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SEASONAL CHANGES IN SPECIES DIVERSITY AND DOMINANCE STRUCTURE IN COMMUNITIES OF ORIBATID MITES (SARCOPTIFORMES, ORIBATEI) IN MEGALOPOLIS GREEN AREAS

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Seasonal Changes in Species Diversity and Dominance Structure in Communities of Oribatid Mites (Acari, Oribatei) in Megalopolis Green Areas. Shevchenko O. S, Kolodochka L. A. — Species complexes of oribatid mites in soil and litter in 10 plots in green areas of different parts of Kyiv city in April–September 2011 were studied. In total, 107 species of 76 genera of 44 families of oribatids were found. Trends of seasonal fluctuations of species diversity and dominance structure of oribatids in studied plots were assessed.

K e y w o r d s: oribatid mites, seasonal changes of species complexes, city.

Сезонные изменения видового разнообразия и структуры доминирования в сообществах орибатид (Acari, Oribatei) зелёных зон мегаполиса. Шевченко А. С., Колодочка Л. А. — Исследованы видовые комплексы клещей-орибатид в почвах и растительном опаде 10 участков зелёных зон различных районов г. Киева с апреля по сентябрь 2011 г. Выявлено 107 видов 76 родов 44 семейств орибатид. Установлены тенденции сезонных изменений видового разнообразия и структуры доминирования орибатид на обследованных участках.

К л ю ч е в ы е с л о в а: панцирные клещи, сезонные изменения видовых комплексов, город.

Introduction

Animal inhabitants of soil fluctuate in numbers according to their life cycles, and to decomposition of organic matter and seasonal changes in climatic conditions. Oribatid mites are active in soil throughout the year. Their biotope-specific communities are characterized by peaks and recessions of population densities that are implicit in accounting for species composition. Species diversity of various animal groups in urban conditions changes in accordance with remoteness from city centre (Klausnitzer, 1990). Seasonal changes in oribatid communities were studied in various biotopes (Badejo, 1990; Grishina, 1970). In this paper, we analyse changes in composition and dominance structure of oribatids in 10 plots at green areas of different types in Kyiv during April–September 2011.

Material and methods

Samples of soil and litter, 10 samples per plot, were taken from April to September 2011 in several plots in Kyiv, as follow.

Plot 1 (PV) is at north-western city outskirts in mixed forest of Puscha-Voditsa near Kyiv (here and after the number and the abbreviation denote the plot); 50°32′23″ N, 30°21′10″ E.

Plot 2 (SDP) is located in mixed forest at north-western part of the city, in Syrets Dendrological Park; 50°28′58″ N, 30°25′23″ E.

Plot 3 (TS) is at south-western city outskirts. It is an unkempt green-belt area at Trublaini street, planted over with broad-leaf trees; 50°24′28″ N, 30°24′38″ E.

Plot 4 (NOT) was chosen at southern city outskirts in natural object Teremki. It is in deciduous forest around experimental centre "Teremki" of Schmalhausen Institute of Zoology of National Academy of Sciences of Ukraine; 50°21′34″ N, 30°27′4″ E.

Plot 5 (OP) is a small green area Otradny park in western part of the city. There are broadleaf and coniferous trees. Accumulation of the litter is prohibited; 50°25′58″ N, 30°25′38″ E.

Plot 6 (NOSG) is at north-eastern city outskirts in natural object Suhi Gory ("Dry Mountains"). The plot is at the edges of mixed forest (mostly coniferous) and housing area "Lisovy"; 50°29′31″ N, 30°38′14″ E.

Plot 7 (DC) is at the eastern part of the city, on Darnitske cemetery; 50°25′33″ N, 30°38′6″ E.

Plot 8 (JS) is at eastern outskirts of the city in mixed forest alongside the Jalynkova str. that separates it from housing area "Kharkivsky"; 50°24′54″ N, 30°40′35″ E.

Plot 9 (DSFP) is at eastern part of the city. It is a small green area, park of Darnitsky silk factory with both coniferous (pines) and broadleaf trees (chesnuts, limes, maples); litter accumulation occurs here; 50°27′28″ N, 30°38′9″ E.

Plot 10 (MP) is at northern part of the city — Molodizhny park, a small and newly established green area at housing area "Troeschina". It is located on alluvial sands and imported soils. There are broadleaf trees and almost no litter; 50°31′16″ N, 30°37′25″ E.

Plots 1–5 are located on the right bank of Dnipro River, plots 6–10 are on the left bank.

The mites were extracted from samples using Berlese funnells, fixed in 70 % ethanol or 30 % glicerine and mounted on slides with Hoyer's liquid. Species were identified with the keys as follows: Key… (1975), Pavlichenko (1994), and Sergienko (1994).

Statictical analysis was carried out in Microsoft Excel 2003 and PAST. To compare total species diversity cluster analysis was used. For quantitative comparison of species status in a community, Paliy–Kovnatsky index (relative dominance of a species in a community) was applied: more then 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 of community (*SM*) (Shitikov et al., 2003). Morphoecological types were ascertained according to Krivolutsky (1965).

Results and discussion

In total, about 18000 adult mites were identified to the species level or to genus level in case of Oppioidea resulting in 107 species of 76 genera 44 families. Species diversity was most numerous (76 species) in Syrets DP; somewhat less in Puscha-Voditsa (59 species) and forest at Jalynkova str. (55). Species composition at Molodizhny Park was the poorest (only 19).

Overall the maximal rates of species diversity were recorded in July and August 2011. In May and September numbers of oribatid species in samples decreased. This cannot be explained only by withdrawal of the litter because in forested plots (1, 2, 6, 8) where it doesn′t occur, the trends are same.

Spring increase in species diversity in most plots occurred in April with subsequent sharp decline in May. In July and August species complexes of oribatids in large green areas at the outskirts of the city (plots in Puscha-Voditsa, Syrets DP, at Jalynkova str. and natural object Suhi gory) were more diverse than in other plots. One of the possible reasons is the increase in mean temperature and relative humidity of air (table 1; to assess daytime aerial temperature and relative humidity only the data (Archive…, 2003) from 8 am till 8 pm were used) and changes in rates of litter decomposition. At the same time in plots in small green areas located nearer to the city centre, oribatid species diversity never exceeded the numbers from Syrets DP in May.

Species complexes of researched communities were studied using cluster analysis before assessing seasonal changes (fig. 1). Species complexes of soil mites in plots from different green areas of the city occured to be significantly different themselves.

Eight of the species complexes formed 4 paired groups, most similar in composition (as follows from fig. 1). The *A* group consists of species complexes of local small green park areas (OP, plot 5; DSFP, plot 9; see above). It is adjoined by *B* group of oribatids from DC, plot 7 and MP, plot 10. Group *C* includes species complexes from natural object SG (plot 6) and JS

Table 1. Mean daytime temperature and relative humidity of air in Kyiv in April–September 2011

Таблица 1. Средняя дневная температура и относительная влажность воздуха в Киеве в апреле–сентябре 2011 г.

Aerial characteristics	April	May	June	Jule	August	September
Mean daytime temperature , T (M±m, ^{0}C)	12,2±5,8	19,1±6,2	22,9±4,8	24±4,2	21,7±3,7	18,2±4,2
Mean daytime relative humidity RH (M±m, %)	48,6±23,4	51,5±24,7	54,3±24,7	65,9±17,1	60,1±20,6	57,1±19,5

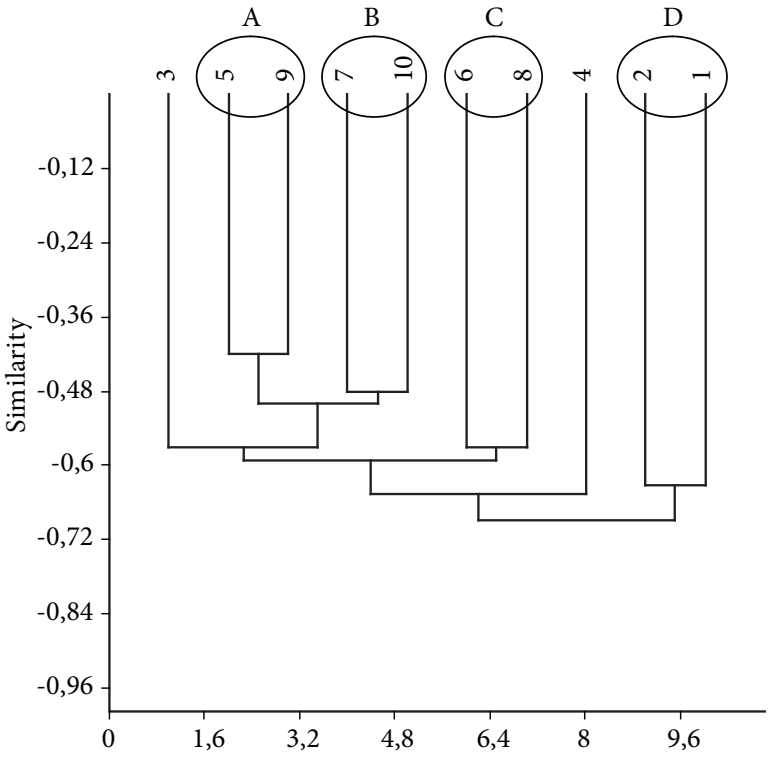

Fig. 1. Cluster analysis of oribatid species diversity in studied plots at April–September 2011 (plot indexes are given in Material and methods).

Рис. 1. Кластерный анализ видового разнообразия орибатид на исследованных участках за апрель-сентябрь 2011 г. (расшифровка цифровых обозначений участков дана в разделе Материалы и методы).

(plot 8). Group *D* is formed by soil mites complexes from PV (plot 1) and SDP (plot 2).

Seasonal changes in dominance structure of oribatid communities were analyzed according to these groups of most similar species compositions.

Oribatid complexes of group *A* include 34 species in Otradny Park and 37 in the Park of Darnitsky Silk Factory. The local dominant species are representatives of secondarily unspecialized morhoecological types (*Scheloribates laevigatus, Tectocepheus velatus, Punctoribates punctum)* and litter dwellers *(Metabelba papillipes, Galumna allifera, Xenillus tegeocranus, Trichoribates novus).* Though the structure of the community can still change somewhat during season. In April species diversity at Otradny Park was minimal and there were no secondary members of oribatid community while other ranks were filled (dominant, subdominant, subdominant of the I order). The maximal oribatid species diversity in Otradny Park was registered in July (fig. 2), along with maximal numbers in ranks of subdominant, subdominant of the I order and secondary members of community and no dominant species (table 2).

In the Park of Darnitsky Silk Factory oribatid species were lest numerous in May. Aside of solitary dominant and secondary member species, other ranks were filled by minimal numbers. The maximal number of species was registered in July and was accompanied by likewise increase in numbers of subdominants of the I order and secondary members of the community.

Oribatid species diversity of these two green areas was meagre in comparison with such of natural habitats yet far more various then those of city lawns (Kononenko, 2010).

Species complexes of soil mites of group *B* (table 3) mirrors the disturbed state of these habitats. This follows from low numbers and low species diversity in both plots, along

Table 2. Dominance structure of oribatid species complexes at Otradny and DSF parks in April–September 2011 (Paliy-Kovnatsky index)

Таблица 2. Доминирование структуры панцирных видовых комплексов на Отрадный и DSF парке в апрель–сентябрь 2011 г. (индекс Палия-Ковнацкого)

Month	*D**		*SD*		*SD1*		*SM*	
	OP	DSFP	OP	DSFP	OP	DSFP	OP	DSFP
April	*P. punctum*	*S. laevigatus*	2	5	3	5	0	0
May	*P. punctum*	*T. velatus*	4	3	3	4	1	1
June	*P. punctum*	*P. punctum, T. velatus, T. novus*	4	1	4	7	0	5
July		*T. velatus, P. punctum*	7	4	8	11	8	10
August	*P. punctum, S. laevigatus, T. velatus, G. allifera*	*M. papillipes*	3	5	5	4	5	5
September	*T. velatus*	*X. tegeocranus*	4	6	7	9	2	0

* Abbreviations are given in Material and methods.

with domination of secondarily unspecialized forms of *T. velatus* and *Punctoribates* genus, and dwellers of small soil pores of *Oppia* genus. Yet at Darnitsky Cemetery there were 34 oribatid species which is almost twice the number of Molodizhny Park (19 species), the most disturbed habitat of all mentioned. Plant cover at Molodizhny Park resembles a lawn due to its recent establishment and underdeveloped litter layer that limit oribatid species spectrum. Oribatid diversity here is characherized by smooth line with two little peaks in May and August. These peaks match the increase in secondary members of community. The lowest diversity was recorded in June but it didn't reflect on dominance structure. The diagram of species diversity of plot 7 is also smooth (fig. 2, *2*). The higher diversity of species composition here can possibly be explained by more heterogenous and fragmented microbiotopes then at Molodizhny Park.

Dominance structures of soil mites species complexes of group *C* are given in table 4 (fig. 2, *3*). Among the dominants there are secondarily unspecialized forms *T. velatus, P. punctum, P. zachvatkini* and *Zygoribatula ucrainica* along with litter dwelling *Suctobelbella* spp. and *Neoribates auranthiacum*. In total oribatid species diversity in plot 6 equalled 44. It was minimal in May. It was reflected by the minimal numbers of subdominant and secondary members but maximal number of subdominant of the I order species. Numbers of registered oribatid species were maximal in July and August. All of the

Table 3. Dominance structure of oribatid species complexes at Molodizhny Park and Darnitske Cemetery in April–September 2011 (Paliy-Kovnatsky index)

Таблица 3. Структура доминирования видовых комплексов орибатид в парке Молодежный и на Дарницком кладбище в апреле–сентябре 2011 г. (индекс Палия-Ковнацкого)

Month	*D*		*SD*		*SD1*		*SM*	
	MP	DC	MP	DC	MP	DC	MP	DC
April	*Oppia minus*	*T. velatus*	2	8	7	8	0	1
May	*T. velatus, P. zachvatkini*	*T. velatus, Oppia* sp.	3	7	7	5	3	2
June	*T. velatus*	*T. velatus*	4	3	4	8	1	6
Jule	*O. minus*	*T. velatus, P. punctum*	5	3	4	5	0	5
August		*T. velatus*	6	5	4	8	4	0
September	*T. velatus*		2	2	4	8	0	4

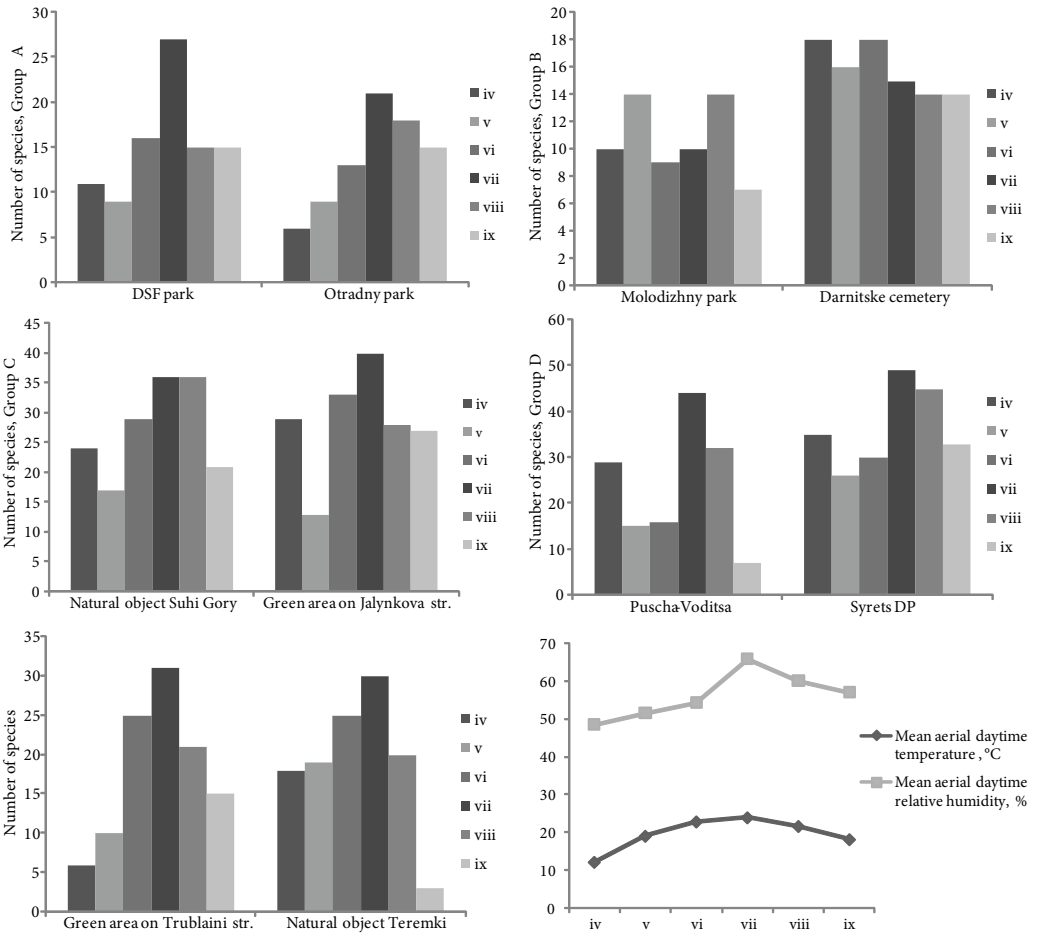

Fig. 2. Seasonal fluctuations of numbers of registered species, mean aerial daytime temperature and relative humidity (iv — April, v — May, vi — June, vii — July, viii — August, ix — September).

Рис. 2. Сезонные изменения количества найденных видов, средние дневные температура и относительная влажность воздуха (iv — апрель, v — май, vi — июнь, vii — июль, viii — август, ix — сентябрь).

ranks of dominance structure were filled with maximal or nearly so numbers of species. In forest at Jalynkova street the lowest oribatid diversity was registered also in May and the highest increase in July, followed with decrease in August. It is reflected in fluctuating numbers of secondary members of community (table 4) and, less sharply, in fluctuating numbers of subdominant and subdominat of the I order species.

Soil mites diversity of the group *D* is characterized by 0–3 dominant species per month (table 5). Akin to previous group there were many species with low population density, ranking from subdominants of the I order to secondary members. Among the dominants in Puscha-Voditsa in April–September 2011, were secondarily unspecialized cosmopolitan species *T. velatus* and dwellers of small soil pores *O. minus* and *Oppiella nova.* At Syrets Dendrological Park the dominant species were *T. velatus* and likewise secondarily unspecialized *Oribatula tibialis* and panphytophagous *Xiphobates kieviensis,* as well as dwellers of litter (*Achipteria coleoptrata* and *M. papillipes*) and small soil pores (*Oppia* sp.). In Puscha-Voditsa the minimal number of species was registered in September (fig. 2, *4*), some decrease also in May–June. This was mirrored by decline in numbers of subdominant of the I order species and secondary members of community. The highest local oribatid diversity was registered in July, along with no dominant species

Table 4. Dominance structure of oribatid species complexes at natural object Suhi Gory and forest on Jalynkova str. in April–September 2011 (Paliy–Kovnatsky index)

Таблица 4. Структура доминирования видовых комплексов орибатид в урочище Сухие горы и лесу по ул. Ялынковой в апреле–сентябре 2011 г. (индекс Палия-Ковнацкого)

Month	*D*		*SD*		*SD1*		SM	
	NOSG	JS	NOSG	JS	NOSG	JS	NOSG	JS
April	*P. zachvatkini*	*T. velatus*	6	4	10	12	7	13
May	*Z. ucrainica*	*T. velatus, P. punctum*	3	5	13	3	0	2
June	*P. zachvatkini*	*P. punctum, N. auranthiacum*	4	4	12	5	13	22
July	*T. velatus, Z. ucrainica*	*T. velatus, P. punctum*	6	3	12	7	15	28
August	*T. velatus, Suctobelbella spp.*	*T. velatus*	7	6	10	8	17	13
September	*T. velatus*	*P. zachvatkini, N. auranthiacum*	10	4	0	11	0	10

and maximal numbers of species of other dominance ranks. In April, despite relatively high diversity, there were no extremums in dominance structure. In Syrets Dendrological Park in April there were middling numbers of species in dominance structure. In May there was decrease in number of secondary members (table 5). Increased species diversity in July reflected on numbers of subdominant (decline) and subdominant of the I order and secondary members of community (rise).

Species complexes of oribatids of green area on Trublaini str. (plot 3) and natural object Teremki (plot 4) considered distant from the aforementioned groups according to cluster analysis are discussed here (table 6). Among the dominant species were secondarily unspecialized forms *T. velatus, P. punctum,* dwellers of small soil pore of the genus *Oppia (Oppia* sp., *O. minus),* and *Acrotritia ardua affinis* which is the most ecologycally plastic species of Lower Oribatida. Highest species diversity was registered in both plots in July (fig. 2, *5*).

Conclusions

Altogether 107 oribatid species of 76 genera in total were found in soil and litter of 10 studied green areas of Kyiv. Species diversity in urban plantations as in natural cenoses depends firstly on habitat conditions. Distribution of living organisms and in particular

Table 5. Dominance structure of oribatid species complexes in Puscha-Voditsa and Syrets Dendrological Park in April–September 2011 (Paliy–Kovnatsky index)

Таблица 5. Структура доминирования видовых комплексов орибатид в Пуще-Водице и Сырецком дендрологическом парке в апреле–сентябре 2011 г. (индекс Палия-Ковнацкого)

Month	*D*		*SD*		*SD1*		*SM*	
	PV	SDP	PV	SDP	PV	SDP	PV	SDP
April	*Oppiella nova*	*M. papillipes*	4	9	10	11	14	15
May		*Oppia* sp.	6	6	9	11	0	8
June	*T. velatus*		3	5	8	10	4	15
July		*T. velatus*	10	5	16	20	18	25
August	*T. velatus*	*T. velatus, O. tibialis*	9	7	10	9	12	28
September	*O. minus, O. nova, T. velatus*	*X. kieviensis, O. tibialis, A. coleoptrata*	4	6	0	10	0	14

Table 6. Dominance structure of oribatid species complexes in natural object Teremki and green area on Trublaini str. in April–September 2011 (Paliy-Kovnatsky index)

Таблица 6. Структура доминирования видовых комплексов орибатид в урочище Теремки и зелёной зоне по ул. Трублаини в апреле–сентябре 2011 г. (индекс Палия-Ковнацкого)

Month	*D*		*SD*		*SD1*		*SM*	
	NOT	TS	NOT	TS	NOT	TS	NOT	TS
April		*T. velatus, A. a. affinis*	7	1	11	3	0	0
May			8	5	6	5	5	0
June	*P. punctum*	*T. velatus*	6	9	8	10	11	6
July	*Oppia* sp.		4	8	8	7	19	10
August	*Oppia* sp.	*O. minus*	3	6	6	11	10	12
September	*T. velatus, P. punctum*	*S. laevigatus*	1	5	0	10	0	5

oribatid mites in soils of settlements is influenced by some human-specific factors: soil compression and salinization of diverse etiology; intencified fragmentation of landscape accompanied by reduction of area of open grounds and per fragment etc. This results in declining species diversity of soil inhabitants up to elimination of some of the taxa (species, genera and of higher ranks). Simplification of biocenotic structure in turn leads to dropping effectiveness of oribatids as participants in transformation of organic matter. This results in lessening of urban (etc.) soils productivity and their suitability for dwelling in. In case of oribatids, this manifests in declining species diversity from city outskirts inwards. Maximal diversity in soils and litter of large green areas is found on the outskirts of the city. The lowest species diversity of soil mites was registered in plots at small green areas nearer to the megalopolis centre and in lawn-like habitats.

Level of habitat disturbance certainly influences oribatid community formation. For example, soil under a layer of litter dries out slower then otherwise. The very presence of litter and humificated detritus has immediate impact on the stability of food base of oribatids and the diversity of microhabitats.

During the sampling period, species composition of studied plots changed. In green areas less affected by human impact, highest levels of species diversity were registered in July–August with following decrease in September. This follows the monthly fluctuation of mean relative humidity and temperature of air.

The structure of dominance of species complexes in every studied plot of megalopolis was very unstable though the domination of secondarily unspecialized forms prevailed. Increase in species diversity reflected upon higher numbers of subdominant, subdominant of the I order and secondary members of the community.

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