

Corvid Roosts in the City: First Results about their Impact on the Taxonomic Diversity and Trophic Structure of the Soil Nematode Community

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Abstract: The aim of this study is to assess the influence of urban corvid roosts on soil nematodes. Two neighbouring areas in the city of Warsaw were investigated, one subject to winter corvid roosting activity and the other not influenced by birds. The results show that in the soil inside and outside the roost two distinct nematode communities were established, differing in density, diversity and trophic structure. On each sampling date, we found more nematodes in soil inside the roost than outside it. However, both taxonomic and trophic diversity of nematodes were lower in soil under the roost than outside. Among the trophic groups, bacterial- and fungal-feeding nematodes were found to respond positively to soil conditions in the roosting site, while plant feeders, omnivores and especially predators responded negatively. We infer that nematode community parameters are good indicators of changes in soil caused by corvid roosting activity.

Key words: urban ecology, soil enrichment, nematode abundance, trophic groups

Introduction

Corvid roosting is a phenomenon that occurs all over the world, especially in winter. A roost is a place where birds gather to sleep at night. Corvids usually form large roosts from November to March, after which they go back to their home territories to start the nest-building and breeding process. The presence of food sources of anthropogenic origin and the effects of the urban heat island (felt mainly during the winter) have been associated with increased frequency of bird colonisation in urban areas (JOKIMAKI & SUHONEN 1998, PINOWSKA et al. 2005).

Roosting sites regularly occupied by large numbers of birds undergo considerable modification. Increased deposition of droppings contributes to nutrient enrichment of the soil under the roost. Several studies have indicated distinct changes in the physical and chemical properties of soil (LIGĘZA & MISZTAŁ 1999, LIGĘZA ET AL. 2000) AND VEGETATION COVER (MAKSYM & SŁAWSKA 2011) caused by the activity of the corvids in a roost. Only a few

studies have investigated the response of soil fauna to corvid roosting behaviour in urban areas (MAKSYM & SŁAWSKA 2011, ILIEVA-MAKULEC et al. 2015b).

Among soil invertebrates, nematodes play an important role in the processes of decomposition and mineralisation and contribute notably to nutrient turnover in the soil (INGHAM et al. 1985, FRECKMAN 1988). Nematodes occur at different trophic levels as bacterial and fungal feeders, plant feeders, omnivores and predators that show different responses to changes in soil (temperature, moisture, acidity, nutrient flow, etc.) and vegetation characteristics (YEATES et al. 1993, DE GOEDE & BONGERS 1994). It should therefore be expected that nematode community parameters are good indicators of changes related to corvid roosting behaviour.

The aim of the study is to assess the impact of bird roosting on soil nematode communities. Based on the results of above-mentioned research, which indicates strong modifications in the soil and plant characteristics

of different roosting sites, we have assumed that in our study the roost impact would bring about an increase in the density of nematode communities but a decrease in their taxonomic and trophic diversity. We have also expected the nematode response to be more pronounced in the topsoil and the impact of winter bird roosting on nematodes to decrease over time.

Materials and Methods

Study area

The study area was in Warsaw (52°17'49"N–21°2'40"E) about 7–8 km away from the city centre and 3.4–3.5 km from the river Vistula. The area consisted mainly of blocks of flats with small, not very diverse tree plantings and lawns between them. Two sampling plots of trees (about 100 m² each) were selected: one where trees were used as a bird roost for several years and the other adjacent to (less than

20 m from) the roosting area but not subject to any bird influence. The dominant tree species was the horse chestnut (*Aesculus hippocastanum* L.), and the height of most of the trees exceeded 10 m.

Most of the birds observed in the roosting area were corvids (Corvidae): the rook (*Corvus frugilegus* L.), the western jackdaw (*Coloeus monedula* L.) and the hooded crow (*Corvus cornix* L.). Within the roosting area, many signs indicating bird activity were found both on the leaves of trees and on the soil (Fig. 1). Corvid droppings at the site consisted mainly of undigested food residues in admixture with a whitish uric acid.

Sampling

Soil sampling started in spring after a significant decrease in the number of birds arriving at the roost was noticed. Samples were collected three times: in spring (May), summer (July) and

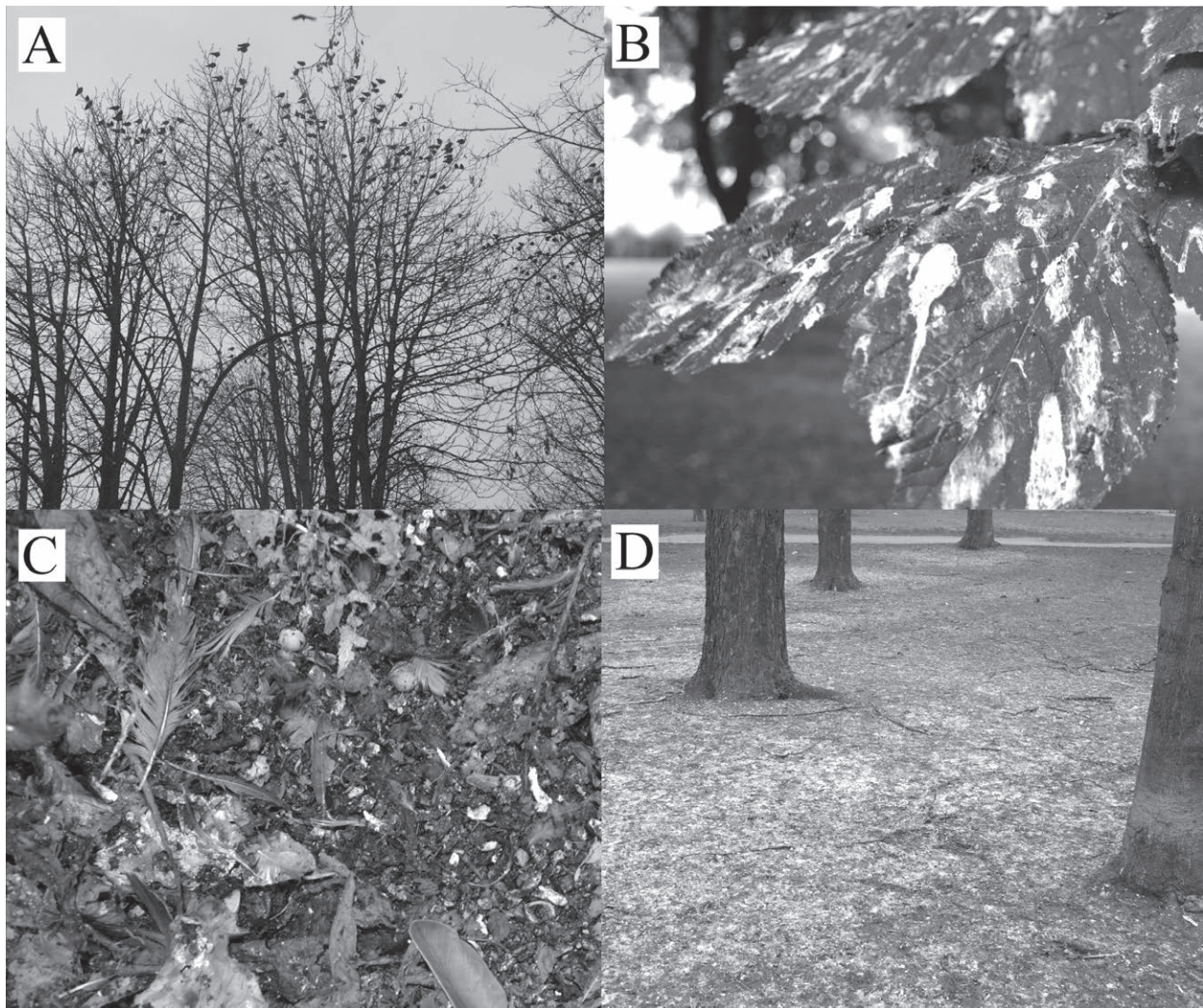


Fig. 1. A view of the roosting area: birds gathering in the treetops (A), chestnut leaf with visible traces of droppings (B), birds excrements, feathers, bones, fruit stones on the ground under the roost (C and D).

autumn (September) 2013. From each habitat (inside and outside the roost), five soil samples were taken in spring and ten samples in summer and in autumn. Soil cores were collected using a 2.5 cm² steel corer to a depth of 20 cm. The samples were divided into two layers: topsoil (0–10 cm) and subsoil (10–20 cm). Nematodes were extracted from the soil samples (each of about 50 g fresh weight) by a modified Baermann method (FLEGG & HOOPER 1970), heat killed and fixed with 4% formaldehyde solution. The extracted nematodes were counted, and 100 randomly selected specimens from each sample were determined to generic level under a light microscope (Leica DM5000B, 400×) using mainly the keys in BONGERS (1988). All identified nematode genera were assigned to trophic groups (plant feeders, hyphal feeders, bacterial feeders, omnivores or predators) according to YEATES et al. (1993) and to coloniser-persister (*c-p*) classes (after BONGERS 1990, 1999).

Data processing

In order to characterise the nematode communities, the following ecological parameters and indices were used: nematode density, relative abundance of trophic groups, and generic richness. The Shannon-Wiener Diversity Index (H') (SOUTHWOOD 1978) was calculated using PAST software v. 2.17 (HAMMER et al. 2001) in two ways: as a mean diversity of individual samples and as a total diversity of a set of samples, which enabled the study not only to take into account the number of genera but also to preserve generic identity. The index of similarity was calculated according to Sørensen (SOUTHWOOD & HENDERSON 2000). Two nematode-specific indices were also estimated: the Maturity Index (MI) and the Enrichment Index (EI). MI, based on nematode life-history traits and their ecological requirements, is used to assess the state of disturbance (BONGERS 1990). Food-web EI is an indicator of resource availability and is based on the relative abundance of both bacterial- and fungal-feeding nematodes, which have short life cycles (FERRIS et al. 2001). In addition, two ratios were calculated: Bf/(Bf+Hf), the ratio of bacterial-feeding (Bf) to hyphal-feeding nematodes (Hf), which provides information on the dominant pathway in the decomposition of organic matter, namely whether bacteria or fungi predominate (WASILEWSKA 1997); and (Bf+Hf)/Pf, the ratio of (bacterial feeders + hyphal feeders) to plant feeders, which indicates differences in mineralisation in the detritus food chain or in the herbivore food chain (WASILEWSKA 1997).

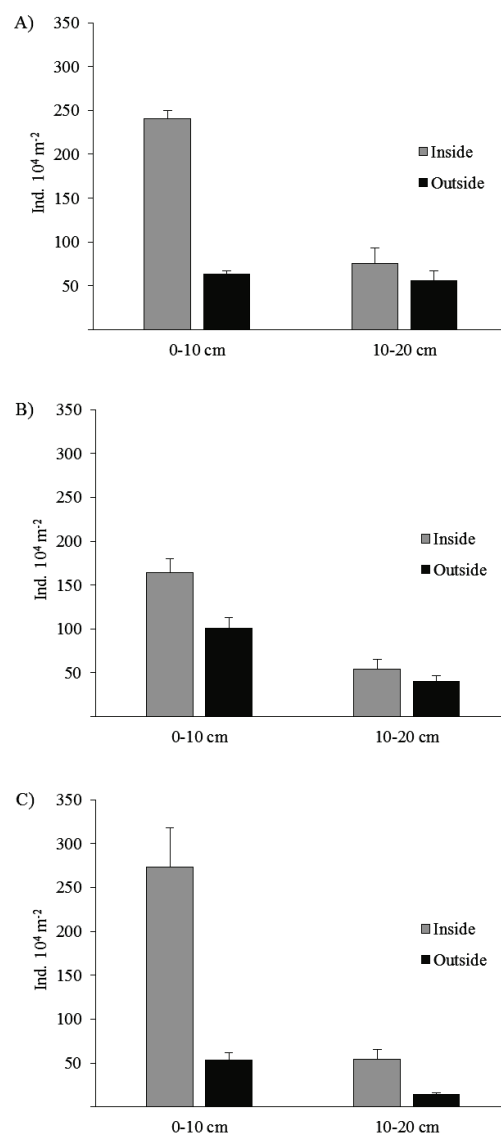


Fig. 2. Nematode density in topsoil (0–10 cm) and subsoil (10–20 cm) inside and outside the roosting area in spring (A), summer (B) and autumn (C). Mean values + SE are given.

Statistical analysis

To assess the statistical significance of the influence on nematode abundance of habitat (inside and outside the roost), soil layer (topsoil and subsoil) and season (spring, summer and autumn), a multi-way analysis of variance (ANOVA) followed by Tukey's multiple range test was applied. Differences were considered significant at $p < 0.05$. For the analyses, nematode densities were log-transformed. The statistical analyses were carried out using the data analysis software system STATISTICA v. 12 STATSOFT, Inc. (2014).

The differences between habitats in terms of the mean values of H' and MI were tested with the nonparametric Mann–Whitney U test, while total

Table 1. Multivariate ANOVA analysis for the corvid roost influence on nematodes density. Significant effects ($p < 0.05$) are bolded.

Source of variation	F	p
Habitat (inside or outside the roost)	72.649	0.0000
Layer (0–10 cm, 10–20 cm)	115.786	0.0000
Season (spring, summer, autumn)	8.820	0.0003
Habitat × Layer	7.729	0.0066
Habitat × Season	12.344	0.0000
Layer × Season	4.149	0.0189
Habitat × Layer × Season	1.028	0.3619

Table 2. Selected diversity, similarity and functional indices of nematode communities in the soil inside and outside the roost. Differences between habitat were tested with Mann-Whitney U test (mean values) and t test (total diversities), * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, n.s. – not significant, n.d. – not determined. Bf – bacterial feeders, Hf – hyphal feeders, Pf – plant feeders. $n = 10$ (on summer and autumn sampling), $n = 5$ (on spring sampling).

Parameter	Season	Inside (H1)		Outside (H2)		H1/H2 p values	H1/H2 p values
		0-10 cm	10-20 cm	0-10 cm	10-20 cm	top	sub
Total number of genera ¹	spring	11	15	17	21	n.d.	n.d.
	summer	12	15	24	23	n.d.	n.d.
	autumn	10	14	23	25	n.d.	n.d.
Shannon Diversity Index (H') ¹	spring	0.93	0.97	1.48	1.57	**	**
	summer	1.50	1.43	2.13	2.51	***	***
	autumn	1.53	1.66	2.38	2.32	***	**
Shannon Diversity Index (H') ¹	spring	1.05±0.56	0.93±0.48	1.22±0.81	1.28±0.53	n.s.	n.s.
	summer	1.35±0.36	1.01±0.14	1.61±0.37	1.93±0.30	n.s.	***
	autumn	1.30±0.19	1.37±0.22	1.80±0.28	1.73±0.26	***	*
Maturity Index	spring	1.15±0.08	1.18±0.17	1.39±0.13	1.32±0.06	*	*
	summer	1.42±0.27	1.36±0.21	1.83±0.22	1.81±0.21	*	***
	autumn	1.27±0.13	1.30±0.11	1.60±0.19	1.59±0.33	***	**
Bf/(Bf+Hf) ¹	spring	0.94	0.97	0.95	0.95	n.d.	n.d.
	summer	0.88	0.89	0.92	0.75	n.d.	n.d.
	autumn	0.87	0.95	0.83	0.88	n.d.	n.d.
(BF+Hf)/Pf ¹	spring	327.3	47.73	22.24	19.43	n.d.	n.d.
	summer	279.5	42.00	48.14	8.32	n.d.	n.d.
	autumn	no Pf	50.75	10.972	7.49	n.d.	n.d.
Enrichment Index	spring	95.71	94.82	92.21	92.02	n.d.	n.d.
	summer	85.64	89.81	66.32	79.05	n.d.	n.d.
	autumn	91.91	90.65	70.05	84.27	n.d.	n.d.
Sørensen Similarity Index ¹	spring	76%		68%		71%	61%
	summer	66%		65%		62%	58%
	autumn	64%		54%		48%	50%

¹These parameters were determined using the total number of genera (for the whole community or for the certain trophic groups) found on each sampling date in a given habitat and soil layer; differences between habitats for these parameters were not determined.

diversities of nematode communities were compared using a t-test carried out using PAST software v. 2.17 (HAMMER et al. 2001).

Principal Components Analysis (PCA) was performed to determine nematode generic composition distribution between the two habitats. The data were analysed separately by season and soil layer using CANOCO software for ordination, v. 5.0 (TER BRAAK & ŠMILAUER 2012).

Results

Density and trophic structure of nematode communities

During the study, the density of nematodes ranged from 55×10^4 to 274×10^4 ind.m⁻² in the soil within the roosting area and from 14×10^4 to 101×10^4 ind.m⁻² in the soil outside the roost (Fig. 2). The results of ANOVA indicate significant influence of the studied factors (habitat, layer and season) on nematode density (Table 1). On each sampling date, in each soil layer we found nematode communities to be more numerous in soil inside than outside the roost. Statistically significant differences in the density between the habitats were observed in the topsoil (on all sampling dates) while in the subsoil only in the autumn. Moreover at each habitat, significantly more nematodes were found in the topsoil than in the subsoil ($p < 0.05$). Only in spring and outside the roost was no difference in nematode density between the two soil layers observed ($p > 0.05$).

Bacterial-feeding nematodes were the most numerous trophic group represented in both habitats (Fig. 3). In topsoil their percentage share of the total community was high (more than 75%) and no differences between habitats was observed ($p > 0.05$). In subsoil, during the summer and autumn sampling, the relative abundance of bacterial feeders was significantly higher inside than outside the roost ($p < 0.05$).

The relative abundance of hyphal feeders in the topsoil did not differ between the habitats ($p > 0.05$). In the subsoil, relatively more hyphal feeders were found outside than inside the roost but the only significant difference was observed for the summer sampling ($p < 0.05$) (Fig. 3).

In both habitats, relatively more plant feeders were found in subsoil than in the topsoil. The percentage share of this trophic group was significantly higher in soil outside than inside the roost ($p < 0.05$) (Fig. 3).

Omnivores were reported in very low numbers in both the soil layers outside the roost but within the roost only in the subsoil (Fig. 3).

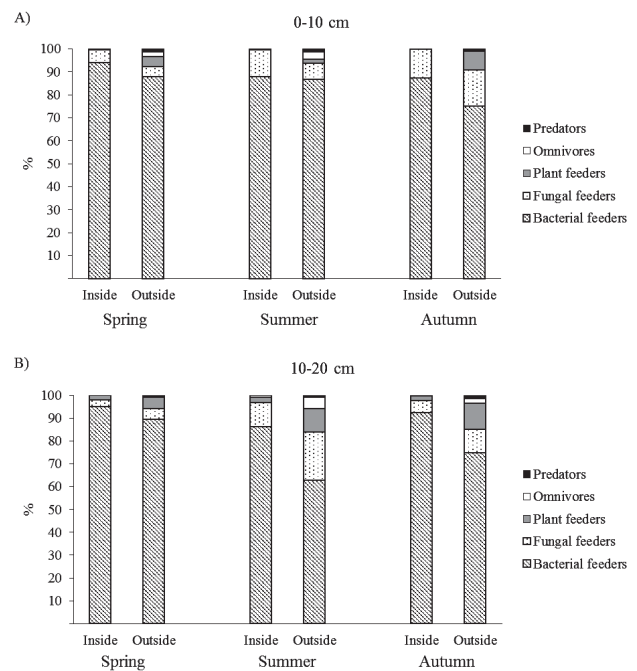


Fig. 3. Nematode trophic structure in topsoil (A) and subsoil (B) inside and outside the roosting area.

Predators were not found in the soil within the roost. They were noticed only outside the roost and at a very low percentage share (Fig. 3).

Nematode taxonomic and functional indices

In total, 51 genera of nematodes were found in the study, 27 in soil inside and 45 in soil outside the roost. The number of genera at the roosting site (especially in the top layer) was lower than at the non-roosting site (Table 2). These differences are connected mainly with the absence of predators, a distinctly lower number of genera in the group of omnivores and plant feeders (especially in topsoil), and somewhat fewer bacterial feeders in the soil inside than outside the roost (Table 3).

According to the values of H' , on all sampling dates the total generic diversity of nematodes in the two soil layers inside the roost was significant lower than in the same layers outside the roost. In each habitat, no significant differences in nematode diversity between the soil layers were noticed ($p > 0.05$). Mean generic diversity values (based on individual samples) differed significantly between the habitats only in autumn (in both layers) and in summer (only in the subsoil) (Table 2).

The Sørensen Index values indicate a greater similarity in generic composition between the soil layers in each habitat than between the habitats in each layer. Over the course of the study, the nematode generic composition in the two habitats became less similar (Table 2).

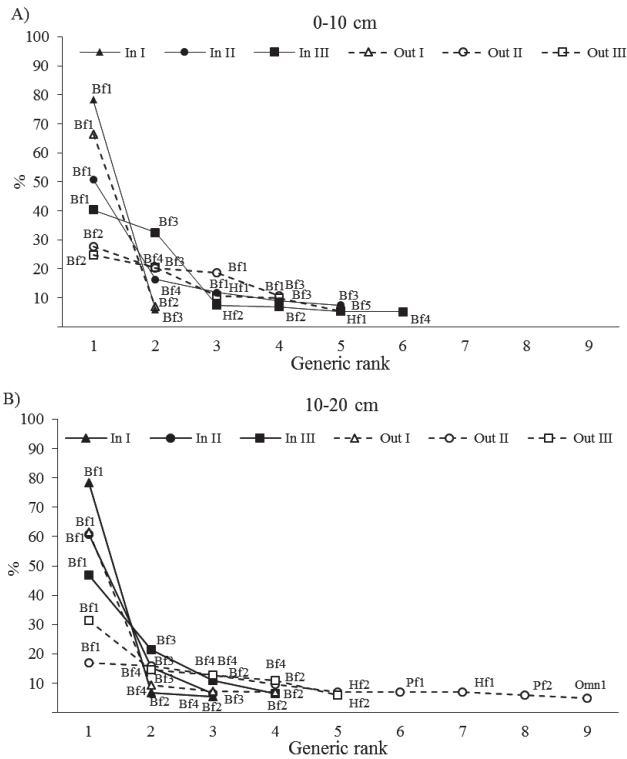


Fig. 4. Rank-abundance curves of dominated nematode genera in topsoil (A) and subsoil (B) communities inside and outside the roost. Genera with $\geq 5\%$ percent share of the total nematode communities are presented. I, II, III – spring, summer and autumn samplings. In and Out – inside and outside the roost. Bf – bacterial feeders, Hf – hyphal feeders, Pf – plant feeders, Omn – omnivores. Bf1 – *Rhabditis*, Bf2 – *Cephalobus*, Bf3 – *Panagrolaimus*, Bf4 – *Acrobeloides*, Bf5 – *Eucephalobus*, Hf1 – *Aphelenchus*, Hf2 – *Aphelenchoides*, Pf1 – *Boleodorus*, Pf2 – *Helicotylenchus*, Omn1 – *Eudorylaimus*.

The mean values of MI were low in both habitats but still significantly lower inside than outside the roost. However, when looking at a given habitat, no differences in the MI values between the two layers were noticed (Table 2).

On all sampling dates and in both studied habitats, the ratio $Bf/(Bf+Hf)$ had relatively high values (above 0.75), which indicates a higher proportion of bacterial feeders than of hyphal feeders in the total nematode communities (Table 2).

The ratio $(Bf+Hf)/Pf$ was found to be distinctly higher inside than outside the roost, irrespective of the soil layer (Table 2). In each habitat, this ratio was higher in the topsoil than in the subsoil.

On all sampling dates, EI was higher inside than outside the roost, although the biggest differences between habitats were observed in the topsoil on the summer and autumn sampling dates.

Rank-abundance curves of dominant nematode

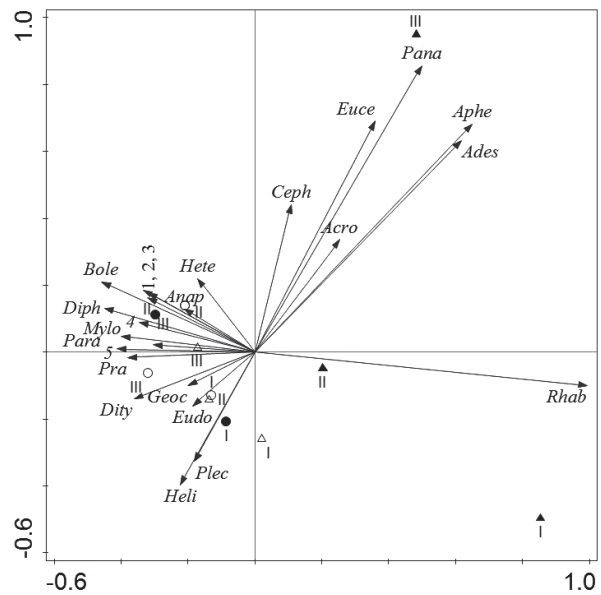


Fig. 5. Biplot diagram of nematode fauna inside and outside the roost in PCA ordination. Sample symbols: black triangles – topsoil inside the roost, empty triangles – subsoil inside the roost; black circles – topsoil outside the roost, empty circles – subsoil outside the roost. I, II and III – spring, summer and autumn samples. Genera are indicated by arrows. Full genera names: *Acro* – *Acrobeloides*, *Anap* – *Anaplectus*, *Ades* – *Aphelenchoides*, *Aphe* – *Aphelenchus*, *Bole* – *Boleodorus*, *Ceph* – *Cephalobus*, *Diph* – *Diphtheraphora*, *Dity* – *Ditylenchus*, *Euce* – *Eucephalobus*, *Eudo* – *Eudorylaimus*, *Geoc* – *Geocenamus*, *Heli* – *Helicotylenchus*, *Hete* – *Heterocephalobus*, *Mylo* – *Mylonchulus*, *Pana* – *Panagrolaimus*, *Para* – *Paratylenchus*, *Plec* – *Plectus*, *Prat* – *Pratylenchus*, *Rhab* – *Rhabditis*; 1 – *Discolaimium*, 2 – *Crassolabium*, 3 – *Mesodorylaimus*, 4 – *Tylencholaimus*, 5 – *Rhabdolaimus*.

genera were found to be sharper inside than outside the roost, irrespective of soil layer (Fig. 4). In both habitats, among the dominants were genera belonging to groups of bacterial and hyphal feeders. However, in the summer, when the weakest domination occurred in the subsoil outside the roost, two plant feeders and one omnivorous genus were noticed among the dominants (Fig. 4). The genus with the highest dominance in our study was *Rhabditis*. Its relative abundance decreased with time, but the reduction was more pronounced in soil outside the roost, whereas in the topsoil *Rhabditis* became less dominant and the genus *Cephalobus* took its place (Fig. 4).

The PCA (Fig. 5) based on the abundances of nematode genera and their distribution inside and outside the roost showed a clear gradient along the first axis. The higher eigenvalue for the first axis (0.82) indicates its higher importance (i.e., it explains

Table 3. Generic richness of nematode trophic groups in soil inside and outside the roost. “–“ not found any genus.

Trophic group	Season	Topsoil		Subsoil	
		Inside	Outside	Inside	Outside
Bacterial feeders	spring	8 (3-6)	8 (2-7)	8 (2-7)	10 (3-7)
	summer	8 (3-5)	10 (3-7)	8 (3-5)	13 (3-6)
	autumn	8 (2-5)	11 (3-7)	8 (3-6)	9 (3-5)
Hyphal feeders	spring	2 (0-2)	3 (0-3)	3 (0-3)	4 (0-3)
	summer	2 (1-2)	4 (0-4)	2 (0-2)	3 (1-2)
	autumn	2 (0-2)	4 (1-3)	3 (0-2)	3 (0-3)
Plant feeders	spring	1 (0-1)	2 (0-2)	4 (0-2)	4 (0-4)
	summer	2 (0-2)	4 (0-4)	4 (0-3)	4 (0-3)
	autumn	-	6 (0-6)	2 (0-2)	7 (0-3)
Omnivores	spring	-	3 (0-3)	-	2 (0-2)
	summer	-	4 (0-3)	1 (0-1)	1 (0-1)
	autumn	-	1(0-1)	1 (0-1)	4 (0-3)
Predators	spring	-	1 (0-1)	-	1 (0-1)
	summer	-	2 (0-2)	-	2 (0-1)
	autumn	-	1 (0-1)	-	2 (0-1)

a greater amount of variation) in comparison to the second axis (with an eigenvalue of only 0.14). The two first axes explained 95.6% of the data cumulative variation. The first ordination axis differentiated nematode communities inhabiting the topsoil layers of both habitats (outside and inside the roost). The abundance and distribution of bacterial feeders *Rhabditis*, *Panagrolaimus* and *Eucephalobus* and hyphal feeders *Aphelenchoides* and *Aphelenchus* were most strongly associated with the topsoil layer inside the roost. The position of other genera did not show such clear preference for a given habitat or soil layer; they could be found in the subsoil layers at both sites and in the topsoil layer of the non-roosting site.

Discussion

Corvid winter roosting sites in urban areas are usually occupied by large numbers of birds, reaching even more than 100,000 individuals (MAZGAJSKI & SZCZEPANOWSKI 2005). Increased deposition of droppings at roosts (HICKS 1979) has been found to lead to major transformations in the physico-chemical characteristics of the soil (GILMORE et al. 1984, JULIN 1986, LIGEZA & MISZTAL 1999, LIGEZA et al. 2000, 2001, LIGEZA S. & SMAL H. 2003, ZWOLICKI et al. 2013) and of microbial (TEIXEIRA et al. 2013) and plant communities (KOLB et al. 2010, MAKSYM & SŁAWSKA 2011). Based on this knowledge, we expected to detect shifts in nematode communities in

soil influenced by winter bird-roosting activity. We found that nematode communities in the soil inside and outside the roost differed in terms of density, generic diversity and trophic structure. Nematodes in the roosting site were significantly more abundant than outside the roost, and thus our results seem to confirm our expectations. Similarly, a positive response from two other groups of soil fauna (mites and collembolans) was noticed in the area of the corvid roosts (MAKSYM & SŁAWSKA 2011, ILIEVA-MAKULEC et al. 2015b).

Nematode genera identified in our study were classified into five trophic groups. The results of many research show that nematodes can be good indicators primarily because nematode genera or trophic groups (bacterial, fungal feeders, plant feeders, omnivores and predators) respond in different ways to changes in soil (temperature, moisture, acidity, nutrient flow, etc.) and vegetation characteristics (FRECKMAN 1988, DE GOEDE & BONGERS 1994, FERRIS & BONGERS 2006, ZHAO & NEHER 2013). Our results are in agreement with those findings. Nematodes belonging to bacterial-feeding group (especially *Rhabditis*, *Panagrolaimus* and *Cephalobus*) and to fungal-feeding group (mainly *Aphelenchus* and *Aphelenchoides*) were found to respond extremely positively to corvid roosting activity. However the predominance of bacterial over hyphal feeders in our study (especially inside the roost) was reflected in the very high values (above

0.83) of the ratio Bf/(Bf+Hf). Similarly to the present study, a positive response of bacterial feeders to external input of nutrients in the area of gull colonies on the Island on Surtsey has been noticed (ILIEVA-MAKULEC et al. 2015a). In both studies (ours and that on Surtsey), nematodes of the genera *Rhabditis* and *Panagrolaimus* occurred in higher density at sites influenced by birds. *Rhabditis* nematodes are known to require large food resources (numerous bacterial populations) to develop their populations (ILIEVA-MAKULEC 2001). BONGERS (1999) called nematodes of these two genera “enrichment opportunists” due to the fact they are good indicators of the availability of large food resources. An example of the positive response of some bacterial groups to the high ammonia and nitrogen content in the soil influenced by birds has been given by TEIXEIRA et al. (2013). On the other hand, the fact that inside the roost *Rhabditis* was the most dominant genus for a longer period than outside indicates that high food levels sustain for longer in the roosting site. The higher values of the food-web EI inside than outside the roost provide further confirmation of this.

The high relative abundance of bacterial and hyphal feeders in the communities in the two habitats was found to be well reflected in the low values of MI (below 2 on a scale of 1 to 5). However, the lower values of MI in soil inside than outside the roost could be closely related to the very high proportion of bacterial feeders of genus *Rhabditis* and *Panagrolaimus* with *c*-*p* value 1. MI is an index based on the life-history strategies of the nematode taxa (their place on the scale of *r*-*K* strategists) and on their responses to different disturbances (including nutrient supply or pollution) (Bongers 1990). We can therefore conclude that the lower MI values in the roosting sites indicate a higher level of disturbance than in the non-roosting site, and the two genera *Rhabditis* and *Panagrolaimus* best predict this type of disturbance.

In our study, nematode generic richness was found to be a parameter strongly negatively influenced by bird-roosting activity. The differences in nematode generic composition between the two habitats – and the lower nematode taxonomic diversity in soil inside than outside the roost – could be explained by the varied sensitivity of nematode genera to certain chemical constituents of bird droppings. For example, some compounds in droppings, such as low molecular weight fatty acids (acetic, propionic and butyric acids) or hydrogen sulfide, have been found to be toxic and to show strong nematicidal activity (BADRA et al. 1979). Moreover, the complete lack of omnivorous and predatory nematodes in the

topsoil and the small numbers of omnivorous nematodes in the subsoil under the roost could be related to the influence of the heavy metals that often accumulate on roosting sites. It is known that birds ingest with their food certain pollutants that they later expel, which leads to an accumulation of pollutants (mainly heavy metals) in the soil. For example, a fivefold increase in the content of certain heavy metals in the surface soil layer under a corvid roost was noticed by LIGEŻA et al. (2000), while a negative response of omnivorous and predatory nematodes to the long-term effects of copper was observed by KORTHALS et al. (1996).

Plant-feeding nematodes were another group we found to respond negatively to bird-roosting activity. The main reason for the observed low densities of plant-feeding nematodes within the roosting area could be lack of food (due to the very low number of plants or even total loss of ground vegetation under the roost). Our observations are in agreement with the findings of MAKSYM & ŚLAWSKA (2011), who observed a significant decrease in plant species in the ground layer at a roosting site. As shown by KOLB et al. (2010), a reduction of plant species diversity can occur in eutrophied terrestrial communities, presumably because of ammonium poisoning. In our study, the low densities of plant feeders in the soil under the roost were reflected in the values of the ratio of bacterivores + fungivores to plant feeders (Bf + Hf)/Pf. The very high values of the ratio (Table 2) imply that mineralization process in the roosting site is going mainly through the detritus pathway.

In conclusion, although our results cover a period of only one year, they indicate that bird roosting has a distinct impact on nematode community parameters. Taking into account the role of nematodes in the soil food-web, further and more detailed studies are needed to establish how these community changes influence processes of decomposition and nutrient turnover in urban soil over longer periods of time.

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Received 18.07.2017

Accepted 10.12.2017

