Екол. Зашт. Живот. Сред. Ekol. Zašt. Život. Sred.	Том 5 Vol.	Бр. 1 No.	стр. 3-10 pp.	Скопје 1997 Skopje

Примено во редакција:
23 јули 1997

ISSN 0354-2491
UDC: 595.2:504.054
оригинален научен труд

STRUCTURE OF THE COMMUNITIES OF ARTHROPODS, INHABITANTS OF THE HERBACEOUS LAYER IN ANTHROPOGENETICALLY POLLUTED ECOSYSTEMS

Emilia MARKOVA & Elitza KOYTCHEVA

Department of Ecology and Environmental Protection, Faculty of Biology, Sofia University, Sofia, Bulgaria

ABSTRACT

Markova, E., Koytcheva, E. (1997). Structure of the communities of arthropods, inhabitants of the heraceous layer in anthropogenetically polluted ecosystems. Ekol. Zašt. Život. Sred., Vol. 5, No. 1, Skopje.

The structure of the communities of arthropods, inhabitants of the herbaceous layer in anthropogenetically polluted ecosystems was investigated. The seasonal dynamics of the following numerical parameters that describe the structural state of the communities was studied - population density of the different arthropod groups, numerical similarity, total mean number and degree of dominance

Key words: arthropods, density, numerical similarity, degree of dominance

ИЗВОД

Маркова, Е., Којчева, Е. (1997). Структура на артроподните заедници во тревестиот кат во загадени екосистеми од човекот Екол. Зашт. Живот. Сред., Том 5, Бр. 1. Скопје.

Беше испитувана структурата на заедниците на артроподи во тревестиот кат во загадени екосистеми од човекот, Беше испитувана сезонската динамика на нумерички параметри што ја опишуваат на структурата на заедниците како што се: густина на популација на различни групи на артроподи, нумеричка сличност, средна вредност, степен на доминантност.

Клучни зборови: артроподи, густина, нумеричка сличност, степен на доминантност

INTRODUCTION

The arthropods inhabitants of the herbaceous layer are a significant component of every biocenosis. They include representatives from the main levels of the trophic chain - phitophags, predators, parasites and saprophags, the latter being bioreductors. Thus, the arthropods participate in the transformation of substances and energy practically at every level of trophic chains and in every type of trophic chains.

The pollution of air, soil and water causes a destruction of the normal functioning of the arthropod populations which leads to very serious consequences for the ecosystems as a whole (Катаев et al. 1983).

In the foreign literature there is a lot information on the dynamics of the population of a different arthropod groups (mainly insects) influenced by different types of industrial pollution (Dunger et al. 1974; Strojan 1978; Lesniak 1979). However, the comparative analysis of the information is difficult because they reflect the influence of different industrial complexes whose products are different in quantity and quality.

The present study is a part of a complex task aiming at revealing of the influence of the environmental pollution on the structure and functioning of zoocoenoses. The investigation was carried out in the region of the town Etropole - where the anthropogenic pollution is at a considerable level. There are two main sources of pollution - mine Elatzite and the Copper Plant situated near Pirdop and Zlatitza whose emissions reach Etropole by air.

The preliminary studies in the region showed high natural radioactive background (Dimitrova et al. 1966) and concentration of some of heavy metals (Markova et al. unpublished) measured in the biological samples collected from all experimental sites.

MATERIAL AND METHODS

The study was carried out within the period from August 1993 to June 1994 (included). The samples were collected on 26 and 27.08, 13 and 14.10.1994, and 14-17 06.1994.

Five sites were studied. They were situated by Pravetz, village Lunga, village Yamna, in the locality Bash Samokov, and the locality Kashana. The site near Pravetz was chosen as a control site because it was not within the region around Etropole and was geographically isolated from the influence of the pollution sources.

The experimental sites were chosen on the basis of maximal similarity in the herbaceous plant associations. They were parts from mezoxerothermic ecosystems that had been used as a hay meadows and pastures. The grass species *Chrysopogon gryllus* L. and *Agrostis capilaris* L. prevailed.

The material was collected using the method of "mowing" whit a standard entomological sack with diameter d= 0.30 m. From every experimental site ten samples were collected. Every sample is based on 100 mowing with average length - 1 m.

The samples were collected in dry and calm weather and, as much as possible, in one the same part of the day.

The population density of the different arthropod groups was measured according to the method of Гшшров (1974), and the total number of individuals - following the general variation-statistical methods. The numerical strength of the different arthropod groups was compared using the Jaccard-Naumov's index (Чернов 1975). The dominant structure was described according to the classification of Arzamasov et al. (after Хотмко et al. 1982). The similarity between the different dominant complexes was assessed on the basis of Jaccard's index.

RESULTS AND DISCUSSION

During the study, totally 150 samples were processed - 50 from every season. The total number of identified individuals was 30634.

Taxonomic characteristics of the studied material

The collected material allowed a correct analysis of the systematic groups at the order' level. The taxa represented by a low number of individuals of these which were rare were not taken into consideration for the ecological analysis.

Among the insects the representatives from the order Homoptera predominated. These were the typical phitophags - mainly cicadas Auchenorhyncha and plant lice Aphidodea. High number of individuals from Diptera and Coleoptera groups. The highest number of individuals from Diptera went to the phitophags form Chloropidae, some saprophags families - Anthomyidae, Muscidae, Chironomidae and Phoridae, as well as to the predators -

Emphididae and Dolichopodidae. From the Coleoptera group prevailed the representatives of the phitophag families Chrysomelidae and Curcolionidae. From the Hymenoptera parasites predominated the representatives of the subfamilies Chalcidoidea and Ichneumonoidea By comparatively high number of individuals were characterized also the orders Heteroptera and Thysanoptera including mainly phitophags and to a lower extent - predators.

Number of individuals in the different arthropods groups

The number of individuals in the arthropod groups exhibited considerable differences in the experimental sites and during the seasons. The data are presented on la and in tables 1,2,3.

Tab. 1 Numbers (number ind.$\cdot a^{-1}$) of the established groups of arthropods in the investigated grass ecosystems in the spring. Таб. 1 Број (број инд.$\cdot ca^{-1}$) на утврдените групи артроподи во истражуваните тревести екосистеми на пролет.

Groups of Arthropods Групи артроподи	Control Area Контролна површина	Experimental Areas Експериментална површина			
		Lunga	Yamna	Bash Samokov	Kashana
Aranei	53±7	14±2	19±5	12±5	6±2
Orthoptera	33±7	14±3	5±2	179±36	20±7
Homoptera	1020±168	734±44	734±83	357±68	825±268
Heteroptera	265±16	34±5	82±21	9±1	11±2
Thysanoptera	327±76	16±3	310±70	26±5	7±3
Coleoptera	109±8	70 13	83±5	36±4	27±9
Neuroptera	38±8	-	3±1	-	27±11
Hymenoptera	163±24	56±19	292±38	40±7	17±5
Diptera	307±25	62±18	346±44	188±37	177±70
Lepidoptera	60±6	61±16	48±10	7±1	9±2

Tab, 2 Numbers (number ind.$\cdot a^{-1}$) of the established groups of arthropods in the investigated grass ecosystems in the summer

Таб. 2 Број (број инд.ca^{-1}) на утврдените групи артроподи во истражуваните тревести екосистеми на лето.

Groups of Arthropods Групи артроподи	Control Area Контролна површина	Experimental Areas Експериментална површина			
		Lunga	Yamna	Bash Samokov	Kashana
Aranei	25±6	11±5	33±8	7±3	51±12
Orthoptera	50±13	8±2	15±5	15±4	35±8
Homoptera	75±19	3±1	29±1	63±5	125±31
Heteroptera	28±6	29±6	23±8	67±1	123±20
Thysanoptera	1±1	3±1	2±1	-	231±75
Coleoptera	578±139	9±4	126±41	26±7	33±8
Neuroptera	1±1	-	-	-	-
Hymenoptera	35±19	11±3	67±22	11±3	28±6
Diptera	9±3	5±2	29±9	96±24	532±135
Lepidoptera	6±1	1±0	8±1	1±0	16±5

Tab. 3 Numbers (number ind.$\cdot a^{-1}$) of the established groups of arthropods in the investigated grass ecosystems in the autumn Таб. 3 Број (број инд.$\cdot$са$^{-1}$) на утврдените групи артроподи во истражуваните тревести екосистеми на есен.

Groups of Arthropods Групи артроподи	Control Area Контролна површина	Experimental Areas Експериментална површина			
		Lunga	Yamna	Bash Samokov	Kashana
Aranei	18±4	12±4	7±2	3±2	17±4
Orthoptera	28±6	9±3	6±2	17±3	4±1
Homoptera	34±11	22±12	18±6	8±2	22±6
Heteroptera	3±2	3±1	2±1	2±0	18±5
Thysanoptera	1±1	2±1	-	1±1	9±4
Coleoptera	135±35	81±27	67±14	20±6	5±2
Neuroptera	-	-	-	-	-
Hymenoptera	10±2	7±2	13±7	2±1	7±2
Diptera	14±4	105±44	12±4	18±9	13±3
Lepidoptera	5±2	3±1	1±1	1±1	8±3

The analyses of the data for the order Aranei showed a general tendency towards statistically reliable decrease in the number of spiders during the tree seasons in almost every experimental site compared to the control site. This tendency was very strongly expressed in the experimental sites in the localities Bash Samokov and Kashana. Supposedly, the limiting factor for the development of spiders in the anthropogenetically polluted areas was the accumulation in the biotops of toxic atmospheric of water waste substances. The experimental site in the locality Bash Samokov was immediately under the mine Elatzite. For the experimental site in the locality Kashana which was situated above the same mine we had a confirmed reason to consider that it was a subjected most strongly to atmospheric pollution as a result of the emissions of the Copper Plant which is in the immediate vicinity of Etropole. On the other hand, (bearing in mind that the spiders are predators), it was highly possible that the pollution led to changes in the environmental situation - the food resources getting poorer as a result of decrease in the species diversity and total abundance of the invertebrates (Штернберг 1989). The data obtained by us coincided with these of some other authors (Катаев et al. 1983) who had also established a decrease in number of spiders near industrially polluted areas.

The pictures revealed through the study of the arthropods from the class Insecta was different. The number of individuals in the different orders during the tree seasons varied to a higher degree. This fact could be explained with the higher species diversity in the class itself. The lower taxa could not only vary considerably in morphology, anatomy, physiology and biological development but also could occupy different places in the trophic pyramid and obey to the influence of different ecological factors.

The changes in the number of individuals in the orders Orthoptera and Coleoptera were similar. It was possible that the impact of the anthropocenic pollution on these two insect groups to be one and the same bearing in mind that our sample collections the orders Coleoptera and Orthoptera participated mainly with phitophags. During the tree seasons the number of individuals in both orders was statistically lower in the experimental sites compared to the control site. There was only one exception in the order Orthoptera.

Similar was the picture for the orders of Homoptera and Hymenoptera. The number of arthropods in the experimental sites compared to the control site was lower' during the three seasons. A clear statistically reliable decrease in the number of individuals in the order Homoptera was found in the experimental site in the locality Bash Samokov during the summer and autumn, and in the experimental site by villages Luga and Yamna during the summer. In the order Hymenoptera the decrease in the number of individuals compared to the control site was statistically high during the spring in the experimental by the village Luga, and localities Bash Samokov and Kashna, and in the autumn - in the site in the locality Bash Samokov. Worth emphasising was higher' number of individuals in the order Hymenoptera during the three seasons in the experimental site near the village Yamna, but only the increase in spring was statistically reliable. According to some authors (Катаев et al. 1983) some of the hymenopterans increase their number in polluted areas.

For the rest of the orders from the class Insecta it was difficult any regularities in the dynamics of the number of individuals to be established.

Some insect groups - phytophags, which because of their physiological and ecological characteristics were mote pollution resistant, can show increase in their number in polluted areas. Such was the case with the representatives of the orders Diptera, Heteroptera, Thysanoptera and Lepidoptera. The population density in these groups was higher in all experimental sites compared to the control site. Our data coincided again with these established by some other authors (Kataev et al. 1983; Charles & Villemant 1977; Sierpinski 1970, 1972). The authors had found an increase in the number of individuals of Diptera and some Heteroptera and Lepidoptera groups in industrially polluted areas. The increase number, particularly for the order Diptera, in the experimental sites compared to the control was probably to the existence of every-day wastes, rotting organic material, disturbed light regime, etc., which create favorable conditions for the development of synanthrop species.

The similarity in number of individuals of the different arthropod groups in the experimental sites, calculated through the Jaccard-Naumov's index exhibited differences during the three seasons. In spring, the similarity index reached its highest value - within the limits of 17 - 69 %, in the summer it showed the lowest value - 7-30 %, and in autumn it occupied the average place - 25-55 %. During the three seasons the highest similarity degree, compared to the control, was found in the experimental site by village Yamna. The lowest similarity during the spring and summer was found between the complexes in the experimental sites by the village Luga and in the locality Kashna, and in autumn - between the complexes in the experimental sites by the village Luga and locality Bash Samokov.

The total mean number of individuals in the arthropod communities in the different experimental sites also showed some differences. The data for the number of individuals on la"^{1} are presented on Fig.. 1. A clear seasonal dynamics could be established. In spring, the density varied from 501+99 to 2377±228 ind.-a"^{1}, in summer the density was between 80+20 and 1174±245 ind.-a"^{1}, and in autumn is showed the lowest value - between 71±13 and 247±53 ind.-a"^{1}. The differences observed were completely explainable with the climatic factors during the different seasons, especially temperature and humidity, which play a determining role in the development of the inhabitants of the herbaceous associations.

During the seasons, excluding the summer, the highest mean density of arthropod populations was measured in the control site. In spring, the population density in the control site was 4.7 times higher than this in the experimental site by the village Luga (P = 0.999), 2.7 times higher then this in the site in the locality Bash Samokov (P = 0.999), and 2.1 times higher than this in the site in the locality Kashana (P =0.99). Only the difference between the density of the control site and the experimental site by the village Yamna was insignificant from a statistical point of view.

In summer, the highest total number of arthropod was found in the experimental site in the locality Kashana, but the difference from the control site was not statistically reliable. In this season as well, the lowest total number of arthropod was found in the experimental site by village Luga. The density of arthropod population in the experimental site in the locality Kashana was 14.7 times higher than this in the site by Luga (P = 0.999), 5.2 times higher than this in the site in the locality Bash Samokov (P = 0.999), and 3.5 times higher than this in the site by village Yamna (P = 0.99).

In autumn, as it was in spring the highest total mean density exhibited the arthropod communities in the control site. This density was 3.5 times higher than density in the experimental site in the locality Bash Samokov (P = 0.99) and 2.4 times higher than this found in the site in the locality Kashana (P = 0.95). The difference between the density the control site and this in the rest experimental site were not statistically proved. During this season in contrast to the other seasons, a comparatively high density was found in the experimental site by the village Luga, which was due mainly to the number of individuals in the orders Diptera and Coleoptera.

Bearing in the mind the data for the total mean density of the arthropod communities in the studied experimental site we could conclude that the state of the ecosystem by village Luga, compared to the rest experimental site, was less favorable for' the numerical contribution of the atmobiont arthropods. Close to this situation was the ecosystem in the locality Bash Samokov in which the value the total mean density was also several times lowers than this found the control site. Vice versa, the results showed that the ecological conditions in the ecosystems in the locality Kashana were comparatively most favorable for the development of the arthropod inhabitants of the herbaceous layer a whole.

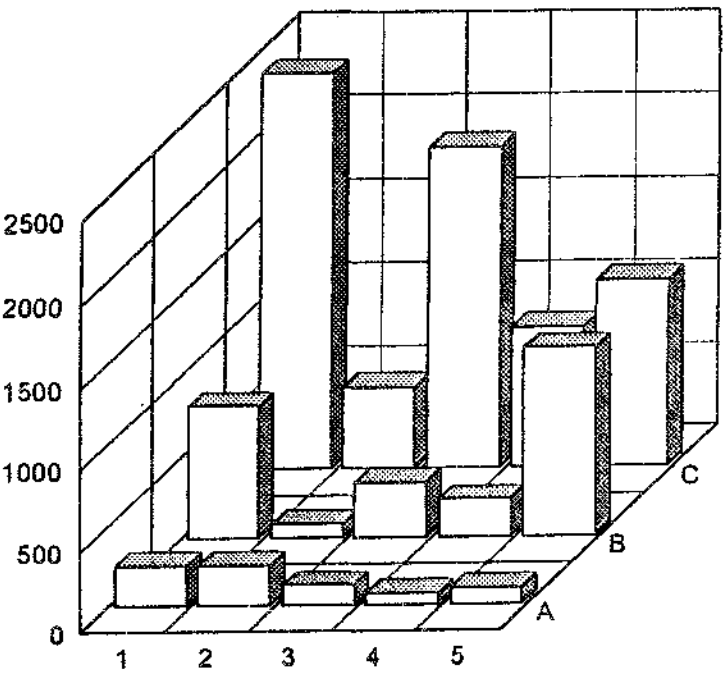

Fig. 1 Total numbers (number ind.$\cdot$a^{-1}) of the arthropods in the investigated grass ecosystems (1 to 5) during the seasons (1 - Control, 2 - Luga, 3 - Yamna, 4 - Bash Samokov, 5 - Kashana; A - autumn, B - summer, C - spring)

Сл. 1 Вкупен број (број инд.ca^{-1}) артроподи во истражуваните тревесте екосистеми (1-5) во текот на сезоните (1 - Контрола, 2 - Луга, 3 - Јамна, 4 - Баш Самоков, 5 - Кашана; A - есен, B - лето, C - пролет)

Dominant structure

The differences in the numerical relationships between the different arthropod groups reflected on the dominant structure of the arthropod communities.

In spring, the order Homoptera was dominant in number. Its relative degree of significance was considerably high - 45.7 %, In summer, there were two orders dominant in number of individuals - Coleoptera (29.5 % out of all individuals) and Diptera (25.6 % out of all individuals). In autumn, dominant in number of the individuals was only the order Coleoptera - 38.8 % degree of dominance.

In the experimental sites the degree of dominance in the different arthropod groups varied considerable during the seasons. In spring, the similarity of dominant between the arthropod complexes in the experimental sites was between 50 and 100%. The reason for this was the fact that more of the experimental sites the dominant arthropod group consisted of homopteras.

In summer, when the species diversity reached its highest rate, the dominant groups showed higher variation degree, the similarity was between 0 and 100 %. In most of the cases no similarity in the dominant complexes was established. Dominating in one or another experimental site were the orders Homoptera, Heteroptera, Coleoptera or Diptera.

In autumn, the dominant groups in the ex-perimental sites consisted of representatives from the orders Coleoptera and Diptera, The similarity in dominants in the experimental sites was between 0 and 100 %. The arthropod complex in the experimental site in the locality Ka-shana was completely different from the others (the similarity in dominants with the other complexes was 0 %; no dominant arthropod group was established).

When investigation on such problems as stated above are carried out, it should be taken into consideration that the changes in the numerical parameters of such big taxa as orders are not always were representatives because of the high species diversity of these arthropod groups It is possible, when material is processed at a lower taxonomic level certain fluctuations from the established tendencies to appear. Nevertheless, such studies provide the possibility for unambiguous conclusions that the different tech-nogenic emissions caused by man's activities can lead to significant changes in the structure of the communities of atmobiont arthropods from different trophic levels. The changes in the composition and number of the individuals of the different taxa are determined to a great extent by the strength and character of the pollution.

REFERENCES

Charles, P. J, Villemant, C. (1977). Modification des niveau de population d'insectes dans les jeunes plantation de pins sylvestres de la foret de Roumare (Seine-Maritime) soumise a la pollution atmos-pherique. Compt. rendus des seances de L'Acad. d'Agriculture de France, 63, 8; 502-510.

Чернов, К). (1975) ОСНОВНБШ СИНЗКОЛОГИ-ческие характеристики почвешшх беспозвоночнмх и методБ! их ана-лиза: 198-216, в: МетодБ! почвенно - зоологических исследовании, М., Наука.

Димитрова, М„, Маркова, Е„, Богданова, В, (1996). Биоакумулации на нмкои естествени радионуклиди в К-БСОПИ-палести скакалци (сем. Acrididae, разред Orthoptera). Почвознание, агрохемин и екологии, 31,6: 27-32.

Dunger, W., Dunger, I., Eugelmann, H. D., Schneider, R. (1974). Untersuchungen zur Longzeitwir-hung von Industrie-Emis-sionen auf Boden, Vegetation und Bod-senfauna des Nei Betales bei Ostritz/Oberlausitz. Abh. uhd Ber. Naturkundemus. Gorlitz., 4, 3: 405-412.

Гилров, М. (1974). Изучение беспоз-ВОНОЧНБГХ животнБгц как компонен-та биоценоза: 146-181, в: ДБШИС, Н. В. (ред,)„ Программа и методика биогеоценологических иселедова-нии, М„, Наука.

ХОТБЖО. З. И., Ветрова, С. Н. Матвеенко, А. А., Чумаков, Л. С. (1982). Почве-ННВіе беспозвоночнБхе ипромБиилен-НБ1е загрзненил, Минск, Наука и техника.

Катаев, О. А„, Голутвин, Г. И„, Селихов-кин, А. В. (1983V. Изменени.ч в сооб-идествах членестоногих леснБК био-ценосов при загрмзнении атмос-ферБ1. Знтомологическое обозре-ние, 62,1:33-41.

Lesniak, A. (1979). Wplyw neiktorych czyn-nikow antropocenicznych na owady lesne. Prace Instytut Badawczego Lesnictwa. Warszawa, 542-548, 113-114.

Штернбергс, М.Т. (1985). Воздеиствие ВБ1бросов цементного завода на пау-ков (Aranei) подстелки леса. (Загрлз-нение природнои средБ! калгциисо-држашеи ПБГЛБГО). Рига, Зинатне, 101-109.

Sierpinski, Z. (1970), Obserwacje Zjawisk hy-lopatologicznich owadiw w drzewosta-nach sosnowych objetych chronicznym dzialaniem przemyslowych zaniec zysz-czen powietrza. Sylwan., 5: 40-48.

Sierpinski, Z, (1972). Die Bedeutung der secun-daren Kiefemschadlinge in Gebeiten chroniscer Einwirkung industrieller Luft-vemneigungen. Mitt. Forstl. Bundes-veruchsanatalt., 97, 2: 609-615

Strojan, C. L. (1978). The impact of zing smelter emissions on forest litter arthropods Oikos, 31,3: 41-46

СТРУКТУРА НА АРТРОПОДНИТЕ ЗАЕДНИЦИ ВО ТРЕВЕСТИОТ КАТ ВО ЗАГАДЕНИ ЕКОСИСТЕМИ ОД ЧОВЕКОТ

Емилија МАРКОВА и Елица КОЈЧЕВА

Катедра за екологија и заштита на животната средина,
Биолошки факултет, Универзитет во Софија
Бул. "Д. Цанков" 8, 1421 Софија

РЕЗИМЕ

Беше испитувана структурата на заедниците на артроподи во тревестиот кат на загадени екосистеми од човекот. Анализите на повеќето артроподни групи покажаа статистички значајно намалување на бројот на артроподи за време на трите сезони скоро кај сите експериментални групи споредено со контролната група..

Некои групи на инсекти - фитофаги, поради своите физиолошки и еколошки карактеристики беа повеќе отпорни на загадување и покажаа зголемување на нивниот број во загадените области.,

Разликите во бројноста помеѓу различни групи на артроподи се одразува врз доминантната структура на артроподните заедници.

Резултатот од истражувањето покажа дека состојбата на екосистемот кај селото Луга, споредено со останатите експериментални групи, беше помалку погодена за бројното учество на артроподите во тревестиот кат. Со други зборови еколошката со-стојба во екосистемот во локалитетот Кашана беше споредбено најпогодна од овој аспект.