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COMPOSITION AND SEASONAL DYNAMICS OF COLLEMBOLAN COMMUNITY IN TWO FOREST HABITATS ON JASTREBAC MOUNTAIN, SERBIA

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The qualitative-quantitative composition of Collembolan community has been studied during five years in two different plant communities - a middle-aged beech forest and adjacent young spruce forest, planted after clear-cutting the beech - on mountain Jastrebac. Seventy-four Collembolan species were recorded in the study sites. Their total abundance varied from 13000 to 100000 ind sq.m in beech stand, and from 38000 to 90000 ind sq. m in spruce stand. The Collembolan community is characterized by the dominance of a few species representing a high percentage of individuals. The studied community in Jastrebac is characterized by a relatively high number of Collembolan species and by their high density as well.

KEY WORDS: Collembola, community, species composition, seasonal dynamics.

INTRODUCTION

Collembola are the most numerous insects in terrestrial ecosystems, and they have a very wide distribution, occurring in all parts of the world where sufficient moisture is present to permit the growth of any vegetation (NOSEK, 1981). The majority of Collembola live in some association with the soil. Most exist either in the soil, on the surface, or in associated habitats such as mulch, leaf mold, dung, and animal nests and burrows (CHRISTIANSEN, 1964). They are among the major components of the decomposer community, specifically involved in the formation of soil humus. They show varying degrees of tolerance to different environmental factors such as the soil structure and its type, the soil pore size, the presence of micro-flora, and moisture content (MATIĆ, 1995).

This research was conducted on two localities - a middle-aged beech forest (*Fagus moesisca*) and adjacent young spruce forest (*Picea excelsa*), planted after clear-

cutting the beech. Although large areas of Yugoslavia have been forested with conifers in the last 40 years, their soil micro-arthropod communities have been very little studied. The purpose of this paper was to investigate the composition and seasonal dynamics of Collembolan community in a beech habitat subjected to the introduction of spruce as a result of forest management on mountain Jastrebac in central Serbia.

DESCRIPTION OF HABITATS

The localities are situated approximately 25 km south of Kruševac (central Serbia) and 5 km northwest of V. Dulica (1491), the peak of mountan Jastrebac, at an altitude of 700 m. The localities were situated 100 m apart.

The middle-aged beech forest is an integral part of the dominant beech belt on mountain Jastrebac. On the study area (1 ha) the tree height was 10-22 m, with diameters ranging from 15-50 cm. The canopy closure was incomplete (70-80%). The middle-story is poorly developed. The understory is composed mainly of *Carex sylvatica, Viola sylvestris, Festuca drymeia, Rubus hirtus* and *Hedera helix*. The litter layer up to 3 cm thick is uniform, and mainly composed of beech leaves in various phases of decomposition.

The spruce forest was a 1 ha, triangular tract of plantation, intergrading into the beech study area, and planted 30 years ago after clear-cutting the beech. The trees are of the same age, 5-12 m high and 7-11 cm in diameter. The canopy structure is not well formed and has a low coverage. The middle- and understories are well developed and with complete coverage. The species *Carpinus betulus, Rubus glandulosus, Dentaria bulbifera, Festuca montana, Galium sylvaticum, Agrostis canina* and *Pteridium aquilinum* are dominant. Litter depth was uniform (about 10 cm), the composition of which was mainly non spruce.

MATERIAL AND METHODS

Material for the study of Collembola was obtained from the soil samples taken seasonally from spring 1984. to autumn 1988. During 1987. samples were taken monthly, from May to October. From each sampling area, in each sampling period ten 15 x 15 cm random samples of soil (SOUTHWOOD, 1978) in a vertical profile down to 10 cm of depth (undecomposed and partly decomposed plant residues), were collected. The extration of Collembola was performed using Tullgren funnels (HAARLOV, 1947; MACFADYEN, 1953): The ten samples were subsequently pooled, and used for further analyses. A total of 360 samples was analyzed with respect to species composition and abundance. The material is deposited in the collection of Institute for biological research "Siniša Stanković" in Belgrade.

RESULTS AND DISCUSSION

Though it exists an abundant literature on Collembolan communities in temperature areas, no many comparative studies have been undertaken to show both seasonal and structural variations of the Collembolan populations in different plant communities simultaneously. A five-years investigation of the two forest stands of Jastrebac mountain resulted in registration of 74 Collembolan species with 46885 individuals. A total number of individuals and the frequency for each species in pooled monthly samples for the whole investigated period is presented on Table I.

Table I

Composition of Collembolan community from 1984. to 1988.

(N - total number of individuals; F - frequency %)

Species	Beech stand		Spruce stand	
	N	F	N	F
Brachystomella parvula	49	27.8	0	0
Cyphoderus bidenticulatus	6	16.7	0	0
Entomobrya bimaculata	0	0	3	5.5
Entomobrya corticalis	39	5.5	0	0
Entomobrya elegans	11	16.7	0	0
Entomobrya handschini	0	0	12	27.8
Entomobrya lanuginosa	81	55.5	128	55.5
Entomobrya multifasciata	118	100	156	77.8
Entomobrya muscorum	120	100	12	27.8
Entomobrya myrmecophila	0	0	30	61.1
Entomobrya quinquelineata	54	50.0	317	61.1
Entomobrya schoetti	0	0	17	11.1
Folsomia decophtalma	1078	16.7	0	0
Folsomia inoculata	40	16.7	0	0
Folsomia microchaeta	305	83.3	226	33.3
Folsomia multiseta	5020	100	3629	100
Folsomia quadrioculata	7567	100	8459	100
Folsomia spinosa	0	0	205	33.3
Folsomia thalassophila	122	77.8	0	0
Heteromurus hispanicus	13	11.1	0	0
Heteromurus major	29	22.2	92	33.3

Species	Beech stand		Spruce stand	
	N	F	N	F
Heteromurus tetrophthalmus	0	0	34	55.5
Hypogastrura assimilis	35	33.3	789	61.1
Hypogastrura denticulata	0	0	11	5.5
Hypogastrura granulata	0	0	205	22.2
Hypogastrura luteospina	35	33.3	39	22.2
Hypogastrura manubrialis	0	0	21	22.2
Hypogastrura parva	129	11.1	38	11.1
Hypogastrura socialis	408	94.4	1208	100
Hypogastrura succinea	2037	66.7	1963	94.4
Hypogastrura vernalis	0	0	7	11.1
Isotoma montana	0	0	56	27.8
Isotoma notabilis	69	61.1	301	66.7
Isotoma viridis	45	22.2	86	33.3
Isotomiella minor	148	88.9	340	100
Isotomina bipunctata	0	0	10	16.7
Isotomina thermophila	0	0	3	11.1
Isotomurus palustris	0	0	106	27.8
Isotomurus schaefferi	0	0	18	27.8
Lepydocyrtus curvicollis	215	100	347	88.9
Lepydocyrtus lanuginosus	936	100	446	94.4
Lepydocyrtus violaceus	42	33.3	0	0
Lipothrix lubbocki	0	0	41	33.3
Neanura carolli	242	100	535	100
Neanura conjuncta	0	0	14	16.7
Neanura villosa	18	33.3	7	16.7
Onychiurus armatus	0	0	557	100
Onychiurus fimatus	1622	100	2059	100
Onychiurus glebatus	387	61.1	325	22.2
Onychiurus terricola	0	0	143	16.7
Orchesella bulgarica	0	0	22	22.2
Orchesella cincta	0	0	10	27.8
Orchesella multifasciata	0	0	28	11.1
Orchesella spectabilis	3	11.1	46	61.1
Pseudosinella alba	101	61.1	31	33.3
Pseudosinella duodecimocellata	414	33.3	44	33.3

Species	Beech stand		Spruce stand	
	N	F	N	F
Pseudosinella duodecimopunctata	55	61.1	34	27.8
Pseudosinella fallax	0	0	6	5.5
Pseudosinella octopunctata	0	0	17	22.2
Pseudosinella petterseni	0	0	15	5.5
Pseudosinella sexoculata	28	27.8	39	33.3
Siera domestica	4	11.1	0	0
Sminthurides pumilis	0	0	98	66.7
Sminthurinus aureus	81	5.5	236	100
Sminthurinus elegans	39	83.3	197	100
Sminthurus fuscus	36	55.5	102	66.7
Sminthurus maculatus	15	44.4	0	0
Tomocerus baudoti	92	33.3	428	100
Tomocerus flavescens	0	0	10	11.1
Tomocerus longicornis	0	0	7	11.1
Tomocerus minor	0	0	65	55.5
Tomocerus minutus	0	0	37	50
Tomocerus terrestralis	176	100	305	100
Tomocerus vulgaris	0	0	49	27.8

A total of 43 Collembolan species with 22064 individuals in the beech forest samples is registered, compared to 63 species with 24821 individuals in the spruce forest samples. A total of 32 species was shared by two sets of samples corresponding to a 60% similarity of species composition (S').

For the beech community 11 species and for the spruce community 31 species are characteristic. Between characteristic species in beech only *Folsomia thalassophila* is characterized with high frequency (77.8%). Between characteristic species in the spruce dominated species with low frequency, with an exception of *Onychiurus armatus* (100% frequency).

Species *Folsomia multiseta*, *F. quadrioculata, Neanura carolli, Onychiurus fimatus* and *Tomocerus terrestralis* in both communities occurred with a frequency of 100% among the months and they represent constant species. Apart from this, in the beech community constant species are *Entomobrya multifasciata, E. muscorum* and *Lepydocyrtus lanuginosus* (frequency rate of 1), while five more species had an occurrence rate higher of 0.75. This thirteen constant species accounted for 30.2% of the species composition in beech community. In the spruce community constant

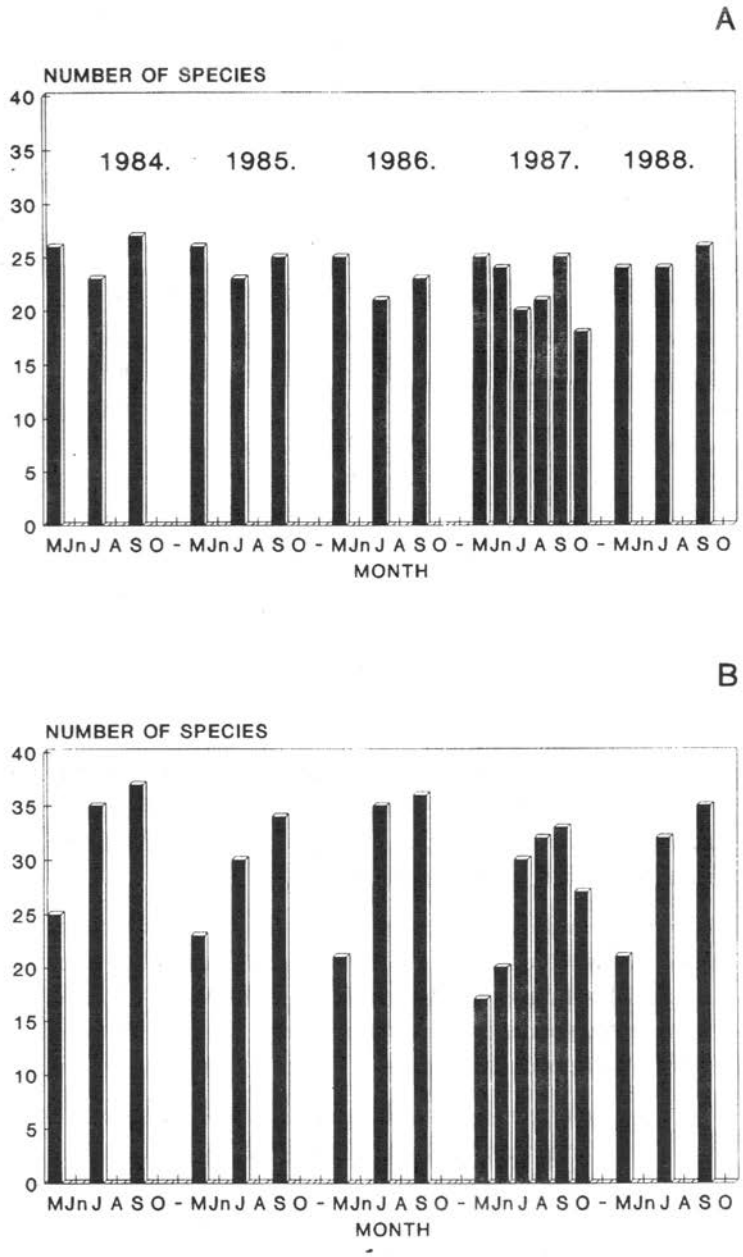

Fig. 1. - Composition of the Collembolan community in two stands: A-beech, B-spruce; (M – May, Jn – June, J – July, A – August, S – September, O – October)

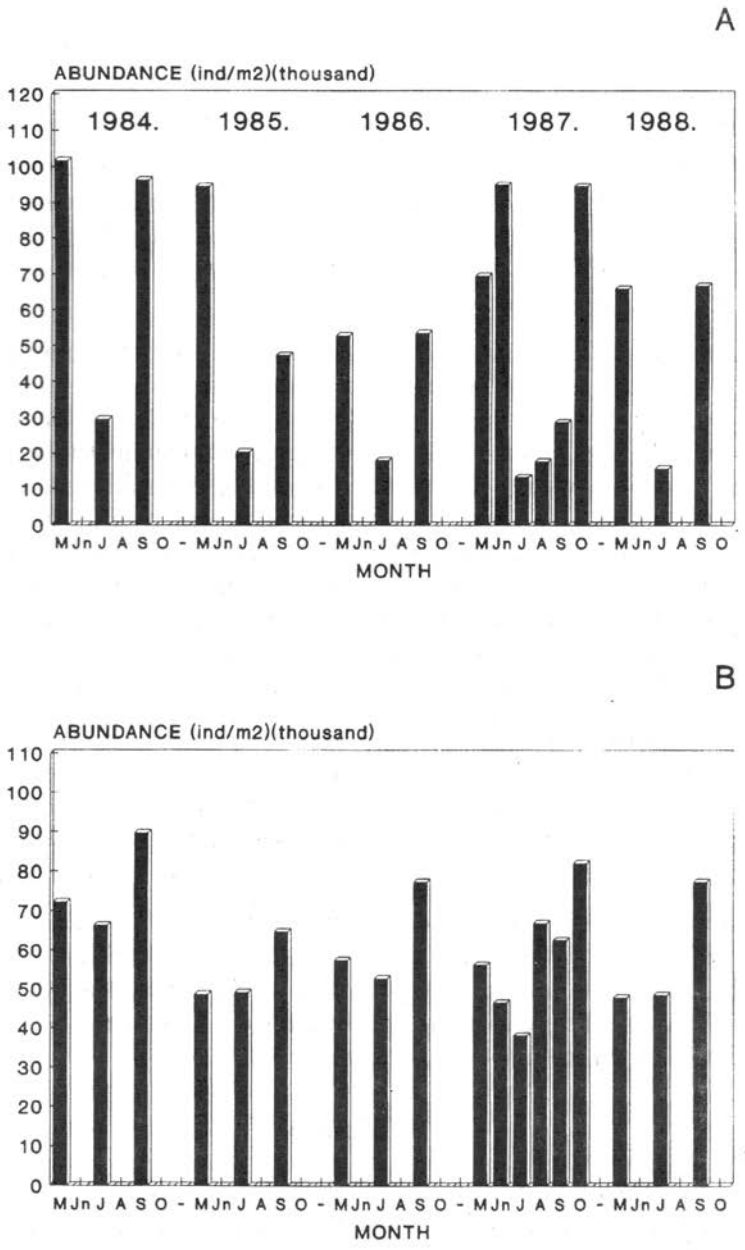

Fig. 2. Abundance of the Collembolan community in two stands: A-beech, B-spruce; (M – May, Jn – June, J – July, A – August, S – September, O – October)

species (frequency rate of 1) are *Hypogastrura socialis, Isotomiella minor, Onychiurus armatus, Sminthurinus aureus, S. elegans* and *Tomocerus baudoti*, while four more species had an occurrence rate higher of 0.75. This fifteen constant species accounted for 23.8% of the species composition in the spruce community.

In both communities, species *Folsomia quadrioculata* and *F. multiseta* which belong to family Isotomidae, are always dominant. This species are mentioned as important members of Collembolan communities by several authors (STEVANOVIĆ 1968; KOLEDIN 1975; HUHTA & MIKKONEN 1982; POZO *et al.* 1986; BOGOJEVIĆ 1994; TAKEDA 1995; SHAW & USHER 1996).

The monthly species number and total abundance for both communities are given in Figs. 1. and 2. In the beech community a decline in species number during the passing on of spring in summer is observed, with a minimum in July. This community has an additional, autumnal, decline in species number in October (Fig. 1A). The species number in spruce community shoved higher oscillations than in the beech community (Fig. 1B). The smallest number of species over the whole investigated period is recorded in May 1987, with a subsequent increase during the summer and autumn. The changes in the structure of the dominant and constant species complex throughout the sampling period were not observed, so the oscillation in species number in both communities could be attributed to the turnover in the subdominant and accessory species complex, which belong to the family Entomobryidae.

The analysis of seasonal dynamics of community abundance (Fig. 2.), shoved that both communities have minimum densities in July. The abundance decline (ninefold) occurred within one month in the beech (Fig. 2A), while being more gradual and lower in the spruce (Fig. 2B). The observed decline in density is solely attributed to a vernal decrease in abundance of the dominant species complex.

Comparing the results of various authors (POOLE, 1961; KOLEDIN, 1976; HAGVAR, 1982; WALTERS, 1983; POZO *et al.* 1986; TAKEDA, 1987) concerning the Collembolan community in forest ecosystems, it can be concluded that the studied communities in Jastrebac are characterized by a relatively high number of Collembolan species and by their high density as well.

CONCLUSION

A five-years investigation of the two forest stands of Jastrebac mountain resulted in registration of 74 Collembolan species. A total of 43 Collembolan species with 22064 individuals in the beech forest samples is registered, compared to 63 species with 24821 individuals in the spruce forest samples. A total of 32 species was shared by two sets of samples corresponding to a 60% similarity of species composition (S').

The changes in community structure always occur in the spruce first with a change of species composition, followed by a change in abundance, contrary to the trend in beech. In both habitats phenological change occurs by a decrease in abundance of the dominant species followed by an increase in the abundance of accessory species.

The distribution of Collembola is closely connected and conditioned by characteristics of forest communities on Jastrebac mountain, such as the composition, distribution, phenology of the plant cover, especially the grade of disassemblage of the organic material.

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САСТАВ И СЕЗОНСКА ДИНАМИКА НАСЕЉА COLLEMBOLA У ДВА ШУМСКА СТАНИШТА НА ПЛАНИНИ ЈАСТРЕБАЦ

Р. МАТИЋ

Извод

У периоду од пролећа 1984. до јесени 1988. године проучаван је састав и сезонска динамика насеља Collembola на две огледне површине на планини Јастребац (централна Србија) - у аутохтоној буковој заједници и култури смрче која је засађена после тоталне сече букве.

У току целокупног периода истраживања у насељу Collembola укупно је регистровано 74 врсте, при чему се две врсте (*Folsomia quadrioculata* и *F. multiseta*) карактеришу изузетном доминантношћу. Насеље Collembola букове заједнице карактерише се присуством 43 врсте, а насеље смрчеве заједнице 63 врсте. Укупно 32 врсте су заједничке за оба насеља, што одговара релативно високом коефицијенту сличности састава врста (S'=0.60). Осцилације у броју присутних врста су много израженије у смрчевој заједници. Укупна бројност насеља у буковој заједници кретала се од 13000 до 100000 ind m^{-2}, а у смрчевој заједници од 38000 до 90000 ind m^{-2}. За динамику квантитативне структуре насеља у буковој заједници карактеристичан је велики пад у бројности са почетком летњег периода, док је летњи пад бројности у насељу смрчеве заједнице много мањи и постепенији. Карактеристичан летњи пад бројности у оба насеља резултат је пада бројности доминантног комплекса врста.

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