofauna of the BF: *Lasius distinguendus* (Emery, 1916), *Leptothorax gredleri* Mayr, 1855, *Formica rufibarbis* Fabricius, 1793 and *Camponotus fallax* (Nylander, 1856). The species were collected in the *Calamagrostio-Piceetum* community in the BNP (Table 1). One species – *Formica pressilabris* Nylander, 1846 – recorded so far exclusively from



Figure 2. Study plot 3 located in a fresh deciduous forest (*Tilio-Carpinetum stachyetosum*) in Białowieża National Park.



Figure 3. Study plot 5 located a fresh mixed coniferous forest (*Calamagrostio-Piceetum*) in Białowieża National Park (photo: J.M. Gutowski).

the Belarusian part of BF has been confirmed on the Polish part (Table 1). The highest numbers of ant species and individuals (26 species and 6883 collected individuals) were recorded in the fresh mixed coniferous forest in BNP. In the same forest type outside the park, 17 species were recorded from 760 captured individuals (Table 1). The fresh deciduous forest supported fewer species and individuals: 14 species from 488 captured individuals in the BNP, and 9 species from 194 captured individuals outside the park (Table 1). Among the collected species, *Myrmica ruginodis* Nylander, 1846, *Formica fusca* Linnaeus, 1758; *Camponotus herculeanus* (Linnaeus, 1758); *Lasius platythorax* Seifert, 1991; and *Formica sanguinea* Latreille, 1798 were numerically dominant with 3661, 1263, 1201, 1181 and 656 captured individuals, respectively. For each species, the highest abundances were recorded in the fresh mixed coniferous forest of BNP. Some other species were represented by a single individual: *Formica pressilabris*, *F. rufibarbis*, *Lasius distinguendus*, *Leptothorax acervorum* (Fabricius, 1793), and *Temnothorax crassispinus* (Karavaiev, 1926) (Table 1).

The results summarized in Table 1 highlight several species of notable faunistic importance. Brief descriptions of the most significant taxa – particularly those

that are protected, red-listed, and newly recorded for the Białowieża Forest – are presented below, together with their subgeneric classification.

***Formica (Formica) polycтена* Förster, 1850**

- BNP, plot 5, Moericke trap, 1 ex., queen, 11 May 2004, 1 ex., queen, 11 May 2011;
- BNP, plot 5, IBL-2bis screen trap, 1 ex., queen, 8 Jun 2004;
- BNP, plot 3, IBL-2bis screen trap, 1 ex., queen, 14 May 2003;
- Białowieża Forest District: plot 8, Barber trap, 1 ex., worker, 16 Jul 2012, 1 ex., worker, 5 Aug 2013, 1 ex., queen, 5 Aug 2013.

This is one of the six Polish species included in the *Formica rufa* group and known as Red Wood Ants. It is a common species throughout Poland and, among the mound-building wood ants in Europe, forms the large polydomous colony systems (Czechowski et al. 2012; Stockan & Robinson 2016). It is an oligotrophic species of coniferous and mixed forests (Czechowski et al. 2012; Seifert 2018). In the mountains it occurs up to the lower boundary of the lower montane forest zone (Czechowski et al. 2012). Conservation status in Poland: near threatened (NT) (Czechowski 2002) and partially protected species (Balzani et al. 2022).



Figure 4. IBL-2bis screen trap used for ant sampling in the Białowieża Forest (photo: J.M. Gutowski).

***Lasius (Chetonolasius) meridionalis* (Bondroit, 1920)**

- BNP, plot 5, Barber trap, 1 ex., queen, 18 Jul 2012, 1 ex., queen, 25 Jun 2013, 1 ex., queen, 5 Aug 2014;
- BNP, plot 5, Moericke trap, 2 exx., queens, 11 Aug 2005, 3 exx., queens, 12 Jun 2008, 1 ex., male, 12 Jun 2008, 1 ex., queen, 3 Sep 2008, 1 ex., male, 3 Sep 2008;
- BNP, plot 3, Barber trap, 1 ex., queen, 15 Jun 2006;
- Białowieża Forest District: plot 8, Moericke trap, 1 ex., male, 19 Aug 2013.

The species is known from a limited number of localities along the Pomeranian Lakeland, Masurian Lakeland, Mazovian Lowland, Podlasie Lowland, and Lubelska Upland (Czechowski et al. 2012). It is temporary social parasite of *Lasius* s. str. species, with *Lasius psammophilus* considered its principal host, while *L. paralienus* has also been confirmed as a host (Seifert & Buschinger 2001). This thermophilous species occurs mainly in sandy xerothermous grassland and the grassy parts of open sandy heaths (Seifert 2018). Conservation status in Poland: data deficient (DD) (Czechowski 2002; Czechowski et al. 2012).

***Lasius (Chetonolasius) mixtus* (Nylander, 1846)**

- BNP, plot 5, Barber trap, 1 ex., queen, 5 Aug 2013;
- Białowieża Forest District: plot 8, Barber trap, 1 ex., queen, 20 Jul 2015.

In Poland, this species is fairly rare but widely distributed, and is absent from the upper parts of the mountains (Czechowski et al. 2012). It is a temporary social parasite and a mesohygrothermophilic oligotroph of humid habitats, occurring in both open and wooded areas (Czechowski et al. 2012; Seifert 2018). Conservation status in Poland: data deficient (DD) (Czechowski 2002; Czechowski et al. 2012).

***Strongylognathus testaceus* (Schenk, 1852)**

- BNP, plot 5, Barber trap, 1 ex., queen, 14 Jul 2005, 1 ex., worker, 14 Jul 2005, 1 ex., queen, 28 Jul 2005, 1 ex., worker, 28 Jul 2005;
- BNP, plot 5, Moericke trap, 1 ex., queen, 16 Aug 2007.

The species probably occurs throughout Poland (Czechowski et al. 2012). It is an obligate social parasite, found in xerothermous habitats with sufficient densities of *Tetramorium* hosts, in both natural and urban areas (Seifert 2018). Conservation status: data deficient (DD) (Czechowski 2002; Czechowski et al. 2012).

***Camponotus (Myrmentoma) fallax* (Nylander, 1856)**

- first record in BF
- BNP, plot 5, Moericke trap, 1 ex., worker, 9 Jul 2003, 1 ex., worker, 27 Jun 2006, 1 ex., worker, 21 Sep 2006, 1 ex., worker, 24 May 2007, 1 ex., worker, 7 Jun 2007, 1 ex., worker, 12 Jun 2008, 1 ex., worker, 9 Jul 2009;
- BNP, plot 5, Barber trap, 1 ex., worker, 25 Aug 2005, 1 ex., worker, 21 Jun 2007, 2 exx., workers, 24 Oct 2014.

The species is known from several regions: Pomeranian Lakeland, Masurian Lakeland, Wielkopolsko-Kujawska Lowland, Mazovian Lowland, Podlasie Lowland, Lower Silesia, Upper Silesia, Krakowsko-Częstochowska Upland, Małopolska Upland, Świętokrzyskie Mountains, Lubelska Upland, Roztocze Upland, Sandomierska Lowland, and the Western Sudeten Mountains (Czechowski et al. 2012). It is a moderately thermophilous species whose main habitats are closed broad-leaved forests and parks (Seifert 2018). Conservation status in Poland: near threatened (NT) (Czechowski 2002; Czechowski et al. 2012).

Table 1. List of species and number of ants caught during research from 2003 to 2015 in the Polish part of the Białowieża Forest, divided by research plots (*new species for the whole Białowieża Forest, #new species for the Polish part of the Białowieża Forest).

No	Ant species	Number of individuals				Total
		Plot 3	Plot 5	Plot 8	Plot 9	
1	* <i>Camponotus fallax</i> (Nylander, 1856)		11			11
2	<i>Camponotus herculeanus</i> (Linnaeus, 1758)	7	1188	6		1201
3	<i>Formica fusca</i> Linnaeus, 1758	7	1218	37	1	1263
4	<i>Formica polyctena</i> Förster, 1850	1	3	3		7
5	# <i>Formica pressilabris</i> Nylander, 1846	1				1
6	* <i>Formica rufibarbis</i> Fabricius, 1793		1			1
7	<i>Formica sanguinea</i> Latreille, 1798	1	654	1		656
8	<i>Lasius alienus</i> (Förster, 1850)	2	24	3	5	34
9	<i>Lasius brunneus</i> (Latreille, 1798)	13	48		10	71
10	* <i>Lasius distinguendus</i> (Emery, 1916)		1			1
11	<i>Lasius flavus</i> (Fabricius, 1782)	1	3	3		7
12	<i>Lasius fuliginosus</i> (Latreille, 1798)	2	23	23	2	50
13	<i>Lasius meridionalis</i> (Bondroit, 1920)	1	11	1		13
14	<i>Lasius mixtus</i> (Nylander, 1846)		2	1		3
15	<i>Lasius niger</i> (Linnaeus, 1758)		2	1		3
16	<i>Lasius platythorax</i> Seifert, 1991	2	814	313	52	1181
17	<i>Lasius umbratus</i> (Nylander, 1846)		12	1	1	14
18	<i>Leptothorax acervorum</i> (Fabricius, 1793)		1			1
19	* <i>Leptothorax gredleri</i> Mayr, 1855		4			4
20	<i>Leptothorax muscorum</i> (Nylander, 1846)		3			3
21	<i>Myrmica lobicornis</i> Nylander, 1846		2	3		5
22	<i>Myrmica rubra</i> (Linnaeus, 1758)	46	2	1	6	55
23	<i>Myrmica ruginodis</i> Nylander, 1846	351	2842	352	116	3661
24	<i>Myrmica rugulosa</i> Nylander, 1849	53	1			54
25	<i>Stenamma debile</i> (Förster, 1850)		4	10	1	15
26	<i>Strongylognathus testaceus</i> (Schenck, 1852)		5			5
27	<i>Temnothorax crassispinus</i> (Karavaiev, 1926)			1		1
28	<i>Tetramorium caespitum</i> (Linnaeus, 1758)		4			4
Total		488	6883	760	194	8325

***Formica (Coptoformica) pressilabris* Nylander, 1846**

– first record for the Polish part of the BF

– BNP, plot 3, Barber trap, 1 ex., worker, 27 Jul 2006.

In Poland, this species is known from most of the country (Czechowski et al. 2012). It is a facultative social parasite that prefers dry to fresh grasslands, such as pastures, alpine short grassland, woodland clearings, and continental steppes (Seifert 2018). Conservation status in Poland: least concern (LC) (Czechowski 2002; Czechowski et al. 2012).

***Formica (Serviformica) rufibarbis* Fabricius, 1793**

– first record in BF

– BNP, plot 5, Barber trap, 1 ex., worker, 17 Sep 2009.

In Poland, known from almost all the country (Czechowski et al. 2012). It is a xerothermophilous species of open, dry and sun exposed habitats (Czechowski et al. 2012; Seifert 2018). Conservation status in Poland: not listed.

Table 2. List of ant species (Formicidae) and literature records from the Polish and Belarusian parts of the Białowieża Forest.

	Species	Polish part	Belarusian part
1	<i>Camponotus aethiops</i> (Latreille, 1798)	Bischoff 1925; Pisarski 1961; Czechowski & Dyachenko 2001	
2	<i>Camponotus fallax</i> (Nylander, 1856)	this study	
3	<i>Camponotus herculeanus</i> (Linnaeus, 1758)	Bischoff 1925; Karpiński 1956; Pisarski 1961; Pisarski & Blum 1988; Czechowski et al. 1995, 2002, 2012; Czechowski 1998; Czechowski & Dyachenko 2001; Mazur 2001, 2006; Maák et al. 2021	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
4	<i>Campanotus vagus</i> (Scopoli, 1763)	Bischoff 1925; Pisarski 1961; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012; Mazur 2006	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
5	<i>Dolichoderus quadripunctatus</i> (Linnaeus, 1771)	Czechowski et al. 1999, 2002, 2012; Czechowski & Dyachenko 2001; Mazur 2001, 2006	Kazulka & Makovetskaya 2017; Makovetskaya & Kazulka 2017
6	<i>Formica candida</i> Smith, 1878	Karpiński 1956; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012	
7	<i>Formica cinerea</i> Mayr, 1853	Dlussky & Pisarski 1971; Czechowski 1998; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
8	<i>Formica cunicularia</i> Latreille, 1798	Bischoff 1925; Dlussky & Pisarski 1971; Czechowski & Rotkiewicz 1997; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012	Dyachenko 1997; Dyachenko 2017; Makovetskaya & Kazulka 2017
9	<i>Formica exsecta</i> Nylander, 1846	Bischoff 1925; Begdon 1954; Pisarski 1962; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2006; Mazur 2006	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
10	<i>Formica fusca</i> Linnaeus, 1758	Bischoff 1925; Karpiński 1956; Dlussky & Pisarski 1971; Czechowski 1993, 1994, 1996, 1997, 1998; Czechowski et al. 1995, 2002, 2012; Czechowski & Dyachenko 2001; Mazur 2002, 2006; Maák et al. 2021	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
11	<i>Formica glauca</i> Ruzsky, 1896	Czechowski & Radchenko 2000; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012	Dyachenko 2017; Makovetskaya & Kazulka 2017
12	<i>Formica polyctena</i> Förster, 1850	Dlussky & Pisarski 1971; Czechowski 1993, 1994, 1996, 1998; Czechowski et al. 1995, 2002, 2012; Czechowski & Dyachenko 2001; Mazur 2002, 2006; Czechowski & Markó 2006; Sondej et al. 2018, 2021; Maák et al. 2021; Trigospéral et al. 2021; Sondej & Domisch 2022, 2024, 2025	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
13	<i>Formica pratensis</i> Retzius, 1783	Karpiński 1965; Czechowski 1996a, 1996b; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012; Mazur 2006; Sondej et al. 2018; Sondej & Domisch 2024	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017

	Species	Polish part	Belarusian part
14	<i>Formica pressilabris</i> Nylander, 1846	this study	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
15	<i>Formica rufa</i> Linnaeus, 1761	Bischoff 1925; Tenenbaum 1931; Karpiński 1956; Dlussky & Pisarski 1971; Czechowski et al. 1995, 2002, 2012; Czechowski 1998; Czechowski & Dyachenko 2001; Mazur 2002, 2006; Sondej et al. 2018, 2021; Maák et al. 2021; Sondej & Domisch 2024, 2025	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
16	<i>Formica rufibarbis</i> Fabricius, 1793	this study	
17	<i>Formica sanguinea</i> Latreille, 1798	Bischoff 1925; Karpiński 1956; Dlussky & Pisarski 1971; Czechowski 1993, 1994, 1996, 1997, 1998; Czechowski et al. 1995, 2002, 2012; Czechowski & Dyachenko 2001; Mazur 2002, 2006	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
18	<i>Formica truncorum</i> Fabricius, 1804	Karpiński 1956; Dlussky & Pisarski 1971; Czechowski 1994b, 1996, 1998; Czechowski et al. 1995, 2002, 2012; Czechowski & Dyachenko 2001; Mazur 2002	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
19	<i>Formicoxenus nitidulus</i> (Nylander, 1846)	Czechowski & Czechowska 1999; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012	
20	<i>Harpagoxenus sublaevis</i> (Nylander, 1849)	Mazur 2002	
21	<i>Lasius citrinus</i> Emery, 1922	Karpiński 1956; Pisarski 1975; Czechowska & Czechowski 1997; Czechowski & Dyachenko 2001; Czechowski et al. 2012	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
22	<i>Lasius alienus</i> (Förster, 1850)	Bischoff 1925; Karpiński 1956; Czechowski et al. 1995, 2002, 2012; Czechowski & Dyachenko 2001; Mazur 2001, 2006	Dyachenko 1997; Makovetskaya & Kazulka 2017
23	<i>Lasius brunneus</i> (Latreille, 1798)	Bischoff 1925; Karpiński 1956; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012;	Dyachenko 1997; Makovetskaya & Kazulka 2017
24	<i>Lasius distinguendus</i> (Emery, 1916)	Mazur 2006, 2006; Maák et al. 2021 this study	
25	<i>Lasius flavus</i> (Fabricius, 1782)	Bischoff 1925; Karpiński 1956; Gutowski & Krzysztofiak 1988; Czechowski et al. 1995, 2002, 2012; Czechowski 1998; Czechowski & Dyachenko 2001; Mazur 2001, 2006; Maák et al. 2021	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
26	<i>Lasius fuliginosus</i> (Latreille, 1798)	Bischoff 1925; Karpiński 1956; Czechowski et al. 1995, 2002, 2012; Czechowski 1998; Czechowski & Dyachenko 2001; Mazur 2002, 2006	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
27	<i>Lasius meridionalis</i> (Bondroit, 1920)	Czechowski et al. 1995, 2002, 2012	
28	<i>Lasius mixtus</i> (Nylander, 1846)	Karpiński 1956; Czechowski et al. 1995, 2002, 2012; Czechowski & Dyachenko 2001	Dyachenko 1997; Makovetskaya & Kazulka 2017

Species		Polish part	Belarusian part
Species		Polish part	Belarusian part
29	<i>Lasius niger</i> (Linnaeus, 1758)	Bischoff 1925; Karpiński 1956; Gutowski & Krzysztofiak 1988; Czechowski et al. 1995, 2002, 2012; Czechowski 1998; Radchenko et al. 1999; Czechowski & Dyachenko 2001; Mazur 2001, 2006; Maák et al. 2021	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
30	<i>Lasius platythorax</i> Seifert, 1991	Radchenko et al. 1999; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012; Mazur 2006; Maák et al. 2021	
31	<i>Lasius umbratus</i> (Nylander, 1846)	Karpiński 1956; Czechowski et al. 1995, 2002, 2012; Czechowski 1998; Czechowski & Dyachenko 2001; Mazur 2002, 2006	Dyachenko 1997; Makovetskaya & Kazulka 2017
32	<i>Leptothorax acervorum</i> (Fabricius, 1793)	Karpiński 1956; Czechowski et al. 1995; Czechowski 1998; Czechowski & Dyachenko 2001; Mazur 2001, 2006; Czechowski et al. 2002, 2012	Dyachenko 1997; Makovetskaya & Kazulka 2017
33	<i>Leptothorax corticalis</i> (Schenck, 1852)	Czechowski et al. 1998; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012; Maák et al. 2021	
34	<i>Leptothorax gredleri</i> Mayr, 1855	this study	
35	<i>Leptothorax muscorum</i> (Nylander, 1846)	Czechowski et al. 1995; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012	
36	<i>Myrmica gallienii</i> Bondroit, 1920	Czechowski et al. 1997, 2002, 2012; Radchenko et al., 1997; Czechowski & Dyachenko 2001	
37	<i>Myrmica lobicornis</i> Nylander, 1846	Karpiński 1956; Czechowski et al. 1995, 2002, 2012; Radchenko et al. 1997; Czechowski & Dyachenko 2001; Mazur 2001, 2006; Czechowski & Czechowska 2006; Maák et al. 2021	Dyachenko 1997; Makovetskaya & Kazulka 2017
38	<i>Myrmica lona</i> Finzi, 1926	Czechowski et al. 1997, 2002, 2012; Czechowski & Dyachenko 2001; Maák et al. 2021	
39	<i>Myrmica rubra</i> (Linnaeus, 1758)	Bischoff 1925; Karpiński 1956; Gutowski & Krzysztofiak 1988; Czechowski et al. 1995, 2002, 2012; Czechowski & Dyachenko 2001; Mazur 2001, 2006; Maziarsz et al. 2020, 2026; Maák et al. 2021	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
40	<i>Myrmica ruginodis</i> Nylander, 1846	Bischoff 1925; Karpiński 1956; Gutowski & Krzysztofiak 1988; Czechowski et al. 1995, 2002, 2012; Czechowski 1998; Czechowski & Dyachenko 2001; Mazur 2001, 2006; Maziarsz et al. 2020, 2026; Maák et al. 2021	Dyachenko 1975; Czechowski & Dyachenko 2001; Makovetskaya & Kazulka 2017
41	<i>Myrmica rugulosa</i> Nylander, 1849	Czechowski 1994a; Radchenko et al. 1997; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012; Mazur 2006	Arnol'di 1970; Makovetskaya & Kazulka 2017

Species	Polish part	Belarusian part
42 <i>Myrmica sabuleti</i> Meinert, 1861	Czechowski et al. 1995; Czechowski & Dyachenko 2001; Mazur 2001, 2006; Czechowski et al. 2002, 2012	
43 <i>Myrmica scabrinodis</i> Nylander, 1846	Bischoff 1925; Karpiński 1956; Czechowski et al. 1995; Czechowski & Dyachenko 2001; Mazur 2001, 2006; Czechowski et al. 2002, 2012; Dziekańska et al. 2020	Dyachenko 1997; Makovetskaya & Kazulka 2017
44 <i>Myrmica schencki</i> Viereck 1903	Karpiński 1956; Czechowski et al. 1995; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012	Dyachenko 1997; Makovetskaya & Kazulka 2017
45 <i>Polyergus rufescens</i> (Latreille, 1798)	Bischoff 1925; Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012	
46 <i>Solenopsis fugax</i> (Latreille, 1798)	Czechowski & Dyachenko 2001; Czechowski et al. 2002, 2012; Mazur 2006	
47 <i>Stenamma debile</i> (Förster, 1850)	Czechowski et al. 1995, 2002, 2012; Czechowski & Dyachenko 2001; Mazur 2001, 2006; Maák et al. 2021	Kazulka & Makovetskaya 2017; Makovetskaya & Kazulka 2017
48 <i>Strongylognathus testaceus</i> (Schenck, 1852)	Czechowski et al. 1995, 2002, 2012; Czechowski 1998; Czechowski & Dyachenko 2001; Mazur 2006	Dyachenko 1975; Czechowski & Dyachenko 2001
49 <i>Temnothorax crassispinus</i> (Karavajev, 1926)	Karpiński 1956; Czechowski & Dyachenko 2001; Mazur 2001, 2006; Czechowski et al. 2002, 2012	Dyachenko 1997; Makovetskaya & Kazulka 2017
50 <i>Tetramorium caespitum</i> (Linnaeus, 1758)	Czechowski et al. 1995, 2002, 2012; Czechowski 1998; Czechowski & Dyachenko 2001; Mazur 2001, 2006; Maák et al. 2021	Czechowski & Dyachenko 2001; Dyachenko 1997; Makovetskaya & Kazulka 2017

***Lasius (Chtonolasius) distinguendus* (Emery, 1916)**

– first record in BF

– BNP, plot 5, Barber trap, 1 ex., queen, 20 July 2011.

A rarely collected species, known from the Baltic Coast, Mazovian Lowland, Kraków-Częstochowa Upland, Małopolska Upland, Lublin Upland, Eastern Beskid Mountains, Bieszczady Mountains, and Pieniny Mountains (Czechowski et al. 2012). It is a temporary social parasite of *Lasius* s. str. species, with *L. alienus* and *L. paralienus* considered its main hosts, but also associated with *L. platythorax* and *L. niger* (Schlick-Steiner et al. 2002). This thermophilous species occurs in open steppe habitats with no or low-intensity grassland management, and occasionally at warm woodland margins (Czechowski et al. 2012; Seifert 2018). Conservation status in Poland: data deficient (DD) (Czechowski 2002).

***Leptothorax gredleri* Mayr, 1855** – first record in BF

– BNP, plot 5, Moericke trap, 1 ex., worker, 14 Sept 2004, 2 exx., queens, 23 Jun 2009;

– BNP, plot 5, Barber trap, 1 ex., worker, 27 Jul 2006.

In Poland, a relatively poorly known species, reported from three regions: Wielkopolsko-Kujawska Lowland, Mazovian Lowland, Lower Silesia (Czechowski et al. 2012). It is an oligothermophilous species of mesophilous deciduous woodlands, particularly those with a high proportion of *Quercus* (Czechowski et al. 2012; Seifert 2018). Conservation status in Poland: not listed.

DISCUSSION

This study presents the most recent and comprehensive overview of the ant (Formicidae) fauna of the BF. Our findings confirm that historically recorded species continue to persist and identify additional taxa not previously recorded, underscoring the importance of long-term monitoring in ancient forest ecosystems.

As mentioned above, previous publications set a total of 45 ant species in the BF, with 45 species for the Polish part and 33 species for the Belarusian part. The present study highlights the well-established ecological importance of the BF by adding four species to the Białowieża Forest and confirming one additional species for the Polish part. The most frequently col-

lected species during research conducted in the Polish part of the forest were: *Formica polychlena*, *F. rufa*, *F. fusca*, *F. sanguinea*, *Camponotus herculeanus*, *Myrmica lobicornis*, *M. rubra*, *M. ruginodis*, and *Lasius niger* (Table 2).

In our study, 28 ant species were collected, with the highest species richness and abundance recorded in the fresh mixed coniferous forest (*Calamagrostio-Piceetum*) within the strictly protected zone of BNP. This pattern may be partly explained by differences in sampling intensity between plots, as sampling in the managed part of the Białowieża Forest District was conducted over a shorter period than in the BNP plots. Consequently, direct comparisons between all plots should be interpreted with caution, particularly regarding species richness and abundance. However, the substantially higher number of species and individuals recorded in the plot in the fresh mixed coniferous forest compared with the plot in the fresh deciduous forest, despite the same sampling period, likely reflects ecological differences between the studied forest types. The mixed coniferous forest plot provided more favourable conditions for forest ant assemblages, including greater habitat heterogeneity, higher availability of dead wood and nesting sites, and a more open canopy structure, which may have promoted higher ant activity and diversity. Other studies have previously shown that older and less disturbed forest stands can host high ant diversity (Karpiński 1965; Czechowski et al. 2002, 2012; Mazur 2002, 2006). The higher number of temporary social parasitic species recorded in the mixed coniferous forest plot further supports this interpretation. Social parasitic ants are generally associated with structurally complex and stable ant communities, which are more typical of old-growth and long-undisturbed forests. These habitats support long-lived colonies and stable ecological networks that facilitate the persistence and evolution of specialized symbiotic relationships, including social parasitism (Hölldobler & Wilson 1990; Buschinger 2009; Rabeling 2020). For instance, the ancient and wild nature of the BF is essential to the presence of the recorded *Chthonolasius*, *Coptoformica*, *Raptiformica* (*F. sanguinea*) and *Strongylognathus*. The dominance of *Myrmica ruginodis*, *Formica fusca*, *Camponotus herculeanus*, *Lasius platythorax* and *F. sanguinea* is consistent with previous studies in BF, where these species were among the most abundant (Czechowski et al. 1995, 2002, 2012; Mazur 2002, 2006). These taxa, strongly linked to wooden structures, are characteristic of forest ecosystems with complex vertical and horizontal structures, providing ample nesting opportunities and trophic resources (Seifert 2018).

Far from the homogeneity of disturbed habitats, mature natural forests are characterized by high structural complexity and the presence of diverse microhabitats (Hölzel 2005; Michel & Winter 2009). This is reflected in the wide ecological diversity of the ant species recorded in the forest. The four species newly recorded in Białowieża Forest also confirm to this pattern: two species are associated with open habitats

(*Lasius distinguendus* and *Formica rufibarbis*), while the other two are linked to forested, wooded stands (*Leptothorax gredleri* and *Camponotus fallax*). For example, the presence of *L. distinguendus*, a thermophilous species associated with open steppe habitats and woodland edges (Czechowski et al. 2012; Seifert 2018), suggests occasional colonisation of microhabitats within mature coniferous stands. Similarly, *L. gredleri*, a mesophilous species of deciduous woodlands with a preference for *Quercus*-dominated sites (Seifert 2018), reflects the heterogeneous structure of the forest, which supports the presence of species typically considered rare in Poland. The presence of *F. rufibarbis*, the most xerothermophilous species of all four (Czechowski et al. 2002; Seifert 2018), is linked to well-insolate microhabitats within the forest landscape – conditions that also support other xerothermic species, such as *F. cinerea*. In addition, the presence of decaying wood and tree stands provides suitable habitat for carpenter ants (*Camponotus* species), which are represented by four species in the study area, including the newly recorded *Camponotus fallax*. This species, moderately thermophilous and associated with closed broad-leaved forests (Seifert 2018), was repeatedly collected over several years, supporting the presence of a stable local population within BF. Finally, *Formica pressilabris*, previously recorded only in the Belarusian part of BF, has now also been confirmed in the Polish part. Two of the newly recorded species, *F. rufibarbis* and *L. distinguendus*, were detected based on single individuals. Although single records may require cautious interpretation, they do not undermine the reliability of their presence in the study area. These species are, however, rarely detected and/or exhibit specific habitat requirements, which, combined with the standard sampling protocol and the long-term nature of the study, rather suggests their actual, albeit scarce, occurrence in the local myrmecofauna. Besides their ecological importance, these new records underscore the importance of continued, standardised sampling, as rare or cryptic species may remain undetected in sporadic surveys (Mazur 2006; Czechowski et al. 2012).

Currently, a total of 50 ant species have been documented in the BF, comprising 50 species recorded from the Polish part and 33 from the Belarusian part (Table 2). It should be noted that the 28 species recorded in the present study represent a subset of the total ant fauna known from the BF. This discrepancy is primarily attributable to differences in sampling design and spatial coverage. Previous studies were based on a broader range of habitat types, including a greater diversity of microhabitats and forest stands, as well as cumulative data from multiple sources and sampling efforts conducted over extended periods. In contrast, the present study focused on selected forest types within the Polish part of the BF, with a standardized sampling protocol applied within a defined study design. Therefore, the lower number of species reflects methodological and spatial constraints rather than a reduced local species pool. The lower number of re-

cords from the Belarusian section most likely reflects lower sampling intensity and the limited availability of published faunistic studies. The Polish section of the forest therefore harbours approximately 50% of the native ant fauna known from Poland, highlighting the exceptional importance of this area for the conservation of the country's myrmecofauna (Czechowski et al. 2012). Compared with other regions of Poland, the BF is characterized by relatively high ant species richness. Previous studies reported 46 species in the Pieniny National Park (Czechowska 1976) and 63 species in the entire Pieniny Mountains region (Czechowski et al. 2002), 32 species in both the Stołowe Mountains National Park (Salata 2014) and Wigry National Park (Krzysztofiak 2001), 31 species in the Ojcowski National Park (Dylewska & Wiśniowski 2003), and 29 species in the Świętokrzyski National Park (Krzysztofiak 1984; Rzeszowski et al. 2013).

Our study suggests that, despite many years of entomological research, the myrmecofauna of the Białowieża Forest remains insufficiently documented (Czechowski et al. 2002, 2012; Mazur 2002, 2006; Makovetskaya & Kazulka 2017), particularly in the Belarusian part of the forest. The presence of diverse forest types, wetlands, open forest edges and thermophilous microhabitats creates conditions suitable for a wide spectrum of ant species with different ecological requirements (Seifert 2018). Furthermore, the geographical ranges of several Central and Eastern European species overlap in this region, increasing the likelihood that additional taxa may occur in the BF but have not yet been recorded (Czechowski et al. 2012; Seifert 2018). Continued and methodologically diverse sampling, particularly in underexplored habitats such as canopy microhabitats or dead wood, may therefore reveal further species.

This study demonstrates the critical role of long-term monitoring in capturing the full spectrum of ant diversity in complex forest ecosystems. Continuous sampling across multiple habitat types enabled the detection of rare and newly recorded species, which might have been overlooked in short-term or opportunistic studies. The BF continues to harbour a rich and ecologically diverse myrmecofauna. Newly recorded species highlight the potential for further discoveries, emphasising the need for ongoing monitoring.

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STRESZCZENIE

Mrówki (Hymenoptera: Formicidae) Puszczy Białowieskiej – przegląd gatunków oraz znaczenie długoterminowego monitoringu w wykrywaniu nowych gatunków

Wiedza o rozmieszczeniu mrówek (Hymenoptera: Formicidae) w Polsce pozostaje nadal niepełna, pomimo rosnącej liczby badań faunistycznych i ekologicznych. Puszcza Białowieska, będąca jednym z najcenniejszych kompleksów leśnych Europy, od wielu lat objęta jest monitoringiem bezkręgowców, jednak jej myrmekofauna nie była kompleksowo podsumowana od blisko dekady. W pracy przedstawiono syntezę wyników badań prowadzonych w latach 2003–2015 na stałych powierzchniach monitoringowych zlokalizowanych zarówno w Obszarze Ochrony Ścisłej Białowieskiego Parku Narodowego, jak i w zagospodarowanej części Puszczy Białowieskiej. Materiał zebrano z wykorzystaniem pułapek Moerickego, Barbera oraz IBL-2bis na powierzchniach reprezentujących dwa typy siedlisk leśnych: bór mieszany świeży (*Calamagrostio-Piceetum*) oraz las świeży (*Tilio-Carpinetum*). Łącznie stwierdzono występowanie 28 gatunków mrówek. Cztery gatunki: *Lasius distinguendus* (Emery, 1916), *Camponotus fallax* (Nylander, 1856), *Formica rufibarbis* Fabricius, 1793 oraz *Leptothorax gredleri* Mayr, 1855 wykazano po raz pierwszy z terenu Puszczy Białowieskiej. Gatunek *Formica pressilabris* Nylander, 1846 został po raz pierwszy odnotowany w polskiej części Puszczy Białowieskiej. Największą liczbę gatunków oraz osobników stwierdzono na powierzchniach boru mieszanego świeżego zlokalizowanych w Białowieskim Parku Narodowym, jednak porównania pomiędzy typami siedlisk należy interpretować ostrożnie ze względu na różną intensywność odłowów. Najczęściej rejestrowanymi gatunkami były: *Myrmica ruginodis* Nylander, 1846, *Formica fusca* Linnaeus, 1758, *Camponotus herculeanus* (Linnaeus, 1758), *Lasius platythorax* Seifert, 1991 oraz *F. sanguinea* Latreille, 1798. Obecnie z terenu całej Puszczy Białowieskiej wykazano 50 gatunków mrówek, z czego 50 odnotowano w części polskiej, a 33 w części białoruskiej. Różnice te wynikają przede wszystkim z odmiennej intensywności i zakresu badań myrmekologicznych prowadzonych po obu stronach granicy, a nie z rzeczywistych różnic faunistycznych. Uzyskane wyniki stanowią aktualizację wiedzy o myrmekofaunie Puszczy Białowieskiej oraz podkreślają znaczenie długoterminowego monitoringu w wykrywaniu gatunków rzadkich i nowych dla badanego obszaru, a także w poznawaniu zróżnicowania zespołów mrówek związanych z różnymi typami siedlisk leśnych.
