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IMPACT OF MUNICIPAL LANDFILL SITE IN TARNOW ON THE OCCURRENCE OF BENEFICIAL BEETLES

WPŁYW SKŁADOWISKA ODPADÓW KOMUNALNYCH W TARNOWIE NA WYSTĘPOWANIE POŻYTECZNYCH CHRZĄSZCZY

Abstract: The investigations on the occurrence of beneficial epigeal enthomofauna were conducted in 2006 and 2007 on plots situated in the immediate vicinity of the solid waste landfill site in Tarnow. The structure of enthomofauna domination differed considerably depending on the plot location towards the active landfill sector. The greatest diversity of *Col. Carabidae* was observed on the spots located at a longer distance from the landfill site. The vicinity of forest areas positively impacted the presence of predatory beetles.

Keywords: municipal landfill sites, *Col. Carabidae*, *Col. Staphylinidae*

Municipal landfill sites may impact the neighbouring areas among others through the emission of microbial and chemical pollutants. Gaseous, dust and microbial pollutants may pose a serious hazard to human health and life [1–3] and also lead to degradation of the surrounding soils, surface and underground waters and greenery. This may result in disturbing the balance in the environment and in consequence to changes among others in the numbers and species composition of fauna and flora [4]. The factor which additionally affects the fauna of municipal landfill sites is organic waste which is deposited there together with other wastes. A great amount of organic waste favours the presence of some organisms, such as birds or rodents. Also numerous appearances of dipterans from the *Muscidae*, *Calliphoridae* and *Sarcophagidae* genera are observed, which may carry pathogenic microorganisms.

Municipal landfill sites are often located next to agricultural areas and wastelands. An important element of fauna in these areas consists of beneficial epigeal enthomofauna. Beetles from *Col. Carabidae* and *Col. Staphylinidae* families play a particular

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role. Most of beetle species from these families are predatory and hunts other insects, including many species which are crop pests. These beetles are sensitive to environmental pollution and other changes brought about by human activities [5, 6]. Therefore, maintaining the balance in the natural environment and agrocenoses is a crucial challenge.

The present paper aimed to investigate the occurrence of beneficial epigeal fauna in the zone immediately adjoining a municipal landfill site.

Material and methods

The research was conducted in 2006 and 2007 in Tarnow. The solid waste landfill site in the vicinity of which the research was carried out is situated in the city northern quarter called Krzyz. The landfill area is surrounded by ploughlands, wastelands and forest. Observations were conducted on experimental plots located in the immediate vicinity of the landfill site. Plots were established at each side of the landfill in two zones: less than 250 m and between 250 and 500 m from its boundaries. The plot marking was presented in Table 1. Horse bean, Nadwislanski c.v. was cultivated on each plot with an area of 20 m^2. The experiment was set up in four replications and identical cultivation measures were applied on each plot.

Table 1

Soil sampling sites in the vicinity of the municipal landfill site in Tarnow

Plot	Location of plots in relation to landfill site		Surroundings
	Direction	Zone [m]	
W I	West	Less than 250	arable land, hay meadow
W II	West	250–500	arable land, hay meadow
N I	North	less than 250	wasteland
N II	North	250–500	wasteland, arable land
E I	East	less than 250	wasteland, forest
E II	East	250–500	wasteland, forest
S I	South	less than 250	forest, wasteland
S II	South	250–500	forest, arable land
Z	Reclaimed sector	0	active sector, hay meadow

The western winds dominate in the area of Tarnow city, average wind speed is 2.2 m/s, pointing to light wind. Detailed data on wind distribution are as follows: north winds – 6 %, northeast winds – 7.1 %, east winds – 16.7 %, southeast winds – 4.8 %, south winds – 14.8 %, southwest winds – 7.4 %, west winds – 22.6 %, northwest winds – 8.8 % and calm air – 11.8 %. Chemical properties of soils in plots are presented in Table 2.

Table 2

Chemical properties of soils occurring in the vicinity of municipal landfill site in Tarnow

Plot	pH_{H_2O}	Heavy metals				
		Cd	Cu	Ni	Pb	Zn
		$mg \cdot kg^{-1}$				
W I	5.1	1.09	5.46	4.87	22.92	57.37
W II	5.1	1.24	4.45	5.32	30.46	60.70
N I	5.6	1.17	9.01	5.24	30.73	67.72
N II	4.8	0.93	5.64	4.33	27.39	58.27
E I	4.8	0.99	5.48	4.62	25.38	58.55
E II	4.9	0.94	7.16	5.26	29.29	71.50
S I	7.5	1.08	10.43	8.61	26.92	97.70
S II	4.7	0.91	5.66	5.15	22.51	62.46
Z	4.7	0.99	7.96	7.19	24.32	60.78

Enthomofauna was captured into Barber's traps (glass jars dug into the ground level with the soil surface). The traps were dug in the middle of each plot. They did not contain the conserving liquid. They were covered with roofs to protect them against rain water. The collected insects were taken to a laboratory for their classification into orders and families using the appropriate keys [7, 8]. Beetles from *Col. Carabidae* family were classified into species or genus on the spot and live specimens were set free. 10 analyses were performed in 2006 and 12 in 2007.

The results were analysed statistically using the Statistica programme. ANOVA analysis was conducted and the Newman-Keuls critical intervals were computed. The value of the final step was used for differentiating means at the significance level $p < 0.05$.

Results and discussion

A total of 2461 *Carabidae* beetles were caught and 224 from *Staphylinidae* family. The solid waste landfill site in Tarnow affected the number and species composition of the captured *Carabidae* (Table 3). The greatest species diversity was found on the plots located on the southern side of the landfill site where the area is forested and thus these beetles might have migrated from there to the arable lands. A marked decrease in *Carabidae* numbers was registered on the plots situated in zone I – less than 250 m from the landfill boundaries. In this zone species the diversity of *Carabidae* was smaller than in zone II situated further from the landfill site.

The greatest number of *Carabidae* was captured on the plot located on the southern side of the landfill site in zone II. The smallest number of the specimens was spotted on the plot situated on the northern side of zone I (Table 4). *Staphylinidae* occurred far less numerously than *Carabidae*. Generally, they were more frequently captured on the plots in zone II. More *Staphylinidae* specimens were trapped in the second year of the investigations.

Table 3

Number of specimens and species of *Col. Carabidae* from analysed plots

Carabidae	Year	Plots							
		W		N		E		S	
		I	II	I	II	I	II	I	II
Number of specimens	2006	135	140	97	144	108	141	133	168
	2007	170	198	125	165	130	166	184	257
Number of species	2006	12	17	11	16	13	18	17	25
	2007	14	15	16	16	16	17	24	26

Table 4

Occurrence of beneficial epigeal enthomofauna depending on location of plots towards the landfill site

Taxon	Year	Average number of captured specimens per season [pcs.]								$LSD_{p<0.05}$
		Plots								
		W		N		E		S		
		I	II	I	II	I	II	I	II	
Carabidae	2006	33.8	35.0	24.3	36.0	27.0	35.3	33.3	42.03	
	2007	42.5	49.5	31.5	41.3	32.5	41.5	46.0	64.30	
	Mean	38.2	42.3	27.9	38.7	29.8	38.4	39.7	53.20	*13.75*
Staphylinidae	2006	3.3	3.8	2.8	4.0	2.5	2.3	2.3	4.5	
	2007	4.0	4.8	4.0	3.8	2.5	2.8	3.3	5.0	
	Mean	3.7	4.3	3.4	3.9	2.5	2.6	2.8	4.8	*n.s.*

n.s. – non-significant differences.

The structure of *Carabidae* domination on the analyzed plots was similar (Table 5). Two species: *Pterostichus cupreus* and *Bembidion properans* dominated on all plots. However, it may be noticed that both species had the greatest share on the plots situated on the western, northern and eastern sides. Particularly in zone I the number of eudominants was small. Ground beetles from the *Carabus* species occurred only on the plots situated close to the forest site. Big zoophages prefer forest sites [9]. These big beetles might have migrated from the forest to arable plots.

Beetles from *Carabidae* family play an important role in agrocenose environment because of their predatory lifestyle. Therefore, it is important to maintain high numbers of these beetles on farmlands. As was shown by the research conducted by other authors [10], *Carabidae* are particularly numerous on fields adjoining forested areas or fallows. In the presented investigations also more numerous presence of *Carabidae* was noticed on the fields adjacent to the forest site. A negative effect of pollution on *Carabidae* populations is also well known [11]. *Carabidae* are often used as bioindicators of environmental pollution and the state of its equilibrium. A decline in *Carabidae*

Table 5

Percentage of the most numerous species from *Col. Carabidae* genus and biodiversity indicators

Taxon	Percentage of share – domination structure							
	Plots							
	W		N		E		S	
	I	II	I	II	I	II	I	II
Pterostichus cupreus	29.5 ED	27.8 ED	34.2 ED	24.3 ED	35.3 ED	27.0 ED	22.1 ED	17.2 ED
Pterostichus lepidus	3.6 SD	8.3 D	0.0	7.8 D	4.2 SD	4.6 SD	2.8 SD	3.3 SD
Amara plebeja	7.9 D	9.2 D	8.1 D	10.4 ED	4.2 SD	6.8 D	8.8 D	7.1 D
Amara aenea	1.3 R	0.9 SR	1.8 R	1.6 R	0.0	0.0	1.6 R	5.2 D
Harpalus rufipes	7.2 D	8.9 D	8.1 D	12.3 ED	8.0 D	12.7 ED	11.7 ED	13.6 ED
Bembidion properans	31.5 ED	24.9 ED	30.2 ED	25.6 ED	29.8 ED	24.8 ED	18.6 ED	14.4 ED
Poecilus lepidus	6.6 D	8.9 D	3.6 D	8.1 D	4.6	9.1 D	11.7 ED	13.9 ED
Platynus dorsalis	0.7 SR	0.3 SR	4.1 SD	1.6 R	2.5 SD	2.0 R	5.0 SD	1.2 R
Carabus coriaceus	0.0	0.0	0.0	0.0	0.4 SR	1.6 R	2.5 SD	5.4 D
Carabus granulatus	0.0	0.0	0.0	0.6 SR	1.7 R	2.6 SD	3.5 SD	5.2 D
Other *Carabidae*	11.7	10.8	9.9	7.7	9.3	8.8	11.7	13.5

Eudominants (> 10 %) – ED, Dominants (5–10 %) – D, Subdominants (2–5 %) – SD, Recededents (1–2 %) – R, Subrecedents (< 1 %) – SR.

biodiversity observed in the zone adjoining the landfill site points to a strong negative impact of such facilities upon the natural environment. It is necessary to surround landfill sites with forest areas to minimize their negative environmental effect on the environment. Agrocenoses are especially exposed to such an effect. Therefore, a buffer zone between a landfill site and arable fields is necessary. Semi-natural, non-farmed sites provide convenient conditions for the survival of beneficial organisms [12].

Conclusions

1. Changes in the environment brought about by the active municipal landfill site influenced a decrease in *Carabidae* biodiversity in the agricultural crops.

2. Forest sites have an influence on the diminishing of the negative effect of landfill site on the neighbouring farmlands, owing to maintained biodiversity of predatory beetles.

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WPŁYW SKŁADOWISKA ODPADÓW KOMUNALNYCH W TARNOWIE NA WYSTĘPOWANIE POŻYTECZNYCH CHRZĄSZCZY

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Abstrakt: Badania nad występowaniem pożytecznej entomofauny naziemnej przeprowadzono na poletkach zlokalizowanych w bezpośrednim sąsiedztwie składowiska odpadów komunalnych w Tarnowie w 2006 i 2007 r. Struktura dominacji entomofany różniła się w zależności od lokalizacji poletek względem czynnego sektora składowiska. Największą bioróżnorodność biegaczowatych stwierdzono na poletkach położonych w większej odległości od składowiska. Korzystnie na występowanie drapieżnych chrząszczy wpływała bliska lokalizacja terenów leśnych.

Słowa kluczowe: składowiska odpadów komunalnych, biegaczowate, kusakowate