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Structure of collembolan and chortobiont communities in grass urboecosystems

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ABSTRACT. The results of long-term study of chortobionts (*Orthoptera*) and pedobionts (mainly *Collembola*) at anthropogenic grasslands inside a small city of diffusive type are discussed. The rate of demutation for orthopteran communities is more or less high, especially in comparison with vegetation cover, whereas the rate of transformation of grassland collembolan populations is slow. The "roadsides" community is standing on a chronic initial stage being very similar to that in technogenic landscapes.

INTRODUCTION

The main aim of this paper is to describe patterns of changing communities in connection with anthropogenic successions inside a small city of diffusive type. Evidently, it is connected with the problem of ecosystem stability. We have chosen two model ecological groups - pedobionts (mainly springtails - the order *Collembola*) and chortobionts (chiefly grasshoppers and katydids - the order *Orthoptera*) because they are known as the best markers of succession's processes.

We have investigated such communities in the main types of grass anthropogenic landscapes at Akademgorodok/Novosibirsk. It lies at the boundary between the forests and the steppes. Originally there were some pine, mixed and birch forests with different upland meadows (mainly steppe-like and dry). Now we can see a mosaic of these natural, seminatural and disturbed landscapes. The last-named ones include planted forests, parks with openings and edges, lawns, roads and their sides, gardens, agricultural fields, buildings. This paper is limited by an analysis of the local open plots with grassland vegetation.

Collembolan or microarthropods communities in the urboecosystems were studied in details in Warsaw (STERZYŃSKA 1981, 1982) and Moscow (KUZNETSOVA, BUGROV 1991, KUZNETSOVA 1995). The investi-gations in Russia were concerned with communities under wooden vegetation in general. Grass urboecosystems in continental climate were not investigated in this respect. The similar studies of orthopteran communities were more detailed, and general patterns of community changes were discussed (see SERGEEV 1987).

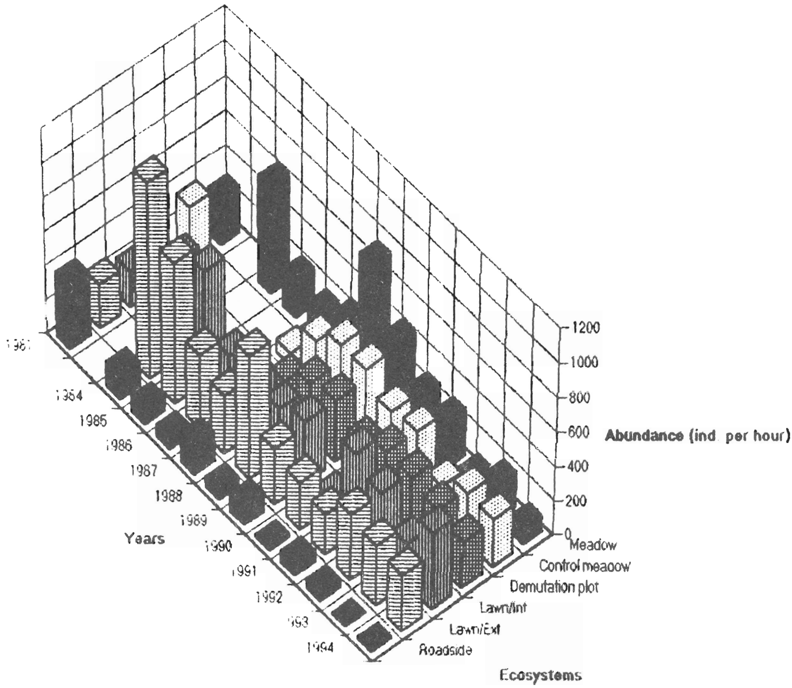
MATERIALS AND METHODS

The set of permanent plots has been used: (1) roadsides along highway; (2) a lawn nearby highway (at the distance about 100-500 m) - lawn/external; (3) a lawn in downtown of the sity - lawn/internal; (4) an experimental demutation plot - its vegetation and soil covers were destroyed in 1985-1986 during building construction; (5) a neighboring plot with meadow vegetation - the control one; (6) a wet secondary meadow and (7) an opening in birch forest - both nearby the lawn/internal.

The communities of microarthropods were studied during late autumn 1992-1993, early spring 1993, both in spring (May) and summer (July) 1994 (S.K.S.). 10-20 blocks of soil to depth 5 cm were cut from each studied ecosystems. The total volume of separate sample was 125 cm^3. The arthropods were extracted within three days of collection in standard funnel apparatus. The above mentioned "roadsides" ecosystem for microarthropods included not only edges of roads but a lawn itself along highway. We used a standard method of net catching of *Orthoptera* during fixed periods of time in every studied plot (see SERGEEV 1987) in 1981, 1984-1994 (M.G.S.). After that, we have compared our data for different types of landscapes, years and seasons.

RESULTS

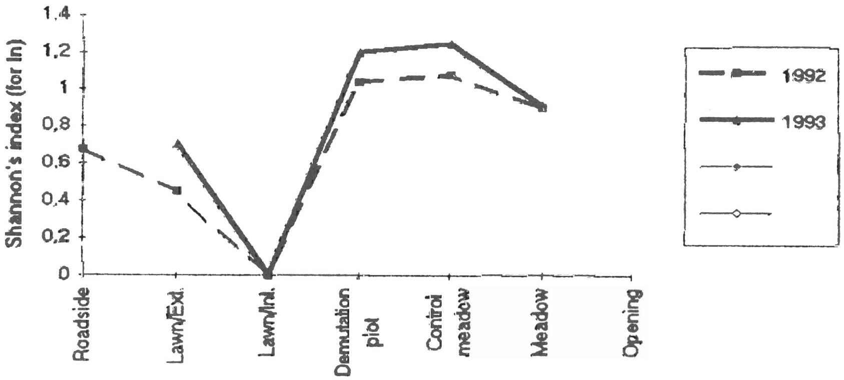
Chortobionts. Our data allows us to suggest an idea that the main reasons for changing of local *Orthoptera* communities are climatic variability and human activity. The former determines evident fluctuations of general abundance (Fig. 1). Species diversity of each community



1. Orthoptera abundance at anthropogenic grasslands

is not too changeable. The majority of local communities may be characterized as more or less stable (SERGEEV 1985, 1987). The results of human activities are more complicated. They are evident for the roadsides and the experimental disturbed plot (Fig. 1). The orthopteran communities of roadsides may be characterized by decreasing of abundance and diversity. That is a long-term trend. Such situation seems to be connected with increasing traffic pollution. It is interesting that the local roadsides are the main way for spreading (from the south to the north) and living of some typical steppe grasshoppers (*Dociostaurus brevicollis* (EVERSMANN), *Glyptobothrus dubius* (ZUBOVSKY), *Oedipoda caerulescens* (LINNAEUS)) (SERGEEV 1982, 1984, 1985).

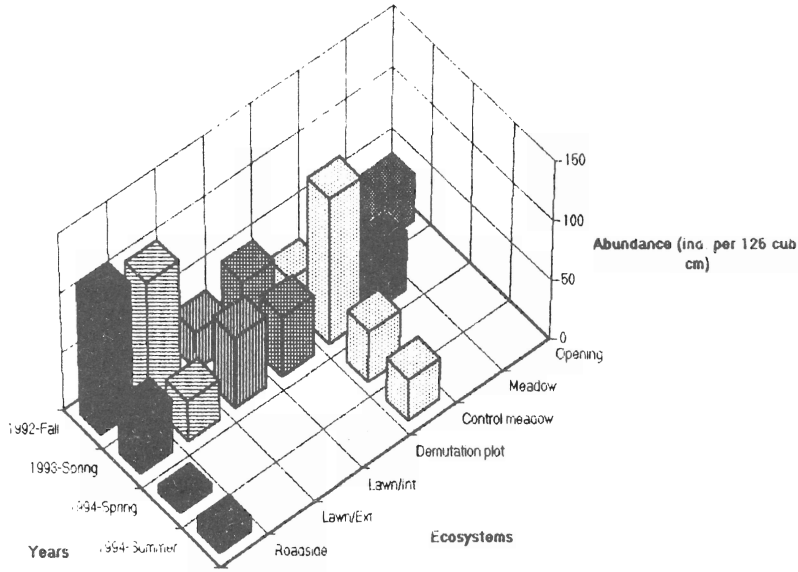
From the start, the experimental plot was settled by some widely distributed Palaearctic species (*Glyptobothrus biguttulus* (LINNAEUS)) usually associated with primary stages of successions. After first three years of demutation, the community included the main part of species for the neighboring control plot. Their abundance has reached the level of this natural (generally - semi-natural) community. After 5 years, the taxonomic and ecological features of both communities became very similar. The forms connected with natural meadows (katydids - *Bicolorana bicolor* (PHILIPPI); grasshoppers - *Euthystira brachyptera* (OCSKAY), *Chorthippus dorsatus* (ZETTERSTEDT)) might be observed on this stage of demutation. In 1994 the taxonomic compositions of the control and experimental plots were equal, and levels of general abundance were very close. It may be illustrated by SHANNON's index (Fig. 2). These indices for the control and demutation plots were nearly equal while on the roadsides and lawn/external these values were lower. Therefore, the rate of demutation for orthopteran communities is more or less high, especially in comparison with vegetation cover and pedobiont communities.



2. SHANNON's index for the orthopteran communities

Microarthropods. The total abundance of *Collembola* in disturbed grasslands in late autumn 1992 was higher than ones in the control meadow or the opening plot, decreasing permanently from 44 ths. to 12.7 ths. ind. per m^2 from the roadsides to lawn/internal (density of microarthropods ranged from 118.3 ths. to 57 ths. ind. per m^2). After winter, the collembolan abundance in the first site decreased in 3-4 times due to decreasing number of *Hypogastrura vernalis* (CARL) and *Proisotoma minuta* (TULLB.) juveniles. The very low density of *Collembola* was registered in dry summer 1994 (Fig. 3).

The share of *Collembola* in comparison with other groups of microarthropods varied from 18.3 to 37.4% in autumn 1992 and from 24.2 to 47.7% in spring 1993. In autumn, the participation of the *Oribatei* mites in all disturbed grasslands was in 4-8 times lower in

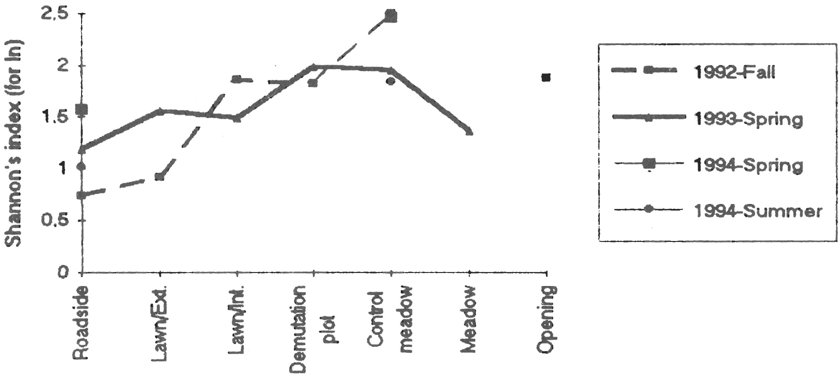


3. *Collembola* abundance at anthropogenic grasslands

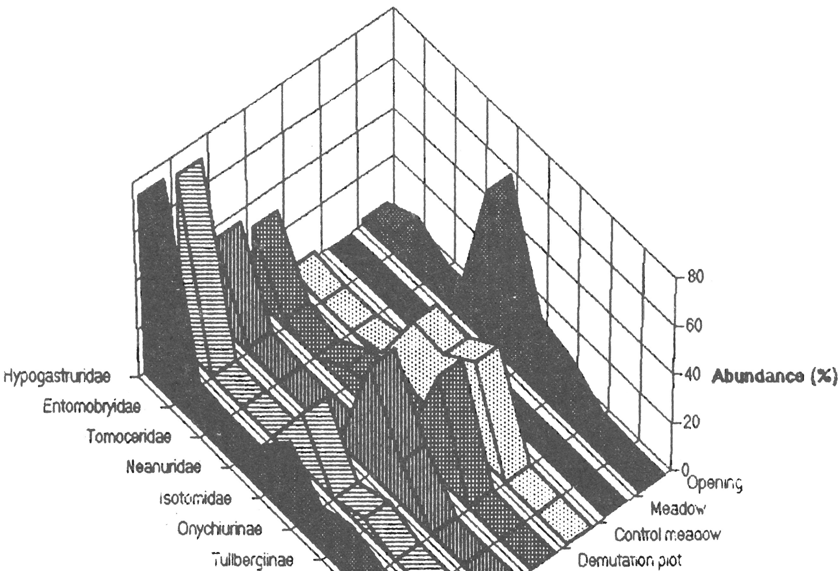
comparison with the control meadow. The share of *Gamasina* mites increased up to 19.2% on the demutation plot in spring 1993, but in autumn this value was not more than 10.4%.

During the three-year period of sampling a total of 48 collembolan species were found in all investigated grasslands though never more than 8-15 species were recorded in separate disturbed ecosystem during each sampling period. In the control meadow, 34 species were registered, in this case, 14 species of them were constant. The diversity of *Collembola* drastically reduced because of anthropogenic pressure, especially during unfavorable climatic conditions. So in the "roadsides" ecosystem, 10-14 species were recorded in 1992-1993 but only 4 of them occurred here in dry summer 1994. A total number of species for 3 years in roadsides was 21 but only 4 species registered here regularly. Fig. 4 shows SHANNON's indices for different collembolan communities. In roadsides, it was exceptionally low in late autumn 1992 as well as in dry summer 1994 (down to 1.0). In the control meadow, this index was highest in any season (1.8-2.5).

Fig. 5 shows the taxonomic structure of collembolan communities. In autumn 1992 the disturbed ecosystems were characterized by higher rate of *Hypogastruridae* (in general, due to *Hypogastrura vernalis*).



4. SHANNON's index for the springtail communities



From other families only *Isotomidae* was rather abundant on the roadsides and external lawn due to ruderal *Proisotoma minuta*. The control meadow differed from other sites by the dominance of species from the families *Isotomidae* and *Onychiuridae*. The secondary meadow, being studied in spring 1993, differed from the control site by dominance of *Tullbergiinae*, due to high abundance of *Mesaphorura ghilarovi* KHANISL. The species of forestry or wet meadow ecosystems as *Folsomia quadrioculata* (TULLB.), *F. volgensis* MART., *Isotoma (Parisotoma) notabilis* (SCHÄFF.) practically do not penetrate in lawns with high level of traffic pollution, but they are recorded as dominants or subdominants in both the control meadow and the glades of birch forests. The proportion and diversity of surface-dwelling springtails from the families *Entomobryidae (Drepanura quadrilineata* STEB.) and *Tomoceridae (Tomocerus minor* (LUB.), *T. minutus* TULLB.) on the lawns are rather low too, perhaps as a result of almost total absence of the litter.

The variety of large euedaphic forms of the subfamily *Onychiurinae* can be good test of disturbance of ecosystems. So the species of the genus *Onychiurus* s. str. can be dominants on the lawns under slight pollution, but the species of the genus *Protaphorura* practically absent on the roadsides and the external lawns. The only species of *Tullbergiinae* - *Mesaphorura macrochaeta* RUSEK was recorded in all investigated grasslands both in spring and autumn. In the control meadow, *Mesaphorura sylvatica* RUSEK and *Metaphorura affinis* BÖRN. were also characteristic species.

CONCLUSIONS

As a result of urbanization of grasslands, both of decreasing of diversity and transformation of communities among first of all springtails and oribatid mites are observed. The similar situation is described for *Orthoptera*. The very small share of the forestry collembolan species is the characteristic features of disturbed grasslands. Biocoenotic similarity of the collembolan communities (by coefficient of JACKARD 1902, modified by NAUMOV 1964) is rather high (about 70%) between the roadsides and the external lawns, but it is not more than 1.25-1.96% between the first one and the control meadow. As a whole, the pattern of urbotransformation of grassland collembolan communities in Siberia is similar to that in the forest Moscow urbosystems throughout the transition from forest-parks to boulevards (KUZNETSOVA, BUGROV

1991). Whereas a significant synanthropic transformation of collembolan communities is the characteristic feature for Warsaw (STERZYŃSKA 1992), it is not recorded in Siberian grass urboecosystems.

Demutation of orthopteran communities is more or less fast process. Such situation seems to be typical for grass landscapes. On the contrary, the rate of transformation of grassland collembolan populations in the direction of the natural meadow ones is rather slow. So the significant difference from the control sites is maintained in the 35 years old roadsides despite on the progress in vegetation successions. The "roadsides" community being standing on a chronic initial stage is very similar to that in technogenic landscapes.

ACKNOWLEDGMENTS

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REFERENCES

KUZNETSOVA, N. A., 1995, Formation and dynamics of collembolan population in soil of small isolate areas of urban greens, (In:) M. STERZYŃSKA (ed.) 4th Seminar on Apterygota, Polskie Pismo Entomol. **64**: 149-158.

KUZNETSOVA, N. A., BUGROV, S. A., 1991, The state of soil microarthropods complex in city wooden plantations, Problems of Soil Zoology, Novosibirsk: 235. (In Russian)

NAUMOV, R. L., 1964, Birds in the tick-borne encephalitis foci in Krasnoyarsk region: Thesis of candidate diss., Moscow: 19 pp. (In Russian)

SERGEEV, M. G., 1982, New localities for *Orthoptera* in Siberia and their possible zoogeographical significance. 1, (In:) Poleznye i vrednye nasekomye Sibiri, Novosibirsk: 42-46. (In Russian)

SERGEEV, M. G., 1984, *Orthoptera (Insecta)* community and population structure in an open-planned town, Novosibirsk Academic-Town, Izvestija SO AN SSSR, Serija biologicheskih nauk, N **13/2**: 122-125. (In Russian).

SERGEEV, M. G, 1985, *Orthoptera* community structure in grassy areas of an open-planned town, Novosibirsk Academic-Town, (In:) G. S.Zolotarenko (ed.) Antropogennye vozdejstvija na soobstshestva nasekomyh, Nauka Publ., Novosibirsk: 105-122. (In Russian).

SERGEEV, M. G., 1987, Patterns of *Orthoptera* communities formation in urbocoenoses, Zhournal Obstshej Biologii, **48**: 230-237. (In Russian).

STERZYŃSKA, M., 1981, Skoczogonki (*Collembola*), Fragmenta faunistica, **26** (10): 157-173.

STERZYŃSKA, M., 1982, Springtails (*Collembola*) of Warsaw and Mazovia, Memorabilia zool., **36**: 217-234.