HUNGARIAN UNIVERSITY OF AGRICULTURAL AND LIFE SCIENCES

A MULTIVARIATE COMPARATIVE STUDY OF SESSILE OAK STANDS OF DIFFERENT AGES

Theses of doctoral (PhD) dissertation

TRENYIK PETRA

Gödöllő
2023

The Doctoral School

Name: Ph.D School of Environmental Sciences

Discipline: Environemental Sciences

Head of School: Csákiné Prof. Dr. Michéli Erika
professor, DSc
Hungarian University of Agricultural and Life Sciences,
Institute of Environmental Sciences,
Department of Soil Science

Scientific Supervisor: Prof. Dr. Czóbel Szilárd
professor, PhD
University of Szeged,
Faculty of Agriculture,
Institute of Plant Sciences and Environmental Protection

Associate Supervisor: Dr. Szirmai Orsolya
research associate, PhD
University of Szeged,
Faculty of Agriculture,
Institute of Animal Sciences and Wildlife Management

....
Prof. Dr. Michéli Erika
Approval of Head of School

....
Prof. Dr. Czóbel Szilárd
Approval of Scientific Supervisor

....
Dr. Szirmai Orsolya
Approval of Scientific Co-Supervisor

Background and objectives

The Earth's climate is constantly changing, but analysis of past data shows that the alternation of glacials and interglacials has been much slower than the current warming. In its 2018 Thematic Report, the IPCC summarises the impacts and risks of a global temperature rise of 1.5-2°C and the potential for greenhouse gas emissions to mitigate it (MASSON-DELMOTTE, 2018).
The climate monitoring of the National Meteorological Service shows that since the beginning of the last century, the average temperature increase in Hungary has been higher than predicted in the IPCC Fifth Assessment Report (http1). The Carpathian Basin therefore belongs to the regions that are warming more than average.
In addition to analysing meteorological data, a more complete picture of climate change can be obtained by analysing global and regional climate models. Climate models also predict rising temperatures, increasing frequency and intensity of extreme weather events (droughts, sudden heavy rainfall, windstorms, heat waves) (BARTHOLY & PONGRÁCZ, 2005, 2007; SZALAI & MIKA, 2007; BARTHOLY et al., 2009; GÁLOS et al., 2012).
Living organisms adapt to extreme climatic events much more difficult than the change in climate averages (MÁTYÁS et al., 2010; RASZTOVITS et al., 2014). Rising temperatures and increasingly arid climates are likely to affect species' ranges.
The lower limit of distribution is regulated by the amount of precipitation (HAMP& PETIT, 2005). In the Carpathian Basin, this is also very important, because the lower aridity limit of several tree species lies here (BERKI et al., 2007; MÁTYÁS et al., 2009; MÁTYÁS & GÁLOS, 2010; CZÚCZ et al., 2011).
The main difficulty in studying the responses of organisms to climate change is that the responses of organisms are completely different for different regions or species. Thus, to make accurate spatial and temporal predictions, we need a very large number of studies (WALTHER et al., 2002; PARMESAN & YOHE, 2003; ROOT et al., 2003; PARMESAN, 2006).
According to RISSER (1995), climatically defined zones will react most sensitively. In addition to rising temperatures, the ecosystems of the Carpathian Basin are most threatened by changes in the currently observed and predicted precipitation conditions (CZÓBEL et al., 2010). However, the responses of ecosystems to these changes are still poorly understood (CZÓBEL et al., 2008).
The researchers warn that global climate change is not only associated with rising temperatures, but also with more frequent periods of drought. These periods pose a serious threat to the health of the forest stands, as research has shown that during these periods the health of the stands deteriorates, leading to thinning or even the complete destruction of the younger stands (CSÓKA et al., 2007; CSÓKA et al., 2009).
According to CZÚCZ et al. (2013), the optimal climate range for the sessile oak (*Quercus petraea*) in Hungary can be significantly reduced. According to their

research, by 2050, 80-100% of Hungarian sessile oak stands may fall outside their optimal climate.

The destruction of our main tree species has already been observed, in parallel with periods of drought. Among them, *Q. petraea* was perhaps the most severely affected. The cause of this decline has been investigated by a number of researchers, including IGMÁNDY et al. (1985), JAKUCS (1988), BERKI (1991, 1995).

The main cause of oak mortality in Hungary has also been identified by researchers as drought periods, when herbivorous insects and parasitic fungi appear in large numbers on trees weakened by water shortages (VAJNA, 1989, 1990).

Tree stands have a direct effect on the microclimate, soil and light conditions, which indirectly affect almost all groups of organisms, not only woody regeneration, but also the level of shrubs and the quantity and quality of forest herbs (WHIGHAM, 2004; HART & CHEN, 2006). The climate characteristic of each stand (SZÁSZ et al., 1997) is formed by the interactions of the structural, growing place, and landscape variables of many tree stands (AUSSENAC, 2000). The factors affecting the microclimate can also be fitted into a hierarchical system (AUSSENAC, 2000; WENG et al., 2007); as the main variable, the climate and relief conditions characteristic of the area can be taken into account, which determine the soil type and vegetation (OKE, 2002, GEIGER et al., 1995).

In the species richness of a forest community, the living conditions prevailing in the given habitat and the competition for them, as well as the relationship between flora and fauna, play a major role. The system described above determines whether the conditions are suitable for the spread of a species or not, as this plays a major role in the development of biodiversity. Forest management tries to influence these natural processes. In order for the forests to fulfill their function as much as possible, the preservation of the ecosystem, the protection of the soil and climate are of paramount importance in close-to-nature forestry, which also serves to preserve biodiversity in the long term (SOMOGYI et al., 2001).

It is also an important aspect that the preservation of biodiversity can result in a reduction of ecological and economic risks at the same time, since the association becomes more resistant through more complicated trophic relationships (BESZE et al., 1999).

We have a lot of data on damage to domestic forest stands, thanks to, among other things, the EVH (Forest Protection Network) monitoring system and the Forest Protection Damage Report Forms system (HIRKA et al., 2015), but these surveys do not use exact measurements, but estimate methods to determine the extent of damages. In this way, my research work can also be regarded as filling a gap from this point of view, since I used instrumental measurements to evaluate the health status of the herds.

The main goals of this survey were the following:

- To determine and compare the rotting of *Q. petraea* in three mountains of the Carpathian basin along a west-east transect.
- To determine and compare the rotting of *Q. petraea* in 5 different age groups, in all 3 selected mountains.
- Evaluation of the health status of *Q. petraea* in each age group and mountain range.
- Phytosociological sampling in 5 different age groups in 3 mountains.
- The evaluation of the results of the phytosociological sampling based on similarity, diversity, social behavior types and relative ecological indicators.
- Collection and evaluation of precipitation data in the study areas.
- Evaluation of the main soil parameters in the study areas.

Material and method

Studied objects

Measurements were carried out in Hungary, along a more than 300 km long west-eastern transect in the Kőszeg, Börzsöny and Zemplén Mountains.

In all three mountain ranges, 5 age groups were selected, which were 20, 40, 60, 80 and 100 years old. In order to make the data comparable, I selected the stands to be examined according to standard parameters. Each age group was represented by a *Q. petraea*-dominant subcompartment, in which the selected examined stands are located at an altitude of 400 meters above sea level, with a southern exposure, on a mountainside with a slope angle of 2-17 degrees.

The geological, soil and vegetation characteristics of the selected mountains

The ***Kőszeg Mountains*** are part of the Eastern Alps and are mostly made up of crystalline shale, clay shale, sandstone and gneiss. The highlands are characterized by podzolic brown forest soils and brown forest soils with clay stains. The annual rainfall in the lower areas is 750-800 mm, while in the higher areas it exceeds 800 mm. Its flora is diverse, with a high number of European and Central European elements. Some alpine plants appeared thanks to the Gyöngyös stream, like *Crocus albiflorus* and *Alnus incana*. Only a few Atlantic elements occur, but sometimes they appear abundantly, like *Calluna vulgaris*. More typical sub-Mediterranean species are *Castanea sativa*, *Knautia drymeia*, *Genista sagittalis*, *Cyclamen purpurescens* and *Primula vulgaris*. The proportion of continental species is low. Pine plantations have reduced the stands of native trees.

Börzsöny Mountains were created as a result of the internal volcanic activity of the Carpathians. Its bedrock is mainly andesite, andesite tuff, clastic rock of volcanic origin, and in some places sandstone and limestone. Its soils are mostly ranker soils, as well as clay soil and Ramann's brown forest soil, but there are podzolic brown, pseudoglay brown and slope alluvium forest soils, as well as earthy barren skeleton soils. 600-800 mm of precipitation falls annually on its territory. Since the volcanic rocks of Börzsöny do not have a high water storage capacity, most of the precipitation cannot infiltrating into the bedrock, which is why its watercourses are characterized by extremely extreme water conditions. While 600-650 mm of precipitation falls on average in the peripheral areas, it is 800-850 mm in the central areas, but in more rainy years this value can be 900-950 mm. The mountains were less affected by man's landscape-changing activities, and even the extent of deforestation was smaller than in other regions of our country, so the forest cover can be said to be almost natural in many places. Due to its specific topography, it has a characteristic microclimate. According to some estimates, there are about 1,250 types of plants in Börzsöny, including species, subspecies and hybrids. The flora of the mountain range is diverse, relict species appear in small numbers in a small area. On the higher terrains, up to 700 meters high, this side of the mountain is covered with hornbeam-sessile oak communities, and typically above 600 meters we find closed beeches.

The ***Zemplén Mountains*** are the foothills of the Carpathians and are also part of the inner volcanic belt. The rock material is rhyolite and andesite, and their tuffs. In most parts of the Zemplén Mountains, the average annual temperature is typically 6-7 °C, but on the southern sides it can be up to 10 °C. In the inner areas of the mountain range, the amount of annual precipitation is around 500-800 mm. In terms of its climate, it is significantly different from the Pannonian climate prevailing in our country, it is cooler and wetter, reminiscent of the Carpathians. While on the southern sides of Zemplén there is heat-loving, sometimes drought-tolerant vegetation, on the northern sides, in wetter valleys, species of the Carpathian flora appear. 85% of the mountain range is forested, the northern sides and above 600 m are typically dominated by beech trees.

Methods

Instrumental examination of the inside of the tree trunk (FAKOPP)

The health status of trees is basically determined by the internal state of the tree trunk, thus the Fakopp 3D Acoustic Tomograph 5.2 instrument was used for the field measurements. By measuring the speed of sound, this instrument is able to determine the size and location of cavities and decay in the trunk of the tree, and also helps to determine the current strength of the wooden structure, as well as the extent and extension of the damage. The speed of propagation perpendicular to the fibers can reach up to 2000 m/s, which is 15 times faster than the speed of propagation in air. So the propagation speed of sound waves is closely related to the mechanical properties of the wood interior, i.e. the wood material. To measure the speed of sound, we need to place at least two sensors on the trunk of the tree, but if we also want to determine the location of decay, you need more than two sensors.

Field measurements

Instrumental measurements were completed in 2015 and 2016, some of the 2016 measurements were repeat measurements. The foresters of the locally competent forestry companies provided assistance in the designation of the stands. In order to make the data comparable, I selected the forest stands to be examined according to standard parameters (i.e. altitude, the exposure, the slope angle, the main tree species forming the stand is *Q. petraea*).

Within the selected forest stands, sample trees were selected by first delineating sampling quadrats (20×20 m) representative of the stand for the phytosociological samplings. After that, the *Q. petraea* individuals closest to the corner points and the center of the quadrats - 5 individuals per quadrat - were selected.

I took measurements on the trees designated for measurement in a total of 5 layers, at heights of 40, 80, 120, 160 and 200 cm from the ground level, making sure that the cross-section of the trunk of the selected individuals was as circular as possible. In 2015 and 2016, I worked with 10 sample trees per forest subcompartment, so that I repeated the measurements of 5 sample trees in 2016 out of the 10 sample trees examined in the first year, thus I was able to draw conclusions about the annual rate of decay spread. During the two-year period of the field measurement, a total of 1,500 layer recordings were carried out.

Phytosociological samplings

Phytosociological samplings were carried out in each mountain range, in each age group, in 2 quadrats representative of the given forest subcompartment. The samplings were based on the modified method of BRAUN-BLANQUET (1964), where the cover values of vascular plant species were recorded per quadrat and layer (canopy, shrub and ground layer) based on their percentage estimation. The side lengths of the square sampling quadrats were uniformly 20 meters. I examined the similarity of the recorded plant species according to elevations using principal component analysis (PCA). The nomenclature of the species follows SIMON (2000).

Statistical evaluation of FAKOPP data

During the analysis of the data, a two-sample analysis of variance was used to investigate the relationship between decay and the mountain range, age group, and layer. To determine the difference within the factor levels, as well as to estimate the average of each factor level, I used the so-called "treatment contrast". Among the post hoc means comparison tests, I used the Fisher-LSD test.

Similarity studies

To examine the similarity of the 3-3 populations of the three mountain ranges, the Sørensen index was used, which I modified. The values of the Sørensen index vary between 0 and 1, where 0 shows that the investigated associations have no common point, and 1 shows that they are 100 percent identical.

Diversity studies

In my studies, both the Shannon and Simpson diversity indices were used to determine the diversity of the age group levels. In addition, in order to rank the different abundances of the different species according to their diversity, the method of Hill's numbers was also used. The analysis of variance was selected to examine the relationship between mountain ranges and age groups within each level.

Ecological characterisation of stands

To characterize the association and vegetation dynamics of the stands, the recorded taxa were evaluated according to social behaviour types and relative ecological indicators. The trends of ecological indicators and social behaviour types among mountains, age groups and layers were evaluated using hierarchical cluster analysis based on Euclidean distance. For the statistical evaluation I used the statistical program MINITAB.

Soil tests

Soil samples were collected in 2015 and 2016 from 3-3 different quadrats of the upper 0-10 cm soil layer of the 5-5 age groups of the Kőszeg, Börzsöny and Zemplén Mountains, selected during the two years. The soil samples were analysed in the soil laboratory of the Department of Soil Science and Agrochemistry of Szent István University (now known as MATE Department of Soil Science). Humus content, pH (KCl) and physical characteristic were evaluated.

Meteorology data collection

Precipitation data series have been collected from 1950 onwards from the stations closest to our sample areas. In the Kőszeg Mountains the data of the Kőszeg meteorological station, in the Börzsöny the data of the station in Diósjenő were used. In the Zemplén Mountains firstly the data of the Sárospatak meteorological station was used until 1970 and from then the data of the Tolcsva station.

Results and discussion

Fakopp instrument measurement

Statistical evaluation of decay by analysis of variance showed significant differences between stands in each mountain range ($F_{6,133}=0.0022$; $p<0.01$). The stand in Börzsöny was found to be in the worst health condition, with an average decay of 4.4% (95% CI: 3.56; 5.23; n=375) for the studied tree speciments. The deterioration of *Q. petraea* individuals in the Kőszeg and Zemplén Mountains was similar, the former with 2.41% (95% CI: 1.58; 3.24; n=375) and the latter with 2.8% (95% CI: 1.97; 3.64; n=375).

When comparing the age groups of the three mountain ranges, the health of the 100 year old population was found to be the worst in all three mountain ranges. Within a mountain range, some of the younger stands were more deteriorated than their older age-groups. This may be explained by the fact that the health of stands can be significantly improved by removing diseased tree individuals during cultivation. However, the silvicultural operations themselves may also induce health deterioration through the resulting wounds.

In evaluating the tomography of each sample tree in the older stands, I found that the decay pattern of the trees could be distinguished by whether they were of coppice (root sucker) or seed origin. In the case of *Q. petraea* of coppice origin, the decay starts from the earlier trunk, affecting the inner parts of the trunk, and then decreases towards the higher layers of the trunk. In contrast, in old stands of seed origin, the decay starts from the bark and typically affects the higher layers. This was the case for the 100-year-old age group in Börzsöny, while the 100-year-old age group in Zemplén was also measured to confirm the origin of the seed. The results of the repeat measurements showed an increase in decay after only one year, which averaged 1% for all age groups in the three mountain ranges. The increase in the decay rate has already reached an average of 2.25% for the 100-year-old stands in the mountain ranges, which highlights the vulnerability of the older stands.

Phytosociological sampling

In the canopy layer, the dominance of *Q. petraea* was observed during the phytosociological samplings. This tree species was also isolated from the other tree species in the principal component analysis, suggesting that its presence negatively influences the canopy cover of the other tree species, which is not at all uncommon in the native conditions.

Similarity tests

The similarity tests showed the highest similarity at the canopy layer, but as the number of species within the quadrat increased at the shrub and ground layer, the similarity decreased. I found higher similarity values for the two quadrats of age groups than for the age groups of the same age in the three mountains. The decrease in similarity can be explained partly by an increase in the number of species and partly by the fact that the intersection of the three sets cannot be larger than that of two.

Diversity studies

For all layers, the highest diversity was found in the stands of the Börzsöny, followed by the stands of the Kőszeg- and the Zemplén Mountains for canopy and shrub layers. For the ground layer, however, the diversity was lower in the Kőszegi Mountains.

Social behaviour types and relative ecological indicators

Competitor species dominated the canopy cover of all three mountain ranges. In contrast, the shrub and ground layer was characterised by a high proportion of generalist and natural disturbance tolerant species. In the evaluation of the ecological indicators, the number of categories within each indicator suggested that relative heat demand (TB), relative water demand (WB) and relative soil reaction (RB) were more limiting for species than relative nitrogen demand (NB) or relative light demand (LB).

Soil results

The soil surveys in all three mountain ranges revealed highly humic brown forest soils with an average humus content of 6.19%, which supports the results of HEFLER (2020), who reported an increase in humus content in Hungarian forests (http2). The potassium chloride pH of the soils indicated mostly acid soils.

Precipitation data series

The Kőszeg Mountains received the highest average annual precipitation (777 mm), followed by the Börzsöny (695 mm) and the Zemplén Mountains (596 mm). Although the Kőszeg Mountains had the highest average annual precipitation, the Börzsöny had the highest annual precipitation in 2010 (1318 mm) and the highest standard deviation (155). Interestingly, the maximum annual precipitation in the Zemplén Mountains exceeds that of the Kőszegi Mountains (1096 mm), also measured in 2010 (1132 mm).

Conclusions and recommendations

The study of decay has allowed a number of conclusions to be drawn by observing trends between mountain ranges, age groups and layers.

Among the three mountain ranges, the lowest deterioration was measured in the Kőszeg Mountains, which is also the most precipitated mountain range among the study areas, and although precipitation decreased slightly during the study period, the standard deviation values were the lowest. These results suggest that a decrease in precipitation in similarly precipitous mountain ranges with lower standard deviation values does not yet cause a decline in the health of *Q. petraea* stands.

On the other hand, in Börzsöny, where the average rainfall was about 80 mm lower than Kőszeg Mountains in the study period, the health of the stands was still the worst. However, the number of years of drought during the study period was significant compared to those in the Kőszeg Mountains, which may have caused a decline in the vitality of the stands (STOJANOVIĆ et al., 2015, THOMAS et al., 2002). Climate change may increase the growing season (MENZEL & FABIAN, 1999), which may also increase forest productivity (PRETZSCH et al., 2014). The resulting wider annual rings are more sensitive to powdery mildew (TRENYIK, 2016). Based on the above, it can be assumed that the damage caused by wood-decay fungi will increase in the future. Thus, *Q. petraea* stands in the rainier mountain ranges may also experience health deterioration if more frequent drought periods occur. This hypothesis is supported by research results on oak mortality (CSÓKA et al., 2007; CSÓKA et al., 2009, VAJNA, 1989,1990).

The Zemplén Mountains had the lowest average annual precipitation, but the degradation data were still lower than in Börzsöny. This may be explained by the fact that the conditions for the growth of the wood-decay fungi are less favourable in drier areas and that *Q. petraea* is also adapted to drier climates. Thus, it is possible that *Q. petraea* stands in the lower aridity limit will be less sensitive to changes in rainfall than predicted.

Using measurements with the FAKOPP 3D Acoustic Tomograph, I was able to accurately determine the extent and location of the decay affecting each sample tree. Therefore, I believe that similar surveys of the main native tree species could provide an even more accurate picture of their health.

The health of the oldest 100-year-old stands was found to be the poorest, which also means that these stands may be the most sensitive to weather extremes. This also raises the possibility of using FAKOPP in areas more exposed to weather extremes, as a risk assessment to estimate the vulnerability of the stands.

In the similarity tests, relatively low similarity values were found when comparing stands of the same age in mountain areas, although the stands were delimited by introducing standard parameters and *Q. petraea* was the dominant tree species in all stands. Nevertheless, climatic and geological factors, as well as silvicultural management, have a strong influence on the range of species present in stands,

even when they are similar associations.
In the diversity studies, the highest diversity values were found in the study areas of Börzsöny, while the amount of precipitation was also significant. However, in the case of the Zemplén Mountains, not only was the diversity value lower at all three layers, but the average annual precipitation was also lower than in the Börzsöny areas, by almost 100 mm. Thus, it can be assumed that the diversity of the submontane sessile oak stands may be negatively affected by the decrease in precipitation averages.
For the ecological indicators, relative heat demand was one of the categories that is assumed to be more strongly limiting the number of species occurring in each area, as only a few categories included species. SZMORAD (2011) studied the forests of the Sopron Mountains and found that, compared to the 1959 survey, by 1997 the dominance of species in the montane coniferous forest belt (4) had shifted towards the dominance of species in the montane deciduous forest belt (5). The results of the present study also show that montane deciduous forest belt (5) species were the most abundant at ground level in all three mountain ranges. The northern range of many species is shifting upwards due to climate change, resulting in an increase in the number of species preferring warmer climates. At the same time, this also indicates a change in the range of species that make up the ground layer of sessile oak, which may be losing species that prefer cooler climates.
One of the reasons for the high humus content of the soils studied may be due to the felling, as the more open, warmer and drier conditions created by the felled forest may lead to a faster decomposition of organic matter. For soil pH, a range between 6 and 7 would be optimal for the utilisation of macroelements. However, acidification of forest soils is one of the consequences of acid deposition due to air pollution. The research results also suggest that soil acidification is a likely cause of oak decline, which is exacerbated by longer or shorter periods of drought.

New scientific results

My new scientific results are summarised in the following points:

- I found that the health of 100-year-old *Q. petraea* stands is the worst and that the *Q. petraea* stands of the Kőszegi Mountains are the best.
- Using instrumental measurements, I was able to separate the old stands according to their origin by determining and comparing the deterioration patterns of the stands of coppice and seed origin.
- By repeating the instrumental measurements on the same trees for two consecutive years, I found that the rate of decay of *Q. petraea* increases by an average of 1% per year.
- The climate adaptation of *Q. petraea* may be indicated by the fact that the highest decay values were not measured in the driest areas.
- To compare the species pools for the age groups of the three mountain ranges, a version of the Sørensen index was used that I modified to compare not only 2 but also 3 groups.

Publications related to the topic of the thesis

Publications in international peer-reviewed journals with an impact factor

Trenyik P., Skutai J., Szirmai O., Czóbel Sz. (2019): Instrumental analysis of health status of Quercus petraea stands in the Carpathian Basin. Central European Forestry Journal 65: 34-40. https://doi.org/10.2478/forj-2019-0001 Impact Factor: 0,241

A peer-reviewed, full-text scientific communication published in scientific journals

In a non-impact factor journal in a foreign language:

Demeter A., Falvai D., **Trenyik P.,** Czóbel Sz. (2017): Ecological indicator based comparative study of tree of heaven (Ailanthus altissima) stands' herb layer. Columella - Journal of Agricultural and Environmental Sciences 4 (1): 15-20. DOI: 10.18380/SZIE.COLUM.2017.4.1.15

Trenyik P., Ficsor Cs., Demeter A., Falvai D., Czóbel Sz. (2017): Examination the health state with instrumental measurements and the diversity of sessile oak stands in Zemplén mountains. Columella - Journal of Agricultural and Environmental Sciences 4 (1): 21-30. DOI: 10.18380/SZIE.COLUM.2017.4.1.21

Trenyik P., Szirmai O., Magyar V., Demeter A., Skutai J., Czóbel Sz. (2017): Instrumental measurement of health status of old natural sessile oak stands. Studia Botanica Hungarica 48: 125-132. DOI: http://dx.doi.org/10.17110/StudBot.2017.48.1.125

Trenyik P., Szirmai O., Barczi A., Skutai J., Czóbel Sz. (2016): Examination on the state of health regarding a protected sessile oak stock. Review of Faculty of Engineering Analecta Technica Szegedinensia 10: 23-28.

Trenyik P., Borcsa-Bodolay J., Barczi A.; Czóbel Sz. (2014): Eltérő korcsoportú kocsánytalan tölgyes állományok diverzitásának összehasonlító vizsgálata a Börzsönyben pp. 35-39 In: Kóródi M. (szerk.): Economica – A Szolnoki Főiskola Tudományos Közleményei VII. új évfolyam 1. szám, 2014

In a non-impact factor journal in Hungarian:

Trenyik P., Barczi A., Demeter A., Czóbel Sz. (2014): Műszeres egészségiállapot felmérés két időskorú kocsánytalan tölgyes állományban a Börzsöny és a Gödöllői-dombság területén. pp. 359-364 In: Kóródi M. (szerk.): Economica – A Szolnoki Főiskola Tudományos Közleményei VIII. új évfolyam 4/2. szám, 2015, ISSN: 1585-6216

Trenyik P., Borcsa-Bodolay J., Molnár M., Barczi A., Czóbel Sz. (2013): Különböző korú kocsánytalan tölgyes állományok diverzitásának összehasonlító vizsgálata a Börzsönyben, Tájökológiai Lapok 11: 373-377

Proofread university note

Czóbel Sz. & **Trenyik P**. (eds.) (2015): Terepi vizsgálati módszerek. Egyetemi jegyzet. Szent István Egyetemi Kiadó, Gödöllő. pp. 126. ISBN: 978-963-269-494-8

Papers published in congress publications

Peer-reviewed, full-text paper in congress publication:

Trenyik P., Borcsa-Bodolay J., Barczi A., Czóbel Sz. (2014): Impact of forest management in semi-natural oak stands in the Börzsöny Mountains, Hungary pp. 573-582 In: Bene Sz. (eds): 20th Youth Scientific Forum, University of Pannonia Georgikon Faculty, Keszthely, Hungary, p. 600.

Abstracts:

Pályiné Deák N., **Trenyik P.**, Skutai J., Czóbel Sz. (2016): Idős kocsánytalan tölgyek egészségügyi állapotfelmérése a Szent István Egyetem Botanikus Kertjében Gödöllőn. / Health check of old sessile oak trees in the Botanical Garden of Szent István University in Gödöllő. pp. 200-202. In: Barina Z., Buczkó K., Lőkös L., Papp B., Pifkó D., Szurdoki E. (eds.): „XI. Aktuális flora- és vegetációkutatás a Kárpát-medencében" nemzetközi konferencia/"Advances in research on the flora and vegetation of the Carpato-Pannonian region" 11th international conference, Budapest, Magyar Természettudományi Múzeum, 2016. február 12-14.. Előadások és poszterek összefoglalói/Book of abstracts, 255 p. ISBN 978-963-9877-25-2

Trenyik P., Skutai J., Nagy V., Czóbel Sz. (2016): Applicability of instrumental examinations in nature conservation based on the example of a protected forest stock. p. 42. In: Hodúr C.; Krisch J; Boross N. (eds.): „International Conference on Science and Technique Based on Applied and Fundamental Research" ICoSTAF, Szeged, University of Szeged Faculty of Engineering, 2016. június 2. Book of Abstracts, 58 p. ISBN 978-963-306-482-5

Trenyik P., Szirmai O., Demeter A., Czóbel Sz. (2016): Idős természetközeli kocsánytalan tölgyes állományok egészségi állapotának műszeres vizsgálata. / Instrumental analysis of the health status in old natural sessile oak stands. pp. 226-227. In: Barina Z., Buczkó K., Lőkös L., Papp B., Pifkó D., Szurdoki E. (eds.): „XI. Aktuális flora- és vegetációkutatás a Kárpát-medencében" nemzetközi konferencia/"Advances in research on the flora and vegetation of the Carpato-Pannonian region" 11th international conference, Budapest, Magyar Természettudományi Múzeum, 2016. február 12-14.. Előadások és poszterek összefoglalói/Book of abstracts, 255 p. ISBN 978-963-9877-25-2

Trenyik P., Barczi A., Czóbel Sz. (2015): Idős mag és sarj eredetű kocsánytalan tölgy dominálta állományok egészségi állapotának összehasonlító

vizsgálata. p. 146 In: Padisák J., Liker A., Stenger-Kovács Cs. (szerk.): 10. Magyar Ökológus Kongresszus, Előadások és poszterek összefoglalói. Veszprém, 2015. augusztus 12-14., 165 p.

Trenyik P., Czóbel Sz. (2015): Kocsánytalan tölgyes állományok egészségi állapotának vizsgálata a Zemplénben, valamint a Kőszegi-hegységben. 120 p. In: Nagy Z. B. (szerk.) LVII. Georgikon Napok Kivonat-kötet. 136 pp. ISBN 978-963-9639-81-2

Trenyik P., Szirmai O., Barczi A., Czóbel Sz. (2015): Examination of old sessile oak stand with 3D acustic tomography. 128 p. In: Bonis A., Bouzillé J.B., Rapinel S. (eds.) Book of abstracts, 24th International Workshop of the European Vegetation Survey, Rennes (France), 4-8 May 2015, 142 pp.

Trenyik P., Szirmai O., Barczi A., Czóbel Sz. (2015): Prunetalia elemek előfordulása eltérő korú börzsönyi tölgyes állományokban. Occurrence of Prunetalia elements in different ages oak stands in the Börzsöny Mountains. pp. 249. In: Kerényi-Nagy V., Szirmai O., Helyes L., Penksza K., Neményi A. (szerk.): "I. Rózsa- és galagonya-konferencia a Kárpát-medencében" 2015. május 29-30. Nemzetközi Konferencia Kötet. "1st Rose and hawnthorn conference in Carpathian Basin" International Conference Proceedings Book.pp. 255 ISBN: 978-963-269-479-5 Gödöllő, Szent István Egyetemi Kiadó, 2015.

Trenyik P., Szirmai O., Czóbel Sz. (2015): Idős kocsánytalan tölgyes állományok többszempontú összehasonlító vizsgálata. 59-60 pp. In: Szélpál Sz., Halász J., Hannus I., Kovács K., Wölfling J., Szilágyi Á., Androsits B. (szerk.) "Innováció a természettudományban – Doktorandusz Konferencia 2015" absztrakt ebook, Szeged, 2015.09.26. 61pp. ISBN 978-963-9970-63-2

Czóbel S., Berecz T., **Trenyik P**., Molnár M., Schellenberger J., Szirmai O., Saláta D., Barczi A. (2014): Spatial pattern of oak seedlings and weed vegetation in a reconstructed natural stand of Aceri campestri-Quercetum roboris community pp. 147. In: A. Čarni, N. Juvan, D. Riberio (eds.) 23rd International Workshop of the European Vegetation Survey – Book of Abstracts Ljubljana 8-12 May p. 231.

Czóbel Sz., **Trenyik P**., Berecz T., Saláta D., Molnár M., Schellenberger J., Bősze D., Szirmai O., Barczi A. (2014): Rekonstruált gyertyánelegyes mezei juharos tölgyes társulás tölgyújulatának és gyomviszonyainak vizsgálata. p. 141. In: Schmidt D., Kovács M., Bartha D. (szerk.): X. Aktuális Flóra- és Vegetációkutatás a Kárpát-medencében nemzetközi konferencia absztraktkötete. Nyugat-magyarországi Egyetem Kiadó, Sopron, pp. 235. ISBN: 978-963-334-153-7

Trenyik P., Borcsa-Bodolay J., Schellenberger J., Molnár M., Barczi A., Czóbel Sz. (2014): Comparative study of different-aged sessile oak stands in the Börzsöny Mountains, Hungary pp. 122. In: A. Čarni, N. Juvan, D. Riberio (eds.) 23rd International Workshop of the European Vegetation Survey – Book of Abstracts Ljubljana 8-12 May p. 231.

Trenyik P., Czóbel Sz., Borcsa-Bodolay J., Molnár M., Schellenberger J., Barczi A. (2014): Eltérő korú hegyvidéki tölgyes állományok vizsgálata a Börzsönyben. p. 224. In: Schmidt D. – Kovács M. – Bartha D. (eds.): X. Aktuális Flóra- és Vegetációkutatás a Kárpát-medencében nemzetközi konferencia absztraktkötete. Nyugat-magyarországi Egyetem Kiadó, Sopron, pp. 235. ISBN: 978-963-334-153-7

Trenyik P., Borcsa-Bodolay J., Molnár M., Barczi A., Czóbel Sz. (2013): Comparative study of diversity of different-aged sessile oak standsin the Börzsöny Mountain pp. 133-134 In: Zimmermann Z., Szabó G. (eds.): VIII. Carpathian Basin Biological Symposium – I. Sustainable development int he Carpathian Basin, Book of Abstract, p.144. ISBN: 978-963-269-387-3

Trenyik P., Borcsa-Bodolay J., Molnár M., Barczi A., Czóbel Sz. (2013): Különböző korú kocsánytalan tölgyes állományok diverzitásának összehasonlító vizsgálata a Börzsönyben pp. 134. In: Zimmermann Z., Szabó G. (eds.): VIII. Kárpát-medencei Biológiai Szimpózium – I. Fenntartható fejlődés a Kárpát- medencében nemzetközi konferencia absztraktkötete, p.144. ISBN: 978-963-269-387-3

References

AUSSENAC G., (2000): Interactions between forest stands and microclimate: Ecophysiological aspects and consequences for silviculture. Annals of Forest Science. 57, 287-301 p.

BARTHOLY J., PONGRÁCZ R. (2005): Néhány extrém éghajlati paraméter globális és a Kárpát-medencére számított tendenciája a XX. században. AGRO-21 Füzetek, 40: 70-93 p.

BARTHOLY J., PONGRÁCZ R. (2007): Regional analysis of extreme temperature and precipitation indices for the Carpathian Basin from 1946 to 2001. Global and Planetary Change, 57: 83-95 p.

BARTHOLY J., PONGRÁCZ R., PIECZKA I., KARDOS P., HUNYADY A. (2009): Analysis of expected climate change in the Carpathian Basin using a dynamical climate model. Lecture Notes in Computer Science, 5434: 176– 183 p.

BERKI I. (1991): Research into the cause of oak decay decline in Hungary. Proceedings of International Symposium on Ecological Approaches of Environmental Chemicals. Debrecen, 8–14 p.

BERKI I. (1995): Az Északi-középhegységi kocsánytalan tölgypusztulás néhány okának vizsgálata. Kandidátusi értekezés, Debrecen, 132 p.

BERKI I., MÓRICZ N., RASZTOVITS E., VIG P. (2007): A bükk szárazság tolerancia határának meghatározása. In: MÁTYÁS CS., VIG P. (Szerk.) Erdő és Klíma V. Sopron, 213-228 pp.

BESZE P., FARKAS J., MÁRTA V. (Szerk.) (1999): Pro Silva. Pro Silva Hungaria, Mátrafüred, 15 p.

BRAUN-BLANQUET J. (1964): Pflanzensoziologie (Dritte, neubearbeitete und wesentlich vermehrte Auflage). – Springer-Verlag, Wien – New York, 865 pp.

CZÓBEL SZ., HORVÁTH, L., SZIRMAI, O., BALOGH J., PINTÉR, K., NÉMETH, Z., ÜRMÖS, ZS., GROSZ, B., TUBA Z. (2010): Comparison of N2O and CH4 fluxes from Pannonian natural ecosystems. European Journal of Soil Science 61: 671-682 p.

CZÓBEL SZ., SZIRMAI, O., NAGY, J., BALOGH, J., ÜRMÖS, ZS., PÉLI, E.R., TUBA Z. (2008): Effects of irrigation on the community composition, and carbon uptake in Pannonian loess grassland monoliths. Community Ecology 9: 91-96 p.

CZÚCZ B., GÁLHIDY L., MÁTYÁS CS. (2011): Present and forecasted xeric climatic limits of beech and sessile oak distribution at low altitudes in Central Europe. Annals of Forest Science 68(1): 99-108 p.

CZÚCZ B., GÁLHIDY L., MÁTYÁS CS. (2013): A bükk és a kocsánytalan tölgy elterjedésének szárazsági határa. Erdészettudományi Közlemények, 3(1): 39-53 p.

CSÓKA GY.; KOLTAY, A.; HIRKA, A., JANIK, G. (2007): Az aszályosság

hatása kocsánytalan tölgyeseink és bükköseink egészségi állapotára. In: MÁTYÁS CS. ÉS VIG P. (Szerk.): Erdő és klíma V. kötet, Sopron, 229–239 p.
CSÓKA GY., KOLTAY A., HIRKA A., JANIK G. (2009): Az aszályosság hatása kocsánytalan tölgyesek és bükkösök egészségi állapotára. „Klíma-21" Füzetek, 57: 64-73 p.
GÁLOS B., MÁTYÁS CS., JACOB D. (2012): Az erdőtelepítés szerepe a klímaváltozás hatásának mérséklésében. Erdészettudományi Közlemények, 2(1): 35-45 p.
GEIGER R., ARON, R.H., TODHUNTER, P. (1995): The climate near the ground. Vieweg, Braunschwei, Germany. 528 p.
HAMPE A., PETIT R.J. (2005): Conserving biodiversity under climate change: the rear edge matters. Ecology Letters, 8: 461–467 p.
HART S.A., CHEN, H.Y.H. (2006): Understory vegetation dynamics of North American boreal forests. Critical Review of Plant Sciences, 25: 381-397 p.
HIRKA A., KOLTAY A., KOLOZS L., SZŐCS L., CSÓKA GY., (2015): Erdeink egészségi állapota 2014-ben. Erdészeti lapok CL. évf. 9. szám 258-261 p.
IGMÁNDY Z.; PAGONY H.; SZONTAGH P., VARGA F. (1985): A kocsánytalan tölgy (Quercus petraea MATT./Lieb) pusztulása hazánkban. Növényvédelem, 21(7): 311–311 p.
JAKUCS, P. (1988): Ecological approach to forest decay in Hungary. Ambio, 17(4): 267–274 p.
MASSON-DELMOTTE V. (Szerk.): Global Warming of 1.5 OC: An IPCC Special Report on the Impacts of Global Warming of 1.5° C Above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty (World Meteorological Organization, 2018).
MÁTYÁS CS., FÜHRER E., BERKI I., CSÓKA GY., DRÜSZLER Á., LAKATOS F., MÓRICZ N., RASZTOVITS E., SOMOGYI Z., VEPERDI G., VÍG P., GÁLOS B. (2010): Erdők a szárazsági határon. „Klíma-21" Füzetek, 61: 84-97 p.
MÁTYÁS CS., GÁLOS B. (2010): Erdőgazdálkodás és klimatikus szélsőségek: problémák és feladatok. „Klíma-21" Füzetek, 63: 25-32 p.
MÁTYÁS CS., VENDRAMIN G.G., FADY B. (2009): Forests at the limit: evolutionary-genetic consequences of environmental changes at the receding (xeric) edge of distribution. Annals of Forest Science, 66: 800–803 p.
MENZEL A., FABIAN P. (1999). Growing season extended in Europe. *Nature*, *397*(6721), 659-659.p.
OKE T.R. (2002): Boundary layer climates. Routledge. London and New York
PARMESAN C. (2006): Ecological and Evolutionary responses to recent climate

change. Annual Review of Ecology, Evolution, and Systematics, 37: 637-669 p.
PARMESAN C., YOHE, G. (2003): A globally coherent fingerprint of climate change impacts across natural systems. Nature, 421: 37–42 p.
PRETZSCH H., BIBER P., SCHÜTZE G., UHL E., RÖTZER T. (2014): Forest stand growth dynamics in Central Europe have accelerated since 1870. *Nature communications*, 5:4967, DOI: 10.1038/ncomms5967
RASZTOVITS E., BERK, I., MÁTYÁS CS., CZIMBER K., PÖTZELSBERGER E., MÓRICZ N. (2014): The incorporation of extreme drought events improves models for beech persistence at its distribution limit. Annals of Forest Science, 71: 201–210 p. https:// doi.org/10.1007/s13595-013-0346-0
RISSER P.G. (1995): The status of the science examining ecotones. BioScience, 45: 318–325 p.
ROOT T.L., PRICE J.T., HALL K.R., SCHNEIDER S.H., ROSENZWEIG C., POUNDS J.A. (2003): Fingerprints of global warming on wild animals and plants. Nature, 421: 57–60 p.
SIMON T. (szerk.) (2000): A magyarországi edényes flóra határozója. - Tankönyvkiadó, Budapest pp. 687.
SOMOGYI ZOLTÁN, BARTHA DÉNES, BAROVICS ATTILA, CSÓKA GYÖRGY (2001): Erdő nélkül? L'Harmattan Kiadó, Budapest, 268 p.
STOJANOVIĆ D., LEVANIČ T., MATOVIĆ B., ORLOVIĆ S (2015): Growth decrease and mortality of oak floodplain forests as a response to change of water regime and climate. *Eur. J. For. Res*., 134 (2015), pp. 555-567
SZALAI S., MIKA J. (2007): A klímaváltozás és időjárási anomáliák előrejelzése az erdőtakaró szempontjából fontos tényezőkre. In: MÁTYÁS CS., VIG P. (Szerk.) Erdő és klima V. Sopron, pp. 133-143.
SZÁSZ G., TŐKEI, L. (Szerk.), 1997. Meteorológia mezőgazdáknak, kertészeknek, erdészeknek. Mezőgazda Kiadó, Budapest. 722 p.
SZMORAD F. (2011): A Soproni-hegység erdeinek történeti, növényföldrajzi és cönológiai vizsgálata. *Tilia* vol 16. 287p
THOMAS F.M., BLANK R., HARTMANN G. (2002): Abiotic and biotic factors and their interactions as causes of oak decline in Central Europe. *For. Pathol*., 32 (2002), pp. 277-307 p.
TRENYIK P., SZIRMAI O., BARCZI A., SKUTAI J., Czóbel Sz. (2016): Examination on the state of health regarding a protected sessile oak stock. *Review of Faculty of Engineering Analecta Technica Szegedinensia* 10: 23-28 p.
VAJNA L. (1989): A kocsánytalan tölgy pusztulásának kórok- és járványtani kérdései. Erdő, 38: 169–175 p.
VAJNA L. (1990): Fungi associated with oak-decline. EPPO Bulletin, 20: 3 p.
WALTHER G.R., POST, E., CONVEY, P., MENZEL, A., PARMESAN, C., BEEBEE, T.J.C., FROMENTIN, J.M., HOEGH-GULDBERG, O.H., BAIRLEIN, F. (2002): Ecological responses to recent climate change.

Nature, 416: 389–395 p.

WENG S.H., KUO, S.R., GUAN, B.T., CHANG, T.Y., HSU, H.W., SHEN, C.W. (2007): Microclimatic responses to different thinning intensities in a Japanese cedar plantation of northern Taiwan. Forest Ecology and Management 241, 91-100 p.

WHIGHAM D.F. (2004): Ecology of woodland herbs in temperate deciduous forests. Annual Review of Ecology and Systematics, 35: 583-621 p.

Electronic references:

http1: https://www.met.hu/ismeret-tar/erdekessegek_tanulmanyok/index.php?id=2334 (Downloaded: 2023.03.08)

http2: http://talaj.hu/wp-content/uploads/2020/09/Hefler_PICO_TVGY2020_Sarvar.pdf (Downloadedhtt: 2023.03.08)