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Waste dumps as local biodiversity hotspots for soil macrofauna and ground beetles (Coleoptera: Carabidae) in the agricultural landscape

B. Baranová [a,*], P. Manko [a], T. Jászay [b]

[a] Department of Ecology, Faculty of Humanities and Natural Sciences, University of Prešov in Prešov, 17. novembra 1, 081 16 Prešov, Slovakia
[b] The Šariš Museum in Bardejov, Department of Natural Sciences, Radničné námestie 13, 085 01 Bardejov, Slovakia

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ABSTRACT

Man-made sites are found to often provide biodiversity refuges in anthropogenically impacted landscape and offering valuable analogues of natural habitats. We surveyed surface dwelling soil macrofauna and ground beetles (Coleoptera: Carabidae) assemblages by pitfall trapping across the eight stands of waste dumps and eight comparative biotopes in Eastern Slovakia. To our knowledge, this is the first such survey. During 18 weeks period in 2011 and 2012, a total of 38.814 individuals were trapped belonging to 17 soil macrofauna orders, 38 Coleopteran families and 98 Carabidae species. We analysed differences in assemblages of waste dumps and comparative biotopes and tested responses of orders, beetles and carabids to selected environmental variables. Assemblages collected from waste dumps had consistently higher diversity than their surrounding habitats, waste dumps equally showed higher proportion of slow-moving sapro-phytophagous orders and large wingless ground beetles colonizing native habitats. Ten rare ground beetles species were only captured from waste dumps. No clearly, unambiguous pattern was observed concerning distinctions in assemblages in relation to selected environmental variables, however, trees and shrub vegetation as well as soil moisture apparently affected community distinctions between studied habitats. We concluded, that reclaimed waste dumps as well as illegal waste dumps under different stages of succession could support surface dwelling soil macrofauna functional and the ground beetle species diversity in the agricultural landscape.

1. Introduction

Agricultural landscape is a heterogeneous mosaic providing array of semi-natural, anthropogenic and man-made sites, which can by used by varied soil faunal groups (Bennet et al., 2006). Fragments of the natural and semi-natural habitats may support stenotopic groups and habitat specialists survive, thereby increasing agricultural landscape-level biodiversity (Tropek and Řehounek, 2011; Diekötter and Crist, 2013). Waste dumps arise by regular and irregular accumulation of organic and inorganic solid waste from industry, agriculture and households. In general, they are considered to be potential sources of pollution of water, soil and air, also causing the spread of parasites, pathogens, invasive plants and animals (Ružičková et al., 1996). Apart from legal ones, there often exist a number of illegal waste dumps scattered in the landscape, used for irregular, uncontrolled deposition of municipal and household garbage. According to State of the Environment Report of the Slovak republic (Klinda and Lieskovská, 2014) and the Ministry of Environment of the SR, there existed more then 120 legal and over 6000 illegal waste dumps in Slovakia in 2013.

Such a anthropogenic sites can support stenotopic invertebrates groups, and are valuable habitats and refuges for rare, endangered species across the urbanized areas and agricultural landscape: urban derelict sites (brown fields) in UK are important habitats for beetles (Eyre et al., 2003), carabids (Small et al., 2003) and phytophagous insects, such as grasshoppers and leafhoppers (Strauss and Biedermann, 2006); open-cast lignite mines support surface-dwelling beetles (Brändle et al., 2000); un-reclaimed spoil heaps after coal mining can be important for Heteroptera, ground beetles, snails and slugs (Hendrychová et al., 2008); black coal spoil dumps for orthopteroids, spiders, leafhoppers, ground beetles, herbivorous beetles, true bugs, butterflies and moths (Tropek et al., 2012) or limestone quarries for endangered arthropods and plants (Tropek et al., 2010). Old municipal waste dumps were confirmed to be important refuges for ants (Wiezik, 2006), some rare Gastropoda and silvicolous or steppe fauna within the urbanised areas (Šteffek, 2006). In comparison to surrounding land degraded by coal mining, the waste dump can represent the naturally

* Corresponding author. Tel.: +421 51 7570611.
E-mail addresses: bbaranova@gmail.com, beata.baranova@unipo.sk (B. Baranová).

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valuable area which support characteristic ground beetles assemblage, including rare and endangered species (Moravec and Vonička, 2000). Doubtless, there increase the evidence, that man-made sites often provide biodiversity refuges in anthropogenically impacted landscape and offering valuable analogues of natural habitats (Eversham et al., 1996).

The Carabidae are one of the model groups used in ecological research (Lovei and Sunderland, 1996), as bioindicators of changes in environment and landscape structure, ecological sustainability or ecosystem health (Rainio and Niemelä, 2003) and for more deep understanding of ecological processes (Żmihorski et al., 2013). The reason is their species richness, geographical extension, good knowledge of their taxonomy, relatively easy diagnosis, bionomy and ecology of particular species as well as their ability to reflect biotic and abiotic environmental conditions, consequences of human disturbance. Similarly, the ground beetles assemblage is also well definable (Bezděk, 2001; Lővei, 2008; Avgin and Luff, 2010; Koivula, 2011; Żmihorski et al., 2013).

In our study, we surveyed surface-dwelling soil macrofauna and ground beetles on 8 waste dumps and 8 comparative biotopes. To our knowledge, this is the first such a survey. The aim of our study was to (a) characterize the assemblages composition on the soil macrofauna order, Coleoptera families and Carabidae species level, (b) compare activity-abundance, taxonomic richness, diversity, evenness and assemblages similarity/distinctness among the studied habitats, (c) evaluate the surface dwelling soil macrofauna orders according to their food preferences and ground beetles species according to their habitat preference, wing morphology, body size and rarity and (d) in attempt to explain the distribution pattern, we related the assemblages composition to selected environmental variables.

We hypothesis, that (1) assemblages collected from waste dumps will gain higher diversity than their comparative biotopes, which represent conventionally managed agricultural habitats, (2) waste dumps will showed higher proportion of stenotopic, slow-moving sapro-phytophagous orders and (3) large wingless ground beetle habitat specialists.

2. Material and methods

2.1. Study stands

The study was carried out during the seasons 2011 and 2012. The total of 8 waste dumps and 8 nearby, uncontaminated sites for comparison, located in the urban and suburban zone of Prešov town and surrounding villages in eastern Slovakia, were studied. The latitude and longitude ranges and UTM squares of the Localities with studied stands and the year of material collecting are as follows: Ľubotice (WD1, CB1, 2011; WD5, CB5, 2012): 49°0′15″N, 21°16′14″E, UTM: Northing: 5427955, Easting: 519788, Zone/Sector: 34U; Prešov, Cemjata (WD2, CB2, 2011): 48°59′42″N, 21°11′2″E, UTM: Northing: 5426916, Easting: 513452, Zone/Sector: 34U; Prešov, Šalgovík (WD3, CB3, 2011): 48°59′51″N, 21°18′21″E, UTM: Northing: 5427223, Easting: 522370, Zone/Sector: 34U; Svinia (WD4, CB4, 2011): 49°1′38″N, 21°6′35″E, UTM: Northing: 5430488, Easting: 508021, Zone/Sector: 34U; Prešov, Rúrky (WD6, CB6, 2012): 49°0′4″N, 21°12′25″E, UTM: Northing: 5427600, Easting: 515136, Zone/Sector: 34U; Ruská Nová Ves (WD7, CB7, 2012): 48°58′18″N, 21°19′16″E, UTM: Northing: 5424356, Easting: 523500, Zone/Sector: 34U; Vyšná Šebastová (WD8, CB8, 2012): 49°0′7″N, 21°20′1″E, UTM: Northing: 5427725, Easting: 524400, Zone/Sector: 34U.

Waste dumps (Fig. 1) included reclaimed parts of legal municipal waste dumps (WD2, WD4) and six illegal, not officially regulated waste dumps which are used for irregular, uncontrolled deposition of municipal, household and building waste (WD1, WD3, WD5, WD6, WD7, WD8). Illegal waste dumps were under different stages of vegetation succession, with occurrence of pioneer vegetation including several invasive neophytes, sometimes covering the waste itself. As the comparative biotopes,

Fig. 1. Pictures of selected studied stands of waste dumps in the urban and suburban zone of Prešov town and surrounding villages, Eastern Slovakia (WD1, WD3, WD4, WD8).