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**PRELIMINARY DATA ON THE SPECIES DIVERSITY  
OF COLLEMBOLA (HEXAPODA: COLLEMBOLA) ALONG  
AN URBAN GRADIENT IN BUCUREȘTI**

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**Abstract.** The paper presents the Collembola fauna from urban and peri-urban habitats. There were sampled collembolan fauna from a variety of habitats in the metropolitan area of București, in order to assess general species richness and to establish the most sensitive species of Collembola at air pollution. 50 species of Collembola occur in metropolitan area of București.

**Résumé.** On présente la faune de Collembola trouvée dans les habitats urbain et periurbain. On a collecté cette faune de collemboles dans une variété de habitats dans la zone métropolitaine de București, afin d'établir la richesse générale en espèces et d'établir quelles sont les espèces de collemboles les plus sensibles à la pollution de l'air. Dans la zone métropolitaine de București il y a 50 espèces de Collembola.

**Key words:** Collembola, București (Bucharest), urban gradient, peri-urban forest, pollution, bioindicator species.

*INTRODUCTION*

Urbanization and the loss of biotic diversity have a vital direct and indirect influence on the biosphere (Vida, 1978). Urban ecosystems are characterized by high-density human habitation, intense transport processes and only remnants of natural habitats (McIntyre et al., 2001). It is necessary to understand the ecosystem responses to the influence of urbanization in order to ensure that urban areas are managed both for the well-being of city-dwellers and nature (Niemelä, 1999). Since urban development is both spreading and intensifying, knowledge about the functioning of urban ecosystems has vital importance in planning future urban development in order to minimize its negative environmental impacts (McIntyre, op. cit.; Niemelä, op. cit.). Urbanization causes several forms of disturbance, such as alteration, fragmentation and isolation of indigenous habitats, changes of temperature, moisture and edaphic conditions and pollution. Urban sites are often harsh, characterized by many pressures and threats, from limited growing space to adverse climatic conditions and air pollution. This type of ecosystem focuses on urban green space comprising of tree stands as well as individual trees (Konijnendijk et al., 2006).

Nowadays the scientific interest in studying the urban ecosystems has much increased, the analysis of urban Collembola communities allowing the list of new species to expand, a fact that do not occur in natural habitats. Some data are available about Collembola communities inhabiting different types of urban greens in Warsaw - Poland (Sterzynska & Kuznetsova, 1997), Lviv - Ukraine (Shrubovych, 2002), Moscow - Rusia (Krestyaninova & Kuznetsova, 1996; Kuznetsova & Sterzynska, 1995), Wien - Austria (Christian, 1991, 1993), England (Fountain & Hopkin, 2004), Chișinău - Moldova Republik (Bușmachi & Poiras, 2003). Outside Europe, Collembola from urban area were studied in North America (Byrne & Bruns, 2004; Rocheforta et al., 2006).

Soil ecosystems of large cities are usually exposed to a great variety of anthropogenic effects resulting in serious changes of their physical, chemical and biological characteristics. The soil are often polluted with heavy metals, and the contamination from release of Pb and other metals (Cd, Cu, Zn) in exhaust fumes of motor vehicles is among the most important sources of pollution (Piñol, 1999). Collembola was selected as the focal taxon since they are sufficiently varied both taxonomically and ecologically, abundant and sensitive to the changes of the microenvironment and human disturbance. The responses of Collembola assemblages along the urbanization gradient may help guide urban management practices. Despite their global ubiquity, relatively little is known about how these microarthropods respond to urbanization. In this paper we present the results of the first investigation of the collembolan fauna of a big city. We sampled collembolan fauna from a variety of habitats in the metropolitan area of București (Bucharest); the objectives of this paper are: a) to assess general species richness of Collembola along an urban - peri-urban gradient; b) to establish the most sensitive species of Collembola at air pollution.

#### MATERIAL AND METHOD

The urban - peri-urban gradient from central București (44°24'49"N; 26°05'48"E; altitude: 60 - 90 m, 2,000,000 inhabitants, 228 km<sup>2</sup>) to surrounding area was chosen, covering a distance of approximately 40 km.

To give a complete faunistic list of Collembola species, quantitative and qualitative data were used; thirteen sites along the gradient were selected for this study: four urban (Izvor, Unirea, Cișmigiu, garden of the Institute of Biology) and nine peri-urban (Cernica, Măgurele, Pusnicu, Băneasa, Pasărea, Călugăreni, Căldărușani, Comana, Râioasa). Urban sites were located within the core of the city of București, with busy roads, densely populated and polluted sites adjacent. 10 samples of soil and litter from 3 urban habitats (Izvor, Unirea, Cișmigiu) and 3 peri-urban (Cernica, Măgurele, Pusnicu) were sampled in November 2006. The biological material from the other ones peri-urban habitats were taken occasionally. For collecting the edaphic fauna, there were used pitfall traps. All soil samples were transported in plastic bags to the laboratory. Samples from flower pots were also taken and some records of Collembola species from literature were added.

Extraction was done with modified Berlese - Tullgren funnels at a temperature of 18-23°C for 7 days (Edwards, 1991). The individuals were collected and preserved in ethanol 96%. Biological material was determined under a phase-contrast microscope. The taxonomic system of the species list and the nomenclature are arranged according to "The checklist of the Collembola of the World" by Bellinger et al., 1996 - 2007. Collembola were identified to species level, using the most recent keys: Zimdars & Dunger, 1994; Pomorski, 1998; Bretfeld, 1999; Potapov, 2001; Thibaud et al., 2004.

#### RESULTS AND DISCUSSIONS

Our preliminary results exhibited 50 species of Collembola (Tab. 1). Some species were mentioned from București and surrounding area in literature (Ionescu, 1951; Mack-Firă, 1963, 1965; Gruia & Ilie, 2003; Fiera *in*: Sanda et al., 2006). Radwański, Fiera & Weiner (2006) described one new *Protaphorura* species (*P. ionescui*). 17 species are new records for metropolitan area of București. Another 20 species of Collembola were identified at genus level and are not listed in this paper. However, further sampling could offer us the opportunity to discover of additional species.

Table 1

Presence of Collembola along an urban gradient in București.

Species	U1	U2	U3	U4	S1	S2	S3	S4	S5	S6	S7	S8	S9	F	L7
<i>Arrhopalites caecus</i>				+										+	
<i>Cryptopygus debilis</i>										L1					
<i>Cryptopygus ponticus</i>	+														
<i>Cyphoderus albinus</i>	+														
<i>Cyphoderus bidenticulatus</i>	+	+		+											
<i>Desoria violacea</i>											L2				
<i>Deuteraphorura silvaria</i>															L2
<i>Deutonura conjuncta</i>					L2							L2			
<i>Dicyrtoma fusca</i>												L2	L2		
<i>Entomobrya muscorum</i>															L2
<i>Entomobrya nivalis</i>														+	
<i>Entomobrya puncteola</i>				+	+								L2		
<i>Folsomia candida</i>	+		+											+	
<i>Folsomia fimetaria</i>	+													+	
<i>Folsomia quadrioculata</i>										L1					
<i>Folsomides parvulus</i>	+	+	+							L1					
<i>Hemisotoma thermophyla</i>				+											
<i>Heteraphorura variotuberculata</i>									L1						
<i>Heteromurus major</i>		+				+									
<i>Heteromurus nitidus</i>					L2							L2			
<i>Heteromurus sexoculatus</i>							+								
<i>Hypogastrura vernalis</i>															L3
<i>Isotoma anglicana</i>		+								L1					
<i>Isotoma viridis</i>					L2										
<i>Isotomiella minor</i>			+	+						L1					
<i>Lepidocyrtus lanuginosus</i>															L4
<i>Megalothora minimus</i>						+									
<i>Metaphorura affinis</i>		+													
<i>Orchesella spectabilis</i>									+						
<i>Orchesella pontica</i>					L2							L2	L2		
<i>Orthonychiurus rectopapillatus</i>															L2
<i>Parisetoma notabilis</i>	+	+	+			+	+			L1					
<i>Podura aquatica</i>					L5										
<i>Pogonognathellus flavescens</i>					L2										
<i>Pogonognathellus longicornis</i>									+						
<i>Proisetoma minuta</i>	+	+	+	+				L5						+	
<i>Protaphorura armata</i>		+								L1				+	
<i>Protaphorura fimata</i>														+	
<i>Protaphorura ionescui</i>										L6					
<i>Protaphorura quadriocellata</i>		+									L2				
<i>Pseudachorutes parvulus</i>				+											
<i>Pseudosinella octopunctata</i>							+								
<i>Pseudosinella picta</i>										L1					
<i>Schoettella ununguiculata</i>			+												L3
<i>Seira domestica</i>		+							+	L1					
<i>Seira ferrarii</i>				+											
<i>Sminthurinus aureus</i>														+	
<i>Stenaphorurella quadrispina</i>					+					L1					
<i>Tomocerus vulgaris</i>		+								L1					
<i>Willowsia nigromaculata</i>					L2										

Abbreviations used in table: U1 - U4 (urban habitats: U1 - Izvor, U2 - Unirea, U3 - Cișmigiu; U4 - garden of the Institute of Biology); S1 - S9 (peri-urban habitats: S1 - Cernica, S2 - Măgurele, S3 - Puscnicu, S4 - Băneasa, S5 - Pasărea, S6 - Călugăreni, S7 - Căldărușani, S8 - Comana, S9 - Râioasa); F - flower-pots; L - literature data (L1 - Fiera *in*: Sanda et al. (2006); L2 - Gruia & Ilie (2003); L3 - Mack-Firă (1963); L4 - Ionescu (1951); L5 - Mack-Firă (1965), L6 - Radwański, Fiera & Weiner (2006), L7 - București, without specification of any type of habitat.

The density and species richness were reduced in areas affected by airborne pollutants. The aggregation of some species increase (*Cyphoderus bidenticulatus*, *Folsomides parvulus* and *Proisotoma minuta*), while the frequencies of others decrease (*Isotoma anglicana*, *I. candida*). These two species may be affected by the airborne pollutants directly through decreased growth rate, reproduction and/or survival (Bengtsson et al., 1983) or indirectly through a change in food abundance or a decrease in predators. It is possible that *Isotoma anglicana* and *Isotoma candida* are sensitive to pollution, because they are unable to avoid polluted food or their preferred fungal species are metal sensitive.

For future research, we need to identify the content of heavy metal in the body of some sensible Collembola to pollution, a fact which shall allow us to better establish the bioindicator species. Studies on the impact of airborne pollutants on soil fauna must consider pH tolerance of each species. Collembola communities react sensitively to airborne pollutants and often in advance of other components of terrestrial ecosystems. Collembola are also suitable bioindicators for assessing ecological changes caused by such pollutants.

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#### DATE PRELIMINARE PRIVIND DIVERSITATEA SPECIFICĂ A COLEMBOLELOR (HEXAPODA: COLLEMBOLA) DE-A LUNGUL UNUI GRADIENT URBAN ÎN BUCUREȘTI

#### REZUMAT

În această lucrare este prezentată fauna de colembole din habitate urbane și periurbane. S-au prelevat probe dintr-o varietate de habitate din zona metropolitană a Bucureștilor, având drept obiective caracterizarea bogăției specifice a colembolelor și stabilirea speciilor bioindicatoare a poluării aerului. În zona metropolitană a Bucureștilor au fost colectate 50 de specii de colembole.

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