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SEASONAL DYNAMICS OF PROTURA IN AN OAK FOREST IN KRAGUJEVAC (SERBIA)

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ABSTRACT. Protura present a significant part of hemiedaphon which contribute to the better functioning of terrestrial ecosystems, by their presence in soil. The aim of this study was to carry out quantitative and qualitative analysis of Protura, during the period September 2004 - September 2005, in an oak forest in vicinity of Kragujevac. The presence of two species, *Eosentomon transitorium* (Berlese, 1908) and *Acerentomon balcanicum* (Ionescu, 1933), was registered. Among them the more abundant was *Eosentomon transitorium* (84.14%). Soil temperature and moisture were monitored as a factors possibly of influence on dynamics of Protura.

Key words: Protura, *Eosentomon transitorium*, *Acerentomon balcanicum*, oak forest, Kragujevac, Serbia

INTRODUCTION

The members of Apterygota present main component of terrestrial ecosystems. They present approximatelly 50% of the all terrestrial microathropods (AXELSSON *et al*., 1984; CROSSLEY AND COLEMAN, 1999), called terrestrial "plankton". Apterygota surpass by abundance other soil insects. They feed on fungies, bacterias and also on detritus, so they are actively included in degradation, i.e. circulation of nutrient matter, and have influence on structure and activity of microorganisms, as well as on food web stability in terrestrial ecosystems (NEHER, 1999). Thereupon, abundance, diversity and life cycle of the Apterygota, jointly, could be used as an excellent ecological indicator of the quality of environment where they are.

Among them, members of the order Protura present a significant part of the hemiedaphon and contribute to the better functioning of terrestrial ecosystems by. Also, other representatives of the Apterygota (members of the orders Collembola and Diplura) have important role in the same process (SILVESTRI, 1932; IONESCU, 1955; CONDE, 1956; PALISSA, 1964; DE BRUYN *et al*., 2000; DE BRUYN *et al*., 2005).

A great deal of information about the fauna of Protura on the territory of Serbia and Former Republics of Yugoslavia is presented in studies of BLESIĆ (1993, 1998, 2000, 2001, 2002, 2004). Beside the members of meadows' fauna, he analysed soil members of forests' faunas too. From these reasons this investigation present attempt to illustration of dynamics of Protura in relation to variation of some environmental parameters (abiotic and biotic).

MATERIAL AND METHODS

The investigation was conducted in oak forest in Memorial Park Šumarice, in vicinity of Kragujevac city. This oak forest belongs to community *Quercetum confertae-cerris* Rud. In the layer of threes, 11 species were noticed. Species *Quercus conferta* and *Q. cerris* are dominant. This community has got thermophilic character, so that more thermophilic species *Q. conferta* (the most frequent on dry habitat) has diagnostical importance. About twenty five species build layer of shrubs. In this layer, species *Q. conferta* and *Q. cerris* have expressly dominant role. Also, there are frequent *Crataegus monogyna, Viburnum lantana, Prunus spinosa, Pyrus communis, Fraxinus ornus, Cornus mas* and *Acer campestre.* The lowest forest layer is abound with species (about 80). Among to the other there are *Heleborus odorus, Festuca heterophylla, Lathyrus vernus, Geum urbanum, Viola silvatica, Fragaria vesca, Galium verum, Euphorbia cyparissias*.

The investigation was conducted during the period September 2004 - September 2005. The investigated period of one year was divided into four seasons, for easier review of the results: season I (September, October and November 2004), season II (December 2004, February and March 2005), season III (April, May and June 2005) and season IV (July, August and September 2005).

Once monthly, three samples from different soil layers (a-layer depth: 0-10 cm and b-layer depth 10-20 cm) per each of five different points were collected. Soil temperature and soil moisture were measured on these depths to establish influence of ecological factors on Protura vertical and horizontal distribution. Tulgren-Berlesse apparatures were used for separation of individuals in the laboratory. Material was preserved in 70% ethanol, and after preparation individuals were determinated to the level of species.

RESULTS

During the research period, total number of collected individuals from the order Protura was 2150. The total number of individuals of the family Eosentomidae was 1817 (84.51%) while 333 (15.49%) belong to the Acerentomidae. Obviously the first family were dominant in soil samples according to the specimens number.

Within the order Protura, two species were identified during all months of investigation, *Acerentomon balcanicum* and *Eosentomon transitorium*. The variability of their total numbers is given in Tab. 1.

Table 1. - Abundance of species of the order Protura during all months of investigation

Species	Sep	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Acerentomon balcanicum	122	39	11	3	15	8	4	1	5	119	3	3
Eosentomon transitorium	962	352	85	51	24	10	2	25	67	223	13	3

Members of the order Protura reached the first maximum of abundance on begining of the first season (Tab. 1). After that, during the first and second seasons their abundance gradually decreased and reached the first minimum in April 2005. Slowly increasing of their abundance during the third season influenced on their maximum activity in July 2005. The numbers of the specimens decreased again during the fourth season.

During all followed seasons Protura were more numerous in upper soil layer. We noticed their migrations into lower soil layers during second and fourth season.

The more abundant species was *Eosentomon transitorium*. This species was more tolerant on variability of followed parameters and showed gradually changes of its activity. Seasonal dynamics of the *Eosentomon transitorium* is presented on Fig. 1 and Fig. 2.

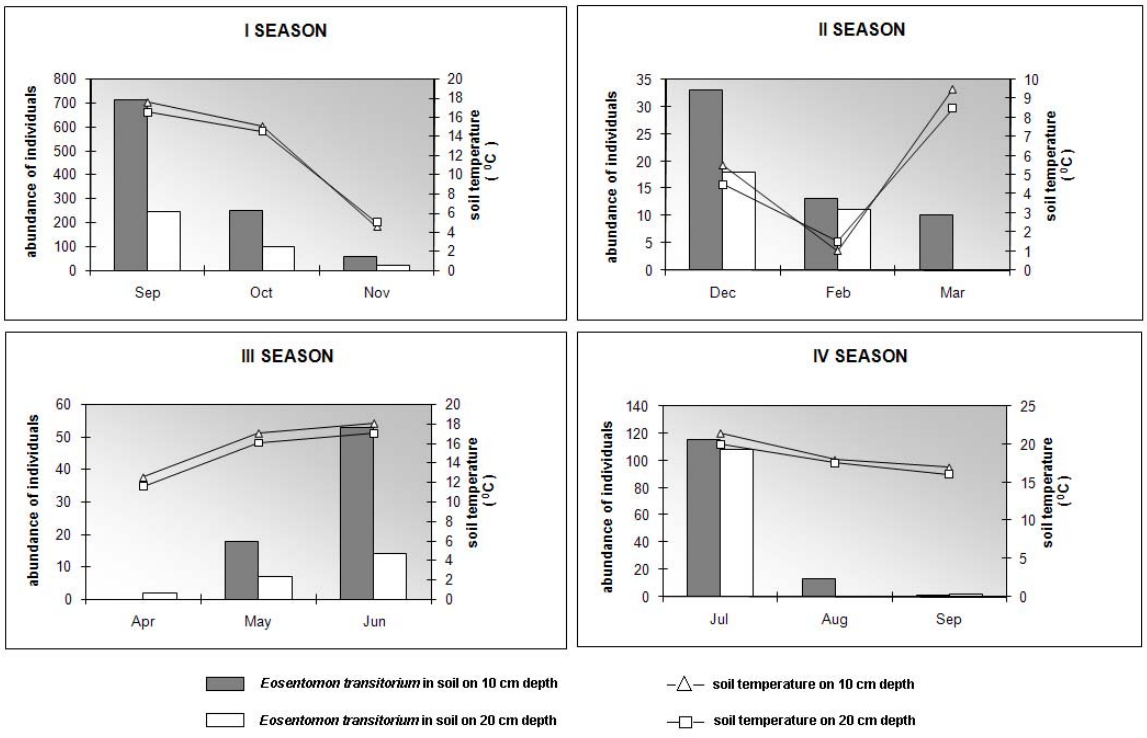

Figure 1. - Total abundance of species *Eosentomon transitorium* in relation to soil temperature at different depths

During September 2004, this species reached the first maximum of abundance, with a total number of 962 individuals. During the first and second seasons, abundance gradually decreased and the first minimum with only two individuals was noticed in April 2005. The next maximum of abundance this species reached in July 2005, and after that number of specimens of *Eosentomon transitorium* decreased again. Decreased abundance of this species during the second and fourth seasons could be results of its migrations into deeper soil layers (because of that individuals of that species were not present in soil samples in moment of sampling).

The species *Acerentomon balcanicum* was less abundant. Its migrations in layers below a depth of 20 cm started earlier, from October 2004. During the next three seasons this species was more dominant in deeper soil layers .

The both species showed the increased activity in September 2004 and July 2005.

DISCUSSION

Most literature about Protura fauna presented their taxonomic study (PACLT,1955; TUXEN 1964; NOSEK, 1973). Probably only 10% of the world Protura fauna is known. The best investigated areas are China (YIN, 1965, 1984, 1999) and Poland (SZEPTYCKI, 1980, 1984, 1991). Their ecology is still poorly known.

BLESIĆ (1993, 1998, 2000, 2001, 2002, 2004) performed taxonomic study of the order Protura on the territory of Serbia and Former Republics of Yugoslavia. He analysed members of meadow and forest fauna and showed that the species *Eosentomon transitorium* was the most abundant and the most frequent at almost all of investigated localities. This results could be explained by its cosmopolitan character (TUXEN, 1964).

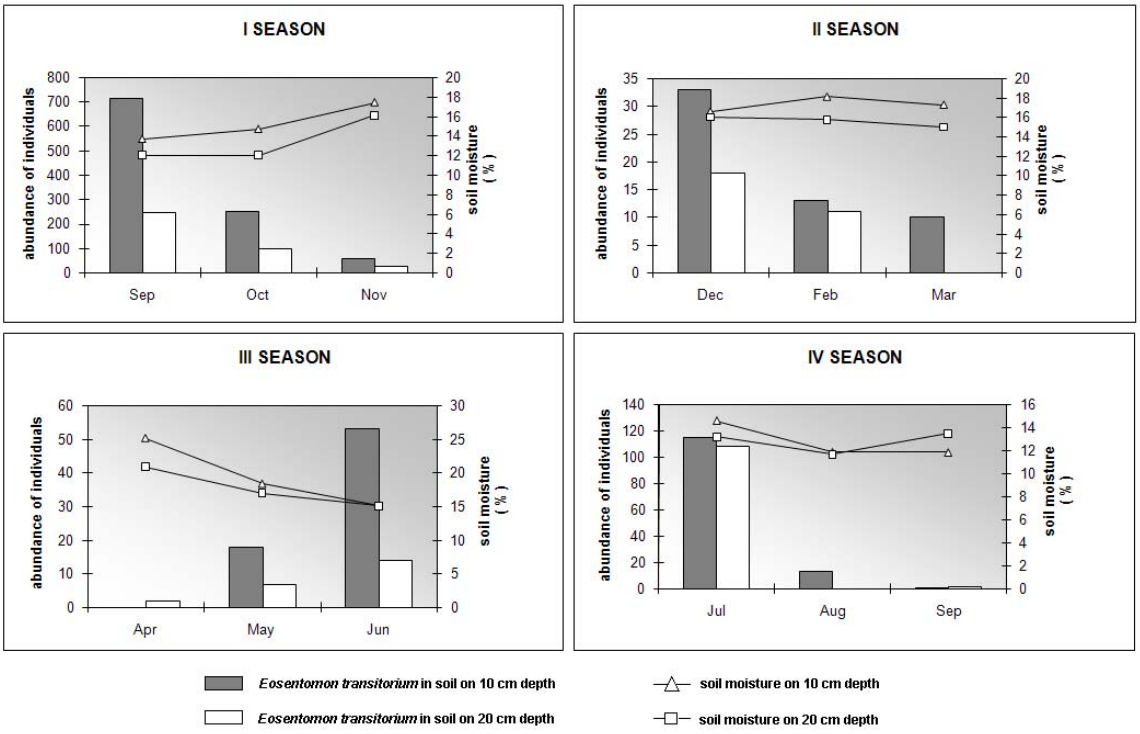

Figure 2. - Total abundance of species *Eosentomon transitorium* in relation to soil moisture at different depths

On the basis of obtained results in this study, it could be noticed that the both species, *Eosentomon transitorium* and *Acerentomon balcanicum*, were frequent during all months of investigation. Among them the more abundant species was *Eosentomon transitorium* (84.14%), which had significant influence on dynamics of abundance of this order.

Optimal soil temperature for development of fauna Protura could be, from obtained results, in interval from 16.5^0C to 17.5^0C, and optimal soil moisture could be in interval from 13.5% to 14.5%. However, almost identical values of the folowed parameters do not always lead to appearance of maximum of abundance, showing the complex influence of ecological factors. That is showed in this study (see abundance of species in Tab. 1 for September 2004 and September 2005). Protura migrate in deeper soil layers during winter and summer periods, in their order to avoide direct influence of negative environmental factors (inadequate soil temperature and soil moisture, increased number of their predators and competitors, etc.). Simillar results were obtained in investigation of Diplura, a significant representatives of Apterygota (MITROVSKI-BOGDANOVIĆ and BLESIĆ, 2007).

In study of GILLOTT (1995) and CHRISTIAN and SZEPTYCKI (2004) it was showed direct influence of soil dessication on vertical migrations of Protura. In other studies it was showed that soil dessication and temperature variations usually influences on decrease of richness of soil microatrhopods and on their vertical migration in deeper soil layers. Then, their activity drastically decreases, and after the first rainy period it increases (ODUM,1971; HORN, 1976; LINDBERG and BENGTSSON, 2005; TSIAFOULI *et al.*, 2005). So, their migrations in deeper soil layers could be results of avoidance of inadequate environmental factors. That was showed in this study. Some authors suppose that predators present key factor in regulation of abundance of the most Apterygota (KAJAK, 1995).

Our aim was to carry out quantitative and qualitative analysis of Protura presence in that way better understanding of rellation among the researched group and abiotic and biotic factors. On the basis of all mentioned results, it can be concluded that seasonal dynamics of the members of Protura is result of influence of complex of ecological factors. Thereupon, it is necessary to study the other factors, which present regulators of their abundance: environmental chemistry, humus structure, resource of food, excretion from a vegetable root, abundance of their predators and parasites, their competitors, as well as period of reproduction and develompent of individuals. That studies can bring new, very important and interesting results.

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