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SPECIES COMPLEXES OF THE ORIBATID MITES (SARCOPTIFORMES, ORIBATEI) IN SOILS OF URBAN STREET LAWNS WITH DIFFERENT POLLUTION RATES

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Species Complexes of the Oribatid Mites (Sarcoptiformes, Oribatei) in Soils of Urban Street Lawns with Different Pollution Rates. Shevchenko O. S., Kolodochka L. A. — Species complexes of oribatid mites at six plots on the street lawns in one of Kyiv districts are studied. In total 27 species of 26 genera and 19 families of oribatid mites are found. Direct correlation between oribatid species diversity and the level of total soil pollution is not shown.

Key words: Sarcoptiformes, Oribatei, oribatid mites, pollution, city.

Видовые комплексы орибатид (Sarcoptiformes, Oribatei) в почвах газонов городских улиц с разной степенью загрязнения. Шевченко А. С., Колодочка Л. А. — Исследованы видовые комплексы клещей-орибатид в почвах 6 участков уличных газонов одного из районов г. Киева. Выявлено 27 видов 25 родов 19 семейств клещей. Непосредственной зависимости видового разнообразия орибатид от степени суммарного загрязнения почвы не обнаружено.

Ключевые слова: Sarcoptiformes, Oribatei, панцирные клещи, загрязненность, город.

Introduction

Various taxonomic groups are used as indicators in contemporary environmental studies. Oribatid mites (Sarcoptiformes, Oribatei) are one of such groups in soil quality assessment. Oribatids are mostly K-strategists, not migrating on significant distances. As a result the oribatid species complexes undergo depletion at local areas if influenced by adverse environmental factors (anthropogenic pressure, etc.) (Weigmann, Kratz, 1987). Nowadays, a lot of oribatid species are characterized by biotopical preferences; species structures of oribatid communities in nature and urban disturbed areas are known (for example, see Weigmann, Kratz, 1987; Murvanidze et al., 2011, etc.). In this paper, oribatid species complexes in roadside lawns from one of Kyiv districts previously evaluated for heavy metal soil pollution (Zhovinskij, Kuraeva, 2002) are studied.

Species depletion of Arthropoda in soils of populated areas has been proven repeatedly in research on different taxa. For oribatid mites there are enough examples in urban ecosystems studies from different climate zones (pertaining to urban lawn soil mite communities, see Ermilov, Chistyakov (2005); Kononenko (2010)). There were no such data for Kyiv. Because of importance of oribatid mites in sustaining stably functioning cenoses this study was conducted in order to ascertain oribatid species composition and complexes structure as well appraise their level of depletion in heavy metal polluted soils of Kyiv roadside lawns.

Material and methods

Samples were taken in May and Jule 2011 and in May 2013 in Sviatoshin District of Kyiv at roadside lawns belonging in four categories of summarized (total) heavy metal soil pollution (Zhovinskij, Kuraeva, 2002), ten samples per plot. In Kyiv, lawn vegetation consists mostly of cereals and perennial bipartite plants. Different trees (a few linden, maple and poplar species etc.) and shrubs (lilacs, spireas) are often planted in various combinations on the roadside or immedately on lawns.

Plots 1–4 are located alongside Peremogy Avenue from the city edge inwards. Plot 5 is alongside Vernadsky boulevard. Plot 6 is at unkempt green-belt area on Trublaini str. at the edge of the city.

Plot 1 is in a green-belt area near bus terminal “Dachna”. Local total soil pollution (TSP) was assessed as the lowest category I. Grass vegetation is comprised of *Capsella bursa-pastoris*, *Taraxacum officinale*, *Trifolium* sp., *Plantago* spp., and *Elytrígia repens*. Trees are *Tilia cordata*. There is no detritus.

Plot 2 (II TSP category) is at the intersection of Peremogy Avenue and Vernadsky Boulevard. Grass vegetation is same as above, *Populus pyramidalis* is the tree species used instead of common *T. cordata* and detritus is less than 1 cm.

Plot 3 (III TSP category) is near subway station "Sviatoshin". The tree and shrub species here are represented by *Tilia cordata*, *Ulmus glabra*, *Cupressus* sp. and *Syrínga vulgaris*; herbage is *E. repens*, *Plantago* sp., *Taraxacum officinale*, *Tulipa* sp., *C. bursa-pastoris*. Detritus layer is insignificant.

Plot 4 (IV TSP category) near subway station "Nyvky" differs from previously described plots in detritus layer up to 3 cm. Trees are *P. pyramidalis,* grasses are represented by *E. repens*, *C. bursa-pastoris*, *T. officinale*, *Plantago* sp., *Trifolium* sp.

Plots 5 (II TSP category) is located alongside Vernadsky Boulevard. Trees and shrubs are *P. pyramidalis*, *Hippophaл rhamnoides*, *Betula pendula, Spiraea* sp.*,* herbage as on plots 1 and 2; soil is unfrequently scarified. Detritus is less than 1 cm.

Plot 6 is at an unkempt green-belt area at Trublaini Street (IV TSP category). None of tree species (*P. pyramidalis*, *Salix* sp., *Acer negundo* is predominating; grasses are *E. repens*, *Urtica* sp., *C. bursa-pastoris*, *T. officinale*, *Tussilago farfara*, *Plantago* sp., etc. Detritus layer is up to 5 cm.

The automobile traffic is highly developed at Peremogy Avenue, less so at Vernadsky Boulevard and is much less intense at Trublaini Street.

The mites were extracted from samples by means Berlese eclectors with fixation in 70 % ethanol and mounted on slides with Hoyer's liquid. Species were identified with the use of Key to soil Sarcoptiformes (1975), Pavlichenko (1994), and Sergienko (1994).

To assess species similarity and compare diversity, Jaccard and Sørensen indexes are used. For quantitative comparison, Paliy–Kovnatsky index (relative dominance of a species in a community, Di) is applied: more than 10 % — dominant species (D); from 1 to 10 % — subdominant (SD); from 0.1 to 1 % — subdominant of the first order (SD1); less than 0.1 % — secondary member (*SM*) (Shitikov et al., 2003). Morphoecological types were ascertained according to Krivolutsky (1965).

Results and discussion

Twenty-seven oribatid species of 19 families are found in studied plots.

There were 6 species of 6 genera (6 families) on plot 1; 12 species of 11 genera (9 families) on plot 2; 6 species of 6 genera (5 families) on plot 3; 13 species of 12 genera (10 families) on plot 4, 13 species of 13 genera (13 families) on plot 5, and 10 species of 10 genera (7 families) on plot 6 (table 1).

Table 1. Species diversity and dominance status (Di) in oribatid complexes on studied plots

Таблица 1. Видовое разнообразие и ранг видов (Di) в комплексах орибатид на исследованных участках

Species	Plot					
	1	2	3	4	5	6
Epilohmannia cylindrica cylindrica Sergienko, 1994	SD1*					
Sellnickochthonius furcatus (Weis-Fogh, 1948)		SD1			SM	
Liochthonius brevis (Michael, 1888)		SD1				
Steganacarus personatus Niedbala, 1983						SD1
Euphthiracarus monodactylus (Willmann, 1919)				SM		SD
Acrotritia ardua affinis (Serg., 1989)		SD1		SD1	SD1	SD
Mesotritia (M.) nuda (Berlese, 1887)						SD1
Trhypochthonius conspectus Serg., 1991			SD	SM	D	
Tectocepheus velatus Michael, 1880	SD	SD	SD	D	SD	SD
Microppia minus (Paoli, 1908)	D	D	SD	SD	SD1	
Oppia sp.		SD1	SD	D		
Oppiella nova (Oudemans, 1902)						SD
Suctobelbella sp.					SM	
Oribatula tibialis Michael, 1855		SD		SM		
Zygoribatula terricola ucrainica Iordansky, 1990	SD1	SD	D			
Scheloribates laevigatus (Koch, 1836)		SD1			SD1	
Protoribates sp.				SM		
Protoribates capucinus Berlese, 1908		SD		SD	SD1	
Punctoribates punctum (Koch, 1839)		D	SD	SD	SD	
Mursia nova Sellnick, 1928	SD1					SD1
Ceratozetes mediocris Berlese, 1908				SD1		SD1
Chamobates cuspidatus (Michael, 1884)				SM		
Tectoribates ornatus (Schuster, 1958)					SD1	SD1
Scutovertex sculptus Michael, 1879					SM	
Acrogalumna longipluma (Berlese, 1904)						SD
Galumna allifera Oudemans, 1919	SD	SD		D	SD	
Neoribates (s. str.) *auranthiacus* (Oudemands, 1914)					SM	

Note. D — dominant; SD — subdominant; SD1 — subdominant of the first order; SM — secondary member of community; 1–6 — numbers of studied plots.

Примечание. D — доминант; SD — субдоминант; SD1 — субдоминант 1 порядка; SM — второстепенный член сообщества; 1–6 — количество исследованных участтков.

Mites of different morphoecological types were represented in studied samples. Cosmopolitic *A. a. affinis* (of the living in litter morphoecotype) of the Lower Oribatida is most abundant in the collected material. This species ranked in oribatid communities from SD to SD1. Notably it is present only on plots 2 and 4–6, where *Lombardy poplar* is used in greenery leading to accumulation of coarse moist detritus. Somewhat accordingly, *T. conspectus* (that can enlarge soil pores and/or inhabit thick litter layers and soils with big pores) is abundant at plots 3 and 5 (with scarified soil). Another representative of the Lower Oribatida, a lawn species *E. c. cylindrica* of the deep soil dwellers is found only in soil of roadside lawn on plot 1. Mites *M. nuda* are found only in soil of unkempt green-belt area (plot 6). A possible explanation of the latter are ecological preferences of *M. nuda* to higher humidity of soil.

Mites of the superfamily Oppioidea (*Oppia, Oppiella, Suctobelbella*) are small soil pores dwellers, while *Oppiella nova* is also considered pioneering during recolonization.

Species *T. ornatus* and *S. sculptus* are eurytopic and common at lawns. They are found at roadside lawns and at unkempt green-belt area both.

Of the three Galumnoidea species that represent inhabitants of soil surface, the species *G. allifera* is highly abundant at 4 of 6 studied plots.

Mites *T. velatus* (of the secondarily unspecified morphoecological type) were abundant in all of the plots because of the species ecological plasticity.

The oribatid community at plot 4 contained 2 dominant species, *T. velatus* and *Oppia* sp. Most likely it is explained by differences in ecological niches of these species that belong to different morphoecological types (see above) allowing them to increase numbers of their populations independently.

Ecological traits of less frequently found species are studied insufficiently to explain their distribution.

According to the literature low species diversity of soil organisms is characteristic of roadside lawns. Explanations are numerous, for example, air pollution, trampling, thin litter layers that lead to lower organic content in soil though in older urban soils the organic content is higher (Scharenbroch et al., 2005). Our data support this conclusion: at each of the studied plots, oribatid diversity never exceeded 13.

According to some studies (Stamou, Argyropoulou, 1995; Khalil et al., 2009), oribatid mites *T. velatus* and *G. allifera* and species of *Zygoribatula* genus are tolerant to industrial pollution. It is also known that mites of the genus *Scutovertex* are capable to survive in inactive state through adverse conditions such as drought (Smrž, 2002).

Species of the groups Ptyctima and Nothroidea are known to be sensitive to human impact (Gulvik, 2007). Our data do not support this conclusion. According to them, these groups are better represented in soils in plot 6 characterized by maximal TSP level (4 species) than in other plots (1–2 species).

This study has not revealed any clear correlation between total soil pollution level and oribatid diversity. Increase in species richness more likely depends on detritus layers.

Generalized similarity of oribatid species complexes at studied lawn plots is shown at figure 1 (see also table 2). Oribatid species complex in soil near

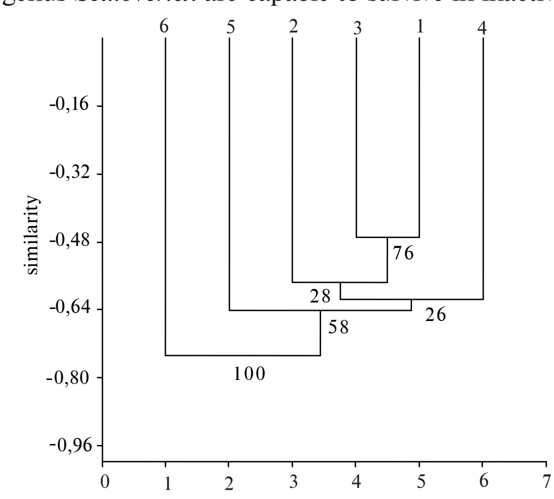

Fig. 1. Dendrogram of similarity of oribatid species complexes at studied plots.

Рис. 1. Дендрограмма сходства видовых комплексов орибатид исследованных участков.

Table 2. Similarity of species lists at studied plots (right-up is Jaccard index, down-left is Sørensen index, %)

Таблица 2. Сходство видовых списков исследованных участков (правый верхний сектор — индекс Жаккара, левый нижний сектор — индекс Съёренсена, %)

Plot	Plot					
	1	2	3	4	5	6
1		40.0	50.0	23.1	23.1	14.3
2	44.4		62.5	88.0	63.6	11.1
3	50.0	55.5		55.5	36.3	7.1
4	31.6	64.0	52.6		58.3	17.6
5	31.6	56.0	42.1	53.8		17.6
6	25.0	18.1	13.3	34.8	18.1	

Note. 1–6 — numbers of studied plots.

subway station “Sviatoshin” (plot 3) is similar both to the complex near bus station “Dachna“ (plot 1) and near Vernadsky Blvd (plot 2). High similarity is shown for plots located at Peremogy Avenue (plots 1–4). The similarity between oribatid complex in the plots near subway station “Nyvky” (plot 4) and at Vernadsky Blvd (plot 5) is lesser. At both of the plots, coarse and moist detritus layers more than 1 cm is accumulated. Possible explanation of specificity of plot 6 on Trublaini Str. is the unkempt state of this green-belt area.

Thus, oribatid communities of soils of roadside lawns in one of Kyiv districts consist of 27 oribatid species from 19 families. They are characterized by relatively low diversity and stable complexes of species. These comlexes are comprised of soil pores dwellers, litter dwellers and secondarily unspecialized forms. No correlation is found between oribatid species diversity and the level of total heavy metal soil pollution. As a preliminary conclusion we suggest that airborne automobile exhaust pollution and accumulation of litter influence oribatid communities more that heavy metal soil pollution.

References

Ermilov S. G., *Chistyakov M. P.* Oribatid mites of lawns in an industrial centre (Nizhny Novgorod City as an example) // PEJ. — 2005. — N 1. — P. 76–79.

Gulvik M. E. Mites (Acari) as indicators of soil biodiversityand land use monitoring: a review // Pol. J. Ecology — 2007. — **55**, N 3. — P. 415–440.

Key to soil Sarcoptiformes / Ed. M. S. Giljarov. — Moscow : Nauka, 1975. — 491 p. — Russian : Определитель обитающих в почве клещей Sarcoptiformes / Отв. ред. М. С. Гиляров.

Khalil M. A., *Janssens T. K. S., Berg M. P., Straalen van Nico M.* Identification of metal-responsive oribatid mites in a comparative survey of polluted soils // Pedobiologia. — 2009. — **52**. — P. 207–221.

Kononenko S. V. Bioindication of motor transport influence on microfauna in Dnipropetrovsk city // Visnyk of Dnipropetrovsk University. Biology. Ecology. — 2010. — **18**, N 1. — P. 67–72.

Krivolutsky D. Morpho-ecological types of oribatid mites (Acariformes, Oribatei) // Zoologicheskii zhurnal. — 1965. — **44**, N 8. — P. 1168–1181.

Murvanidze M., Kvavadze E., Mumladze L., Arabuli T. Comparison of earthworms (Lumbricidae) and oribatid mite (Acari, Oribatida) communities in natural and urban ecosystems // Vestnik zoologii. — 2011. — **45**, N 4. — P. 16–24.

Pavlichenko P. G. A guide to the ceratozetoid mites (Oribatei, Ceratozetoidea) of Ukraine. — Kyiv, 1994. — 142 p. — Russian : *Павличенко П. Г.* Определитель цератозетоидных клещей (Oribatei, Ceratozetoidea) Украины.

Scharenbroch B. C., Lloyd J. E., Johnson-Maynard J. L. Distinguishing urban soils with physical, chemical, and biological properties // Pedobiologia. — 2005. — **49**. — P. 283–296.

Sergienko G. D. Fauna of Ukraine. The mites. Lower Oribatidae. — Kyiv : Naukova dumka, 1994. — Vol. 25, is. 21. — 204 p. — Russian : *Сергиенко Г. Д.* Клещи. Низшие орибатиды.

Shitikov V. K., Rosenberg G. S., Zinchenko T. D. Quantitative hydro-ecology: methods of system identification. — Tolyatti : IEVB RAN, 2003. — 463 p. — Russian : *Шитиков В. К., Розенберг Г. С., Зинченко Т. Д.* Количественная гидроэкология: методы системной идентификации.

Smrž J. Microanatomical and microbiological characteristics of the quiescent state of Scutovertex minutus (Acari: Oribatida) // Experimental and Applied Acarology. — 2002. — **27**, is. 1–2. — P. 103–112.

Stamou G. P., *Argyropoulou M. D.* A preliminary study on the effect of Cu, Pb and Zn contamination of soils on community structure and certain life-history traits of oribatids from urban areas // Experimental and Applied Acarology. — 1995. — **19**, is. 7. — P. 381–390.

Weigmann G., Kratz W. Oribatid mites in urban zones of West Berlin // Biol. Fertil. Soils. — 1987. — Is. 3. — P. 81–84.

Zhovinskij E. Ya., Kuraeva I. V. Geochemistry of Heavy Metals in Ukrainian Soils. — Kyiv : Naukova dumka, 2002. — 213 p. — Russian : *Жовинский Э. Я., Кураева И. В.* Геохимия тяжелых металлов в почвах Украины.

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