University of West Hungary

Doctoral (PhD) thesis

STUDIES ON EDGE PROPERTIES OF TWO FOREST ASSOCIATIONS (*QUERCETUM PETRAEAE-CERRIS* AND *FRAXINO PANNONICAE-ULMETUM*) AT DIFFERENT EXPOSURES

Mónika Papp

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Name of the PhD School:

Doctoral School of Forestry and Wild Farming Sciences Roth Gyula

Programme: Ecology and diversity of forest ecosystems

Supervisor: . Prof. Dr. habil. Dénes Bartha
Doctor of the Hungarian Academy of Sciences
Director of the Institute of Botany and Nature Protection

INTRODUCTION

The forest edges located in the transition zone (ecotone) between forests and open fields play important role in protecting forests and nature. They help in maintaining the microclimate in forests and protecting them against abiotic and biotic stresses. Forest edges located near industrial or populated areas can filter contaminants from the air. An forest edge - especially shrub belt - with a good structure of appropriate plant species may enhance the stability of the forest population.

An important function of forest edges is to preserve biodiversity, depending of their structure even in small areas a great variability in species, life form, the way of multiplication as well as phenological diversity can be observed.

Being an element of biotope association, due to their unique ecological conditions forest edges can provide optimal life conditions for several plant and animal species, as well as for natural enemies of agricultural pests and thus especially important in maintaining biological balance. Additionally, forest edges harbour several sensitive and relic species and provide habitat for cultivated plants of high genetic value as well as wild (e.g.fruit) species.

Diverse and rich flora of forest edges have an important role in landscape beauty, they connect landscape elements and so make harmonious impression. The forest edges covered with flowering plants that follow the natural relief and trees with coloured leaves in autumn contribute to resort and social welfare function.

OBJECTIVES

The aim of our work was to determine species composition of secondary forest edges located between forests and open fields and describe their structure. Characteristics of forest edges near two forest associations (*Quercetum petraeae-cerris* and *Fraxino pannonicae-Ulmetum*) with different ecological conditions were compared.

In this work the following questions have to be clarified:

- Are there any significant differences in species structure among certain structural elements (open field, herbaceous fringe, shrub belt, forest mantle, forest interior) of the transition zone?
- What factors have effect on plant species composition and structure of forest edges?
- What are the similarities and differences between the two forest edges studied regarding species composition and their structure?
- How exposure affects species composition and structure of forest edges?
- How species composition and cultivation method of forest association and open field influence the species condition and structure of the forest edges?

MATERIALS AND METHODS

Selecting the place of investigation

The selection of sample plots was performed in more steps. During preliminary rounds 46 different forest sites were preselected in Soproni-, Kőszegi-, Budai Mountains and Zalai Hills. An important aim was to select natural forests, intact, untouched forest edges that are well accessible.

Methods of investigation

Microclimatic analyses were performed in the transition zone of six different forest associations (*Corno-Quercetum pubescenti-cerris*, *Quercetum petraeae-cerris*, *Castaneo-Querco-Carpinetum*, *Vicio oroboidi-Fagetum*, *Carici brizoidis-Alnetum*, *Fraxino pannonicae-Ulmetum*) between 15th August and 2nd September, 2006.

The daily light intensity, air- and soil temperature were recorded at four transects against the forest edge (open field, herbaceous fringe, shrub belt, forest interior). Light intensity was recorded by a LUXMETR PU150 instrument, temperature was measured 1 meter high above ground and 5 cm deep in the soil. Data were recorded every hour in 12 hour intervals, between 7 am and 7 pm.

For coenological and physiognomial analyses, forest edges at two different elevations were selected – in Budai Mountains *Quercetum petraeae-cerris* transition zone at six places (Budakeszi, Biatorbágy, Telki, Nagykovácsi, Solymár, Piliscsév), and in Répcementi Plain a *Fraxino pannonicae-Ulmetum* transition zone (Csáfordjánosfa) according to microclimatic results.

Coenological records were performed during the summer of 2007 and 2008. In case of each forest edge, three transects against the edges were

selected. Five investigation squares that meet minimum area requirements were selected and sampled in each transect (open field, herbaceous fringe, shrub belt, forest mantle, forest interior). By using quadrat (Braun-Blanquet) method the occurence ratio (%) and covering frequency (A-D value) of the species were estimated.

Physiognomic analyses and structure studies were aimed at determining the horizontal and vertical structure of forest edges.

Methods of statistical analyses

For determining the relations between the elements of the transition zone (open field, herbaceous fringe, shrub belt, forest mantle, forest interior) and the two forest associations, different exposures and species components a non-parametric multivariate analysis of variance (NpMANOVA) were used. Clarification of differences among certain structural elements of the transition zone was done by post-hoc analysis with SIDÁK correction. Comparative statistical analysis of species composition of the two transition zone would have only been possible with same repetitions, therefore for variance analysis four additional ecotones with similar exposure in Budai Mountains (Budakeszi north-east, Solymár north-west, Budakeszi south east and south-west) were chosen. Thus our results can reliably be interpreted in all 12 *Quercetum petraeae-cerris* transition zones.

For investigating relationships between environmental factors and the distribution of individual species, several direct redundantic analyses (RDA) were performed by using covering values of each species modified by Hellinger transformation and independent variables. Altogether fifteen different ordinations were made in order to determine the effect of different environmental factors, the first ordination serie refer to all plots at Budai

Mountains, whereas the second serie compares the four plots of Budai Mountains with those located at Csáfordjánosfa.

RESULTS AND DISCUSSION

Microclimatic investigations

- According to our results we can conclude that microclimatic values showed decreasing gradient from open field to forest interior. The intensity of light, the air- and soil temperature performed similar tendency regardless to forest associations and sites. The highest daily variability was observed in light intensity, the lowest variability occured in case of soil temperature. The temperature balancing effect could be obviously detected in case of each forest associations.
- The observed differences can be attributed to diverse structure of forest edges that are determined by individual forest populations and growing conditions. According to our results the daily conformation of microclimatic elements is determined mainly by the exposion of forest edges.

Results of coenological and physiognomical studies

- Our coenological and physiognomical results were in accordance with the literature: the results indicate that the edges between forest and neighbouring open field can be regarded transition zones regarding species composition and structure, they definitely distinct from the forest association and can be divided into three structural elements (herbaceous fringe, shrub belt, forest mantle).
- The species composition of each elements is determined by its position within the transect (it is the most important factor), the forest association,

the exposure of the edge and the cultivation method of the neighbouring area.

- The most characteristic species in structural elements of the forest edge are herbaceous species that appear only in the edge. Among them some species can exclusively be found in the herbaceous fringe or shrub belt, whereas some species can penetrate from the herbaceous fringe to the outer border of the shrub belt. The forest mantle has no any characteristic herbaceous species. Regarding shrubs, only those species characteristic for the forest appear in the edge, they are especially frequent in the shrub belt. *Prunus spinosa* is an exception in both forest types because it appears in the edges only. Regarding tree species, the same phenomena occurs as in case of shrubs as only those species characteristic for the forest appear in the edge.
- Comparing the species composition of the edges of the two forest associations studied they are almost completely different depending of the growing site, only a few common species occure. The common species in both forest edges are the following: *Dactylis glomerata*, *Poa pratensis*, *Lamium maculatum*, *Prunus spinosa*, *Acer campestre*. In both cases forest edges are composed of native species, however, some invasive species appear in the plots of Budai Mountains.
- The forest edge have higher number of species than the neighbouring open field and forest.
- The number of species in each structural elements of the edges are different in both forest associations. In Budai Mountains, the herbaceous fringe represents the most species, while the number of species in the shrub belt and forest mantle are similar. In the opposite, in Csáfordjánosfa, the number of species in the herbaceous fringe and the forest mantle are similar, but less species can be found in the shrub belt.

− The results of the analysis of variance confirm our outdoor observations. Regarding the number of species and covering values the structural elements of the forest edges significantly differ from each other as well as from the neighbouring open field and forest interior. The species sortiment of the herbaceous fringe is less different from the open field composition but definitely distinct from the shrub belt. On the other hand, on the basis of species the shrub belt, the forest mantle and forest interior are in close relation, the species composition of forest mantle and forest interior are very similar regardless their exposure. The species composition and covering values of the forest edges in Budai Mountains and Csáfordjánosfa were significantly different.

− Our results indicate that the exposure of the forest edges determines their species composition. Most of the species prefer southern or northern exposure, some species, however, do have no preference at all. Herbaceous and shrub species occur at exposures that fits to their preferred ecological condition. The exposure determines the covering value of the given species. The occurence of shrubs basically defined by light circumstances. Southern exposed forest edges differ from the northern ones in species richness and structure, that corresponds to the statements in the literature. The analysis of variance also underline this statement, in case of both forest associations the northern and southern exposed forest edges significantly differed.

− The structure analysis proved that horizontal structure of forest edges basically determined by the cultivation method of the neighbouring areas. On the contrary, for vertical structure the relationship between structural elements within the forest edge, the forest association and exposure have considerable effect. In both forest associations, mostly strait lined forest edges could be observed regardless of their exposure. In *Quercetum petraeae-cerris* obviously the exposure determines the vertical structure of

the forest edge: in northern exposed forest edges the deep sudden slopes, whereas in southern exposed forest edges the gradual slopes are characteristic. Unlike in *Fraxino pannonicae-Ulmetum* forests the structure of the forest edge showed intermediate type between deep sudden slopes and gradual slopes.

− Several factors have considerable effect on the width of the forest edges. The width of herbaceous fringe is determined particulary by the cultivation method of the neighbouring area, whereas shrub edge expansion is effected by the exposure. As a result in both forest associations the shrub belt in northern exposure are usually narrower, while in southern exposure are wider.

Publications related to the topic of the Ph.D dissertation

Papers published in journals having impact factor (in English):

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Papp M. 2005: A szajkó újszerű megítélése. Nimród 11: 30-31.

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