ABSTRACT: Natural forest fires are considered as a part of natural ecosystem processes. Short-term effects of prescribed fire on densities and taxonomic diversity of soil Acari were studied in fresh pine mixed forest (“Biała” forest) in the Mazovia region, Central-Eastern Poland. Three plots (size 1 m²) of similar soil type and vegetation were selected for prescribed burning. Soil samples of an area of 10 cm² and the depth of 5 cm were collected in June 2005 – one day after the burning, 60 days after the burning and 90 days after the burning. Samples were collected from within the border of the burned plots, from the border itself, as well as from the surroundings. Due to the burning, the density of Acari communities decreased from $11.5 \times 10^3$ ind. m⁻² recorded in the surroundings to $3.2 \times 10^3$ ind. m⁻² recorded in the burned plots. Values recorded within the burned plots after the fire differed significantly from those recorded on the border ($P = 0.05$) and in the surroundings ($P = 0.0001$). After 60 days, an increase in Acari abundance was observed in the burned plots ($P = 0.02$), becoming similar to that noted for the border of the plot and for the surroundings. After 90 days, there were no significant differences between the burned parts of the plots, their borders and the surroundings; however, generally decreased densities were observed, possibly due to the seasonal reason. The observed changes suggest the restoration of Acari community after disturbance.

KEY WORDS: Acari, fire, forest, prescribed burning

Natural forest fires – i.e. started by lighting – are considered a natural force involved in the ecosystem processes and having a significant evolutionary importance (Bond and Keeley 2005). Many organisms are adapted to survive them or to recolonize the disturbed areas (Bengtsson 2002). Prescribed fires are used in forest management to reduce fire hazard and to create favourable conditions for plant development (Marshall 2000).

Fire changes the structure and moisture of soil, decreasing the quantity of organic matter and leading to nutrient loss. It also influences the rate of organic matter decomposition. Extinction of vegetation after fire increases the rate of surface runoff as well as soil temperature (by blackening the soil surface). The sites suitable for recolonization had become deficient (Near et al. 1999). Ecosystems can be affected by fire at diverse scales, ranging from days (short-term) to hundreds of years on the time scale, and from a single point to thousands of hectares on the spatial scale (Harvey 2005).

The function of soil microarthropod communities in the ecosystem is important.
as – among others – they control the decomposition of litter (Blair et al. 1992, Scheu and Schaefer 1998). Thus the impact of prescribed burning and wild-fire on these communities was broadly studied in many environments i.e.: grasslands (Lussenhop 1976), Mediterranean phryganic ecosystem (Sgardelis and Margaris 1993), temperate (Dress and Boerner 2004) and boreal forests (Haimi et al. 2000, Wikars and Schimmel 2001). The lethal temperature for almost all microarthropods is under 40°C (Malmstrom 2008) but short-term response of microarthropods to fire can vary significantly and results of studies are often contrasted. Lussenhop (1976) reported no changes in abundance of microarthropods in short period after fire (up to 1 month), while Sgardelis and Margaris (1993) reported severe reduction in abundance of microarthropods, distinguished up to over 3 years.

The presented study is a part of the complex investigations carried out by Department of Soil Environmental Science of Warsaw University of Life Sciences in cooperation with the Main School of Fire Service. The experiments were focused on the manner in which fire and fire-fighting techniques affect the organisms in forest soil.

The aim of this study was to estimate the effect of prescribed fire upon the density and diversity of Acari. The experiment was conducted in “Biała Forest”, 60 km north-east from Warsaw, in fresh pine mixed forest with dominating podzol gley (pH 3.5) with fresh moder humus. In forest tree layer, Scots pine (Pinus sylvestris) was dominant, with numerous birches (Betula pendula), while in shrub layer – common juniper (Juniperus communis) and Frangula alnus were dominant. In herb layer, European blueberry (Vaccinium myrtillus) and Sheep’s Fescue (Festuca ovina) were most common.

In June 2005, three plots, each 1 m² in size, with the same soil and vegetation, were randomly chosen. The prescribed fire lasted 30 minutes, until total burn-out of litter and herb layer. The mean temperature of ground after fire was 377°C. The fire was extinguished with the fire-fighting substances Protektol SAT-10 and Roteor M. Both agents are water-based and commonly used for extinguishing forest fires. The field experiments were assisted by a fire-brigade. The permission from Forest Inspectorate Ostrów Mazowiecka (letter N-24/12/05 from 2005.05.04) was received for this experimental burning.

Environmental data recorded during study period – air temperature, air humidity and litter humidity – are presented in Table 1.

Samples were collected thrice – in June, immediately after the burning, 60 days after the burning (August) and 90 days after the burning (September). The time of second sampling was chosen in order to allow Oribatida to complete at least one generation, i.e. at least 8 weeks (Walter and Proctor 2004).

The samples were taken with a steel corer, from an area 10 cm² to the depth 5 cm. Ten samples were taken in each sampling plot and on each sampling occasion. In total, 90 samples were taken from three experimental plots: 30 samples from burned plots (fire), 30 from borders of burned plots (border) and 30 from the surrounding area, at a distance of 1 m from plot the borders (surroundings).

The microrarthropods were extracted from the samples in Tullgren’s apparatus. Identification of Acari was based on Krantz’s (1978) key and Soil Biology Guide (Dindal 1990). Wilcoxon non-parametric signed-rank test and Kruskall-Wallis non-parametric analysis of variance were used.

Diversity of community was calculated with the Shannon-Wiener index ($H'$). Statistical significance of differences in the $H'$ index values was checked with Hutcheson’s (1970) test.

The density of Acari communities immediately after the fire within burned plots was the lowest from recorded densities and it was significantly different from those recorded for border ($P = 0.05$) and surroundings ($P = 0.0001$) (Fig. 1). 60 days after the burning, about three fold increase of Acari densities was noted in burned plots ($P = 0.02$), but there was no significant difference between all three parts of the plots. After 90 days, a decrease of densities in all parts was observed, but again there were no significant differences between recorded values (Fig.1).

Oribatida were the dominating order during study period (Fig. 2). Their lowest participation rate was noted in borders, where Mesoestigmata participation increased.
Lowest value of $H'$ index for diversity in Acari communities was measured for burned plots (Fig. 3). There were significant differences between the $H'$ indexes for burned plots and borders ($P \leq 0.001$), burned plots and surroundings ($P \leq 0.001$) and for borders and surroundings ($P \leq 0.05$).

In presented study the abundance of microarthropods observed immediately after fire was significantly reduced comparing to control. The same phenomenon i.e. the reduction of microrarthropod numbers by fire was reported by many authors (i.e. Metz and Farrier 1973, Henig-Sever et al. 2001, Wikars and Schimmel 2001). Severe reduction of collembolan abundance was observed in experiment conducted in similar conditions by Olejniczak et al. (2006). Because samples were collected immediately after fire, we can attributed this type of massive reduction directly to fire and high temperature on soil surface, not to post-fire alteration of soil habitat (Wikars and Schimmel 2001).

Significant increase of Acari abundances 60 days after fire was noted. Similar trend was found by Wikars and Schimmel (2001). Decrease of Acari abundance 90 days after fire can be related to seasonal and environmental conditions (Table 1).

Mites found at burned sites might have appeared due to individuals moving from adjacent undisturbed sites or from patches not affected by fire. Many Oribatida can move relatively fast from surroundings to burned plots. Representatives of one of the most common oribatid genera, *Opiella*, can migrate almost 2 meters in 3 months, many other genera can cover a distance of 1 meter in the same time (Ojala and Huhta 2001).

Some specimens found in burned plots could have survived the fire. Higher survival was observed among animals with greater mobility in soil and a thick cuticula (Neary et al. 1999, Wikars and Schimmel 2001). Malmström (2008) found that Oribatida survived higher temperatures than other groups of soil animals, and the thick cuticule is one of the reasons. In our study no mites with weakly sclerotized cuticule were found in burned plots, while Oribatida were still present.

Dress and Boerner (2004) concluded that overall effects of fire are caused not only...
by the fire itself, but by the fire-induced alterations in environment. Post fire changes in soil structure, like presence of ash, can be responsible for further reduction of soil microarthropod abundance (Haimi et al. 2000, Lirii et al. 2002). However, in our study, similar values of microarthropod density in burned and control (surroundings) parts of plots have been found 60 days after the fire; this may be related to environmental factors.

Acari community diversity was lowered by fire, but occurrence of Oribatida and Prostigmata in dominance structure of Acari in burned plots was similar to that recorded in coniferous and mixed forest (Niedbała 1980). Very low abundance of Astigmata in burned sites was also recorded by Dress and Boerner (2004). In general, however, lack of Astigmata in burned plots can be caused by their susceptibility to changes of soil moisture and high temperatures due to poorly sclerotized cuticle (Niedbała 1980).

Fire lowers the numbers of all microarthropods. Mites are less susceptible to fire, high temperatures and post-fire soil alter-
Influence of prescribed fire on soil Acari


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