Vestnik zoologii, **49**(1): 87–94, 2015
DOI 10.1515/vzoo-2015-0009

DE GRUYTER
OPEN

UDC 595.44(292.451/.454:477)

A CASE STUDY OF THE HERB-DWELLING SPIDER ASSEMBLAGES (ARANEI) IN A MEADOW UNDER THE POWER TRANSMISSION LINES IN UKRAINIAN CARPATHIANS

E. V. Prokopenko

Donetsk National University,
Schorsa str., 46, Donetsk, 83050 Ukraine
E-mail: helen_procop@mail.ru

A Case Study of the Herb-Dwelling Spider Assemblages (Aranei) in a Meadow Under the Power Transmission Lines in Ukrainian Carpathians. Prokopenko, E. V. — The fauna and structure of herb-dwelling spider assemblages in mesophitic meadow under the high voltage power line near Irliava village (Uzhhorod District, Transcarpathian Region) were analyzed on the material collected by sweep netting. The counts were held at five sampling sites: 1) under the wires; 2) at a distance of 50 m; 3) 100 m; 4) 150 m; 5) 200 m. In total, 41 spider species of 14 families were collected. *Erigonoplus globipes* (L. Koch, 1872) and *Hylyphantes nigritus* (Simon, 1881) were recorded in the Carpathians for the first time. The reduction of total number and species richness of spiders was registered as the approaching to the high voltage power line. Except single finds, no species avoided the wire nearest sites (0–50 m). Abundance of most spider families (except Araneidae) was not significantly influenced by distance from the high voltage power line.

K e y w o r d s: spiders, Aranei, power transmission line, Ukrainian Carpathians.

Исследование сообществ хортобионтных пауков (Aranei) мезофитного луга под высоковольтной линией электропередачи в Украинских Карпатах. Прокопенко Е. В. — Проанализированы видовой состав и структура сообществ хортобионтных пауков на участке мезофитного луга под высоковольтной линией электропередачи в окрестностях с. Ирлява (Ужгородский район, Закарпатская область). Материал собран кошением стандартным энтомологическим сачком. Учёты были проведены на пяти пробных площадках: 1) под токонесущими проводами; 2) на расстоянии 50 м; 3) 100 м; 4) 150 м; 5) 200 м. В общей сложности найден 41 вид из 14 семейств. *Erigonoplus globipes* (L. Koch, 1872) и *Hylyphantes nigritus* (Simon, 1881) впервые зарегистрированы в Карпатах. По мере приближения к токонесущим проводам наблюдалось незначительное снижение видового богатства и более заметное — численности пауков. За исключением единичных находок, ни один из отмеченных видов не избегал пробных площадок, наиболее близких к ЛЭП (0–50 м). Что касается основных семейств пауков, то достоверные отличия численности на разных расстояниях от ЛЭП зарегистрированы только для Araneidae.

К л ю ч е в ы е с л о в а: пауки, Aranei, высоковольтные линии электропередачи, Украинские Карпаты.

Introduction

Studying of the ecosystem structure and functioning under external impact remains crucial question to ecological science. The overhead power transmission lines pose the significant threat to environment by electromagnetic field (EMF) generation. EMF is a biologically active physical factor which depends on the terms of influence on bio-objects; it can exert harmful, dangerous or striking action (Grigoriev et al., 2006).

A significant amount of field researches into the EMF effect on arthropods were carried out in the former USSR (Eskov, Karev, 2009; Eskov, Sergeechkin, 1985; Eskov, Toboev, 2008; Gordeeva, Ilminskih, 2012; Kron et al., 2008; Kron et al., 2007; Roshko, Kron, 2010, etc). However, the special researches of the spider assemblages under the EMF influence are sparse (Kron et al., 2010; Gordeeva, Ilminskih, 2012). The preliminary results of this work (without the list of the species) were presented earlier (Roshko et al., 2012).

The effect of EMF on bio-objects varies considerably depending on the taxa, physiological state of organism and environmental conditions (vegetation structure, weather, voltage, etc) (Eskov, Toboev, 2008). A deterrent effect of the power transmission lines was noted for different arthropod taxa: for herb-dwelling spiders (Roshko et al., 2012), ground-dwelling spiders, harvestmen and insects (Gordeeva, Ilminskih, 2012), grasshoppers (Eskov, Toboev, 2008; Eskov, Karev, 2009), etc. On the other hand, the contrary result was obtained for the herb-dwelling spider assemblages in the Carpathians. The spider abundance was increased with oncoming to power transmission lines and raising voltage (Kron et al., 2010). Finally, it was found out that ground-dwelling arthropods prefer certain EMF voltage and accumulate in these areas from the neighbor sites of lower or higher voltage (Gordeeva, 2013).

Thus, the presence of conflicting data on the electromagnetic field effect on the arthropod assemblages determines the relevance of our research. This study aims at researching taxonomic composition and quantitative distribution of the herb-dwelling spiders under the power transmission lines in haymaking meadow.

Material and methods

Studies were carried out in Irliava village environs (Uzhhorod District, Transcarpathian Region, 48°30′N 22°34′ E). The material was collected by V. H. Roshko and V. V. Roshko. Samples were taken on 28.08–1.09.2012 and on 2.05–4.08.2013 in mesophitic haymaking meadow under the overhead power transmission line (voltage is 750 kV) by sweep netting (net diameter 30 cm).

Each sample included 100 net sweeps. The counts were held at five sampling sites: 1) under the wires; 2) at a distance of 50 m; 3) 100 m; 4) 150 m; 5) 200 m. In order to determine whether the number of spiders varies depending on the distance to the power lines, five samples at each site in August 2012 were taken. During 2013, 10 samples per site were taken (three in May and June, two in July and August). These data allowed us to expand the list of species and add material for quantitative analysis. In total, 75 samples were taken and 6607 individuals were collected.

Spider species richness was assessed based on the mature individuals only. In order to determine species relative abundance, we used the Tishler rating scale (Tischler, 1949), where eudominant is $n \geq 10$ %; dominant is $5 \leq n < 10$ %; subdominant is $2 \leq n < 5$ %, recedent is $1 \leq n < 2$ %; subrecedent is $n < 1$ %. Two year samples (see above) were pooled together and a percentage of each species of the total sample at each site was calculated.

All statistical analyses were carried out in Statistica 6.0. Total spider abundance at study sites as well as certain species and family abundances were compared using one-way ANOVA tests if the data had a normal distribution (according to Kolmogorov-Smirnov tests) or using Mann-Whitney tests if it had not. ANOVA was followed by Tukey's HSD multiple comparison post hoc test.

In the cluster analysis of spider assemblages we used the number of individuals of all collected species. When preparing a dendrogram of spider assemblages' biocoenotic similarity the Ward's algorithm as a cluster method and Euclidian distance as a similarity measure were used.

The width of the confidence intervals of the spider species and families relative abundances were calculated according to Adjusted Wald Method with the confidence level 95 % (Hrzhybovski, 2008) using the Confidence Interval Calculator for a Completion Rate by Jeff Sauro (http://www.measuringusability. com/wald.htm).

Results and discussion

In total of 41 spider species of 33 genera and 14 families were collected in the studied meadow under electromagnetic lines near the village of Irliava (table 1). *Erigonoplus globipes* (L. Koch, 1872) and *Hylyphantes nigritus* (Simon, 1881) were registered in the Ukrainian Carpathians for the first time (according to data on species distribution in the former Soviet Union by Mikhailov, 2013). Four families were the most species-rich: Thomisidae (10 species, more than 24 % of total species at the study sites), Araneidae (9 species, about 22 %), Salticidae and Linyphiidae (4 species, 10 % each one). *Xysticus* C. L. Koch, 1835 was the most species-rich genus. 28 genera included one species only.

Three families were the most abundant: Thomisidae (26.5–37.4 % of total individuals at the study sites), Araneidae (19.6–31.8 %) and Salticidae (24.9–32.5 %) (table 1). Webspinner spider total relative abundance ranged from 21.8 to 33.3 %. For wandering spiders this parameter changed from 66.7 to 78.2 %.

The obtained data demonstrate that the chronic electro-magnetic pollution did not lead to significant decrease in spider taxonomic richness. Species number was maximal at a distance of 100 m and 150 m (29 and 27 species). Directly under the wires and at 50 m distance, species richness decreased to 24 and 23 species, respectively. At the outermost site (200 m), only 25 species were registered.

Except single finds, no species avoided the wire nearest sites (0–50 m). The differences between abundance of nine species collected at least in 20 samples (from 25 ones gathered in August 2012) were not valid (according to *Mann-Whitney U*-test). There were: *Mangora acalypha* ($p = 1.0$), juvenile *Singa* (*Hypsosinga*) sp. ($p = 1.0$), juvenile *Ebrechtella* sp. ($p = 0.917$), *Thomisus onustus* ($p = 0.468$), *Xysticus striatipes* ($p = 0.251$), juvenile *Xysticus* sp.

Table 1. Species composition and relative abundance of spider species and families collected at the different distances from high voltage power line near Irliava village

Таблица 1. Видовой состав и относительная численность видов и семейств пауков, собранных на различных расстояниях от ЛЭП в окрестностях с. Ирлява

Species	Sites, m				
	0	50	100	150	200
Theridiidae*	2.0 ± 0.88	0.8 ± 0.54	0.8 ± 0.01	0.7 ± 0.44	1.4 ± 0.63
Phylloneta impressa (L. Koch, 1881)	0.9 ± 0.63	0.4 ± 0.41	0.4 ± 0.42	0.5 ± 0.39	0.8 ± 0.49
Theridiidae gen. spp., juv	1.1 ± 0.68	0.4 ± 0.41	0.4 ± 0.42	0.2 ± 0.26	0.6 ± 0.44
Linyphiidae*	0.4 ± 0.46	0.4 ± 0.44	0.3 ± 0.004	0.3 ± 0.26	0.4 ± 0.37
Agyneta rurestris (C. L. Koch, 1836)	0.0	0.0	0.0	0.0	0.1 ± 0.23
Erigonoplus globipes (L. Koch, 1872)	0.0	0.0	0.0	0.1 ± 0.20	0.0
Hylyphantes nigritus (Simon, 1881)	0.3 ± 0.42	0.1 ± 0.27	0.2 ± 0.35	0.1 ± 0.20	0.3 ± 0.32
Nematogmus sanguinolentus (Walckenaer, 1841)	0.0	0.0	0.0	0.1 ± 0.20	0.0
Linyphiidae gen. spp., juv	0.1 ± 0.32	0.3 ± 0.38	0.1 ± 0.27	0.0	0.0
Araneidae*	19.8 ± 2.44	21.1 ± 2.28	19.6 ± 0.02	31.8 ± 2.24	22.2 ± 2.12
Agalenatea redii (Scopoli, 1763)	1.8 ± 0.84	1.6 ± 0.73	1.5 ± 0.71	0.2 ± 0.26	1.0 ± 0.54
Araneus diadematus Clerck, 1757	0.0	0.0	0.0	0.1 ± 0.20	0.0
Araneus quadratus Clerck, 1757	0.0	0.0	0.0	0.1 ± 0.20	0.1 ± 0.23
Araneus spp., juv	9.9 ± 1.83	10.5 ± 1.72	5.4 ± 1.28	7.2 ± 1.26	7.1 ± 1.32
Argiope bruennichi (Scopoli, 1772)	0.4 ± 0.46	1.4 ± 0.68	1.1 ± 0.61	0.8 ± 0.46	0.3 ± 0.32
Argiope bruennichi, juv	0.1 ± 0.32	0.1 ± 0.27	0.6 ± 0.47	0.4 ± 0.35	0.5 ± 0.40
Hypsosinga pygmaea (Sundevall, 1831)	0.4 ± 0.46	0.4 ± 0.41	0.3 ± 0.39	0.3 ± 0.31	0.6 ± 0.44
Hypsosinga sanguinea (C. L. Koch, 1844)	0.1 ± 0.32	0.4 ± 0.41	0.2 ± 0.32	0.1 ± 0.20	0.1 ± 0.23
Mangora acalypha (Walckenaer, 1802)	0.7 ± 0.57	0.3 ± 0.38	0.4 ± 0.42	0.3 ± 0.31	0.6 ± 0.44
Mangora acalypha, juv	3.6 ± 1.16	4.4 ± 1.16	3.8 ± 1.08	14.4 ± 1.70	4.7 ± 1.09
Neoscona adianta (Walckenaer, 1802)	0.2 ± 0.76	0.0	0.1 ± 0.27	0.0	0.1 ± 0.23
Singa hamata (Clerck, 1757)	0.2 ± 0.76	0.2 ± 0.35	0.4 ± 0.42	0.1 ± 0.20	0.2 ± 0.29
Singa (*Hypsosinga*) spp., juv	2.4 ± 0.97	1.8 ± 0.77	6.0 ± 1.34	7.8 ± 1.30	6.9 ± 1.30
Lycosidae*	0.2 ± 0.38	0.1 ± 0.27	0.3 ± 0.004	0.2 ± 0.26	0.4 ± 0.37
Alopecosa pulverulenta (Clerck, 1757)	0.0	0.0	0.1 ± 0.27	0.1 ± 0.20	0.0
Lycosidae gen. spp., juv	0.2 ± 0.76	0.1 ± 0.27	0.2 ± 0.35	0.1 ± 0.20	0.4 ± 0.37
Pisauridae*	4.5 ± 1.29	4.2 ± 1.12	5.0 ± 0.01	1.3 ± 0.56	1.7 ± 0.67
Pisaura mirabilis (Clerck,1757)	0.0	0.2 ± 0.35	0.1 ± 0.27	0.1 ± 0.20	0.1 ± 0.23
Pisaura spp., juv	4.5 ± 1.29	4.0 ± 1.10	4.9 ± 1.22	1.2 ± 0.55	1.6 ± 0.66
Hahniidae*	0.0	0.0	0.1 ± 0.003	0.0	0.0
Hahnia nava (Blackwall, 1841)	0.0	0.0	0.1 ± 0.27	0.0	0.0
Dictynidae*	1.8 ± 0.84	1.4 ± 0.70	0.9 ± 0.01	0.7 ± 0.44	0.8 ± 0.49
Dictyna arundinacea (Linnaeus, 1758)	0.1 ± 0.32	0.3 ± 0.38	0.2 ± 0.35	0.0	0.3 ± 0.35
Dictyna latens (Fabricus, 1775)	0.2 ± 0.76	0.0	0.3 ± 0.39	0.3 ± 0.31	0.0
Dictyna spp., juv	1.5 ± 0.78	1.1 ± 0.63	0.4 ± 0.42	0.4 ± 0.35	0.5 ± 0.40
Oxyopidae*	2.0 ± 0.88	0.9 ± 0.56	0.4 ± 0.004	0.7 ± 0.44	1.2 ± 0.57
Oxyopes ramosus (Martini et Goeze, 1778)	0.1 ± 0.32	0.0	0.0	0.0	0.0
Oxyopes spp., juv	1.9 ± 0.86	0.9 ± 0.56	0.4 ± 0.42	0.7 ± 0.44	1.2 ± 0.57
Eutichuridae*	1.2 ± 0.71	1.1 ± 0.61	0.8 ± 0.01	1.2 ± 0.54	1.7 ± 0.67
Cheiracanthium erraticum (Walckenaer, 1802)	0.0	0.1 ± 0.27	0.1 ± 0.27	0.0	0.1 ± 0.23
Cheiracanthium punctorium (Villers, 1789)	0.0	0.0	0.0	0.1 ± 0.20	0.0
Cheiracanthium spp., juv	1.2 ± 0.71	1.0 ± 0.59	0.7 ± 0.52	1.1 ± 0.53	1.6 ± 0.66
Clubionidae*	0.4 ± 0.46	0.0	0.6 ± 0.01	0.2 ± 0.26	0.3 ± 0.35
Clubiona diversa O. Pickard-Cambridge, 1862	0.0	0.0	0.1 ± 0.27	0.0	0.0

Clubiona spp., juv	0.4 ± 0.46	0.0	0.5 ± 0.45	0.2 ± 0.29	0.3 ± 0.35
Sparassidae*	0.7 ± 0.57	0.5 ± 0.44	0.5 ± 0.01	0.3 ± 0.29	0.1 ± 0.23
Micrommata virescens (Clerck, 1757)	0.0	0.0	0.1 ± 0.27	0.1 ± 0.20	0.0
Micrommata spp., juv	0.7 ± 0.57	0.5 ± 0.44	0.4 ± 0.42	0.2 ± 0.26	0.1 ± 0.23
Philodromidae*	6.6 ± 1.53	7.2 ± 1.45	9.5 ± 0.02	9.0 ± 1.38	8.0 ± 1.40
Philodromus cespitum (Walckenaer, 1802)	0.1 ± 0.32	0.0	0.0	0.0	0.1 ± 0.23
Philodromus spp., juv	1.0 ± 0.65	0.8 ± 0.54	0.6 ± 0.47	0.8 ± 0.46	0.3 ± 0.35
Thanatus formicinus (Clerck, 1758)	0.0	0.0	0.0	0.1 ± 0.20	0.0
Thanatus spp., juv	0.5 ± 0.50	0.0	0.2 ± 0.35	0.6 ± 0.41	0.4 ± 0.37
Tibellus oblongus (Walckenaer, 1802)	0.3 ± 0.42	0.3 ± 0.38	0.5 ± 0.45	0.2 ± 0.26	0.3 ± 0.35
Tibellus spp., juv	4.7 ± 1.31	6.1 ± 1.34	8.2 ± 1.54	7.3 ± 1.27	6.9 ± 1.30
Thomisidae*	35.9 ± 2.93	37.4 ± 2.69	36.2 ± 0.03	26.5 ± 2.13	29.5 ± 2.33
Ebrechtella tricuspidata (Fabricius, 1775)	0.5 ± 0.50	0.6 ± 0.47	0.1 ± 0.27	0.0	0.0
Ebrechtella spp., juv	2.4 ± 0.97	1.9 ± 0.78	0.5 ± 0.45	0.2 ± 0.29	0.7 ± 0.46
Misumena vatia (Clerck, 1757)	1.0 ± 0.65	1.2 ± 0.65	0.3 ± 0.39	0.1 ± 0.23	1.2 ± 0.59
Misumena spp., juv	6.2 ± 1.49	3.9 ± 1.09	2.7 ± 0.93	2.8 ± 0.82	3.8 ± 0.99
Synema spp., juv	0.1 ± 0.32	0.1 ± 0.27	0.1 ± 0.27	0.1 ± 0.20	0.1 ± 0.23
Thomisus onustus Walckenaer, 1805	1.8 ± 0.84	1.6 ± 0.73	1.5 ± 0.71	0.5 ± 0.37	0.3 ± 0.35
Thomisus onustus, juv	1.3 ± 0.73	1.9 ± 0.80	0.6 ± 0.47	0.8 ± 0.47	0.5 ± 0.42
Tmarus piger (Walckenaer, 1802)	0.8 ± 0.60	0.3 ± 0.38	0.2 ± 0.32	0.0	0.1 ± 0.23
Tmarus piger, juv	1.5 ± 0.78	0.5 ± 0.44	0.0	0.5 ± 0.37	0.3 ± 0.35
Xysticus acerbus Thorell, 1872	0.1 ± 0.32	0.0	0.1 ± 0.27	0.1 ± 0.20	0.0
Xysticus bifasciatus (C. L. Koch, 1837)	0.0	0.0	0.0	0.0	0.1 ± 0.23
Xysticus cristatus (Clerck, 1758)	0.1 ± 0.32	0.3 ± 0.38	0.2 ± 0.32	0.1 ± 0.20	0.1 ± 0.23
Xysticus kochi Thorell, 1872	0.0	0.1 ± 0.27	0.0	0.0	0.0
Xysticus striatipes L. Koch, 1870	1.1 ± 0.68	1.6 ± 0.73	1.6 ± 0.72	2.0 ± 0.69	2.6 ± 0.83
Xysticus ulmi (Hahn, 1831)	0.4 ± 0.46	0.2 ± 0.35	0.1 ± 0.27	0.1 ± 0.20	0.1 ± 0.23
Xysticus spp., juv	18.6 ± 2.38	23.2 ± 2.35	28.2 ± 2.52	19.2 ± 1.90	19.6 ± 2.03
Salticidae*	24.9 ± 2.65	25.0 ± 2.41	25.1 ± 0.02	27.3 ± 2.15	32.5 ± 2.39
Evarcha arcuata (Clerck, 1757)	6.0 ± 1.47	6.8 ± 1.41	6.1 ± 1.35	5.5 ± 1.11	6.2 ± 1.24
Evarcha spp., juv	10.6 ± 1.89	12.0 ± 1.81	11.3 ± 1.78	11.0 ± 1.52	12.8 ± 1.71
Heliophanus flavipes (Hahn, 1832)	0.6 ± 0.53	0.2 ± 0.31	0.8 ± 0.55	1.5 ± 0.60	1.1 ± 0.56
Heliophanus spp., juv	7.2 ± 1.60	5.3 ± 1.26	6.4 ± 1.39	9.0 ± 1.39	12.0 ± 1.66
Sibianor aurocinctus (Ohlert, 1865)	0.0	0.0	0.1 ± 0.27	0.0	0.0
Synageles hilarulus (C. L. Koch, 1846)	0.0	0.1 ± 0.27	0.0	0.0	0.0
Salticidae gen. spp., juv	0.5 ± 0.50	0.6 ± 0.47	0.4 ± 0.42	0.3 ± 0.31	0.4 ± 0.37
Total individuals	1026	1236	1225	1647	1473
Total mature individuals	184	233	209	217	249
Total juvenile individuals	842	1003	1016	1430	1224
Total webspinner spiders	23.8	24.0	21.8	33.3	24.6
Total wandering spiders	76.2	76.0	78.2	66.7	75.4
Shannon diversity index	3.02	2.85	2.73	2.69	2.81
Pielou evenness index	0.72	0.68	0.65	0.64	0.67

Note. The confidence intervals are given in the following form: relative abundance ± margin of error (half of the confidence interval width).

* Total relative abundance of family was counted as sum of relative abundances of all its species; juv — juvenile individuals.

(p = 0.676), juvenile *Evarcha* sp. (p = 0.917), *Evarcha arcuata* (p = 0.343), juvenile *Heliophanus* sp. (p = 0.846).

Spider abundance nonlinearly decreased with proximity to power lines (table 1). At the 150 m distance the spider abundance was maximal and at 0 m it was minimal. The difference between abundance maximum and minimum was about 1.6 times. The result of the one-way ANOVA showed that the spider abundance at the study sites differed significantly (table 2, data collected in August 2012). Number of individuals at 150 m and 200 m distance sites was significantly higher than at 0 m and 50 m distance sites (fig. 1) (Tukey's HSD, $p < 0.01$, table 3). The differences between 100 m site and other study sites was not significant (Tukey's HSD, $p > 0.1$), as well as the differences between pairs: 0–50 m sites (Tukey's HSD, p = 0.957) and 150–200 m sites (Tukey's HSD, p = 1).

Proportion of adult and juvenile individuals in the investigated sites ranged from 0.15 (150 m) to 0.23 (50 m), showing no clear tendency depending on the distance from the power line.

Number of individuals of the most abundant families at study sites in August 2012 were compared using one-way ANOVA (Araneidae, Pisauridae, Philodromidae) and *Mann-Whitney U*-test (Thomisidae, Salticidae). Significant differences were registered for Araneidae only (table 2). Tukey's HSD multiple comparison post hoc test showed that significant differences in abundance of Araneidae had the pairs 0–150 m, 0–200 m, 50–150 m and 50–200 m (table 3). Note that abundance of Araneidae was higher at the distant study sites (150–200 m) than near the power line (0–50 m). The differences in abundance between study sites for Pisauridae, Philodromidae, Thomisidae and Salticidae were not significant (table 2).

The eudominant and dominant group at the study sites was comprised of 6–8 species. Juvenile *Xysticus* sp. (18.6–28.2 %) and *Evarcha* sp. (10.6–12.8 %) were eudominant everywhere. Juvenile *Araneus* sp. (10.5 %) joined eudominants at the 50 m site while juvenile *M. acalypha* (14.4 %) joined them at the 150 m one. Juvenile *Heliophanus* sp. was eudominant only at 200 m distance site (12.0 %). The group of dominant was represented by *Araneus* sp. (9.9 %), *Misumena* sp. (6.2 %), *Evarcha* sp. (6.0 %) and *Heliophanus* sp. (7.2 %) at the 0 m distance site. Three dominants were only registered at the 50 m distance site: *Tibellus* sp. (6.1 %), *E. arcuata* (6.8 %) and *Heliophanus* sp. (5.3 %). At the 100 m and 150 m distance sites, the group of dominants consisted of *Araneus* sp. (5.4 and 7.2 %, respectively), *Singa* (*Hypsosinga*) sp. (6.0 and 7.8 %), *Tibellus* sp. (8.2 and 7.3 %), *E. arcuata* (6.5 and 5.5 %) and *Heliophanus* sp. (6.4 and 9 %). The dominants at the 200 m d istance site are the same except *Tibellus* sp.: *Araneus* sp. (7.1 %), *Singa* (*Hypsosinga*) sp. (6.9 %), *Tibellus* sp. (6.9 %), *E. arcuata* (6.2 %).

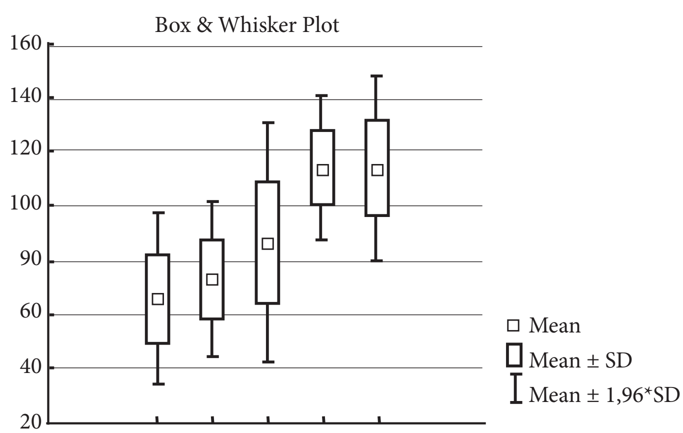

Fig. 1. Number of individuals collected at the different distances from high voltage power line near Irliava village, August 2012 (SD — standard deviation).

Рис. 1. Численность пауков на различных расстояниях от ЛЭП в окрестностях с. Ирлява, август 2012 г. (SD — стандартное отклонение).

Eu- and dominants relative abundance increased in the distances of 150 and 200 m with an increase in total spider abundance at the sites (fig. 2). The total recedent and subrecedent relative abundance decreased in this direction. Under wires, the eu- and dominant species accounted for 58.5 % of total individuals at study sites, and rare species accounted for 23.9 %. These values were 81.4 and 13.8 % respectively in the 150 m distance. Shannon and Pielou indices reflected this tendency. The maximal values of these indices were under the wires with the minimal ones at the 150 m (table 1, fig. 2). In previous papers, an opposite change in dominance structure of spider assemblages under the EMF influence was registered: in the maximum voltage zone, the percentage of dominants increased while the proportion of rare species decreased (Kron et al., 2010). It should be noted that our results also contradict to the data obtained for soil invertebrates. Shannon and Pielou indices decreased while increasing voltage (Kron et al., 2010; Roshko, Kron, 2010). In our case the maximal diversity and evenness as well as the maximal proportion of rare species were registered directly under the wires.

Table 2. One-way ANOVA and Mann-Whitney U-test for total spider and some families abundance at the different distances from high voltage power line near Irliava village

Таблица 2. Результаты one-way ANOVA и Mann-Whitney U-test для суммарной численности пауков и численности отдельных семейств, собранных на различных расстояниях от ЛЭП в окрестностях с. Ирлява

One-way ANOVA, d. f. = 4	F	SS	p
Total spider abundance	8.719	10144.64	0.0003*
Araneidae	5.436	1874.8	0.004*
Pisauridae	2.102	211.2	0.118
Philodromidae	2.269	1395.2	0.978
Mann-Whitney U-test		p	
Thomisidae		0.344	
Salticidae		0.296	

* Significant differences; SS — sum of squares.

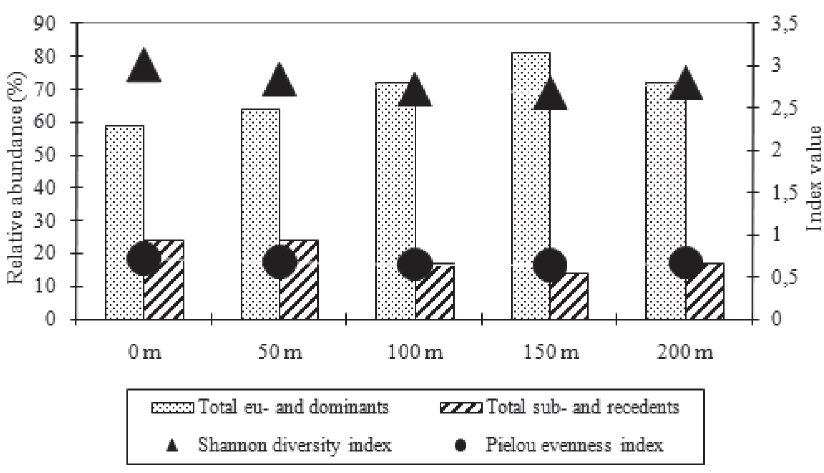

Fig. 2. Total eudominants and dominants, recedents and subrecedents relative abundance, Shannon and Pielou indexes values at the different distances from high voltage power line near Irliava village (according to the two year samples).

Рис. 2. Суммарная относительная численность эудоминантов и доминантов, рецедентов и субрецедентов, значения индексов Шеннона и Пиелу на пробных площадках, расположенных на различных расстояниях от ЛЭП в окрестностях с. Ирлява (данные двух лет учётов).

Table 3. Tukey HSD test for total spider and Araneidae abundance at the different distances from high voltage power line near Irliava village

Таблица 3. Результаты Tukey HSD test для суммарной численности пауков и численности Araneidae на различных расстояниях от ЛЭП в окрестностях с. Ирлява

Site	0 m	50 m	100 m	150 m	200 m
			Total abundance		
0 m		0.957274	0.335340	0.001987 *	0.002149 *
50 m	0.957274		0.727660	0.008909 *	0.009661 *
100 m	0.335340	0.727660		0.117094	0.125406
150 m	0.001987 *	0.008909 *	0.117094		1.000000
200 m	0.002149 *	0.009661 *	0.125406	1.000000	
			Abundance of the Araneidae		
0 m		0.999996	0.335958	0.024649 *	0.034810 *
50 m	0.999996		0.305193	0.021430 *	0.030342 *
100 m	0.335958	0.305193		0.632046	0.728305
150 m	0.024649 *	0.021430 *	0.632046		0.999838
200 m	0.034810 *	0.030342 *	0.728305	0.999838	

* Significant differences.

A dendrogram of spider assemblages' similarity pools the sample sites together based on the distance from the wires (fig. 3). Two clusters are separated from one another: the sites at 0–100 m distance and the sites at 150–200 m distance. The 0 m and 50 m sites are characterized by maximal biocoenotic similarity of herb-dwelling spider assemblages.

Thus, the decrease in herb-dwelling spider species richness and more conspicuous fall in abundance were registered at the wire nearest sites (0–50 m). Abundances of certain species and most families did not differ significantly at the study sites. Abundance of Araneidae was significantly higher at the distant study sites than near the power line.

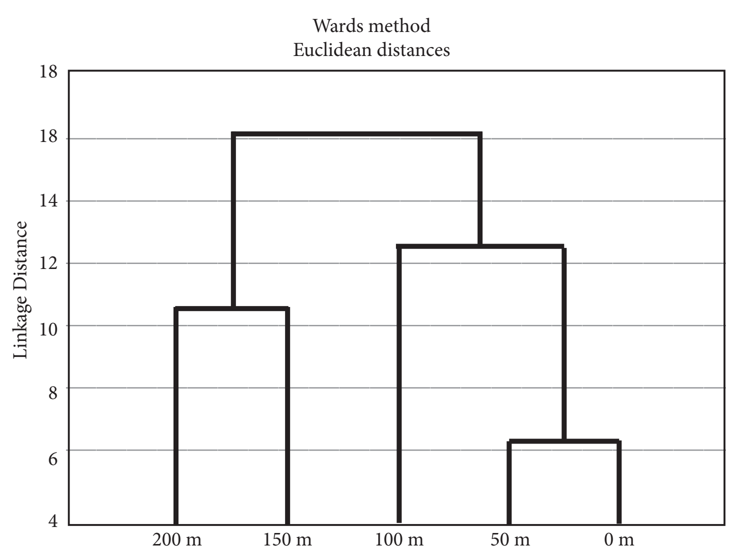

Fig. 3. Dendrogram of biocoenotic similarity of herb-dwelling spider assemblages at the different distances from high voltage power line near Irliava village (based on the number of individuals of each species in the two year samples using Ward's method as cluster algorithm and Euclidian distance as similarity measure).

Рис. 3. Дендрограмма биоценотического сходства сообществ хортобионтных пауков на различных расстояниях от ЛЭП в окрестностях с. Ирлява (основана на численности каждого вида за два года учётов, алгоритм объединения — метод Ворда, мера объединения — евклидово расстояние).

The author sincerely thanks V. H. Roshko and V. V. Roshko (Uzhhorod National University) for providing collected material and I. Yu. Bukhanets (Donetsk National University) for revising the first draft of the English manuscript. The author greatly thanks N. Yu. Polchaninova (Kharkov National University) and K. G. Mikhailov (Zoological Museum of the Moscow State University) for some important critical remarks and corrections.

References

Grigoriev, O. A., Grigoriev, Y. G., Stepanov, V. S., Chekmarev, O. M. Bioelectric terrorism: analysis of possible threat // Annual of Russian National Committee on non-ionizing radiation protection. Papers collection of RNCNIRP members. — Moskow : Allana. — 2006. — P. 205–216. — Russian : *Григорьев О. А., Григорьев Ю. Г., Степанов В. С., Чекмарев О. М.* Биоэлектрический терроризм: анализ возможной угрозы.

Eskov, E. K., Karev, V. A. Fauna of glades of high-voltage transmission lines // Proceedings of the Samara Scientific Center, Russian Academy of Sciences. — 2009. — **11**, N 1. — P. 127–132. — Russian : *Еськов Е. К., Карев В. А.* Фауна просек высоковольтных линий электропередач.

Eskov, E. K., Sergeechkin, V. V. Dynamics of population density of gray grasshoppers under high power lines // Ecology. — 1985. — N 5. — P. 87–89. — Russian : *Еськов Е. К., Сергеечкин В. В.* Динамика плотности населения серых кузнечиков под высоковольтными линиями электропередачи.

Eskov, E. K., Toboev, V. A. Influence artificially generated electromagnetic fields on biological objects // Bulletin of Chuvash University. — 2008. — N 2. — P. 28–36. — Russian : *Еськов Е. К., Тобоев В. А.* Воздействие искусственно генерируемых электромагнитных полей на биологические объекты.

Gordeeva, M. A., Ilminskih, N. G. The influence of electromagnetic fields of power transmission on the herpetobionts // Biology. Ecology. Science. Geosciences. — 2012. — N 2. — P. 31–39. — Russian : *Гордеева М. А., Ильминских Н. Г.* Воздействие электромагнитных полей линий электропередач на герпетобионтов.

Gordeeva, M. A. Spatial distribution of herpetobionts on electromagnetic gradient factor // Agrarian bulletin of Ural. — 2013. — **107**, N 1. — P. 21–24. — Russian : *Гордеева М. А.* Пространственное распределение герпетобионтов на градиенте электромагнитного фактора.

Hrzhybovski, A. M. Confidence intervals for rates and portions // Human ecology. — 2008. — N 5. — P. 57–60. — Russian : *Гржибовский А. М.* Доверительные интервалы для частот и долей.

Kron, A. A., Roshko, V. G., Vlasenko, R. P., Onischuk, I. P. Communities of earthworms (Oligochaeta, Lumbricidae) under conditions of chronic electromagnetic stress // Scientific Bulletin of the Uzhhorod University. Ser. Biology. — Uzhhorod, 2010. — Is. 27. — P. 13–17. — Ukrainian : *Крон А. А., Рошко, В. Г., Власенко, Р. П., Онищук І. П.* Угруповання дощових червів (Oligochaeta, Lumbricidae) в умовах хронічного електромагнітного стресу.

Kron, A. A., Voloshin, O. I., Melamud, V. V., Roshko, V. G. The general nature of the impact of electromagnetic fields of high voltage power lines on soil mites (Arachnida, Acarina) // Scientific Bulletin of the Uzhhorod University. Ser. Biology. — Uzhhorod, 2008. — Is. 23. — P. 174–179. — Ukrainian : *Крон А. А., Волошин О. І., Меламуд В. В., Рошко В. Г.* Загальний характер впливу електромагнітного поля ліній електропередач високої напруги на ґрунтових кліщів (Arachnida, Acarina).

Kron, A. A., Voloshyn, O. I., Roshko, V. H. Response of some groups of Arthropoda to electromagnetic field effect of high-voltage power transmission lines // Landscape architecture and spatial planning as the basic element in the protection of native species (Tuczno, Poland). — 2007. — P. 108–113.

Kron, N. N., Roshko, V. G., Zhukovets, E. M. The spiders assemblages (Aranei) under conditions of chronic electromagnetic stress // Recent developments in entomology. Abstracts of entomol. scient. conf., devoted. 60th anniversary of Ukrainian entomol. Society (Uman, 12–15 October 2010). — Kyiv : Kolobig, 2010. — P. 28–29. — Ukrainian : *Крон Н. Н. Рошко В. Г., Жуковец Є. М.* Угруповання павуків (Aranei) в умовах хронічного електромагнітного стресу.]

Roshko, V. G., Kron, A. A. The reactions of certain pedobiont groups on chronic electromagnetic stress // Scientific Bulletin of the Uzhhorod University. Ser. Biology. — Uzhhorod, 2010. — Is. 29. — P. 65–74. — Ukrainian : *Рошко В. Г., Крон А. А.* Реакції окремих груп педобіонтів на хронічний електромагнітний стрес.

Roshko, V. V., Prokopenko, E. V., Roshko, V. G. General reactions of herb-dwelling spiders assemblages (Arachnida: Aranei) on chronic electromagnetic stress // Scientific Bulletin of the Uzhhorod University. Ser. Biology. — Uzhhorod, 2012. — Is. 32. — P. 45–49. — Ukrainian : *Рошко В. В., Прокопенко О. В., Рошко В. Г.* Загальні реакції угруповань хортобіонтних павуків (Arachnida: Aranei) на хронічний електромагнітний стрес.

Sauro, J. Confidence Interval Calculator for a Completion Rate. — http://www.measuringusability.com/wald.htm

Tischler, W. Grundzüge der terrestrischen Tierökologie. — Braunschweig : Veiweg & Sohn, 1949. — 219 S.

Received 22 May 2014
Accepted 26 November 2014