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The biotopic group spectrum as a *Collembola* community characteristic

Abstract: Biotopic preferences of species can be useful for community characterization. Communities of soil micrarthropod Collembola consist of four categories of species: specialized to the natural biotope being examined, specialized to a different natural biotope, eurytopic and disturbed site species. Four categories of communities (specialized, eurytopic, modular, and ruderal communities) can be distinguished according to the dominance of different biotopic groups. Spectra of biotopic groups are found to be sensitive to human activities. The ratio between specialized and eurytopic species decreases both under industrial pollution and the degree of urbanization. A high diversity (due to high evenness) of biotopic groups is characteristic of modular collembolan communities in urban soils. Specialized collembolan communities are consequently replaced by eurytopic, modular and ruderal ones along gradients of human impact.

Key words: *Collembola*, community, biotopic groups, specialized and eurytopic species, human impact

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INTRODUCTION

Preference of a species for a certain biotope is considered to be a result of its relations with a particular complex of environmental factors. This peculiar relationship is usually shown in taxonomic keys as an environment characteristic of a given species noting, for example, its association with forest or bog sites. Biotopic groups have been successfully applied in studying the ecology of *Carabidae*, *Tenebrionidae*, *Acrididae* and other groups of insects (MORDKOVICH 1977, TURIN 2000 *et al.*).

During the last decade, the quantitative methods were applied to determine biotopic groups of collembolan species. As a result, five groups of species, each associated with a given habitat, were determined in Atlantic temperate grass-woodland ecosystems of France (PONGE 1993). The forest, bog, meadow, compost-ruderal, and eurytopic biotopic groups of species were distinguished in the mixed forest subzone of eastern Europe based on the usage of biotopic preference index and multidimentional scaling method (KUZNETSOVA 2002). Such quantitative approaches provide the basis for further application of obtained species characteristics. These data could be used as a characteristic of a collembolan community because species preferences for a biotope type are not absolute but quantitative. Any collembolan community consists of species belonging to different biotopic groups. For instance, species which are typical of open sites could be found in forest soils as well. An unusual mixed composition of these groups was found in urban soils (KUZNETSOVA 1994).

The aim of this paper is to study collembolan communities with respect to biotopic group composition.

MATERIALS AND METHODS

Collembolan communities were studied at three gradients: 1. pine forests arranged along the gradient of soil humidity, 2. bilberry pine forests along the gradient of industrial pollution (Cherepovets Integrated Iron and Steel Works), 3. lime plantations arranged along a gradient of degree of urbanization.

Description of habitats

1. Pine forests arranged along a gradient of soil humidity were investigated in Darwin's Reserve (58.5N 37.6E), southern taiga. Xeric lichen pine forest (*Pinetum cladinosum*) was 50-year old, crown cover density 0.6-0.7. It was dominated by *Cladonia* spp. (40% ground cover) and pure pine litter. Soil is weakly podzolic, sandy. Humus content 0.65%. Mesic bilberry pine forest (*Pinetum myrtillosum*) was 110-year old, crown cover density 0.8. It was dominated by *Vaccinium myrtyllus* L. Mosses (mainly *Pleurozium schreberi* (BRID.) covered a half of the soil surface, whilst the remainder was bare. Soil is weakly podzolic, gley-like. Litter thickness 8-15 cm, humus content 1.8-2.3%. In hydric sphagnum pine forest (*Pinetum sphagnosum*) pine trees, green mosses and *Vaccinium vitis-idaea* L. occupated about 30% of the surface. *Sphagnum* spp. covered 70% of the soil and included *Carex globularis* L., *C. nigra* REICH., *C. canescens* L., *Eriophorum vaginatum* L., *Vaccinium oxycoccus* L. Crown cover density was 0.5. Soil was peaty-podzolic, gley. The depth of the sphagnum layer was 8-10 cm, and that of turf was 15 cm.

2. Bilberry pine forests along a gradient of industrial pollution were studied near Cherepovets Integrated Iron and Steel Works. The bilberry pine forest investigated in Darwin's Reserve considered as the control one. It is located at 70 km off the soucer of pollution and beyond the 50-km zone of geochemical environmental disturbances. Sampling plots were placed at 14, 9 and 3.5 km (weakly, moderately, and highly polluted pines) to the south of the steel works. Metal dust averaged 150 t/km^2 per year at the highly polluted site and 35 t/km^2 at the weakly polluted site. The pine forest was damaged in the 12-km zone from the source, one-third of the trees were dry or had dry tops, green mosses contained increased concentrations of heavy metals. The soil was alkalified: the pH of its superficial layer was 2-3 units higher than in the control and had almost neutral soil reaction. The weakly and moderately polluted plots represented typical bilberry pine forests, whereas this primary forest type was transformed at a highly polluted plot: the coverage of mosses and dwarf shubs was reduced, and raspberry, nettle, and grases were dominants. At the first two cases the litter was 6-10 cm thick, of raw humus type. At a high level of pollution, the litter had an almost neutral soil reaction and its average thickness was 2-3 cm.

3. Lime plantations arranged along a gradient of urbanization. Natural lime forests (*Tilietum pilosae-caricosum*) which is dominated by *Carex pilosa* SCOP., *Stellaria holostea* L., and *Galeobdolon luteum* HUDS. were investigated in four different districts of Moscow Region placed in the broad-leaved forest subzone. The forests were 70 - 100 years old. The soil was loamy turfy-podzolic (дерново-подзолистая суглинистая), its pH varied from 5.1 to 6.3.

Forest-parks. Sites with lime trees of 60-120 year old were studed in six districts of Moscow. *Aegopodium podagraria* L. and *Geum urbanum* L. predominated in the grass cover. Upper soil layer had almost neutral soil reaction.

Urban parks and boulevards were investigated in seven districts of Moscow. Lime plantations were 70-120 years old. *Poa compressa* L. and other lawn grasses predominated. The soil had weak alkali reaction.

Single asphalt-surrounded lime trees were studied at three urban plots. Trees were 20-30 years old. The ground (4 m^2) under each tree was covered by gratings protecting it against human trampling. These gratings contribute to accumulation of different organic debris.

Sampling

Cores (25 cm^2 at natural habitats and 8 cm^2 at the most of urban plots) were taken through a whole litter in coniferous forests, but in *Pinetum sphagnosum* to a depth of 15 cm and up to 10 cm in lime stands. The cores were arranged in lines between tree trunks. Collembola were extracted from soil cores using Tullgren's funnels during 5-10 days.

1. Pine forests arranged along a gradient of soil humidity. 10-20 cores were taken annually in July from 1981 to 1984 and in 1995 for each forest type. 15 studied series included 255 cores and 20472 collembolan individuals of 55 species.

2. Bilberry pine forests along a gradient of industrial pollution. 15 cores were taken annually in May from 1991 to 1993 in each forest. A total of 135 cores were obtained, and 8019 springtails of 53 species were collected.

3. Lime plantations arranged along a gradient of urbanization. At least 10-20 cores were taken in each plot during 1988 - 1995 years. 19821 individuals of more than 70 species were determinated.

More detailed information about sites, sampling, extraction and statistical techniques is given elsewhere (KUZNETSOVA 1994, 1995, STERZYŃSKA & KUZNETSOVA 1997, KUZNETSOVA & POTAPOV 1997, KUZNETSOVA & KREST'JANINOVA 1998).

We used characteristics of biotopic preferences in *Collembola* according to KUZNETSOVA, 2002.

Table I. Relative abundance (%) of collembolan species in undisturbed pine forests (Darwin's State Reserve) and bilberry pine forests arranged along a gradient of industrial pollution. 1, 2, 3 – plots with weak (1), medium (2) and high (3) pollution. BG - biotopic groups of collembolan species according to Kuznetsova, 2002: F- forest, B – bog, M – meadow, E – eurytopic, CR – compost and ruderal groups.

Species	BG	Undisturbed pine forests			Polluted plots		
		lichen	sphagnum	bilberry	1	2	3
1	2	3	4	5	6	7	8
Schoettella ununguiculata (TULLB.)	F	2.90	0.00	0.03	0.03	0.10	0.00
Choreutinula inermis (TULLB.)	F	0.20	0.20	0.00	0.00	0.00	0.00
Hypogastrura assimilis (KRAUSB.)	CR	0.02	0.04	0.01	0.00	0.00	0.07
Ceratophysella denticulata (BAGN.)	CR	0.02	0.08	0.00	0.00	0.00	0.00
Xenylla brevisimilis GAMA	F	6.70	0.20	0.90	0.03	0.20	0.00
Willemia denisi MILLS	F	0.20	0.80	5.50	0.60	0.70	0.07
W. anophthalma BÖRN.	F	1.10	1.60	2.10	2.00	1.20	0.10
Friesea mirabilis (TULLB.)	E	0.05	0.00	0.01	0.00	1.30	3.90
Anurida granulata (AGRELL)	F	0.00	0.00	0.09	0.00	0.10	0.00
Pseudachorutes parvulus BÖRN.	F	0.00	0.00	0.00	0.20	1.80	0.07
P. corticollus (SCHÄFF.)	F	0.02	0.00	0.00	0.00	0.00	0.00
P. dubius KRAUSB.	?	0.50	1.30	0.20	0.03	0.40	0.00
Micranurida pygmaea BÖRN.	F	2.60	2.70	3.70	1.10	1.10	0.40
Neanura muscorum (TEMPL.)	F	0.02	1.10	0.10	0.40	0.40	0.20
Xenyllodes armatus (AXELS.)	F	0.06	0.00	0.00	0.00	0.00	0.00
Protaphorura armata GISIN	M	0.00	0.00	0.00	0.08	1.20	1.60
P. nemorata GISIN	F	23.30	0.10	2.20	0.00	0.00	0.00
Micraphorura absoloni (BÖRN.)	F	2.10	0.00	6.00	2.40	2.70	0.20
Mesaphorura macrochaeta RUSEK	E	2.90	0.40	8.60	4.60	3.80	0.50
Stenaphorurella quadrispina (BÖRN.)	M	0.00	0.00	0.00	0.03	0.00	0.00
Anurophorus septentrionalis PAL.	F	21.90	0.10	0.40	2.70	0.70	0.00
Pseudanurophorus binoculatus KSEN.	F	0.00	0.00	0.01	0.20	5.00	0.00
Folsomia quadrioculata (TULLB.)	E	0.05	0.04	3.30	8.60	3.60	5.90
F. fimetaria (L.)	CR	0.00	0.00	0.00	0.00	0.00	0.07
F. bisetosa GISIN	B	0.02	6.10	0.00	0.00	0.00	1.10
F. fimetarioides (AXELS.)	F	0.02	0.00	0.00	0.00	0.00	0.00
Proisotoma minima (ABSOL.)	F	0.02	0.04	0.00	0.06	0.20	1.80
Isotomiella minor (SCHÄFF.)	F	4.80	10.70	44.20	39.20	26.30	8.10
Parisotoma notabilis (SCHÄFF.)	E	1.00	0.80	5.50	4.00	12.10	41.40
P. ekmani FJELLB.	B	0.00	0.00	0.00	0.40	0.20	0.00
Desoria hiemalis (SCHÖTT)	F	19.40	5.30	4.60	15.00	5.40	0.40
D. tigrina (NIC.)	M	0.05	0.00	0.00	0.00	0.00	0.07
D. neglecta (SCHÄFF.)	B	0.00	14.30	0.00	0.00	0.00	0.00
Isotoma viridis BOURL.	E	0.50	11.50	0.07	0.30	1.10	0.60
Vertagopus westerlundi (REUTER)	F	0.02	0.00	0.00	0.03	0.00	0.00
Entomobrya nivalis (L.)	F	0.08	0.04	0.01	0.08	0.07	0.07
E. marginata (TULLB.)	F	0.40	0.08	0.30	0.03	0.07	0.40
E. corticalis (NIC.)	F	0.00	0.00	0.01	0.00	0.00	0.00
Orchesella flavescens (BOURL.)	F	0.30	0.70	0.40	0.03	0.20	0.10
O. bifasciata NIC.	F	0.60	0.10	0.60	0.30	0.40	1.05
Lepidocyrtus lignorum (FABR.)	E	7.20	1.50	3.00	4.60	10.70	1.40

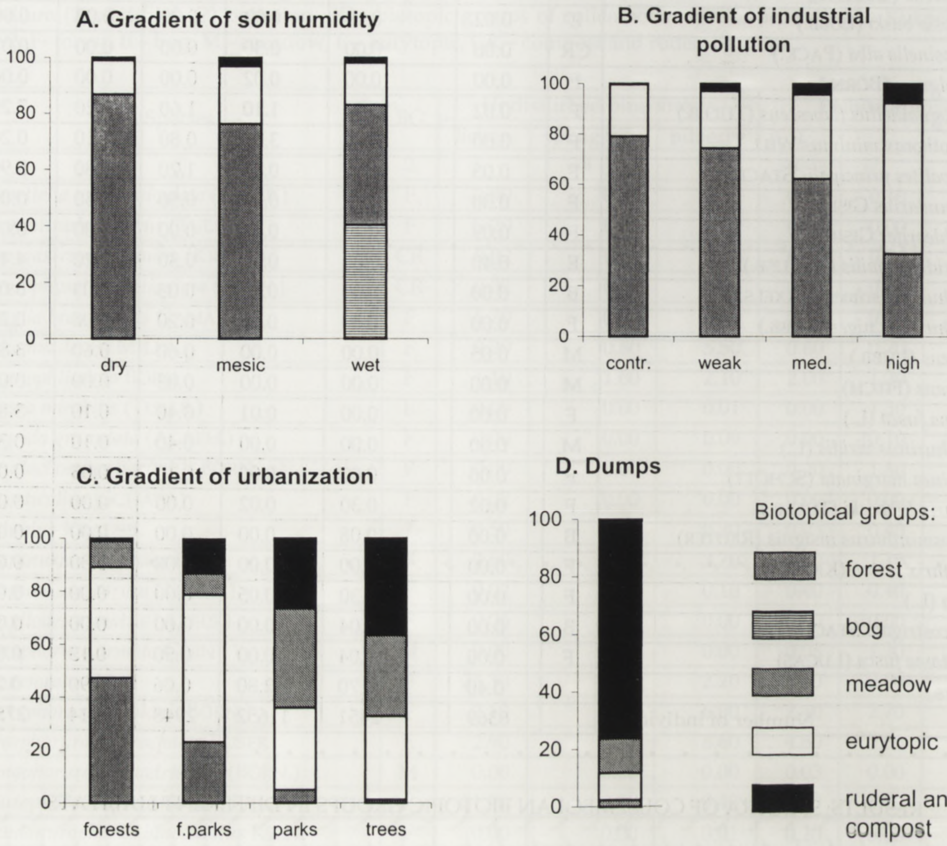
1	2	3	4	5	6	7	8
L. violaceus (GEOFFR.)	E	0.00	0.10	0.01	0.03	0.03	0.70
Willowsia buski (LUBB.)	E	0.02	0.10	0.02	0.00	0.00	0.00
Pseudosinella alba (PACK.)	CR	0.00	0.00	0.30	0.00	0.00	0.07
P. wahlgreni (BÖRN.)	F	0.00	0.00	0.02	0.00	0.00	0.00
Pogonognathellus flavescens (TULLB.)	F	0.02	11.60	1.10	1.60	1.20	7.20
Megalothorax minimus WILL.	F	0.00	0.90	3.00	0.80	1.10	0.20
Arrhopalites principalis STACH	F	0.03	0.80	0.60	1.20	1.80	5.90
A. secundarius GISIN	F	0.00	0.00	0.06	0.50	0.30	0.00
A. cochlearifer GISIN	F	0.09	0.20	0.09	0.00	0.00	0.00
Sphaeridia pumilis (KRAUSB.)	E	0.40	0.00	0.20	0.30	0.20	4.40
Sminthurides schoetti (AXELS.)	B	0.00	0.00	0.00	0.03	0.03	0.00
Sminthurinus niger (LUBB.)	F	0.00	0.00	0.09	0.20	1.00	0.20
S. aureus (LUBB.)	M	0.05	0.00	0.00	0.60	0.60	3.80
S. elegans (FITCH)	M	0.00	0.00	0.00	0.03	0.00	0.00
Allacma fusca (L.)	F	0.00	0.00	0.01	0.40	0.10	3.80
Sminthurinus viridis (L.)	M	0.00	0.00	0.00	0.40	0.10	0.30
Caprainea marginata (SCHÖTT)	F	0.00	0.00	0.00	0.10	0.03	0.00
Lipothrix lubbocki (TULLB.)	F	0.02	0.30	0.02	0.00	0.00	0.00
Heterosminthurus insignis (REUTER)	B	0.00	0.08	0.00	0.00	0.00	0.00
Ptenothrix setosa (KRAUSB.)	F	0.00	0.00	0.00	0.08	0.00	0.00
P. atra (L.)	F	0.00	1.30	0.05	0.00	0.00	0.00
P. leucostrigata STACH	B	0.00	0.04	0.00	0.00	0.00	0.00
Dicyrtoma fusca (LUCAS)	F	0.00	0.04	0.00	0.50	0.13	0.00
Others		0.40	0.70	2.80	0.06	0.90	0.20
Number of individuals		6369	2451	11652	2948	2314	2757

RESULTS: SPECTRA OF COLLEMBOLAN BIOTOPIC GROUPS IN DIFFERENT HABITATS

1. *Pine forests arranged along a gradient of soil humidity*. Relative abundances of collembolan species and characteristics of their biotopic preferences are presented in Table I. The spectra of collembolan biotopic groups calculated on the basis of these data demonstrate dominance of forest collembolan species in mesic and xeric pine forests (Fig. 1A). In wet sphagnum forests the bog group of *Collembola* was abundant, as well as the forest biotopic group. Few eurytopic or ruderal species were present in any of the forest biotopes.

2. *Bilberry pine forests along a gradient of industrial pollution*. The spectra of the collembolan biotopic groups (Fig. 1B) were obtained from the data of Table I. With an increase in pollution the eurytopic group replaced the forest collembolan group.

3. *Lime plantations arranged along a gradient of urbanization*. Forest and eurytopic groups of *Collembola* dominated natural lime forests (Table II, Fig. 1C). The same was true for springtail communities in forest-parks but the latter differed by the presence of compost and ruderal species. In urban parks, boulevards and lawns, collembolan communities consisted of eurytopic, meadow, compost and ruderal species. The forest group of springtails was reduced here. Similar spectra of biotopic groups were typical of the ground under single trees surrounded by pavement.



Figs 1A–1D. Biotopic group spectra of collembolan communities in different habitats.

DISCUSSION

Four categories of species can be distinguished in collembolan communities:

– specialized to the natural biotope being examined, for example, forest species of springtails (*Anurophorus septentrionalis*, *Willemia anophthalma* etc.) in any forest biotope or bog collembolan species (*Sminthurides schoetti*, *Podura aquatica* etc.) in a bog biotope;

– specialized to a different natural biotope, for example, forest species of *Collembola* (*Anurophorus septentrionalis*, *Willemia anophthalma* etc.) in any natural meadow or meadow springtail species (*Metaphorura affinis*, *Stenaphorurella quadrispina* etc.) in a forest biotope;

– eurytopic – not specialized to any one biotope;

– disturbed site species (ruderal = species specialized for weedy habitats and compost).

Table II. Relative abundance (%) of collembolan species in lime forests and at urban sites (1 – KUZNETSOVA 1994, 2 – STERZYŃSKA & KUZNETSOVA, 1997, 3 – Kuznetsova 1995 and unpublished data from the same plots collected during 1995). BG – biotopic groups, their designations in Table 1.

Species	BG	Lime forests[1]	Forest parks[2]	Parks[1]	Single trees[3]
1	2	3	4	5	6
Schoettella ununguiculata (TULLB.)	F	0.00	0.00	0.02	0.40
Hypogastrura assimilis (KRAUSB.)	CR	0.00	0.01	0.80	0.30
H. distincta (AXELS.)	CR	0.00	0.00	0.00	0.03
Ceratophysella succinea GISIN	CR	0.00	0.00	2.10	22.50
C. denticulata (BAGN.)	CR	0.00	0.03	1.00	0.00
Xenylla brevisimilis GAMA	F	0.00	0.04	1.40	0.00
X. grisea AXELS.	R	0.00	0.00	0.00	0.00
X. welchi FOLS.	R	0.00	0.00	0.00	0.00
Willemia denisi MILLS	F	0.08	0.01	0.00	0.01
W. anophthalma BÖRN.	F	0.05	0.06	0.00	0.00
W. intermedia MILLS	M	0.00	0.00	0.60	1.20
Micranurida pygmaea BÖRN.	F	0.10	0.05	0.04	0.80
Friesea mirabilis (TULLB.)	E	0.40	2.90	1.00	2.80
Neanura muscorum (TEMPL.)	F	0.30	0.10	0.10	0.00
Pseudachorutes parvulus BÖRN.	F	6.20	0.10	0.50	0.04
Xenyllodes armatus (AXELS.)	F	0.00	0.00	0.05	0.00
Protaphorura armata GISIN	M	9.10	5.30	20.70	10.30
Onychiurus sp.gr. *fimetarius* DENIS	CR	0.00	0.40	1.10	0.00
Archaphorura naglitschi GISIN	CR	0.00	0.00	0.00	0.60
Micraphorura absoloni (BÖRN.)	F	2.30	0.09	0.03	0.02
M. macrochaeta RUSEK	E	1.30	7.00	11.00	21.90
Stenaphorurella quadrispina (BÖRN.)	M	0.20	1.00	1.40	0.30
Neotullbergia crassicuspis GISIN	M	0.00	0.00	0.50	0.70
Neonaphorura adulta GISIN	M	0.00	0.01	0.20	0.00
Metaphorura affinis (BÖRN.)	M	0.00	0.70	2.50	9.60
Pseudanurophorus binoculatus KSEN.	F	0.30	0.00	0.06	0.00
Isotomodes productus (AXELS.)	M	0.00	0.00	0.50	6.60
Folsomides parvulus STACH	M	0.00	0.20	0.00	0.00
F. quadrioculata s.l. (TULLB.)	E	12.40	7.69	0.20	0.07
F. fimetaria (L.)	CR	0.00	0.50	1.40	0.60
F. fimetarioides (AXELS.)	F	0.00	0.00	0.01	0.00
F. lawrencei RUSEK	CR	0.00	5.90	1.10	3.20
Isotomina bipunctata (AXELS.)	CR	0.00	0.80	12.80	0.10
Proisotoma minima (ABSOL.)	F	0.08	0.01	0.00	0.00
P. minuta (TULLB.)	CR	0.00	0.09	1.20	0.10
Isotomiella minor (SCHÄFF.)	F	28.20	13.80	1.80	0.20
Isotoma notabilis (SCHÄFF.)	E	20.60	23.30	8.20	11.50
I. viridis BOURL.	E	0.00	1.20	0.00	0.00
I. anglicana LUBB.	M	0.00	0.00	8.70	0.60
I. tigrina (NIC.)	M	0.00	0.10	0.70	0.10
I. hiemalis (SCHÖTT)	F	0.08	0.40	0.00	0.00

1	2	3	4	5	6
Isotomurus palustris (MÜLL.)	B	0.00	0.30	0.01	0.00
Entomobrya nivalis L.	F	0.00	0.20	0.04	0.00
E. marginata (TULLB.)	F	0.00	0.00	0.01	0.00
E. corticalis (NIC.)	F	0.00	0.03	0.02	0.00
Orchesella flavescens (BOURL.)	F	0.40	0.07	0.00	0.00
O. cincta (L.)	F	0.00	0.30	0.20	0.00
Heteromurus nitidus (TEMPL.)	CR	0.00	1.00	0.60	0.05
Sinella coeca (SCHÖTT)	CR	0.00	0.03	0.03	0.00
Willowsia buski (LUBB.)	E	0.00	0.00	0.08	0.20
Lepidocyrtus lignorum (FABR.)	E	6.40	12.80	5.10	0.40
L. cyaneus (TULLB.)	E	0.00	0.00	3.10	0.00
L. violaceus (GEOFFR.)	E	0.08	0.30	0.80	0.00
Pseudosinella alba (PACK.)	CR	1.00	3.60	4.30	2.60
P. wahlgreni (BÖRN.)	F	0.00	0.00	0.01	0.00
Pogonognathellus flavescens (TULLB.)	F	0.80	0.50	0.00	0.00
P. longicornis (MÜLL.)	F	0.00	0.01	0.00	0.00
Tomocerus vulgaris (TULLB.)	F	0.00	0.08	0.07	0.00
Sphaeridia pumilis (KRAUSB.)	E	0.60	0.40	1.20	0.02
Sminthurides schoetti (AXELS.)	B	0.00	0.00	0.01	0.00
Arrhopalites principalis STACH	F	0.05	0.01	0.00	0.00
A. caecus (TULLB.)	CR	0.00	0.00	0.00	0.40
Sminthurinus niger (LUBB.)	F	0.00	0.70	0.10	0.04
S. aureus (LUBB.)	M?	0.50	0.40	0.90	0.01
S. elegans (FITCH)	M	0.00	0.20	0.50	1.00
Lipothrix lubbocki (TULLB.)	F	0.00	0.00	0.03	0.00
Allacma fusca (L.)	F	0.00	0.01	0.00	0.00
Sminthurus viridis (L.)	M	0.00	0.03	0.04	0.00
Caprainea marginata (SCHÖTT)	F	0.20	0.02	0.00	0.00
Stenacidia violacea (JEAN.)	CR	0.00	0.00	0.05	0.00
Ptenothrix atra (L.)	F	0.00	0.05	0.00	0.00
Dicyrtoma fusca (LUCAS)	F	0.20	2.20	0.20	0.00
Dicirtomina minuta (FABR.)	M	0.00	0.01	0.00	0.00
Deuterosminthurus repandus (AGREN)	M	0.00	0.02	0.03	0.00
D. bicinctus (KOCH)	E	0.00	0.01	0.00	0.00
Bourletiella hortensis (FITCH)	M	0.00	0.01	0.20	0.00
Megalothorax minimus WILL.	F	8.00	4.10	0.30	0.03
Others		0.00	0.01	0.11	0.50
Number of individuals		1346	9499	2496	6480

This interpretation of biotopic groups allows us to compare different communities and to reveal interesting aspects of their structure. For example, different types of habitats may differ in the ratio of eurytopic and specialized collembolan species. Thus, specialized groups dominate in coniferous forests and bogs of the taiga zone. Broad-leaved forests have a larger share of eurytopic springtails than coniferous forests. Eurytopic species usually dominate meadow soils while species specialized to open sites usually do not exceed 25%.

Collembolan communities in xeric, mesic and hygric pine forests are very different (KUZNETSOVA & KRESTJANINOVA 1998). However, in all investigated forests specialized springtail species always dominate, although they can be represented by a different species group, for example, only forest *Collembola* occur in drier forests but both forest and bog species occur in wet ones.

Spectra of biotopic groups are found to be sensitive to human activities. The ratio between specialized and eurytopic species decreases both under industrial pollution and the degree of urbanization. A high diversity (due to high evenness) of biotopic groups is characteristic of collembolan communities in urban soils (Fig. 1C). This kind of diversity is supposed to be an evidence of habitat disturbance (KUZNETSOVA 1994).

We believe that the whole community can be considered as specialized one if specialized species form its significant part. Our calculations showed the average share of specialized forest species of Collembola in studied coniferous and broad-leaves forests to be 54±14 % (X ± SE). That is why, 40 % (X - SE) can be used as an acceptable threshold of specificity for collembolan communities. Such specialized collembolan communities are typical of the majority of undisturbed habitats, especially coniferous forests. Sometimes there are two groups of specialized species, for example, forest and bog *Collembola* species in a sphagnum pine forest-bog.

Three other categories of community could be distinguished according to the dominance of different biotopic groups: specialized, eurytopic, modular and ruderal ones. The eurytopic species prevail in eurytopic communities and specialized groups do not amount to 40 % of the total abundance. Most meadows, some broad-leaved forests and forest-parks usually support this type of collembolan community. The modular communities include species from different biotopic groups (specialized, eurytopic, ruderal and/or compost springtails) which areabundant at the same site. Such combined communities are characteristic of disturbed habitats, for example urban soils. The ruderal communities are distinguished by the prevalence of only ruderal or compost species (for example, urban dumps – Fig.1 D).

Specialized collembolan communities are seemed to be consequently replaced by eurytopic, modular and ruderal ones along gradients of human impact. Thus, even the broadest approach to distinguishing of the biotopic groups in *Collembola* (without their vertical preferences or their distribution in different variants of forest, meadow and bog habitats) allows to reveal some trends in community changes along the gradients of environment disturbance.

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STRESZCZENIE

[Tytuł: Charakterystyka zgrupowań *Collembola* w oparciu o analizę grup biotycznych]

W pracy rozważana jest biotopowa specyficzność gatunków. W oparciu o analizę struktury dominacji różnych grup biotopowych wyróżniono cztery kategorie zgrupowań: wyspecjalizowane, eurytopowe, modularne i ruderalne. Zmiany w zakresie grup biotopowych były badane w biotopach uszeregowanych w gradiencie wilgotności gleby, zanieczyszczenia przemysłowego i stopnia zurbanizowania. Okazało się, że względna liczebność gatunków wyspecjalizowanych spada, zaś udział gatunków eurytopowych wzrasta wraz z zanieczyszczeniem przemysłowym i urbanizacją badanego obszaru. Zmiany w zakresie grup biotopowych mogą odzwierciedlać stan przekształcenia ekosystemu i stopień zakłóceń antropogenicznych.