MENDELU
Faculty of Forestry
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Mendel
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Silva*Net* – Wood*Net* 2023

Proceedings Abstracts of Student Scientific Conference

Ing. Nikola Žižlavská
Ing. Ondřej Hemr
Ing. Petr Čech
(eds.)

2023 Brno

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Student Conference is organised by the Council of the Internal Grant Agency of the Faculty of Forestry and Wood Technology MENDELU under the patronage of the Dean of Faculty (Faculty of Forestry and Wood Technology MENDELU) Prof. Dr. Ing. Libor Jankovský and in cooperation with listed projects.

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EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
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MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

TENTO PROJEKT JE SPOLUFINANCOVÁN EVROPSKÝM FONDEM PRO REGIONÁLNÍ ROZVOJ

Výzkumné centrum pro studium patogenů z rodu *Phytophthora* CZ.02.1.01/0.0./0.0./15_003/0000453

Dotační titul: OP Výzkum, vývoj a vzdělávání
Výzva č. 02_15_003 pro Podporu excelentních výzkumných týmů v prioritní ose 1 OP
Doba řešení: 1. 12. 2016 – 30. 04. 2023
Příjemce projektu: Mendelova univerzita v Brně
Koordinátor projektu: prof. Dr. Ing. Libor Jankovský

Cílem projektu je vybudování komplexní infrastruktury a vytvoření mezinárodního, interdisciplinárního a multioborového výzkumného týmu se zaměřením na výzkum chorob dřevin rodu *Phytophthora*.
Aplikací a implementací inovativních technologií na bázi mikrobiologie, bioinformatiky, biologie, ekofyziologie, anatomie dřevin, genomiky a bioklimatologie, přispět k hlubšímu poznání faktorů ovlivňujících diverzitu, adaptaci a hybridizační procesy, které probíhají u rodu *Phytophthora*. Dále se pak zabývat evoluční historií tohoto rodu a molekulárními mechanizmy řídící náchylnost a odolnost dubů proti půdním patogenům tohoto rodu. Očekávané výsledky budou rozvíjet disciplínu fytopatologie dřevin, jako jednu z klíčových oblastí excelentního výzkumu na MENDELU, s pozitivními důsledky pro management a ochranu evropských ekosystémů. Bude prohlubována stávající mezinárodní spolupráce s předními světovými institucemi, s cílem a ambicí založit a udržet vzniklý mezinárodní tým VaV centra MENDELU, jako lídra v oboru a získat navazující projekty mezinárodní spolupráce ve výzkumu chorob dřevin rodu *Phytophthora*. V rámci projektu byla doplněna stávající infrastruktura laboratoří VaV MENDELU o špičkové přístroje a vybavení bezprostředně související s výzkumem chorob dřevin zapříčiněných parazity rodu *Phytophthora*.

Partneři projektu:

- Austrian Research and Training Centre for Forests, Natural Hazards and Landscape
- Svaz školkařů České republiky, z. s.
- Arboeko s.r.o.

Phytophthora Research Centre

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BFW. Bundesforschungszentrum für Wald

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ERA-Chair: Striving for Excellence in the Forest Ecosystem

The project “ERA-Chair: Striving for Excellence in the Forest Ecosystem” (EXCELLENTIA) brings new insights into the issue of climate-threatened forest ecosystems in Central Europe concerning the needs of society but also sheds light on how much man has contributed to past instability by moving away from the cultivation of natural forests towards monocultures. EXCELLENTIA builds on the availability of data and the research programme already underway at the Faculty of Forestry and Wood Technology MENDELU. The necessary data collection and practical analysis are also conducted at the University Forest Enterprise Masaryk Forest Křtiny.

A cutting-edge interdisciplinary research group is established under the Faculty of Forestry and Wood Technology to research forest ecosystems under the leadership of leading scientist Professor Douglas L. Godbold. The multidisciplinary team of researchers investigate the sustainability of forest ecosystem functions in the context of the ongoing climate change and ensures forest stability for the coming decades. Drought, tree species responding differently to drought, and the susceptibility or resistance of tree root systems to pathogen attack are other issues the project addresses.

In addition to the scientific line, the EXCELLENTIA project aims to bring about structural changes in sustainable research and innovation, intellectual property rights and research data management, codification of scientific ethics and career guidance. Training activities aimed at young researchers and supervision of BSc, MSc and PhD theses are also part of the projects. Through Professor Godbold’s exceptional contacts within the European scientific community, the team is envisaged to be involved in major international projects.

The results of the project are continuously communicated not only to the professional but also to the general public. The project also envisages cooperation at the level of secondary schools.

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Funded by the European Union

EXCELLENTIA
Forest Ecosystem Research

This project has received funding from the European Union’s Horizon Europe research and innovation programme under grant agreement N°101087262.

Forest of the future: digital tools for learners to foster CCF approach

The Royal Forestry Society of Belgium (SRFB), together with the Mendel University in Brno (Czech Republic), the Genech Institute (France), the Horticultural Technical Institute of the French Community (ITHCF, Belgium) and the Agroforestry Development Centre of Chimay (CDAF, Belgium) initiated a new Erasmus + project called for now “ForDiL” which is a short word for “Forest of the future: digital tools for learners to foster CCF approach”.

This project aims at training adoption and developing up-to-date training content for the forest owners and managers to develop their skills in the new forest management approach, Continuous Cover Forestry (CCF). The approach integrates several specific activities, notably targeting the development of a *Marteloscope* and *Travailloscope,* integrating the CCF approach.

After a research phase and development of the decision scheme, the partners develop and test both tools integrated into an App that can be used in the field. Students from partner institutes and university contribute to testing the tools developed and benefit from exchange with peers from other European institutions on CCF and visiting forest stands.

The expected outcome of the project is an App available in English, French and Czech that allows forest learners and teachers/trainers to benefit from a digital tool to experiment with this approach both virtually and practically and for professionals to be guided in the decision process for a sustainable approach of the forest management, in autonomy. The target users are forest managers and future forest professionals, such as students from sylviculture or forestry fields of study in vocational schools and higher education institutions.

Contact: Lumír Dobrovolný

Co-funded by
the European Union

LECA - CE0100170 – Supporting the coexistence and conservation of Carpathian LargE Carnivores

Duration: 1. 4. 2023 – 31. 3. 2026

Lead partner: Mendel University in Brno

Project coordinator: Mgr. Martin Duľa, Ph.D.

Project partners: WWF Poland, WWF Slovakia, WWF Hungary, Technical University in Zovlen, Bükk National Park Directorate, Tatra National Park, State Nature Conservancy of the Slovak Republic, Friends of the Earth Czech Republic Carnivore Conservation Programme, Ministry of the Environment of the Czech Republic, Zarand Association, Slovenian Forest Service

Large carnivores are key components of forest ecosystems in the Carpathians, hosting one of the most abundant native populations of lynx, wolf and bear in Europe. However, whether populations are stable or growing is unclear as data are not collected harmoniously across borders. There are no shared regulations and policies on large carnivore's conservation (e.g. poaching prevention) and no shared understanding and coordination between stakeholders. Clear is, however, that perceived and actual conflicts between humans and large carnivores are on the rise. To promote coexistence with local stakeholders, to enable viable large carnivores population structures, natural expansion and recolonisation of large carnivores, to establish evidence-based and coordinated practices in the Carpathian countries, and to contravene misconceptions, LECA wants to raise awareness, educate, engage and influence target groups such as hunters, foresters, farmers, livestock and beekeepers, police investigators (poaching), ministries, municipalities and the broad public.

The project aims are (1) a consistent and efficient monitoring approach involving local stakeholders; (2) up-to-date population information in cross-border regions; (3) effective conflict prevention measures to be rolled out at the Carpathian level; and (4) improved participative cooperation of key actors at local, regional and transnational level. A Thematic Guidance on large carnivore's conservation and coexistence in the Carpathians will be created and validated via pilot actions in cross-border pilots (Tatras (SK/PL), East Carpathians (SK/PL/UA), Slovak Karst - North HU Mountains (SK/HU), Beskydy-Kysuce (CZ/SK) and reference areas (SL/RO), driving pilot area strategies, national recommendations and an IT app for the public. The Guidance will cover novel, unified tools for harmonised Monitoring, Poaching investigation and Conflict prevention.

The three-year LECA project is funded by the EU Interreg Central Europe programme.

More information: https://www.interreg-central.eu/projects/leca/

CONTENTS:

Silva*Net* 2023

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FOREST PRACTITIONER'S VIEWS ON FOREST RECREATION FUNCTION AND THEIR MOTIVATION TO CREATE FOREST RECREATION MANAGEMENT

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Keywords: cost and benefits of forest recreation, forester's self-perception, urban forestry

1 INTRODUCTION

Based on semi-structured in-depth interviews, foresters' self-perceptions of the recreational functions of the forest were investigated in relation to forest recreation. Foresters' motivations for creating a recreational environment and how they view the positives and negatives of forest recreation were investigated.
The research also looked at the support forest managers have for creating recreational functions from site owners.

2 METHODOLOGY

Based on semi-structured interviews, interviews with 15 respondents were recorded. Respondents were selected from key locations. The key sites were urban forests and forests adjacent to urban areas. The interviews were transcribed verbatim and the data anonymized. Subsequent analysis was carried out in ATLAS.ti. I used the thematic analysis method to process the data. Which is a flexible method that is not dependent on particular epistemological or theoretical approaches (Maguire et al., 2017).
Thematic analysis is based on the data it identifies and then describes. The key is the researcher who determines how the data will be analysed. To potentially avoid the risks associated with the thematic analysis method, I used the recommended six-step process (Braun et al., 2006).

3 RESULTS

Recreational use of suburban woodland sites has been shown to have a large number of health, social and economic benefits for people (Brown et al., 2013; Yeh, C.-T. et al, 2020; Wei-Lun T. et al., 2019). Recreational use of suburban forests is classified as a non-productive forest function (Vyskot, 2003).
Tourist-used forests managed by the respondents were not always classified as special purpose forests. Some of the sites also fell under economic forests. Respondents mainly emphasized the requirement of the forest sponsor/owner in their approach to management in a given location. The requirements of the owners for the respective managers included communication with the public and adaptation of the site for increased visitor movement, which is understandable given the location of the sites the respondents manage which are suburban sites or sites with high tourism pressure. They have not received detailed training or preparation for these specifics during their preparation for these positions. Thus, they only gained experience when they took up the position. However, respondents were inclined to consider the specifics of their job as part of it.
This is supported by the fact that individual foresters have the most information about individual sites. They see it more as an enriching experience.

They see the positives of recreational functions more in the direction of the users of these functions. At the same time, they perceive that in other locations they are also becoming users. They see the negative aspects primarily in the visitors' lack of knowledge of the basic rules of behaviour in the forest, the most frequently mentioned of which was the pollution of the sites. Even with the abundant placement of litter bins, it did not prevent high pollution of entire sites. Limited hunting was also mentioned, including increased game mortality. From their perspective, mortality occurs because of stressful interactions with loose dogs. The increasing aggressiveness of visitors, especially cyclists, was also mentioned. Another frequently noted aspect of high visitor numbers related to the reduction of logging activities, and in some cases, significant changes to management plans. It was mentioned, for example, that the public often comments negatively on clearfelling. Therefore, to avoid negative comments, they are adapting harvesting to smaller areas and also timing it to when the site is less busy with visitors. They see hope in mitigating negative impacts through education of the general lay public. Support from forest owners has been wide ranging. From the owner having only requirements and the managers having to fund everything from their own resources, to partial funding, to full support for projects related to recreational use.

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THE ROLE OF HYDROGEL ON GROWTH OF SEEDLINGS UNDER GREENHOUSE CONDITIONS

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Keywords: birth rate, limestone quarry, mortality

1 INTRODUCTION

This paper presents research conducted within a limestone quarry reclamation framework in a greenhouse experiment. Several best practices exist for soil management, tree species selection, seed collection, seeding, planting techniques, and other reclamation practices (Neri and Sánchez, 2010). These reclamation methods can expedite the restoration of a quarry (Bonifazi et al., 2003). A significant challenge lies in the loss of soil during quarry restoration, as the soil is often replaced with low-quality substrate. Plants may be subjected to repeated stress, such as drought stress (Oliveira et al., 2011). Currently, global warming is increasing, leading to more frequent drought stress episodes for plants during the growing season. Hydrogel could be one option to alleviate drought stress in plants. This study aims to evaluate the potential of plant growth with and without hydrogel. What effect does the hydrogel have on seedling mortality, natality and growth?

2 MATERIAL AND METHODS

Selected trees were planted in 10-liter rectangular pots. Three soil substrates: from Mokrá quarry - Substrate S1- consisted of crushed limestone (0-16 mm) to mimic natural succession conditions. Substrate S2 was sandy (0.05-2 mm particles), and substrate S3 was soil enriched with crushed limestone (0-16 mm particles). Certified seed materials were sourced from the School Forest Enterprise Masaryk Forest Křtiny. Seed germination was verified in the laboratory at Mendel University through experiments conducted in Petri dishes with filter paper. The germination process was considered successful if roots of at least 1 mm in size were formed, following the criteria outlined by Cantu de Leija et al. (2022). Seed germination rates were as follows: *Pinus sylvestris* 91%, *Larix decidua* 52%, *Picea abies* 43% and *Quercus robur* 49%. Different irrigation doses were applied to the substrates and individual seedlings. The minimum irrigation was determined based on the wilting point using *Lactuca sativa* (250 ml). In each box, a total of 10 lettuce plants were planted, and irrigation was gradually reduced. The optimal irrigation volume was set at twice the minimum irrigation (500 ml). The maximum irrigation dose was determined as 750 ml when the lettuce started to show signs of rot. There were two variants of minimal irrigation: with and without hydrogel. Irrigation was performed once a week. The hydrogel used was sourced from the German manufacturer Degussa AG, Creavis Technologies Innovation, Backerpfad 25, Krefeld. The hydrogel's grain size ranged from 0.2 mm to 0.8 mm. Following the manufacturer's recommendation, the hydrogel was dosed at 3 g per liter of substrate. Soil moisture was measured once every 14 days before irrigation using the ML2 ThetaProbe Soil Moisture Sensor by Delta-T Devices Ltd. The average air temperature in the greenhouse throughout the experiment was 24°C, and the average humidity level was 43%. Natural light was utilized, and light curtains were activated during the summer months. Each variant had three replicates to enable

statistical analysis of the results using the program Statistica 13. The experiment spanned 34 weeks, from November to July. We assessed soil properties: maximum capillary capacity, retention water capacity, porosity, bulk density, specific density, soil reaction (pH/H_2O and pH/KCl) (Zbíral et al., 2011).

3 RESULTS AND DISCUSSION

Substrates S2 and S3 demonstrate the best water retention capability based on calculated hydrolimits. When comparing substrates with and without hydrogel, those enriched with hydrogel achieve slightly lower values of soil moisture compared to soils with optimal irrigation. In fact, substrate S3 even reaches higher volumetric moisture content values. The first seed germination was recorded 4 weeks after planting. Without hydrogel, it occurred on December 16, 2015, in S2 (optimal irrigation for pine) and on December 12, 2015, in S1 (maximum irrigation for spruce). With hydrogel, germination occurred on December 30, 2015, in S3 (pine). *Quercus robur* seeds on all substrates with hydrogel germinated earlier, and further germination occurred in *Picea abies* (S2). Based on the monthly trunk growth increments, different tree species exhibited varying growth. Pine exhibited the highest trunk growth (average monthly increment: 0.5 cm) on substrate S1 with maximum irrigation. Larch and spruce had the largest trunk growth on substrate S3 with maximum irrigation (average monthly increment: larch: 0.5 cm; spruce: 0.6 cm). Oak achieved the best average trunk increment on substrate S2 with optimal irrigation (1.8 cm). The highest trunk growth increments were consistently recorded on substrate S1 for all tree species (average monthly growth: pine 0.5 cm; larch 0.4 cm; spruce 0.5 cm; and oak 1.1 cm).

4 CONCLUSIONS

Addition of hydrogel to the substrate had no significant impact. While soil moisture increased with the hydrogel substrate, values remained within the range of optimal and minimal irrigation. Only in the case of S3 was there an increase in both minimum and maximum moisture levels compared to substrates with optimal irrigation. *Quercus robur* seeds germinated earlier on all substrates with hydrogel compared to other irrigation. Different tree species exhibited varying trunk growth increments in the substrates (pine: S1, larch: S3, spruce: S3, oak: S2), but the substrate with hydrogel addition showed the highest increments for all tree species in substrate S1. However, our results emphasize the importance of carefully selecting substrates and tree species, as each species has specific requirements. In the next phase of our research, we plan to conduct a field experiment directly in the quarry using hydrogel.

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FACTORS AFFECTING INFESTATION OF TEAK TREES BY *XYLEUTES CERAMICA* (WALKER, 1865) (LEPIDOPTERA: COSSIDAE) IN PLANTATIONS IN THAILAND

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Keywords: *Xyleutes ceramica*, stem borer, teak, environmental factors, forest plantation management

1 INTRODUCTION

The teak bee-hole borer (*Xyleutes ceramica* (Walker, 1865)) is a large moth species in the family Cossidae, its larvae develop under the bark and in the wood of living woody plants and cause physiological and technical damage to host woody plants. It is widespread in north of Thailand and is considered the most serious pest of teak in Thailand (Wylie & Speight, 2012). Silviculture practice possess various tools of pest management, e.g., controlling the structure and composition of a forest stand that affect an outbreak of pest. Therefore, to prevent and minimize the losses from pest infestations, detailed knowledge on bionomy and habitat requirement of pests is crucial to provide specific silvicultural and technical control measures at different stages in the rotation. The main goal of this study is to gain new knowledge on the habitat preferences of the species concerning tree and stand characteristics to provide recommendations of management to minimize damage of trees by the species.

2 MATERIAL AND METHODS

The study sites were located on 3 teak plantations in northern Thailand where the occurrence of *X. ceramica* has been reported. The sample plots were distributed covering three age classes (from young to old stands). At each study plot, the number of current entrance holes of *X. ceramica* was counted for all individual teak trees up to a height of 10 m above the ground. The characteristics of tree and stand, i. e. diameter at breast height (DBH), total height, mean annual increment of DBH, stem damage, vitality, plot position, understory coverage, canopy closure, age and site quality were recorded. The effects of all characteristics on the severity of infestation by the species were investigated by applying random forest algorithm. The conditional permutation importance was used to check the importance of the explanatory variables and evaluate the statistical significance of each explanatory variable. Lastly, the marginal effect of the selected significant variables on the number of entrance holes was visualised with a partial dependence plot.

3 RESULTS

A total number of 1,952 teak trees were sampled at the study localities in northern Thailand. Overall, the preference of the species was comparatively driven by characteristic of teak stands more than individual teak tree, as the explanatory power of stand characteristics were substantial higher than the others at a tree level. The most significant variables at tree level were DBH increment, DBH, stem damage and height, respectively (Fig. 1). At stand level, the most significant variables were

understory coverage, site quality, age, locality, canopy coverage and mean DBH increment, respectively (Fig. 2).

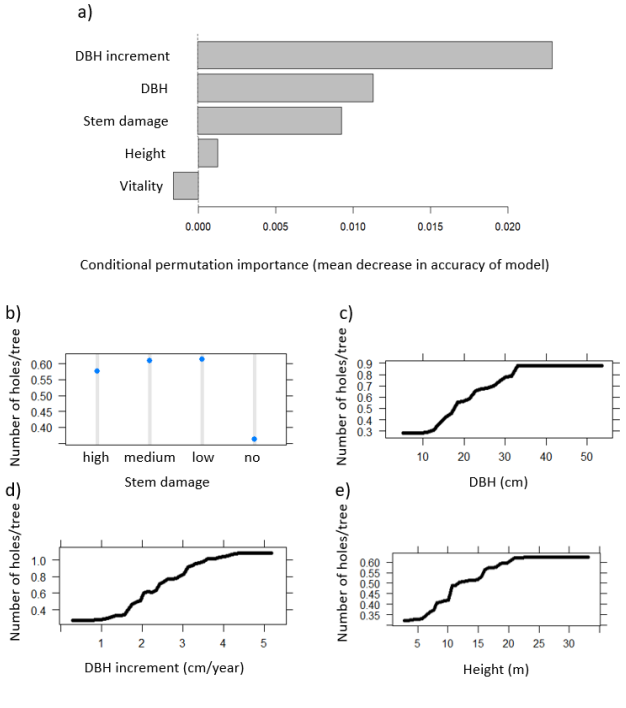

Fig. 1: Results of random forest regression of number of *Xyleutes ceramica* entrance holes/tree as the response variable: (a) conditional permutation importance plot showing the importance of particular variables for the number of attacks by the species at tree level (the value > 0 means p-value ≤ 0.05); (b,c,d,e) partial dependence plots showing the marginal effect of selected significant explanatory variables on the mean number of the species entrance holes/tree.

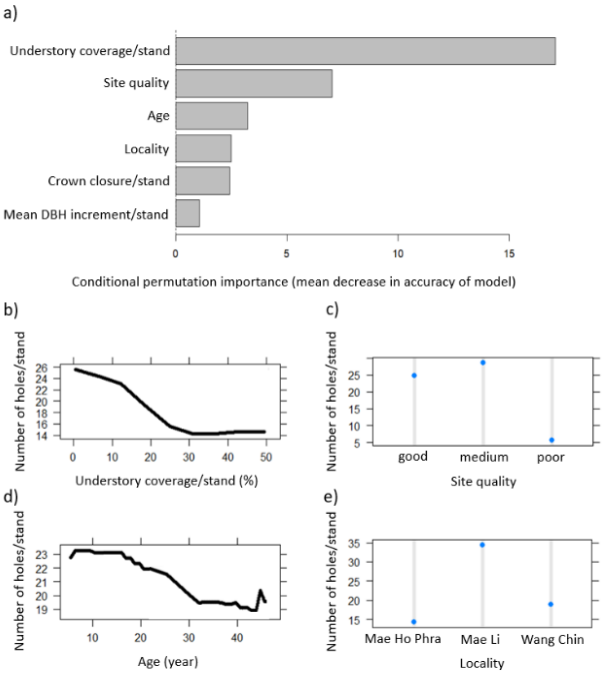

Fig. 2: Results of random forest regression of number of *Xyleutes ceramica* entrance holes/stand as the response variable: (a) conditional permutation importance plot showing the importance of particular variables for the number of attacks by the species at stand level (the value > 0 means p-value ≤ 0.05); (b,c,d,e) partial dependence plots showing the marginal effect of selected significant explanatory variables on the mean number of the species entrance holes/stand.

4 CONCLUSIONS

Based on the results of this study and information from the literature, a conclusion can be made that ecological niches of *X. ceramica* in teak plantation depends mostly upon well-growing and/or damaged teak trees planted in a highly homogenous stand with a warm microclimate, particularly in the more open canopy in young and medium aged stands.

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TREE COMPETITION AND ITS IMPACT TO PRODUCTIVITY IN DIFERENT TYPES OF FOREST STRUCTURE

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Keywords: basal area increment, competition, forest structure

1 INTRODUCTION

Forest ecosystems are initially compromised by non-living factors due to the ongoing global climate change (GCC). These weakened stands are then further damaged by secondary living factors. The GCC is marked by an increase in air temperatures and alterations in the distribution of annual precipitation (Cavin et al., 2013). Currently, mixed stands appear to be a viable adaptation approach for sustainable management under uncertain climatic conditions (Pretzsch and Schütze, 2021; Pretzsch et al., 2021). Mixed stands have been shown to surpass monocultures of productivity (Jactel et al., 2018) and are more resource efficient utilisation (Forrester, 2014). Moreover, the production superiority of mixed stands can be intensified during drought periods (Dănescu et al., 2018). Numerous studies have been conducted on mixed stands, for instance (Pretzsch et al., 2020). However, uneven-aged mixtures have been the subject of only a few studies, so far. Spruce mixed with beech can take advantage of its stem flow or hydraulic lift, where deeper rooting beech can improve water availability to shallower rooting spruce, which is then more competitively balanced (Dawson, 1993).

2 METHODS

Across the country, seven sets of three different stand structures (A, B, C) have been established in various locations (Polánky, Hradec Králové, Šumava, Beskydy, Křtiny). These sets include all four primary tree species in the Czech Republic (i.e., beech, spruce, pine, and oak), depending on altitudinal zones. Each set covers an area larger than 0.5 hectares (plots range from 40 x 40 m to 50 x 50 m, depending on species and structural diversity), and all three plots (A, B, C) are located in the same site (soil and climate). Each set is composed of three forest stands with varying structures:
A – Mono-specific even-aged stand (monoculture)
B – Even-aged mixed stand (two individually mixed tree species)
C – Uneven-aged mixtures (differentiated stands with rich structure – DBH, tree height, spatial differentiation, and species richness).

3 RESULTS AND DISCUSSION

This study shows from preliminary results that there is only a negligible effect of interspecific competition on spruce production. In terms of thickness concordance, we can compare Norway spruce in a mixed stand (B) to Norway spruce in a structural variant (C). However, in canopy competition, Norway spruce (B) logically shows higher competition indices due to better interspace filling with beech. Important from

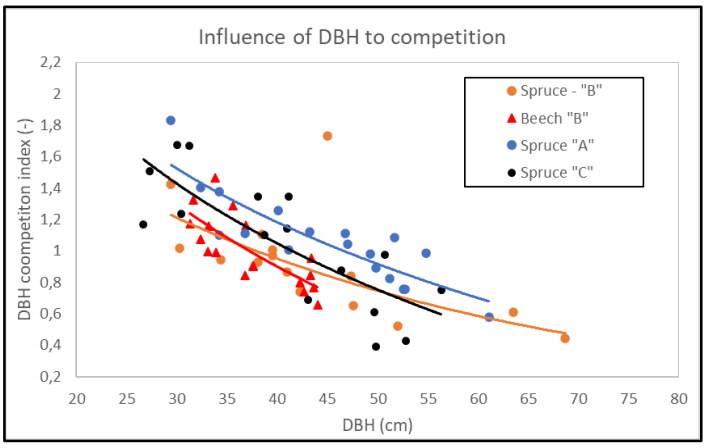

Fig. 1: Influence of DBH to Norway spruce competition in different types of structure

the perspective of forest production is biomass production, however, in which Norway spruce (B) competes with beech in a decent way when comparing DBH complexity. In terms of production and thickness competition, spruce is competitive even in a mixture with beech (Dawson, 1993). It can be seen from Fig. 1 that, based on preliminary results, the competitive pressure in a monoculture or mixture is not negative in terms of timber production alone.

4 CONCLUSIONS

Overall, understanding the dynamics of interspecific competition through competition indices can provide valuable insights for forest management strategies. However, it is important to have information on how different tree species may respond to changing environmental conditions in different competitive environments of different species and their developmental stages.

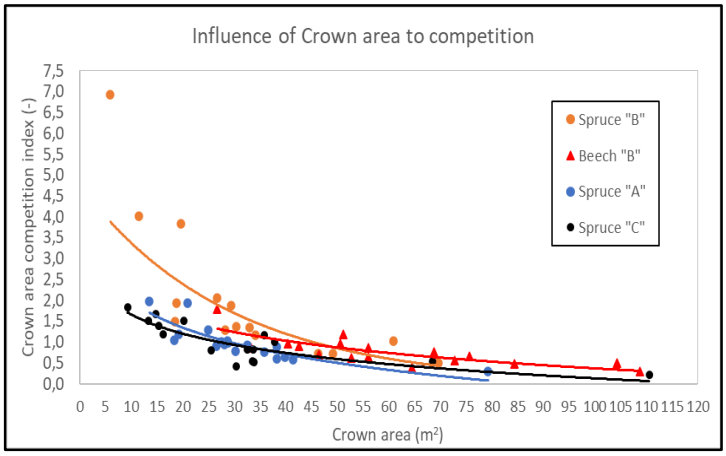

Fig. 2: Influence of DBH and crown area to Norway spruce competition in different types of structure

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WATER RELATIONS OF MISTLETOE *VISCUM ALBUM* L. AND ITS HOST *TILIA CORDATA* MILL.

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Keywords: hemiparasite, mistletoe, photosynthesis, water potential, water regime

1 INTRODUCTION

Water plays an important role in the life of trees, providing their growth and development. It is involved in many processes necessary for the normal functioning of plants. A lack of water can lead to stress, wilting, reduced growth, increased vulnerability to diseases and pests, root damage, and in extreme cases, tree mortality. *Viscum album* L., known as European mistletoe, is a hemi-parasitic shrub that taps mainly the xylem of its host via haustoria that penetrate host vascular tissues [1]. European mistletoe infestation is one of the significant factors that may decrease vitality of broad range of it host trees species, they can impair host growth and vigor, reduce fruiting, wood quality and quantities [2, 3]. Understanding the mechanisms behind the parasitic plant and its host is crucial, for avoiding of unwanted events that can cause economic, social, and ecological damages. In our study, we assessed the water relation: water potential, stomata conductance, and transpiration rate of mistletoe (*Viscum album* L.) and its host Linden (*Tilia cordata* Mill.) during the growing season.

2 MATERIAL AND METHODS

Our research took place on the Brno city cemetery, Czech Republic (49°10’14,55” N and 16°35’38.83” E). This area was heavily infested with mistletoe, *Viscum Album* L., growing on the linden trees, *Tilia cordata* Mill. We conducted measurements of water potential over the course of summer, specifically on the warm and sunny days of July and August. These measurements were taken from 9:30 a.m. to 5.30 p.m. Using Scholander pressure chamber (PMS 1505D-EXP), we assessed the water potential of mistletoe leaves, as well as leaves of both infested and non-infested linden trees. The stomata conductance and transpiration rate were measured using LI-COR 6400-Portable System.

3 RESULTS AND DISCUSSION

In accordance with previous study [1, 4], mistletoe maintained the lowest (more negative) leaf water potential (Fig. 1), with average values of -2.3±0.3 MPa, in contrast to its infested host, linden tree, which had an average of -1.8±0.2 MPa, and non-infected trees, which averaged -1.6±0.1 MPa. Contrary to the assumptions, the infested linden trees had higher water potential contrary to the non-infested ones, which could be explained by higher water stress of infested trees. Infested linden trees exhibited a closure of stomata, resulting in decreased water transpiration, and a decrease in net photosynthesis (A_{net}) (Fig. 1). This suggests that Tilia is isohydric species trying to follow water saving strategy and keep water potential level above embolism threshold, which is on the expense of carbon sequestration as low rate of photosynthesis was observed in infested linden leaves before the noon which

remained till the evening (Fig. 1). Thus, carbon starvation could be considered as one of the factor contributing to the tree mortality by mistletoe infestation.

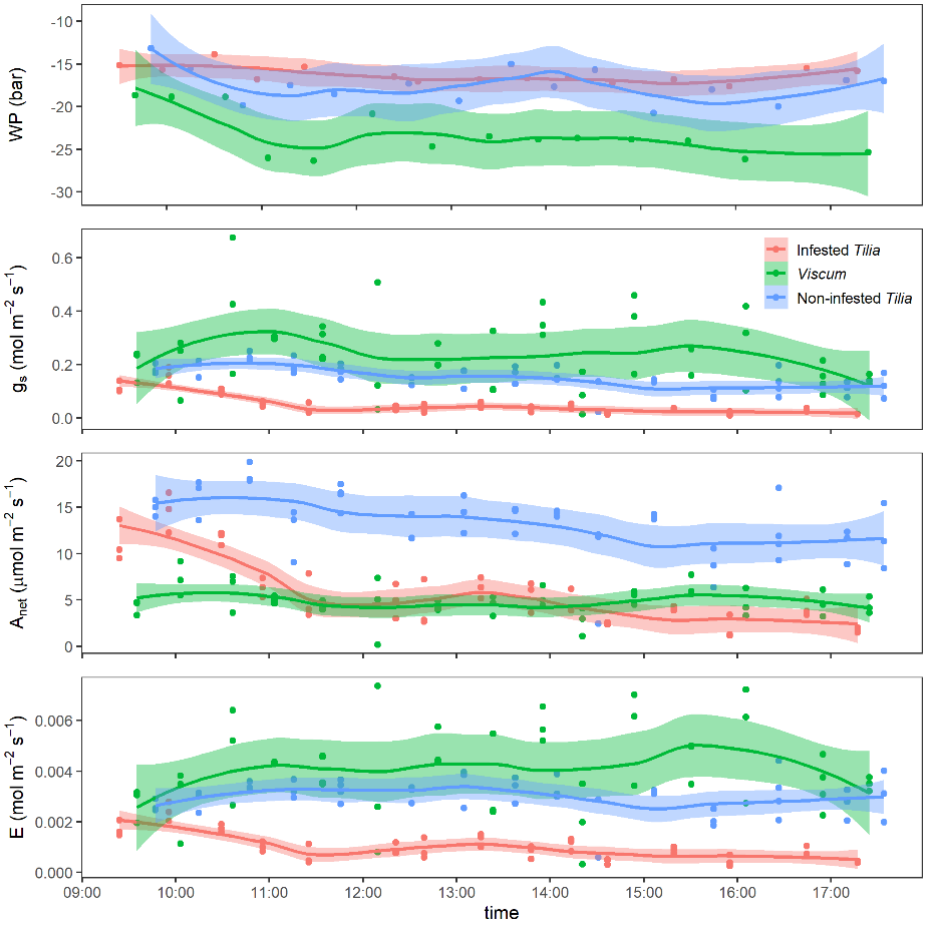

Fig.1: Daily course of water potential (WP), stomatal conductance (g_s), transpiration (E), and net assimilation rate (A_{net}) of the mistletoe *Viscum album* (green), infested *Tilia cordata* (red), and control non-infested *Tilia cordata* (blue).

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IDENTIFICATION AND CHARACTERIZATION OF TRUNK PATHOGENS OF SEEDLINGS IN FOREST NURSERIES THROUGH HIGH-THROUGHPUT Amplicon SEQUENCING

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Keywords: DNA, forest nurseries, high-throughput amplicon sequencing, seedlings, trunk pathogens

Forest nurseries are having a key role in the detection of plant pests and diseases for the building of healthy forest stands (Wingfield et al., 2015). Trunk disease (TD) pathogens are aggressive species that colonize the xylem and phloem of their host and cause plant decay (Mora-Sala et al., 2018). High-throughput amplicon sequencing (HTAS) is the method used routinely for the detection of microbial communities of different enviromental samples (Tremblay et al., 2018). The aim of this research is (1) to detect the fungal community (mycobiome) presented in vascular tissue in tree seedlings by the use of HTAS; (2) description of the relationship between the incidence of fungal genera presented in vascular tissue of European beech (*Fagus sylvatica* L.; FS), English oak (*Quercus robur* L.; QR), and Sessile oak (*Quercus petrea* L.; QP) and (3) evaluation of influence of soil type on fungal diversity in plant and nursery location.
Seedlings were sampled from 12 forest nurseries – (FS*)* and (QP) during spring 2023 and (QR) spring 2021. In total 10 seedlings of each species with TD symptoms were sampled per nursery, 190 seedlings in total, 2 samples per plant (base and stem), 380 samples in total. The processing of samples was: total DNA extraction (Macherey-Nagel; Duren DNA extraction kit), PCR, dillution (c=10 ng/ml) and pooling of 380 PCR amplicons into 38 samples; 12 (FS), 12 (*QP*), 14 (QR). Dilluted amplicons of ITS1/ITS4 primers (Gardes & Bruns, 1993) were processed in amplicon libraries constructed with Nextera library preparation kit (Illumina Inc.) and sequenced by MiniSeq (Illumina Inc.). Bioinformatic data were processed in SEED v.2.0. (Větrovský et al., 2018), resulted operational taxonomic units (OTU) were specified at 97% similarity using USEARCH v11.0.667 (Edgar, 2013). Relative abundance, Alfa diversity and Beta diversity were determined by Microbiome Analyst (Dhariwal et al., 2017). Venn diagram was created by Venn diagram tool (Qlucore) (Bardou et al., 2014) and CYTOSCAPE v.2.0 was used to generate the type of interaction among particular species (Kohl et al., 2011).
The dataset consisted of 411,574 fungal ITS1 sequences extracted in the full-length of the ITS region. Clustering at a 97% sequence similarity threshold produced 728 unique OTUs. Ascomycota (389,696; 95%), Basidiomycota (20,381, 5%). The most common genera were *Dactylonectria* (172,797, 42%); *Aureobasidium* (17,416, 4%); *Alternaria* (10,876, 3%); *Diaporthe* (9 539, 2%). Alfa diversity differences between forest nurseries based on Shannon diversity index was statistically significant (p-value = 0.013623). Chao1 index analysis detected different statistically significant richness between plant species (p-value = 0.00015505). Shannon index of species evenness detected statistically significant differences in soil type (p-value = 0.026435). Beta diversity was statistically

significant between species and locality (p-value = 0.001). Analysis of the fungal network detected a positive correlation among fungal genera occurring on (FS) and negative correlation among fungal genera occurring on (QP) and (QR).
This study revealed the different distribution patterns and assembly mechanisms of interaction of fungal diversity between the seedlings of three species (FS, QP, QR), nursery locality, soil type, and plant sample site. For evaluation of detected genera as phytopathologically problematic is necessary to continue in research of particular fungal isolates associated with TD. To fulfill Koch's postulates, the specific isolates should be inoculated into the wood of non-infected plants.

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MODELLING OF STEM TAPER CURVE FOR DOUGLAS FIR IN THE CONDITIONS OF THE CZECH REPUBLIC

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Keywords: diameter over bark, *Pseudotsuga menziesii*, stem profiles, stem shape, stem volume

1 INTRODUCTION

"Douglas fir (*Pseudotsuga menziesii* [Mirb.] Franco) is a species with high commercial importance in the World as well as in the Europe, widely used in the forest management of many countries" (Podrázský et al., 2020). Due to current low percentage of Douglas fir in the forests of the Czech Republic, that makes up only 0.22% (5 800 ha) (Zeidler et al., 2018), separate stem taper curve has not been developed in the Czech Republic yet. Douglas fir is an interesting tree, because it can substitute declining Norway spruce (Podrázský et al., 2020). The production potential of Douglas fir in lower and mid altitudes is higher than that of other domestic tree species (Kubeček et al., 2014).

2 MATERIALS AND METHODS

Dataset was collected from 213 felled sample trees of Douglas fir. On sample trees diameter at breast height (dbh), total tree height (H) and diameter (d) at intervals of 1 m along the stem (measurement height - h) were measured. All diameters were measured by caliper twice perpendicular to each other. Merchantable stem volume was calculated from all these values by Smalian method of sections. Sample trees were felled at Training Forest Enterprise Masaryk Forest Křtiny, Training Forest District Hůrky, Forests of Písek city and Forests of Vysoké Mýto city. Stands were selected through all age classes. Several models of stem taper curve were selected for the evaluation, for example: Clark et al. (1991), Fang et al. (2000), Kozak (2004), Munro (1966), Riemer et al. (1995), Sharma and Zhang (2004) etc. As a goodness of fit criteria were selected determination index - R^2, mean of residuals - MR, standard deviation of residuals - SD, root mean square error - RMSE and Akaike´s information criterion - AIC (Akaike, 1973).

3 RESULTS AND DISCUSSION

Preliminary results were shown that according to goodness of fit criteria (Fig. 1) is the best Riemer et al. (1995) as stem taper curve model. Its equation with estimated parameters is written in formula 1. Similar results were found by Adolt (2008) for Norway spruce in the Czech Republic. Next step will be development of mixed effects model of stem taper curve.

$$d = \frac{-0.2577dbh}{1-e^{-0.1507(1.3-H)}} + \left(\frac{dbh}{2} + 0.2577dbh\right)\left[1 - \frac{1}{1-e^{-0.0678(1.3-H)}}\right] + e^{0.0678h}\left[\frac{\left(\frac{dbh}{2}+0.2577dbh\right)e^{1.3(-0.0678)}}{1-e^{-0.0678(1.3-H)}}\right] - e^{-0.1507h}\left[\frac{-0.2577dbhe^{0.1507H}}{1-e^{-0.1507(1.3-H)}}\right] \quad (1)$$

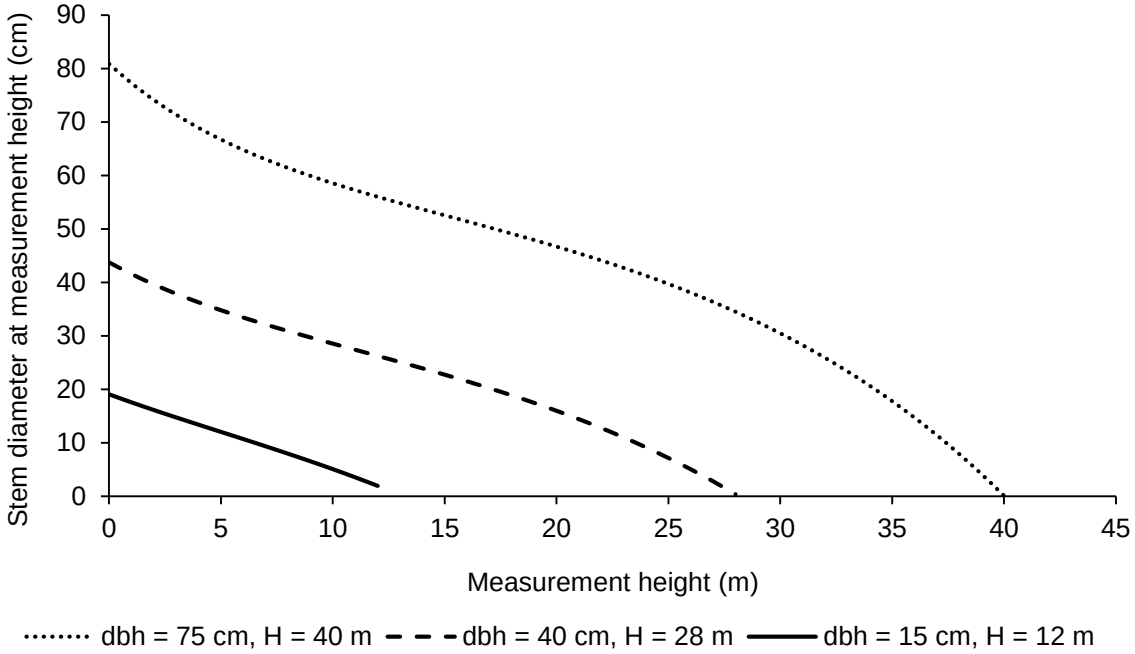

Fig. 1: Predicted stem taper curves fitted by model of Riemer et al. (1995) for Douglas fir with dbh and H 15 cm/12 m, 40 cm/28 m and 75 cm/40 m respectively.

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DIEBACK ENVIRONMENT FROM A FOREST SOIL PERSPECTIVE – 3RD YEAR PROJECT REPORT

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Keywords: bark beetle, Norway spruce, soil biochemistry, soil DNA, soil moisture

1 INTRODUCTION

After the third year of the project solution, the final major and the most interesting results are presented in this contribution. The project was focused on the forest soil properties changes determination in specific conditions after the Norway spruce (*Picea abies* (L.)) disturbancies caused by the drought and bark beetle infestation during the last decade. The research took place on the eight research plots with the following treatment triplets: (1) clear-cut, (2) declined with standing trees and (3) healthy stand. The study and particular hypothesis were carried out within four work packages: WP1 – Soil typology; WP2 – Soil biochemistry and biology; WP3 – Humus conditions and soil carbon; WP4 – Physical and hydrophysical properties.

2 RESULTS

WP1:

Within the system of examined Norway spruce stands in the Bohemian-Moravian Masiff and its foothill (with the area of 16.792 km2 and 36,3% forestation), 35 soil types in total were classified. They represent 0,63% of mapped forest soils. The major detected soil types were Cambisols with the following subtypes: Haplic (37,1%), Luvic (26,9%), Skeletic (8,8%) and Dystric (4,7%).

The soils were classified into six hydric groups, with the majority of anhydromorphic light sandy soils (93,6%). Redoximorphic (2,9%) and heavy clay soils (1,9%) represented units of percentage only.

All of the hydric groups were characteristic by the highest retention capacity in upper horizons beside the lower diagnostic horizons. The retention water capacity corresponded with the hydrolimits variability of the light sandy soils across the whole Czech Republic and also indicated the regional differencies of the soils influenced by water within the particular forest regions.

WP2 and WP3:

For the plots established in 2022 (Letovice, Vír and Černá hora II), DNA sequencing was performed to determine the bacterial and fungal community composition. Interim results indicate some apparent trends. Interrelationships were explained by PCA and descriptive statistics with respect to treatment and locality. Graphical representation of fungal data shows that the fungal community separation is mainly due to the treatment, whereas the Bacterial data are distinctly separated by both the treatment and the locality.

Fungal and bacterial abundances were evaluated on the level of kingdom, phyla, and genera. Regarding the archaeal and bacterial ratio, a rapid increase in declined stands

with standing trees was observed. Such shift can be explained by the site's hydric and nitrogen cycle-related changes. On the other hand, the clearcuts show no preliminary obvious change. Detailed descriptive bioinformatics at the phyla and genus level requires further analysis with the background knowledge of each group's specifics and behaviour, e.g., mycorrhizal symbiosis and site conditions can be well demonstrated on the example of the Archaeorhizomyces and Russula genera, which show apparent abundance differences within the treatments and rapid decreases after the stand decline.
Concerning the enzymatic and microbial activity analyses across all research plots, the most interesting results are the amount measurements of ammonia nitrogen – NH4 (for depths of 0–5 cm and 0–10 cm), partly for nitrate nitrogen – NO3 (for the F+H layer) and the activity of the urease enzyme. The results are "against each other", which means that there is the highest amount of NH4 and the lowest activity of urease enzymes at the same time in declined stands. This result is logical because the soil microbiota does not allways have to produce enough urease enzyme, which helps to obtain ammoniacal nitrogen from the organic matter, if there is a relative abundance of it in the surroundings. Suprisingly, the activity of arginine deaminase enzyme (also producing NH4) is statistically significant only in the fermented and humus layers, when its activity is the lowest on the clearcut compared to declined and healthy stands.

WP4:
The example of an initial assessment of water-holding capacity included soils on the locality in Vilémov that are strongly to very strongly water-holding. In general, clearcut was the wetnest site, followed by declined and healthy stands. The clearcut was more than 32% wetter than the healthy stand and 17% wetter than the declined stand. The largest relative differences in moisture were found in the topsoil, at 10 and 30 cm.
During the study period, soil moisture values at all depths were within the range of available water capacity, with the exception of the summer period June to August 2022, when at 10 and 30 cm the moisture values for living and dead stands approached or exceeded the wilting point. Early in this period, the declined stand gradually died back and was eventually harvested in late July and August.
When the microclimatic conditions changed, in the period July/August 2022, after the removal of the dead stand, a leapfrog in soil moisture was observed in this plot, with a growth of more than 13% in the whole soil column and at most 18% in the spruce root zone (i. e. 30 cm). The most significant difference between the two variants is that the original clearcut site is compactly grassed, whereas the new one’s top organic horizons are without vegetation cover and are exposed to the weather conditions. Therefore, in particular, the role of the creation of grass tuf on the site in terms of soil water retention, and its potential negative impact on soil chemistry by excess water, should be a major focus of future research.

3 CONCLUSIONS

This contribution summarizes only the most interesting results of each WP because it is not possible to describe all of them in detail. However, several articles in scientific journals have been published and other manuscripts are being prepared for publication in following year.

ACKNOWLEDGEMENT
This contribution was founded by Internal Grant Agency MENDELU, LDF_TP_2021006 Soil environment response at Norway spruce dieback stands.

DOES SILVICULTURE PRACTICE AFFECT THE CLIMATE-GROWTH RELATIONSHIP IN SPRUCE STANDS?

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Keywords: climate change, forest tending, *Picea abies,* stand structure

1 INTRODUCTION

In the last decades, Norway spruce stands have disintegrated due to frequent drought periods followed by secondary biotic pests, causing severe damage to these ecosystems. The changes have harmed the whole natural ecosystem. For this reason, it is necessary for current Norway spruce stands at middle and mountainous altitudinal zones to maintain at least partly wood-producing function while lowering risks of their disintegration to avoid the same situation in the future. This research addressed the following questions: Which silvicultural approach is the most appropriate for still occurring pure Norway spruce stands in the Czech Republic? Are pure Norway spruce stands under adequate silvicultural management sustainable in the CR in the following decades, and or will Norway spruce be only admixed in forest stands in the middle altitudinal zones?

2 MATERIAL AND METHODS

The long-term silvicultural experimental research plots operated by the Forestry and Game Management Research Institute were used for the project. The project dealt with the influence of different silvicultural management (forest tending) on the resilience of pure mature and pre-mature Norway spruce stands against drought. The studied spruce stands are evenly distributed countrywide (CR) at middle and mountainous altitudinal zones. Most of these plots have an area of 50 x 50 m (with a buffer zone with a width of 10-15 m to separate particular silvicultural variants and to avoid the edge effect). At each locality, the control variant with no silvicultural treatment as a control and the variants with silvicultural treatment (thinning from above, and thinning from below variant at some sites) occur. Detailed information about silvicultural history in the studied plots (thinning treatment description), measurement design, and stabilisation of research plots in the field is described by Slodičák and Novák (2007).

- At each plot, 20 dominant individuals from the upper canopy layer were chosen for sampling using the Pressler increment drill at 1.3 m above the ground surface (Steckel et al., 2020).
- The tree-ring widths of extracted cores were analysed in the lab.
- Tree rings were cross-dated and exported in .rwl. The exported data were processed in the R studio (R Core Team, 2022). At first, the calculation of basic statistical parameters and Basal Area Increment values (BAI) were calculated (Bunn, 2010). After that, data were detrended to eliminate age trends (Bunn, 2010). Finally, chronologies were calculated from tree-ring indices, and used for calculating climate signals for chosen climate variables: monthly precipitation, mean monthly air temperatures, and drought index (SPEI; Zhao et al., 2017).

3 RESULTS AND DISCUSSION

In Fig. 1, correlation with monthly climatic variables (monthly precipitation, mean monthly air temperatures, and drought index SPEI) in 20 years moving windows for "Železná Ruda" location for three different silvicultural regimes: control, heavy and moderate thinning from bellow. These results show the change of climate growth relationships over time. In Fig. 2, the average basal area increment is shown. Similar growth paterns were also observed by Rybníček et al. (2009) in case of spruce in Orlické mountains area.

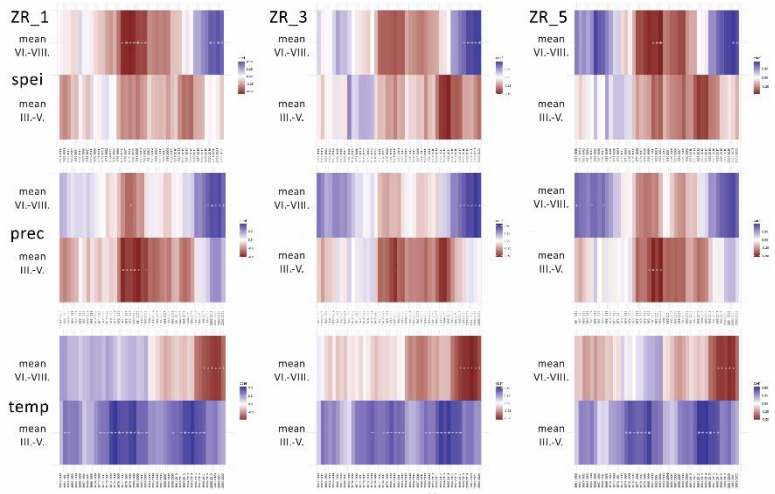

Fig. 1: Moving correlation charts for Železná Ruda site

4 CONCLUSIONS

Based on the results, heavy thinning from bellow seems to be the most efficient silviculture management treatment, with the highest BAI. The different management forms show approximately similar responses to climate variables. From the moving correlation graphs can be observed, that rising average temperatures and evapotranspiration during the last decades are starting to influence negatively spruce stands, even at their ecological optimum. This pattern is similar for all three silvicultural regimes. If the trend of climate change will continue, growing spruce in areas, such as Železná Ruda, could become risky like in lower altitudes nowadays.

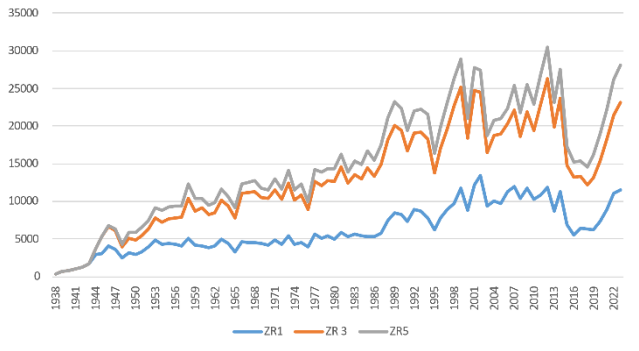

Fig. 2: Basal area increment values (mm^2) for Železná Ruda site

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BEHAVIOURAL EVALUATION OF ODOUR REPELLENTS: EFFECTIVE MITIGATION MEASURE OR WASTED MONEY?

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Keywords: odour repellents, mitigation measures, road ecology, roe deer, wildlife behaviour, wildlife-vehicle collisions, photo traps, traffic counters

ABSTRACT
In the Czech Republic, the proportion of wildlife-vehicle collisions (WVCs) has increased over the last decade. This problem represents a significant threat to traffic safety, but also a threat to sensitive wildlife populations. Every year, WVCs cause injury and death to wildlife and humans, as well as significant economic losses. A number of preventive measures are used to avoid WVCs. Not only in the Czech Republic, but also in many other European countries along the roads the so-called odour repellents ("odour fence") are used. The odour repellent has been developed by the producers to alert the wildlife and influence their behaviour near roads. Our study compared the effect of odour repellent on roe deer (*Capreolus capreolus*), which is one of the most common victims of WVCs and also pose a high risk to drivers and vehicle damage. A mix of odour repellents from Hagopur (DE) and Pacho-lek (CZ) were chosen for testing. Odour repellents were applied in accordance with the producers' instructions. The behaviour of roe deer was assessed before and after the application of odour repellents at selected collision sites in northern and southern Moravia and was repeated over two years. Testing took place at the turn of spring and summer, when the highest frequency of WVCs is generally recorded. The behaviour of roe deer near the road was recorded using automated photo cameras. The behaviour of roe deer was divided into three phases, i. e. the arrival, the reaction phase and the phase of continuing to cross the road. The application of odour repellent did not affect the roe deer decision (reaction) time before crossing the road, nor the number of rejections from the actual crossing. Traffic counters were used to estimate the impact of traffic on the studied road segments. There was evidence of a weak negative relationship between roe deer decision time length and the time gap of passing vehicles. It was also found that road crossings by roe deer were most frequent at night, during dawn and dusk. It is at this time that vehicle drivers should be very attentive and vigilant. Behavioural evaluation does not indicate a difference in roe deer behaviour without use and with use of odour repellents. Our experiments show that odour repellents are not as effective as expected. For an objective assessment, all circumstances need to be taken into account and further studies need to be carried out in the field of road ecology.

IMPACT OF NEGATIVE FACTORS FROM TRAFFIC ON THE WILDLIFE PERMEABILITY OF GREEN BRIDGES

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Keywords: green bridges, landscape fragmentation, mitigation measures, noise pollution, vegetation, transport, wildlife behavior, surface scanning, 3D model, road ecology, traffic safety, photo traps

1 INTRODUCTION

Nowadays, nature and native landscapes in the European context and elsewhere in the world are under enormous pressure from humans. Human activity is creating large-scale settlement structures and transport structures that are drastically fragmenting native ecosystems and are usually irreversibly destroyed. This phenomenon has been described as landscape fragmentation (Saunders et al., 1991), which causes a number of negative impacts on nature and humans, such as wildlife vehicle collisions (WVC) and others (Pagany, 2020). The issue of linear transport structures is particularly critical. More recently, the field of road ecology (Van Der Ree et al., 2015) has begun to address this issue in more detail and is becoming increasingly important. Wildlife crossing structures (WCS) and other mitigation measures have been applied to reduce the level of landscape fragmentation and increase traffic safety against WVC (Clevenger and Ford, 2010). Commonly known associated negative factors from traffic such as noise and light pollution, temperature, etc. can pose a problem for the permeability of WCS (Jackson and Griffin, 2000; Shilling et al., 2018). In our study, we have focused in detail on investigating the effect of noise pollution, the presence of vegetation and noise barriers on the permeability of green bridges (overpasses).

2 MATERIAL AND METHODS

The impact of traffic noise has been investigated on selected three green bridges over main motorways A3, A4 a expressway S4 in Austria. These are green bridges near Arbesthal, Müllendorf and Sigleß, which are located on the important migration route of the Alpine-Carpathian corridor (Egger et al., 2012). Each of the green bridges studied had different mitigation measures at the edge of the bridge body (such as fence screening, noise walls with partial wood infill and full infill) and a different structure of planted vegetation. The green bridges have been monitored using automated photo traps (Browning, Coolife) since spring 2023 and the plan is to continue until the end of 2023. The photo traps were placed in the middle and on the edge of the bridges to cover the entire bridge structure. Almost 30 000 records have been captured so far. The data from the photo traps will be used for comparison with the measured values of noise pollution from traffic. Traffic noise was measured at regular length intervals and time intervals directly on the body of the green bridge. Traffic noise was measured using the NTI Acoustilyzer AL1, which recorded values of integrated average sound pressure (dBLeq), minimum and maximum sound pressure level, etc. Traffic noise measurement points were recorded using GPS and will be spatially evaluated afterwards. The daily traffic volume on the road sections in question is greater than 20 000 vehicles per day (ASFiNAG 2023), which from a physical point of view can be considered a consistent source of noise (MZ ČR 2002). Noise measurement was also

carried out in front of and behind the noise barriers and fencing. Noise measurements were taken during midsummer when vegetation is most abundant. At the same time, a scan of the bridge surface including vegetation was carried out. A hand-held ZEB HORIZON 3D scanner by GeoSLAM was used to scan the surface and density of vegetation. An evaluation of the relationships between traffic noise and vegetation (height and density) with wildlife is anticipated.

3 PRELIMINARY RESULTS

Values ranging from approximately 45 dB to almost 76 dB for integrated average sound pressure (Leq) were measured at the green bridge sites. The highest traffic noise values were recorded at the edge of the bridges, while the lowest in the centre. Peaks above 80 dB have also been recorded. Terrestrial wildlife responses to noise are reported to begin at noise levels of approx. 40 dB (Shannon et al. 2016). The wood noise barrier wall seems to reduce traffic noise (approx. 10 dB). The monitoring so far has registered records of common wildlife species (European hare, Red fox, Marten, Roe deer, European badger, etc.), but also, for example Red deer. The most frequent records are for Roe deer. A 3D model of the surface of the green bridges was created and the traffic noise was interpolated, followed by a map output.

4 CONCLUSION

The data suggest that noise pollution from traffic can be a problem, especially for sensitive species. Conversely, the presence of vegetation or noise barriers can probably help to increase permeability over green bridges. Furthermore, more studies in the field of road ecology are needed to clarify the negative factors on wildlife arising from traffic.

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HOW VIRUSES AFFECT THEIR HOST, THE PANGLOBAL PATHOGEN *PHYTOPHTHORA CINNAMOMI* IN VITRO?

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Keywords: *Phytophthora*, multiple viral infection, virus elimination, in vitro, experiment

Members of genus *Phytophthora* are oomycetes belonging to the kingdom Stramenipila. Most known members of the genus *Phytophthora* are primary plant and forest pathogens causing important economic losses in agriculture, horticulture and forestry industry, threatening natural ecosystems and biodiversity on a global scale (Beakes et al., 2012; Kroon et al., 2012; Thines and Choi, 2016). Arguably the most notorious species that belongs to genus *Phytophthora* is *P. cinnamomi*, a soil-borne pathogen that has a worldwide distribution (Kinal et al., 1993). *Phytophthora* spp., and in particular, *P. cinnamomi*, harbour multiple viral infections and certain type of viruses seem to be very bound to their hosts and to be carried to different world regions. Mycoviruses (fungal and oomycete viruses) can be used as biological control agents (BCAs) against tree and plant pathogens. Therefore, it is important to understand the effect of mycoviruses presence and absence on their hosts. The main aim of this project is to understand whether the viruses hosted by *Phytophthora cinnamomi* have an effect in its virulence viruses. Various elimination methods (monosporic isolation, ribavirin, cycloheximidine) will be used to achieve this aim. The behaviour of naturally virus-infected, virus-free and isogenic virus-infected and isogenic virus-free isolates in vitro will be then compared. The results of this investigation will shed light on how the presence of viruses affects their host.

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TREE HEALTH MONITORING USING VEGETATION INDICES DERIVED FROM HIGH-RESOLUTION MULTISPECTRAL IMAGERY

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Keywords: bark beetle infestation, remote sensing, drone, UAV, multispectral data

1 INTRODUCTION

Permanent monitoring, early identification, and harvesting of affected trees are essential in forest protection. Conventional ground methods are time consuming and, in the case of large, damaged area, they are usually expensive and not efficient, as they require the assessment of individual trees. Remote sensing data are useful for detecting and monitoring areas infested by bark beetles [1], as they provide global, spatially continuous, and periodic data on vegetation condition [2]. Remote sensing data can also contribute to reduce costs associated with field campaigns. Early warning systems are needed to curb the spread as well as to help foresters know the factors facilitating bark beetle attack. The effects of bark beetle on leaf properties affect reflectance in the near-infrared (NIR) and shortwave infrared (SWIR) spectral domains (i. e., 730–1370 nm) [3]. Approaches based on multi-temporal spectral indices have proven to be the most effective to detect bark beetle effects at the green attack phase [4].

2 METHODOLOGY

The health monitoring was conducted in fifteen selected sample plots of mature Norway spruce forests; in each of the sample plots, ten individual trees were selected for bark beetle activity monitoring. Tree crown health monitoring consisted of visual evaluations based on ICP Forest methodology. Primarily, overall defoliation (Tab. 1), percentage of secondary shoots, yellow discoloration and bronzing were evaluated.

Tab. 1: Mean defoliation percentage per plot

Year	Date	Sample plot														
		1	**2**	**3**	**4**	**5**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**16**	**17**	**18**
2021	June 29th	-	-	-	-	-	41	43,5	43,5	46	44	47,5	47,5	44	45,5	45,5
	July 15th	45	44	42,5	46	51	-	-	-	-	-	-	-	-	-	-
2022	May 24th	44	41,5	35*	45,5	49,5	48,33	43	37	39,5	37,5	41,5	41,5	42	41,5	41,25
	October 19th	42	40,5	37,5*	43,5	62,5	43,75	42	37	40,5	39	39,5	42	40,5	41,5	41,25

The sample plots were monitored using unmanned aerial vehicle (UAV) with multispectral camera every two weeks during vegetation season. A normalized difference vegetation index (NDVI) and normalized difference red-edge index (NDRE) were derived from the data collected and statistics were calculated for each dataset for a given time. Since the values of vegetation indices differ during the vegetation period

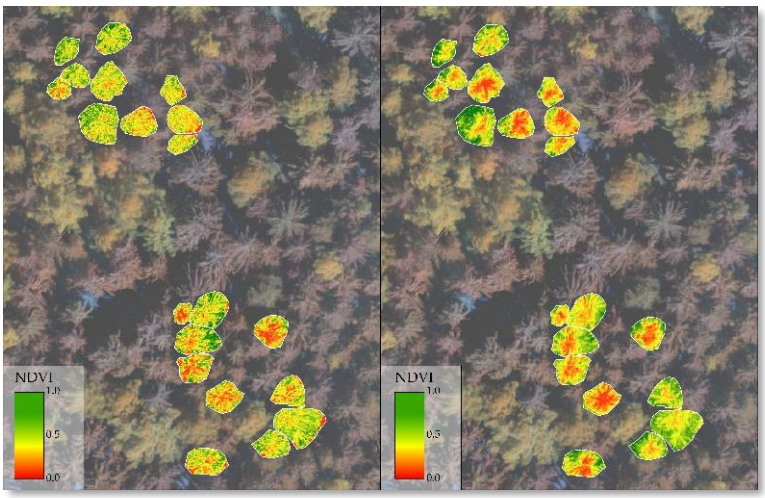

Fig. 3: Changes in spectral behaviour of selected trees during the vegetation season in 2022

(Fig. 1), a theoretical spectral model of tree behaviour will be created using multitemporal regression [4], where the vegetation index at the beginning of the vegetation period represents the explanatory variable and other time points represent the response variable. Trees that show significant residual values will be the infested ones. Bitemporal regression models were constructed for the health status analysis, where the vegetation index (VI) from the beginning of growing season is used as the independent variable and VI during the growing season is used as the dependent variable (Fig. 2). It was assumed, that residuals of these models will then represent infested trees, but NDVI is apparently influenced by precipitation and water saturation, because we also achieved similar results using bitemporal models derived from Sentinel-2 data.

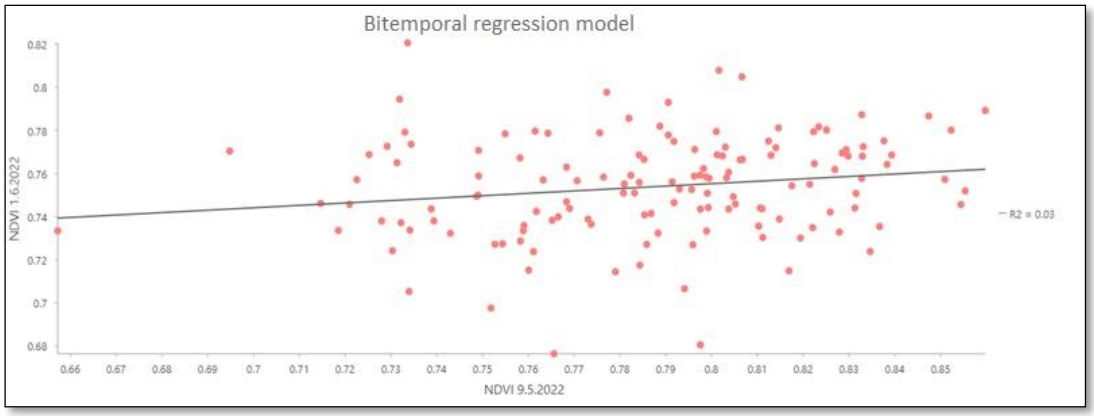

Fig. 4: Bitemporal regression model of spectral behaviour of vegetation

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GEOPHYSICAL IMAGING OF ROOT SYSTEMS: FROM A SINGLE TREE TO FOREST STAND LEVEL

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Keywords: electrical resistivity tomography, European beech, dipole electromagnetic profiling, geophysical surveys, root system

1 INTRODUCTION

Geophysical surveys in forest sites so far have been used mostly for geological survey purposes. As such, the vegetation impact on soil physical and chemical properties has been utilized to a limited extent. However, current trends show that methods such as e.g. electrical resistivity tomography (ERT) and dipole electromagnetic profiling (DEMP) may be successfully and non-invasively utilized for environmental purposes e.g. monitoring of soil water uptake by trees (Cassiani et al., 2015), visualization of root systems and localization of absorption zones (Majewski et al., 2022), detection of root system impact on infrastructure (Hruška et al., 1999) or in developments of new methods and technologies for plant physiological activity monitoring (Aubrecht et al., 2006). Our aim was to estimate the efficiency of geophysical surveying in forest conditions. Our particular focus was to estimate ERT and DEMP possibilities to detect root systems in four selected European beech stands.

2 MATERIALS AND METHODS

1.1 EXPERIMENTAL SITES

The research plots are located in the forest stands of the University enterprise Masaryk Forest in Křtiny. Four 16x16m research plots of 40, 60, and 123 years, and uneven-aged European beech were selected. The geodesic grid of 1x1 m was established on each site allowing soil samples excavation.

1.2 GEOPHYSICAL SURVEYS

Geophysical surveys of ERT and EMI were run at all four forest sites. Electrical resistivity tomography was performed using ARES II resistivity meter (GF Instruments, Czech Republic) and dipole electromagnetic profiling CMD MiniExplorer instrument (GF Instruments, Czech Republic).

1.3 SITE IMAGINING

Terrestrial close-range photogrammetric data was taken for each plot and processed into the form of point clouds, digital surface models, and orthophotos. Point clouds of the entire area including trees were captured by Faro Focus 3D terrestrial laser scanner. The resulting point clouds will be used to derive tree positions, DBH, heights, and other forest or canopy variables.

1.4 ROOT SYSTEM AIR UNCOVERING

To verify ERT and EMI efficiency, root systems excavation was performed using a model 150/90 Air-Spade (Concept Engineering Group, Inc. Verona, PA, USA) and compressor.

3 RESULTS

ERT and DEMP provided resistivity distribution maps on European beech sites for varying depths (Fig. 1). Fig. 2 shows a 3D model derived from close-range photogrammetry.

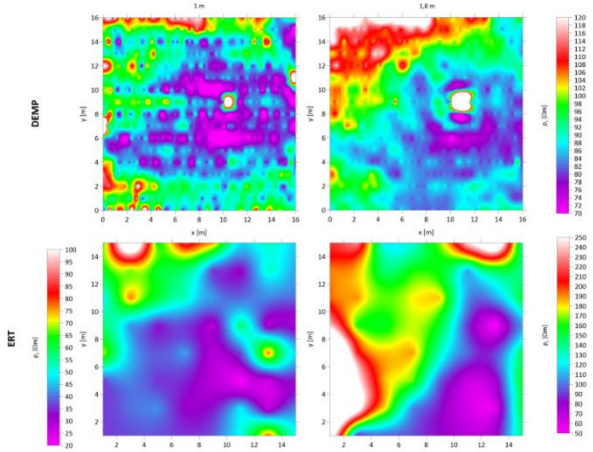

Fig. 1: Depth slices of resistivity distribution by ERT and EMI in 123-year-old European Beech site

Fig. 2: 3D model derived from close-range photogrammetry

4 CONCLUSIONS

Geophysical surveys allow to observe vegetation impact on soil resistivity's distribution generally down to 1 m deep, while shallow soil horizons and lithology structures prevail in depth from 1,8 m deep.

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QUANTIFYING THE OVERLYING ORGANIC HORIZON AND CARBON STOCK UNDER TRADITIONAL FOREST MANAGEMENT

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Keywords: coppice, litter raking, grazing, forest wildlife, forest soil, organomineral horizon

1 INTRODUCTION

The project aims to assess the impact of grazing, litter removal, and forest wildlife, and to quantify their influence on the condition of coppice from dendrometric, pedological, and geobiocoenological perspectives. This project combines the examination of traditional forest management practices (coppicing, litter removal, and grazing) with a ontemporary focus on understanding the effects of game animals on forest ecosystems within unique research sites in the TFE Masaryk Forest, Křtiny. The wildlife monitoring task is to investigate whether the presence of domestic animals (specifically sheep) in the forest is reflected in the spatial utilization of the environment by wild mammals.

2 MATERIALS AND METHODS

The project's measurements were carried out at research plots named 'Hradisko' within Masaryk's Forest, Křtiny. These plots were established in 2017 and are located within sessile oak stands with 80 standards per hectare. There are a total of 15 rectangular research plots (each 40 × 30 meters) with buffer zones, and they vary in terms of forest management. These variations include plots with 'No grazing and no litter raking', 'Grazing and litter raking', 'Grazing and no litter raking', and 'No grazing and no litter raking', along with control plots. This marks the initial year of the new project, and data collection is ongoing and continuously processed. In 2023, various measurements were conducted, including the collection of soil samples from each research plot, dendrometric measurements of oak standards and sprouts at the start and end of the vegetative season, analysis of the organic nutrient content of forage, and the determination of the number of sheep per grazing unit at the beginning of the vegetative season. Additionally, data on interactions between sheep and wildlife were gathered through regularly spaced camera traps. The primary objective of this project is to evaluate dendrometric, pedological, geobiocenological, and forest wildlife measurements in relation to different management types. This contribution primarily focuses on pedological aspects, including carbon stock, organic horizon, the quantity of humus in the forest horizon, and litter volume.

3 RESULTS

We conducted a comparison of various soil characteristics under different traditional management methods, and our findings revealed substantial disparities in carbon stocks.

The control plots exhibit the highest values, with an average carbon stock of 33.18 t/ha. In contrast, the thinned-raked-grazed plots show the lowest average values, with a carbon stock of 27.74 t/ha (Kostka, 2022).

The measurements of the overlying organic horizon yielded the following results: at the start of the experiment, the readings ranged from 4.71 to 4.04 cm. However, in 2021, the values exhibited significant variation. The lowest measurements were observed in the thinned-raked-grazed and thinned-grazed plots, with values of 1.5 cm and 1.54 cm, respectively (Kostka, 2022).

The amount of litter on the research plots ranges from 4.13 to 3.23 t/ha. The highest values are for control plots at 7.6 t/ha (Kostka, 2022).

When examining the Ah horizon, the values in 2021 were found to be higher than those in 2017 (Kostka, 2020), with one exception being the control plot. The highest recorded value for the Ah horizon in 2021 was 12.7 cm, and this was observed in the thinned-raked plots (Kostka, 2022).

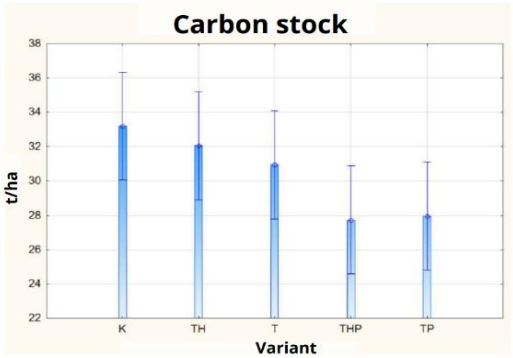

Fig. 1: Mean values of carbon stock in years 2021 between different variants.TH - coppicing and litter raking; T- coppicing; TPH - coppicing, grazing and litter raking; TP - coppicing and grazing; K- control plots

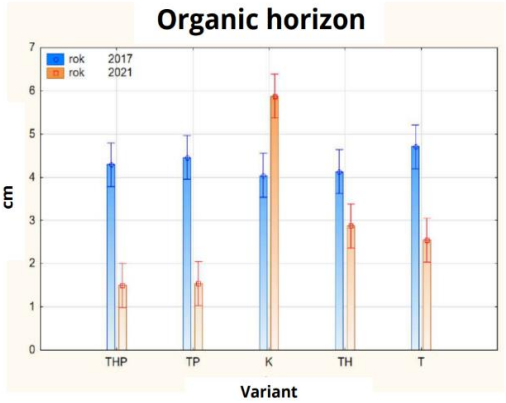

Fig. 2: Amount of overlying organic horizon stock in years 2017-2021 between different variants.TH - coppicing and litter raking; T- coppicing; TPH - coppicing, grazing and litter raking; TP - coppicing and grazing; K- control plots

4 CONCLUSIONS

The primary goal of this project and research was to evaluate the impact of traditional forest management practices on forest ecosystems, with a special emphasis on their effects on dendrometric, pedological, geobiocenological, and forest wildlife measurements. Over the course of five years, significant differences in carbon stock and the thickness of the organic layer were observed among the various management methods employed in the experiment.

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ACKNOWLEDGEMENT

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LONG-TERM DEVELOPMENT OF ASPEN STANDS IN GEORGIA BASED ON ANTHRACOLOGY ANALYSIS

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Keywords: aspen, long-term development, pedoanthracology, *Populus tremula*

1 INTRODUCTION

Aspen (*Populus tremula* L.) is one of trees with a wide geographical distribution, large ecological amplitude, and high biological value. Therefore, it is mentioned more and more often as an important component of forest stands and landscape e.g., for reforestation of clearcuts after bark beetle outbreak logging. However, long-term development of aspen stands was not fully described despite its current popularity. Long-term development of aspen stands in Georgia was the goal of this IGA project.
The project is focused on long-term development of aspen communities in the Greater Caucasus region in the Aragvi River basin, where the current species composition is relatively close to nature and aspen is a common species. This long-term development is described based on pedoanthracological analysis, which uses macrocharcoals accumulated in a soil from forest fires to reconstruct the historic species composition. The specific objective of the project was to describe whether aspen can form long-term stable communities (such as the closely related aspen in North America), or whether it creates only temporary (seral) communities that are subsequently replaced by a community with a different species composition.

2 METHODOLOGY

Forest stands where aspen has been currently dominant were communities of interest. Samples for a subsequent pedoanthracological analysis were taken from a soil profile, which was divided into layers. Each 10 cm thick layer comprised a sample of 10 litres of a fine soil. Separation of charcoal fragments were done by a wet sieving procedure. The sieve mesh was of 1 mm in size so that we were able to separate charcoal fragments greater than 1 mm. Samples were identified using a standard identification key using the microscope Olympus SZ 61. Determined charcoal pieces were weighed for an accuracy of 0,1 mg.
Empirically selected charcoals will be sent to Radiocarbon Laboratory in Prague for radiocarbon dating using the C 14 Accelerator Mass Spectrometry. Attention will be paid to *Populus* charcoal pieces.
Obtained data will be evaluated on:
a) Stable aspen community- aspen will often repeat itself in individual (consecutive) layers, its representation will be similar across individual horizons, and the species composition of the following (younger, higher-lying) horizons will not be directed towards successionally higher communities (towards potential vegetation). Stable aspen stands (*Populus tremuloides* Michx.) are described in North America, where aspen stands have been found in mountainous locations for millennia.
b) Temporary (seral) aspen community - in the species composition, it is evident that the aspen community is replaced by a successionally higher stage in time. The representation of aspen in individual horizons is not constant and has a long-term

downward trend. This seral function is described in the climatic conditions of Central Europe, and in Southern Carpathians.

3 RESULTS

Based on partial results from Georgia, it follows that in these localities aspen behaves like a pioneer species, which is subsequently replaced by a different species composition. It is evident from the results of the AR 149 site (Fig. 1) that a certain representation of aspen was present in almost all soil layers. The results from the lower part of the soil profile (6th layer, 51-60 cm) indicate that aspen was even one of the dominant stands at this time. Radiocarbon dating determined the age of this charcoal to the turn of the Atlantic and Subboreal climatic periods. However, this similar occurrence of aspen was not evident at the other localities (AR 008, AR 126). On these plots, we can see the increase of anthracomass in layers where aspen occurred. This fact can have a connection with the former inhabitants converting “unusable and worthless forests” into pastures or fields.

The results are based on the microanatomical analysis of 805 pieces of determined charcoal pieces taken at different soil depths. A total of 8 pieces of charcoal pieces were sent to determine the age, for which the age was derived using radiocarbon methods.

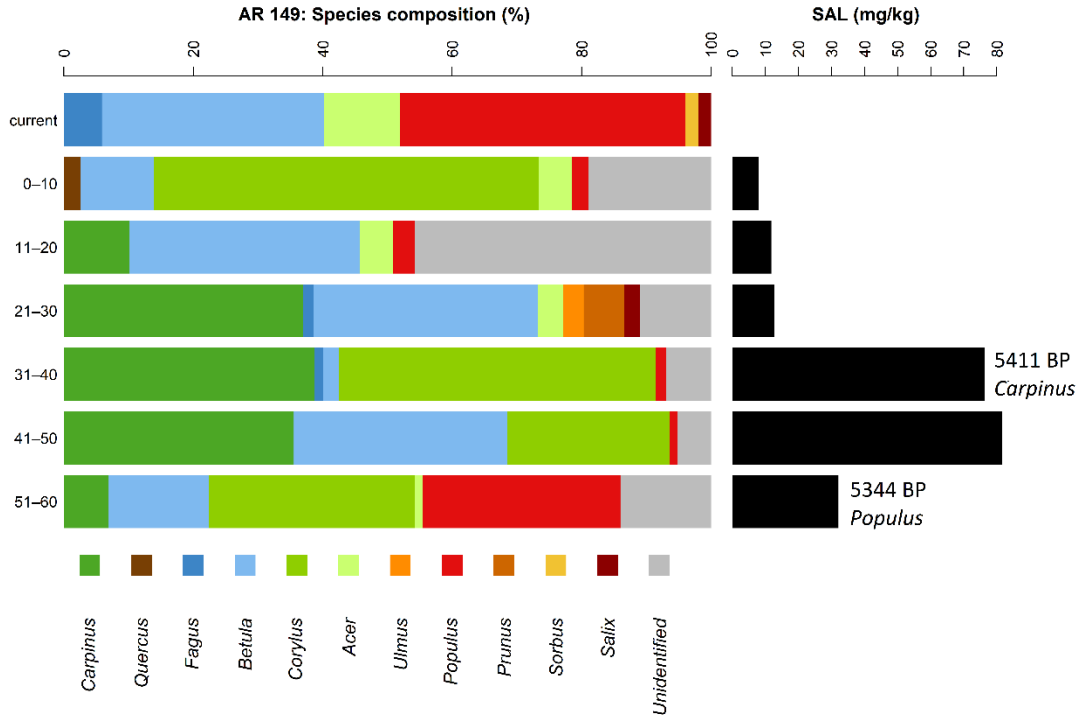

Fig.1: Results from AR 149

ACKNOWLEDGEMENT

This study was supported by the Internal Grant Agency Faculty of Forestry and Wood Technology Mendel University in Brno No. IGA-FFWT-23-IP-038.

IS THE EFFECT OF DROUGHT EXPRESSED BY STEM RADIAL INCREMENT LESS INTENSE IN SPRUCE-BEECH-LARCH MIXED STANDS THAN IN MONOCULTURES?

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Keywords: automatic dendrometer, global climate change, stem diameter variation, tree water deficit

1 INTRODUCTION

Continuously measured stem diameter variation (SDV) by automatic dendrometers shows stem shrinkage caused by water deficit and irreversible stem expansion caused by growth. To determine the tree water deficit (TWD), the "zero-growth concept" approach is commonly used. This approach assumes no growth during stem shrinkage and that growth occurs only when the stem radius exceeds the previous maximum radius value (Krejza et al., 2019, Zweifel et al., 2016).

2 AIM AND HYPOTHESIS

The main aim is to evaluate responses of *Larix decidua* Mill., *Picea abies* (L.) Karst. and *Fagus sylvatica* L. to environmental conditions in 2022 and 2023 and answer whether the presence of larch can mitigate the effect of drought projected as the current value of tree water deficit (TWD). The research was focused on the fully developed crown cover middle-aged monocultures and mixed stand growing in the nutrient-rich habitats of lower altitudes on the ŠLP ML Křtiny. Hypothesis was defined: The value of TWD will increase during drought periods in monoculture stands than in mixed stand with the presence of larch.

3 MATERIALS AND METHODS

We analyzed SDV in spruce, larch, and beech monocultures and mixture stand in 2022 and 2023. The research site area is 0.09 ha, the age varies between 50 – 70 years, and the altitude is 560-580 m asl. The research sites were selected concerning the same climatic conditions. At the beginning of growing season 2022 automatic point dendrometers TOMST were installed. The architecture of the dendrometers network was consequent: 1 dendrometer for the sub-dominant tree, 3 dendrometers for co-dominant trees, and 1 dendrometer for the dominant tree. We calculated stem radial increment (SRI) and stress reaction expressed with TWD at single tree level and averaged curves representing particular stand response.

4 RESULTS

The growing season (from 01.03. to 30.09.) 2022 there was a higher sum of precipitation (406 mm) and lower mean air temperature (13.4 °C) compared to the season 2023, where the sum of precipitation was 369 mm and mean air temperature was 16 °C. Although the sum of precipitation in 2023 was lower by 9% than in 2022, we recorded higher mean SRI by 27% in all tree species growing in the mixture.
This effect could be caused by the differences in distribution of precipitation. In 2023 precipitation significantly dominated at the beginning of the growing season (March-April, Fig. 1, red circle). In the case of monocultures, this interannual effect of different

precipitation was confirmed only in larche's growth which increased by 37%. Spruce's performed decreasing by 8%, and beeches stagnated (Fig. 2).

The longest period with TWD = 0 µm (no drought stress) performed beech trees. However, here we speculate that automatic dendrometers are not tool for identification of TWD in beech

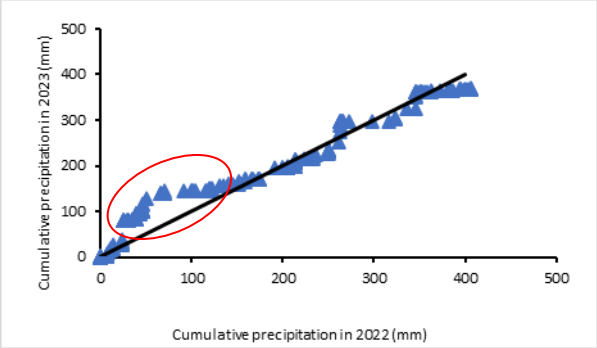

Fig. 1: Cumulative daily precipitation for period 01.03. to 30.09, x-axis precipitation in 2022 and y-axis precipitation in 2023. Black line represents 1:1 line.

The highest TWD (92 µm) performed larch in the mixture and generally, we recorded higher water stress in the mixture stand than in monocultures. Larches and spruces growing in monocultures performed significantly higher increments than in the mixture. Generally, beeches finished their growth period earlier than other tree species, except trees in the mixture stand in 2023, where the growth was prolonged until the end of August. We did not observe a significant benefit of the presence of larch on the growth of other tree species.

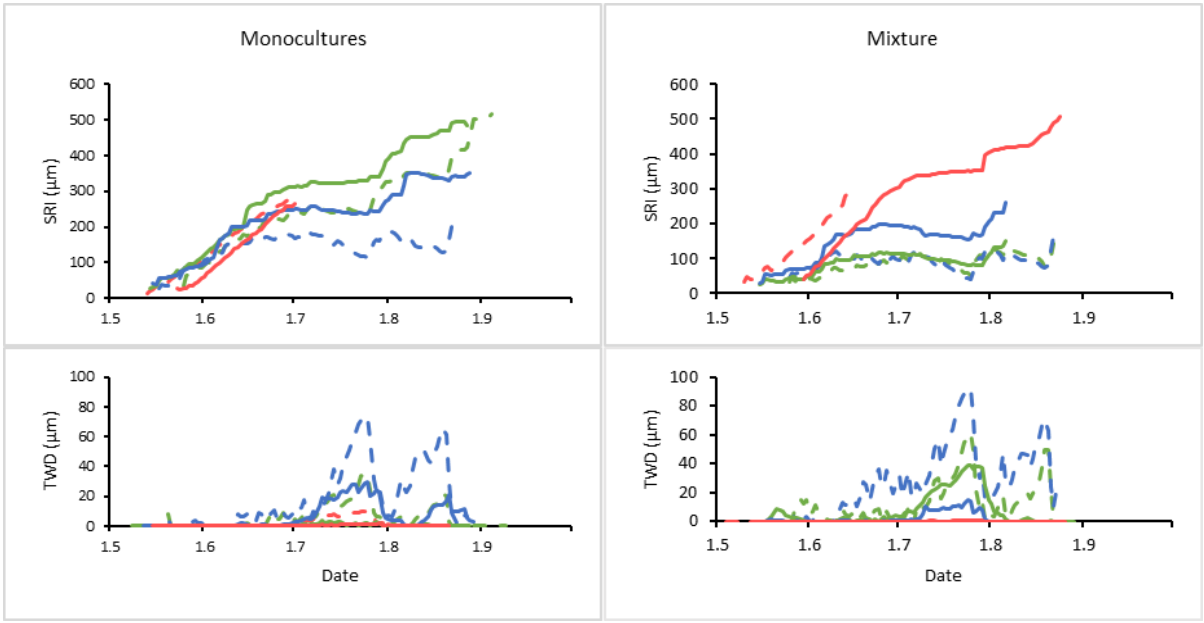

Fig. 2: Seasonal course of mean SRI (upper) and mean TWD (lower) per year 2022 (dashed lines) and 2023 (bold lines). The left plots belong to monocultures of spruce (green), larch (blue) and beech (red) and the right to mixture (spruce 32%, larch 31%, beech 29%).

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ACKNOWLEDGMENT

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DENSITY ESTIMATION OF RED DEER POPULATION AND THE IMPACT TO TREE NATURAL REGENERATION

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Keywords: abundance, distribution, hunting, population, ungulates

The environment of National Park Bohemian Switzerland (NP) has long been under considerable pressure from herbivorous animals. In 2022, it was decided to prepare a study with the aim of determining the estimate of the number of herbivorous animals with an emphasis on deer. The aim of the study was also to assess its influence on the current forest regeneration and the proposal of hunting management for the next period. From June 2022, NP has been continuously monitoring wildlife using camera traps. The method of using a network of photo traps was chosen as the most effective way of obtaining data needed not only for estimating the number of herbivorous species present, but also as a source of information about other animal species. The Random Encounter Model (REM) method was used to estimate the population density of particular game species. This method is currently considered one of the most accurate and is internationally recognized as a comparative method. The exact rules and principles are described in the last year conference paper.
In order to obtain data suitable for this method, a network of 37 photo traps was created in the NP and the surrounding area with a mutual distance of approx. 1.3 km. Camera traps were installed as standard according to the manufacturer's instructions. The regularly obtained photographs were further analyzed and from the obtained data, estimates of the abundance of mainly red deer in 2022 and 2023 were calculated.
The estimate of the number of deer in the years 2022 and 2023 was 549 and 474 respectively in the territory of the entire area of the park - i.e. approximately (69 and 59/1000 ha respectively). According to this estimate, the standardized levels are thus exceeded 2-3 times. The distribution of deer game in the NP is uneven due to seasonal changes with regard to the use of food resources in the NP territory and its surroundings.
The method of control and comparison areas (KSP) was used to analyze the state of forest regeneration damage. The establishment, maintenance, control and registration of results from the KSP are governed by the currently valid legislation. During field investigations, already established (according to Decree No. 101/1996 Coll. and Methodical Instruction of the Ministry of Agriculture No. 14/1996) KSP are evaluated. Here are all the rules for placing, building and evaluating damage on the KSP. Due to the fact that the density of KSP and their current state did not allow obtaining a sufficient amount of the necessary data, the KSP network was supplemented with a network of monitoring areas.
From the analysis of data obtained from 40 monitoring areas and 31 control and comparison areas in the NP in 2022, in a total of 71 areas and 2985 trees of 11 tree species, growing in the height category from 0.1 to 1.3 m outside the fence and without

applied protection against bite, twice as much (44%) damage to the forest by game was found compared to data from the KSP for the whole of the Czech Republic (19%).

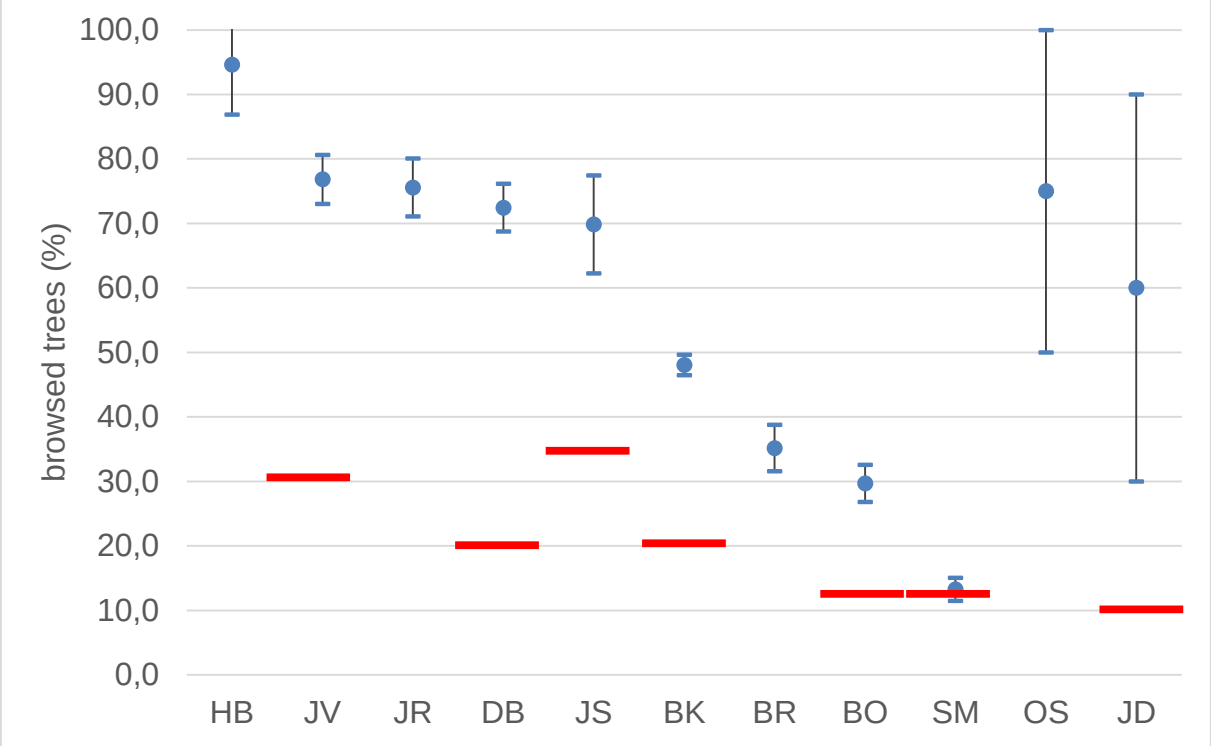

Fig. 1: Proportion (%) of trees with current main shoot damage by herbivores with interval estimation and critical forest damage level (in red) taken from Switzerland (HB-hornbeam, JV-maple, JR-rowan, DB-oak, JS-ash, BK-beech, BR-birch, BO-pine, SM-spruce, OS-poplar, JD-fir).

Data on damage to forest regeneration by individual tree species or genera were compared with the critical level of forest damage that has been used for over twenty years in Switzerland. The analysis revealed that in 2022, all compared tree species in the NP were unbearably damaged by the current browsing caused by the deer (Fig. 1). The level of current damages is also exceeded for beech seedlings and all attractive tree species, compared to the critical level and accepted by the Czech courts, and is in violation of the Forest Act No. 289/1995, paragraph 5) § 32.

At such a high level of damages to forest regeneration by wild herbivores, attractive species of autochthonous and meliorating or strengthening trees may gradually disappear from the population of trees in the NP. As a result, the stands can once again be species-unified in favor of spruce that is not attractive, but which, however, will probably be damaged by gnawing and peeling of the bark at an older age. This process will cause a considerable deviation from the natural development and, to a certain extent, destabilization of the entire forest complex of the NP.

ACKNOWLEDMENT
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THE EFFECT OF INTERSPECIFIC COMPETITION OF OAK AND BEECH IN THE THIRD AND FOURTH FOREST VEGETATION ZONES UNDER THE INFLUENCE OF GLOBAL CHANGE

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Keywords: beech, climate change, competition index, oak, relationships

1 INTRODUCTION

Ongoing climate change causes an increase in the average air temperature and a changing temporal and spatial distribution of precipitation. This increases evapotranspiration demands and leads to gradual vegetation change across ecosystems worldwide (Gonzales et al., 2010). On a regional scale, the impact of climate change on vegetation is best observed in the shift in forest vegetation zones (hereinafter referred to as FVZ) (Čermák et al., 2021). According to Machar et al. (2017), due to climate change, there will be an increase in the spread of lower FVZ in the territory of the Czech Republic and their shift to higher altitudes. The ambiguity in the shift of FVS is the processes of interspecies competition, different phenotypic plasticity and different adaptability of dominant species in individual FVZ (Iverson, McKenzie, 2013). Drought then increases the risk of mortality and changes ecohydrological relationships (Adams et al., 2012). Boisvenue and Running (2006) state that the amount, availability, but also the distribution of water during the year, together with temperature, represent the basic limiting climatic factors for the spread of herbaceous and woody vegetation, their species structure, as well as production on Earth. It is therefore appropriate to deal more with interspecies competition in individual FVZ, especially in transitional or critical ones.

2 METHODS

Research circular plots with a size of each 0.5 ha, have been established at the University Forest Enterprise Masaryk Forest of Křtiny in the fourth vegetation zone. Were selected a total of 4 groups for the categorization of evaluated individuals:
1) Beech in competition with beech
2) Beech in competition with oaks
3) Oak in competition with beeches
4) Oak in competition with oaks

The selected trees on plots were targeted by FieldMap, a dendrochronological analysis was performed, and a competition index was determined for them to express interspecific competition. Calculate the competition index according Heigy (1974):

$$CI = \sum_{j=1}^{n} \left(\frac{DBH_j / DBH_i}{DIST_{ij}} \right) \times w_n$$

where CI = total competition index of the target tree, DBHj = stem diameter of competing tree, DBHi = stem diameter of target tree, DISTij = distance between target tree and competing tree, n = 5 competing trees, wn = 1 - mortality was not considered

3 RESULTS AND DISCUSSION

Preliminary results include first analyses of the position tree species the stand. From these outputs we can then calculate the competition index (Figs 1 and 2).

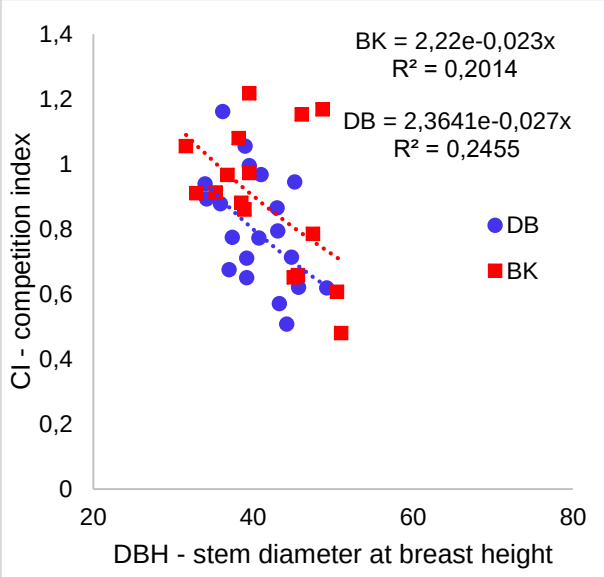

Fig. 1: Graph of the dependence of comtetition index (CI) on the target stem diameter at the breast height (DBH) in pure stands of European beech (BK) and Sessile oak (DB).

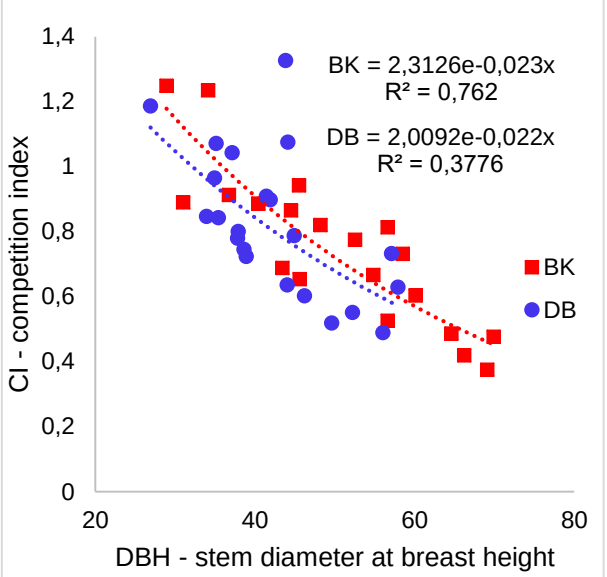

Fig. 2: Graph of the dependence of comtetition index (CI) on the target stem diameter at the breast height (DBH) in mixed stands of European beech (BK) and Sessile oak (DB).

4 CONCLUSIONS

Considering the initial phase of the project's data evaluation, it can be concluded that the DBH of target tree depends on competition index. This is evidenced by preliminary data presentation in Figs 1 and 2. Target trees of oak as well as beech show similar proportion between their CI and DBH in monoculture stands. The beech and oak in the mixture has a height DBH than in the pure stand with the same value of the CI. The CI values are slightly higher for oak in the pure stand than in the mixed stand. Beech has a lower CI in the mixture than in the pure stand.

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IMPACT OF LOGGING RESIDUES OF EUROPEAN LARCH ON BARK BEETLES AND ITS THREAT TO THE FOREST

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Keywords: *Larix decidua*, logging residues, bark beetles

1 INTRODUCTION

Pfeffer and Knížek (1995) defined 11 species of Scolytinae that can infest European larch (*Larix decidua*). Compared to *Pinus sylvestris* L. (48 species) or *Picea abies* L. (39 species), the spectrum of bark beetles appears to be relatively poor. Only *Ips cembrae* Heer and *Cryphalus intermedius* Ferrari are monophagous on larch. *Ips cembrae* is one of several species of the genus *Ips* that naturally occur in Europe. It is the most important pest of European larch with recorded local outbreaks (Grégoire, Evans, 2004, Krehan and Cech, 2004, Grodzki and Kosibowicz, 2009). *Cryphalus intermedius* locally occurs in northern Moravia (Pfeffer, 1989) and more rarely in Bohemia (Fiala and Knížek, 2020). The aim of this study was to assess the bark beetle species that can breed in larch branches and residues from thinning.

2 METHODOLOGY

On 3 model localities every month (from August 2022 to August 2023) 2 trees were felled. The trees were cutted into logs (length = 2 m). The logs from first tree were placed into forest stand and logs from second tree were placed on open area. After the infestation by *I. cembrae*, the logs were debarked in the centre (length = 0.5 m) and the numbers of nuptial chambers, maternal galleries, eggs, and stage of development were recorded. On 5 model localities, 2 piles of branches from larch were placed into forest stand and on open area. After the infestation, the branches were cutted into 0.5 m sections and analyzed for presence of bark beetles. The normality of data was analyzed by Shapiro–Wilk test and differences were tested by Mann–Whitney U test and Kruskal-Wallis H test (KW). Pearson correlation coefficient was used to determine the relationship between diameter and abundance of bark beetles.

3 RESULTS AND DISCUSSION

In total, 5 777 imagoes of *I. cembrae* were recorded in logs. There were significant differences in the abundance of *I. cembrae* on logs felled in winter/spring and summer/autumn (KW: $p < 0.00001$). The highest infestation density was recorded on the top of logs placed in the open area (U: $p = 00001$) (Fig. 1).

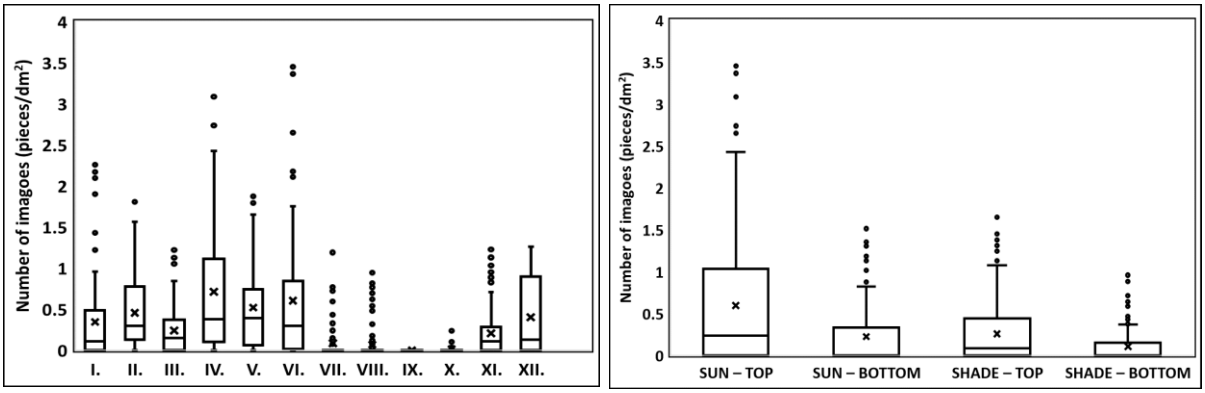

Fig. 1: Numbers of *I. cembrae* adults captured on logs felled in particular months (left) and on top/bottom of the logs (right)

Totally 321 infested sections from larch branches were analyzed. Three species of bark beetles (*I. cembrae*, *C. intermedius* and *Pityogenes chalcographus*) were recorded. *Cryphalus intermedius* was only recorded on the branches placed in the shade. *Pityogenes chalcographus* infested only the branches placed in vicinity of spruce monoculture forest and infested only 9.3 % of the branches. Positive correlation (r = 0.62) was found between the diameter of branch and *I. cembrae* infestation density (p = 0.001). Positive correlation (r = 0.68) was found between the diameter of branch and *C. intermedius* infestation density (p = 0.0001) too.

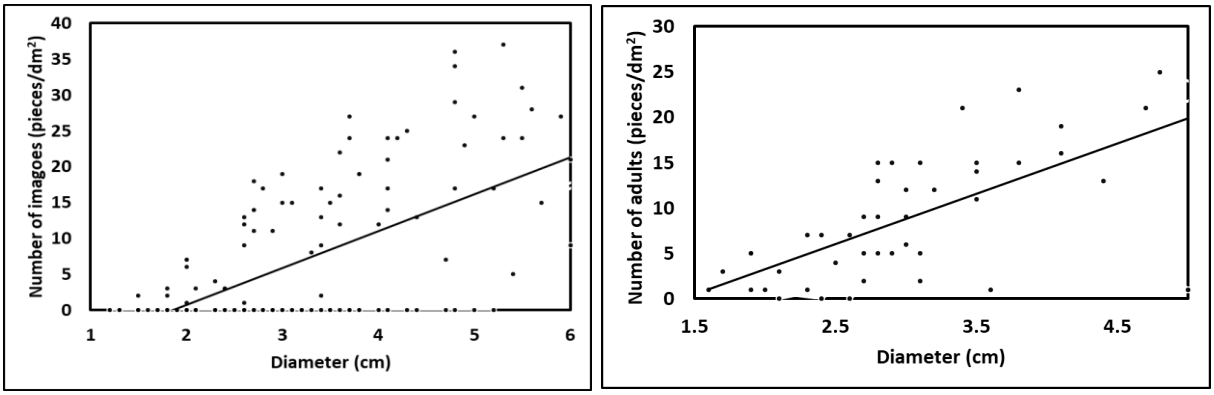

Fig. 2: Scatter plot of diameter of branches and *I. cembrae* (left) and *C. intermedius* (right) infestation density

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IMPACT OF ROOTING OF WILD BOAR (*SUS SCROFA* L.) ON ARTHROPODA

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Keywords: *Sus scrofa*, rooting, arthropoda*,* aceri tatarici-quercion

1 INTRODUCTION

Wild boar (*Sus scrofa*) is mammal native to Eurasia (Massei, Genov, 2004), but now it is present in all continents except Antarctica (Long, 2003). The increased population of wild boar has several negative economic impacts (e. g. rooting of tree seedlings and agricultural crops) (Mayer, 2009, Anderson et al., 2016). Impacts of rooting on epigeic invertebrates were studied by a few authors (e. g. Fagiani et al., 2014, Marshall et al., 2020), but no author has studied effects of rooting on invertebrates in oak forests. Our goal was to evaluate effects of wild boar rooting on most abundant epigeic invertebrates.

2 METHODOLOGY

In 2022 and 2022, on 10 model localities 50 pitfall traps were placed to compare epigeic communities on areas affected by wild boar rooting (5 areas, 25 traps) and area with no rooting (5 areas, 25 traps). The pitfall traps were filled with 4 % solution of chloroform and the samples were collected every month during the growing season from July 2022 to September 2023. The samples were preserved in 75 % solution of ethanol. In the laboratory, the samples were divided into taxonomic groups. Only endangered species, Elateridae, Carabidae and Geotrupidae were identified into species. The normality of data was analyzed by Shapiro–Wilk test and differences between pitfall traps were test by Mann–Whitney U test.

3 RESULTS AND DISCUSSION

In total, 12 180 arthropods were captured in pitfall traps. Our results indicate, that familiae Elateridae, Geotrupidae, Gryllidae, Staphylinidae and Phalangiidae were not affected by rooting ($p > 0.05$). Araneae ($p = 0.000007$), Diplopoda ($p = 0.0008$) and Carabidae ($p = 0.009$) were more active in areas with rooting (Fig. 1).

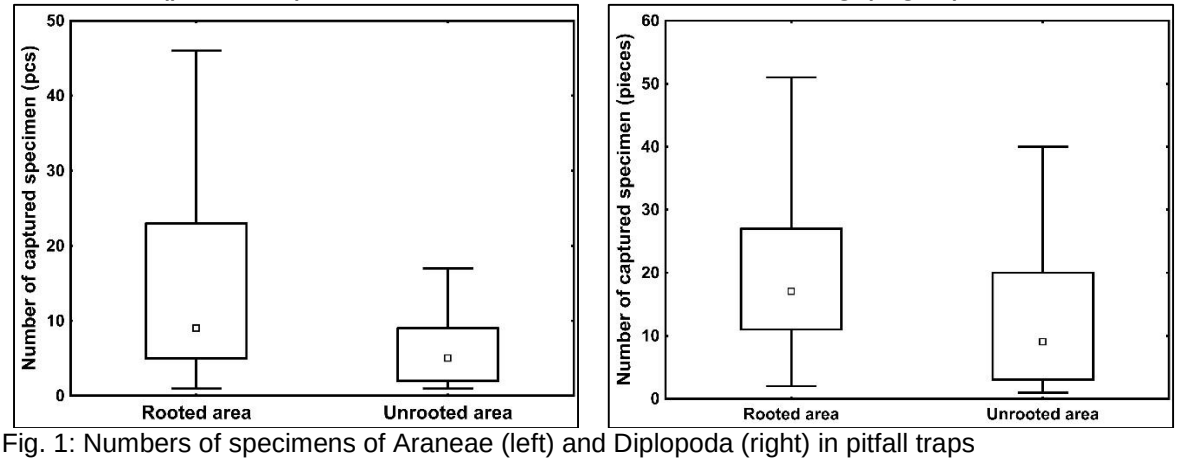

Fig. 1: Numbers of specimens of Araneae (left) and Diplopoda (right) in pitfall traps

Totally 919 specimens of Carabidae were captured. Totally 11 species Carabidae were active in model localities. Most abundant species was *Harpalus rufipes* De Geer (Tab. 1).

Tab. 1: Carabidae species captured in pitfall traps

	Pcs	Share (%)	Area
Badister lacertosus (Sturm, 1815)	1	0.11	R
Calathus fuscipes (Goeze, 1777)	2	0.22	R
Carabus granulatus (Linnaeus, 1758)	1	0.11	U
Carabus hortensis (Linnaeus, 1758)	11	1.20	Both
Carabus violaceus (Linnaeus, 1758)	8	0.87	Both
Harpalus rubripes (Duftschmid, 1812)	1	0.11	U
Harpalus rufipes (DeGeer, 1774)	872	94.89	Both
Leistus ferrugineus (Linnaeus, 1758)	1	0.11	R
Licinus depressus (Paykull, 1790)	1	0.11	U
Nebria brevicollis (Fabricius, 1792)	4	0.44	Both
Poecilus cupreus (Linnaeus, 1758)	1	0.11	R
Pterostichus niger (Schaller, 1783)	15	1.63	Both
Pterostichus oblongopunctatus (Fabricius, 1787)	1	0.11	R

*R – rooted; U – unrooted

During this study, *Licinus depressus* Paykull was recorded for the first time in Hodonín district. *Licinus depressus* is xerophilous ground beetle that is found in dry, sandy or gravelly soils sites in grasslands, on overgrown dunes, and in dry forests (Baur et al., 2023). During the study, two endangered species of Red list of Threatened Species of Czech Republic: Invertebrates (Hejda et al., 2017) *Cucujus cinnaberinus* Scopoli and *Selatosomus cruciatus* L. were present in unrooted areas.

Our results indicate that epigeic insect predators are more abundant in rooted areas by wild boar, which leads to perturbation of forest soil and subsequential attraction of ground predators (Araneae, Carabidae and Diplopoda).

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POSSIBILITIES OF APPLYING 3D PRINTING TECHNOLOGY FOR MODELLING OF RELIEF MAPS AND FOREST STANDS IN FOREST MANAGEMENT AND PLANNING

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Keywords: 3D print, forest management, digital terrain model, forest, point cloud, laser scanning

3D printing technology is a relatively young discipline that only started to develop more in 2009 for public use. This technology is now increasingly becoming an interdisciplinary issue. It is used not only in engineering and construction, but also in science, education, for various planning sectors such as urban planning, natural resource management, transportation planning, etc. [1]
In the field of geoinformation technologies, 3D scenes are nowadays very realistic, but they are still only a visualisation of a 2D image, which requires a high level of imagination. 3D printing has the potential to bridge this gap between the virtual and physical worlds. The result is physically durable, solid and anyone can touch it or rotate it themselves to get the desired view. 3D models created in this way are easy to present to the public [2]. The method of 3D print consists of applying layers of material to a base. The layers are applied one on top of the other from the base upwards, which is why this process is called additive manufacturing [3].
The aim of the project was to explore the possibilities of applying 3D printing technology as an innovative technological tool for the production and visualization of relief maps, forest stands, trees and models of real-world phenomena in forest management and in the visualization of landscape and its management. There were also several sub-objectives like development of a methodology for editing three-dimensional data into the resulting STL format, selection of the optimal method for 3D printing or optimization of printer settings (layer height, scale, material, printing speed). A sub-objective was also to answer the questions whether 3D printing technology can be considered as a new method of visualizing geographic data and what is the most efficient way of processing and preparing data for subsequent printing.
The charcoal sites were scanned in an area near Klepačov - east of Blansko. A few specific ones were chosen from the many confirmed ones. These were scanned from the air in order to create a digital surface model and terrain model. Aerial laser scanning was performed using a DJI Matrice 600 Pro hexacopter equipped with a GeoSLAM Horizon laser scanner with RGB camera. Flight planning (selection of flight altitude and flight path overlap) was done using DJI Ground Station software, data processing and point cloud creation was done in GeoSLAM Hub software. The created point clouds were processed in CloudCompare software (Fig. 1) into a mesh model. For some point clouds it was necessary to split them into several parts when processing, work with them separately and then merge the models back into one large area after printing.

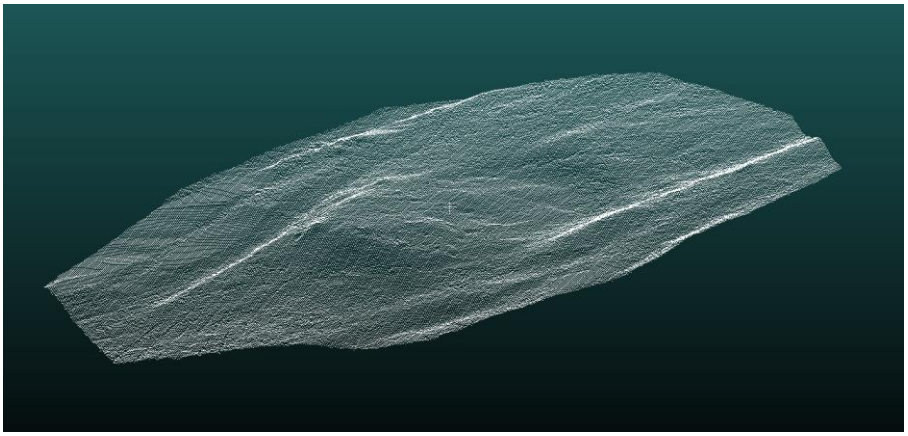

Fig. 5: Point cloud of charcoal site

This model was then inserted into the Meshmixer software where was produced a compact solid for print. This modified object in the form of an STL file was exported to the PrusaSlicer software where the final changes, preparations and settings were made. Then, the models were printed (Figs 2 and 3) on an Original Prusa i3 MK3S+ 3D printer, which allows precise printing of terrain and surface models.

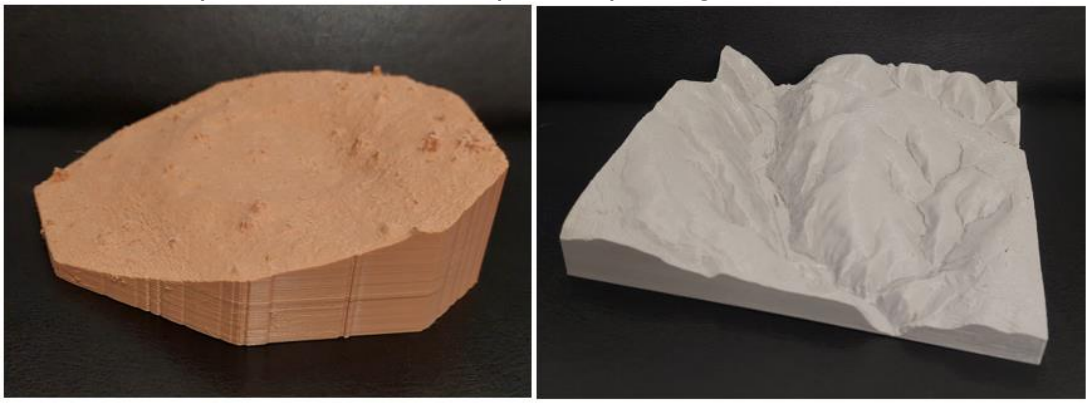

Fig. 2. and 3: Print of charcoal site, print of the area of Klepačov

Within the chosen methodology, the processing of the point cloud and then the adjustment of the layer height, scale, material, and printing speed were optimized for printing the terrain models. The results show that this method of data processing and preparation is suitable for printing 3D relief models and leads to the desired results.

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Wood*Net* 2023

COMPARISON OF WOOD ACETYLATION METHODS WITH GAS AND LIQUID–PHASE CHEMICALS

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Keywords: acetic anhydride, anti–swelling efficiency (ASE), beech wood, equilibrium moisture content (EMC), Fourier transform infrared (FTIR) spectroscopy, pH

1 INTRODUCTION

The reaction of the acetic anhydride agent with wood hydroxyl molecules (hydrophobic hydroxyl replaced by hydrophilic acetyl) is presented as wood acetylation. The main advantages of acetylated wood are uniform density, dimensional stability, smooth surface, and others. The disadvantage is the penetration of the impregnating substance into the wood, which is influenced by its type and the current condition of the wood, the method of application used and the properties of the impregnating substance. If the wood has a higher humidity, the problem usually arises because the water molecules react with the acid anhydride - the formation of acetic acid. Acetic acid as a by-product of the acetyl reaction can cause other negative properties (unpleasant smell, corrosion of metal fasteners or loss of strength). On the other hand, when comparing the rate of gas phase versus liquid phase acetylation, it is extremely fast (Brelid, 2002; Hill, 2007; Gu et al.; 2015).

2 MATERIAL AND METHODS

2.1 WOOD ACETYLATION

European beech (*Fagus sylvatica*) samples with dimensions of 20×20×20 mm were cut for both acetylation processes. The liquid phase took place according to the mentioned procedure, see Čermák et al. (2022). While a vacuum distillation apparatus was assembled for acetylation in the gas phase. The process was carried out at the desired temperature (T=100, 110, 120 or 130 °C) for a certain time (1, 2, 3 and 4 hours). The samples were gradually removed from the heated flask and transferred to a drying oven where they were left for 1 hour at 120 °C. Subsequently, the samples were taken, weighed, dimensions measured and left for 1 week in an air–conditioned room. The samples were again dried at 103±2 °C for 24 hours – and reweighed and measured. These values were used to calculate the values: Weight percentage gain – WPG (1), where m_u is the weight of the unmodified wood sample and m_m is the weight of the modified wood sample. And Bulking coefficient – BC (2), where V_u is the volume of the unmodified wood sample and V_m is the volume of the modified wood sample:

$$WPG=\frac{(m_m-m_u)}{m_u}*100\ [\%]\ (1) \qquad BC=\frac{(V_m-V_u)}{V_u}*100\ [\%]\ (2)$$

2.2 WATER RELATED PROPERTIES

Among these properties, Equilibrium moisture content (EMC) (3) and Anti–swelling efficiency (ASE) (4) were mainly investigated. While to determine the sorption value, the samples were stored in an air-conditioned chamber at a temperature of 20 °C. The relative humidity of the air was subsequently changed according to the required value – 30, 65 and 90%. Subsequently, they were all taken out, weighed and their

dimensions measured. Measurement was repeated. While during the swelling process, these samples were immersed in demineralized water and soaked for a certain period (from 2 hours to 3 months). After three months, the samples were weighed at 0% to record the weight loss (Δm) (5) during the soaking process.

$$EMC=\frac{(m_2-m_1)}{m_1}*100\ [\%]\ (3) \qquad ASE=\frac{(S_u-S_m)}{S_u}*100\ [\%](4)$$

$$\Delta m=\frac{(m_3-m_0)}{m_3}*100\ [\%]\ (5)$$

2.3 CHEMICAL ANALYSIS

In cooperation with BOKU University, measurement of FTIR analysis of wood dust with the help of special equipment.

3 RESULTS AND DISCUSSION

All results within gas phase acetylation reached higher values with longer reaction time or process temperature. This fact was recorded both in the determination of water related properties and chemical analyses. When comparing these results with acetyl samples in the liquid phase, they were lower – mainly due to the achievement of a higher WPG value. These EMC results together with the reference samples were comparable to the publication of Čermák et al. (2022). Water related properties were reduced in both cases of acetylation compared to the reference samples. The results of FTIR analysis in both cases of acetylated samples were comparable to the results of Gu et al. (2015).

4 CONCLUSIONS

A significant improvement in the properties of beech wood was achieved in both methods of acetylation compared to the reference samples in the case of exposure to water in the vapor and liquid phase. Nevertheless, better results were obtained in the case of liquid phase acetylation. This phenomenon can be changed at a higher temperature or a longer reaction time of the process. However, it is important to find out which of these variants is more efficient from the point of view of the process and will less negatively affect the properties of the wood.

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IN-SITU SYNTHESIS OF ZNO, SiO_2, AND TiO_2 NANOPARTICLES TO IMPROVE THE WOOD WITH SUPERHYDROPHOBICITY, UV RESISTANCE, AND ANTIFUNGAL PROPERTIES

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Keywords: nanoparticles, wood modification, hydrophobic, UV resistance, antifungal

1 ABSTRACT

In recent years, there has been a growing interest in enhancing wood materials through in-situ synthesis, benefiting from the potential to blend the inherent qualities of wood with inorganic compounds. This project is dedicated to investigating the effects of in-situ chemosynthesis on modified wood, with a specific focus on microstructural morphology, UV stability, and antibacterial properties. The project will entail the synthesis of nanoparticles using various metal oxides (ZnO, SiO_2, and TiO_2) at varying concentrations (0.1 mol/L, 0.2 mol/L, 0.4 mol/L, and 0.6 mol/L) to optimize the properties of wood. To measure these modifications, the project will evaluate moisture content through tensiometer-based water uptake tests and monitor mass changes. The modified wood will undergo comprehensive characterization through X-ray diffraction (XRD), scanning electron microscopy (SEM), colour change assessments, and contact angle measurements. Additionally, the project will assess UV resistance by subjecting samples to a 360-hour UV exposure before measuring contact angles.

2 OBJECTIVES

The study aims to create uniform nanoparticle formation in the wood cell wall to increase hydrophobicity, UV resistance and antifungal capacities. And to observe why the nanoparticles are forming into the complex wood structure. Which nanoparticles are given the best results in the characterization test? The main objective of the project is to solve the questions.

3 HYPOTHESIS

Nanoparticle impregnation will increase wood's superhydrophobicity, UV resistance and antibacterial properties.

4 METHODOLOGY

Sample preparation: Pine and spruce wood samples from the Czech Republic and Slovakia will be chosen. In the first step, the wood samples are placed in the vacuum chamber for 1hr at 60 °C for drying and cleaning impurities.

Nanoparticle synthesis: ZnO, SiO_2, and TiO_2 nanoparticles are synthesized from different chemicals. The solution is prepared by the in-situ synthesis method at room temperature. A two-step modification method followed. First, (ZnO, TiO_2, SiO_2) nanoparticles are synthesized, and in the second step, the dip and coating process is performed for the uniform formation of the nanostructure to obtain the highest efficiency. Next, deionized water will wash the wood samples until their pH level is

neutral. The samples are oven-dried for 24 hours at 60 °C to create hybrid wood materials, followed by curing the samples at 105˚C.

5 CHARACTERIZATION AND TESTING METHODS

All samples will be tested before and after the chemical treatment to investigate the effect of nanoparticle formation.
Mass changing and water up-taking measurements are performed by tensiometer.
Scanning Electron Microscope (SEM): Scanning Electron Microscopy will be used for the morphological study to verify the microstructure of the nanoparticles is filled in the lumen cell wall. By ImageJ software, we will measure the particle size of the nanoparticle (not more than 100nm).
Fourier-transform infrared spectroscopy (FTIR): FTIR is used to determine the composition of treated and untreated samples. X-Ray Diffraction (XRD): X-Ray Diffraction is a non-destructive test method used to analyze the cellulose nanostructure and reveal the crystalline phase and amorphous of nanoparticles with control and treated samples. UV resistance tests: The treated and untread samples were placed under an artificial UV lamp chambre Antifungal properties tests: Blue stain test and decay in the test are performer. Contact Angle: The water contact and ethylene glycol are used to measure the contact angle of treated and untreated samples.

6 RESULTS

Noticeable changes are observed in all tests when comparing untreated and treated samples. Treated samples demonstrate notably higher hydrophobicity, surpassing 150 ˚C, with this enhanced property remaining consistent following UV exposure. In contrast, untreated samples exhibit a substantial decrease in hydrophobicity after UV exposure. The Fourier-transform infrared (FTIR) and X-ray diffraction (XRD) analyses underscore the conspicuous presence of nanoparticle peaks. Furthermore, Fig. 1 illustrates a pronounced distinction between treated and untreated wood characteristics.

Fig. 1: Demonstrate the antifungal test result (a) blue stain fungi (b) decay fungi (EN113)

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EVALUATION OF BENDING PROPERTIES OF WOOD PLASTIC COMPOSITES BASED ON WASTE PET AND SAWDUST

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Keywords: bending properties, composite, polymer, sawdust, waste PET

1 INTRUDUCTION

Composite materials can generally be defined as a combination of two or more materials that differ in size or composition on a macroscale. Flexural characteristics in the plastic range are an important mechanical property. The bending characteristics are determined from the stress-strain diagram, which is typical for each type of stress. Many mechanical properties can be determined from this diagram. A typical stress strain diagram is depicted in Fig. 1. The aim of this study was to determine the effect of different compositions on the bending characteristics of composite material in the plastic range.

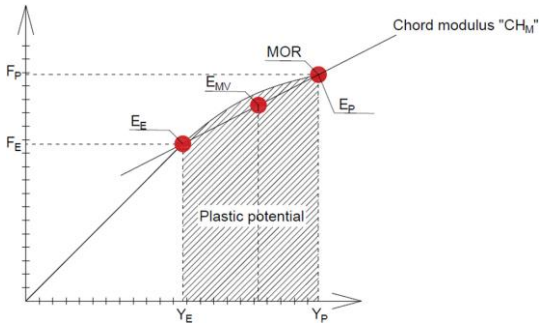

Fig. 1: The bending characteristics in plastic area of force-deformation diagram (adapted from Sikora et al., 2018).

2 MATERIALS AND METHODS

Sawdust dried in an oven at 103±2°C for 24 h. Fiber-to-Polymer ratio for reinforced composites were 20-60 wt% (Tab. 1).

Tab. 1: The composition of composites.

Composite Code	Composition
1	Sawdust (40%), PET waste (60%)
2	Sawdust (60%), PET waste (40%)
3	Sawdust (50%), Y1000P polymer (50%)
4	Sawdust (20%), Rubber (40%), PET waste (40%)

The specimens were bent in middle-length distance using a universal testing machine in accordance with EN 13061-3. All the necessary data such as bending strength were obtained from the measured force-deformation diagrams. The limit of proportionality was determined for the point where the deviation of the curve from the linear part was greater than 1%. Statistical analyses including ANOVA and Duncan grouping test were evaluated by STATISTICA 14 (Statsoft Inc., USA) software.

3 RESULTS AND DISCUSSION

Fig. 2 shows the limit of proportionality of reinforced composites as well as Duncan grouping of the results. Sawdust based composites containing 50% fibers showed the highest limit of proportionality (4.872 MPa). Composites containing 60% and 40% natural fillers demonstrated lower amount of limit of proportionality and the minimum value of the mechanical property belongs to rPET composites reinforced with 20% sawdust and 40% rubber. Based on Duncan grouping test (Fig. 2), there is no

significant difference between reinforced composites containing 60% sawdust and 20% sawdust + 40% rubber.

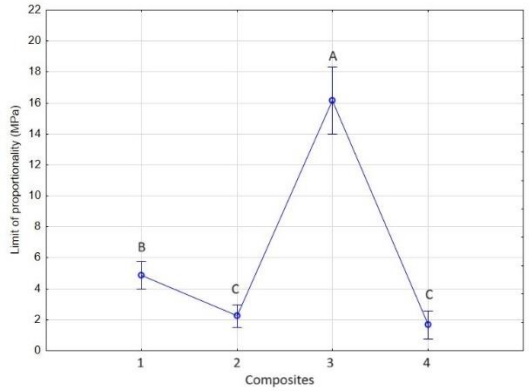

Fig. 2: The effect of different compositions on limit of proportionality of composites.

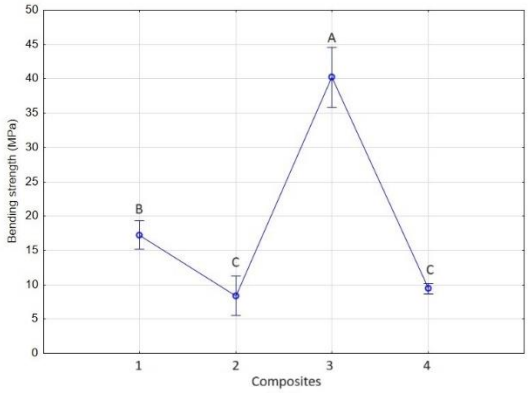

Fig. 3: The effect of different compositions on bending strength of composites.

The bending strength of composites were depicted in Fig. 3. The results of bending strength and Duncan grouping demonstrated as same trend as limit of proportionality, where 50 and 40% filled composites with sawdust showed the higher bending strength values (40.194 and 17.247 MPa), respectively. The reinforced composites containing 60% sawdust and mixed natural fiber and rubber particles showed minimum bending strength without significant difference (Fig. 3).

4 CONCLUSIONS

The results of the study confirmed that both filler and matrix of composite play important role in mechanical properties and the effect of matrix is much more significant than different levels of fillers. According to the obtained results, biodegradable polymer reinforced with 50% sawdust showed the best performance in evaluated mechanical properties. The rPET composite containing 40% natural fibers demonstrated higher mechanical properties among all rPET composites. Based on the Duncan grouping results, there were no significant difference in mechanical characteristics of rPET reinforced composites filled with 60% filler (60% sawdust and 20% sawdust + 40% rubber). Generally, higher levels of filler (60%) decreased mechanical properties.

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COMPARISION OF MECHANICAL PROPERTIES OF INNOVATIVE FURNITURE JOINTS

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Keywords: furniture, CAM joint, dowel, hidden joint, plastic joint, bending moment values – compress/tension

1 INTRODUCTION

This research has dealt with the comparison of selected construction joints. The research also included new connecting elements that appeared on the market few years ago, their main construction part is made of plastic and their main goal is a simple production and assembly. Construction of furniture is influenced by each of components used (Eckelman, 2003). Simple mechanical connection of furniture enables an on-site assembly (Joščák and Gaff, 2011). Smardzewski and Kilic (2016) dealt with innovative connections and focused on 82 types of fittings. Krzyzaniak and Smardzewski (2019) dealt with their own design of innovative types of joints.

2 MATERIAL AND METHODS

As a part of the research the most often used types of furniture joints were selected. Joints were subsequently divided into groups of CAM joints and experimental joints. Distribution was done on the basis of observing the behaviour of carpenters and companies producing furniture. As a part of the research selected types of joints were tested in two groups. Each group was represented by several types of fittings. It is always a visual type of furniture connection, dowels were added to some connection types. The excentre group included samples of excentre joint with a plastic or zinc excenter (Fig. 1) and screw excenter. The group of experimental joints included Onefix plastic excentre samples, SC 8/60 plastic joints and Cabineo joints (Fig. 2). A dowel joint was used as a reference sample. From each type of joint L samples, used for mechanical testing, were made from three-layer chipboard with the thickness of 18 mm and size being 150 x 150 x 356 mm. The tests were carried out on a universal tearing machine with the feed rate of 8 mm/min.

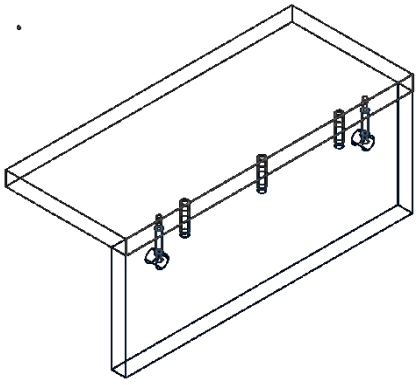

Fig. 2: 3D model of CAM joint sample

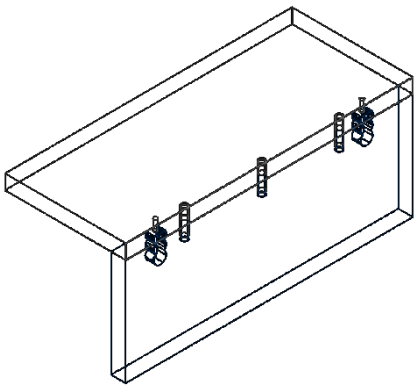

Fig. 1: 3D model of Cabineo with dowels

3 RESULTS AND DISCUSSION

As a part of mechanical testing of bending moment values – compress stress, the samples from the CAM group reached an average value of 30 N.m. As a part of testing of bending moment values – compress stress, the samples from experimental joints group reached an average value of 15 N.m. and reference dowel joint reached 14 N.m. As a part of testing of bending moment values – tensile stress, samples from the CAM group reached an average value of 33 N.m. As a part of testing of bending moment values – tensile stress, samples from the experimental group reached an average value of 24 N.m. and reference dowel joint reached 17 N.m. After cleaning the results data by removing the strength of the dowel joint (Tab. 1), it is clear that the CAM joint group achieved better average results than the experimental group. This result is influenced by the fact that the group of experimental joints includes plastic joints which reach the lowest values both in compression and tension.

Tab. 1: Comparison of individual joints after deduction of dowel joint strength

Group	Sample marking	Bending moment values (compress)	Bending moment values (tension)
CAM joint	Plastic CAM + dowels	19 N.m	18 N.m
	Zinc CAM + dowels	18 N.m	17 N.m
	Tofix + dowels	9 N.m	12 N.m
Experimental joints	Onefix + dowels	5 N.m	6 N.m
	Ixconnect SC 8/60	6 N.m	7 N.m
	Cabineo	11 N.m	24 N.m
	Cabineo + dowels	11 N.m	24 N.m

4 CONCLUSIONS

The individual types of joints can differ considerably from each other, be it construction, type of assembly, price, mechanical properties, etc. The most fundamental difference in the test results was the fact whether the sample contained an additional dowel joint or not. For some degree of comparison the dowel strength values were deducted from the joints containing the dowels. Mechanical testing showed that the samples from the CAM joint group achieved higher values than the samples from the experimental joint group.

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FIRST FINDINGS FROM THE GREENPEA PROJECT – WOODEN CUBESAT FOR LOW EARTH ORBIT

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Keywords: composite panel, CubeSat, space environmental effects in low Earth orbit, wood, wood-based materials

1 INTRODUCTION

The aim of this bachelor thesis is the theoretical design of a wood-based composite panel for a CubeSat operating in low Earth orbit (LEO). It was concerned with (1) the conditions to which the CubeSat is exposed in LEO, (2) the selection of a suitable type of wood and wood-based material whose properties satisfy these conditions, and (3) the theoretical design of the wood-based composite panel that cover the CubeSat. The design was inspired by historical examples where wood has been used in various forms in space engineering. There are currently two projects working on the design of a wood panel for the CubeSat, the first is the Finnish WISA Woodsat (Jari, 2021) and the second is the Japanese LignoSat (SpaceKUwood, 2023) (Fig. 1 and Fig. 2).

Fig. 1: Finnish CubeSat WISA Woodsat (Jari, 2021)

Fig. 2: Japanese CubeSat LignoSat (SpaceKUwood, 2023)

2 METHODOLOGY

The space environmental effects in LEO were analyzed based on NASA (NTRS) and European Space Standards (ECSS) expert sources. The Czech technical Standards (CSN) and Holzatlas (Wagenführ, 2000) were used for the selection of suitable wood species and wood-based materials. The individual influencing factors were classified according to their influence on the wood properties into three groups (1 – negligible influence, 2 – small influence, 3 – significant influence) using sensitivity analysis. Due to the negligible effect of moisture content, the physical and mechanical properties of wood were recalculated to 0% moisture content. The applied thermal stress was considered by calculating the thermal expansion and thermal stress based on a linear elastic model (Hooke's law). The selection of a suitable group of woods or suitable wood species was done by using material indices (Ashby, 2010).

3 RESULTS AND DISCUSSION

Tab. 2 shows the factors affecting LEO and their effect on wood. The gravitational and magnetic fields of the Earth, air humidity, micrometeoroids and orbital debris have a negligible effect. Air density, corpuscular – ionizing radiation and plasma have a small effect. All these forcing factors have been neglected and we have focused on the effects of atmospheric pressure and thermal stress. The most significant effects on wood are due to atomic oxygen, which can degrade chemical bonds,

and electromagnetic radiation, which can damage organic C-C and C-O bonds. The most suitable group of woods to withstand these factors are deciduous species with a diffuse-porous structure. They are characterized by the most homogeneous structure, a suitable ratio between mechanical properties and density, dimensional stability and good thermal properties. From the individual material indices (Fig. 3) including thermal and mechanical properties, the wood species with the highest summation value were selected. These are birch (3.67), balsa (3.53) and cork (2.38). Birch has comparable properties to hornbeam and beech but is more homogeneous and has a lower density. Balsa has the best specific stiffness and strength for its density. Cork was also selected as it has the best values in resistance to thermal shock. The three chosen materials were combined into a composite panel, where each layer represents a specific function. Balsa gives the panel a light weight, birch is responsible for the mechanical properties in bending and cork is responsible for the resistance to thermal shock on the exterior side (Fig. 4).

Tab. 2: Space environmental effects in LEO and their influence on wood

Space environmental effects	Threat factor
Gravity field of the Earth	1
Magnetic field of the Earth	1
Air humidity	1
Micrometeoroids and orbital debris	1 (3)
Air density	2
Air pressure	2
Temperature, thermal cycles and their extremes	2
Corpuscular – Ionizing radiation	2
Plasma	2
Atomic oxygen	3
Electromagnetic radiation	3

(1 – negligible effect; 2 – small effect; 3 – significant effect)

4 CONCLUSION

In the bachelor thesis, wood was evaluated as a structural material for the theoretical design of a wood-based composite panel for a CubeSat considering the operating environment on LEO. The selection of a suitable group of woods and their combination was based on (1) the factors considered at LEO (atmospheric pressure, temperature, atomic oxygen, electromagnetic radiation) and (2) the wood properties in the form of material indices. The optimization criterion was the maximum sum value of all material indices. Preliminary results confirm that wood is a promising material for the construction of LEO satellites. In my next diploma thesis, I would like to work on the GreenPea project, where the vision of a wooden CubeSat satellite seems to be realistic and worth further attention.

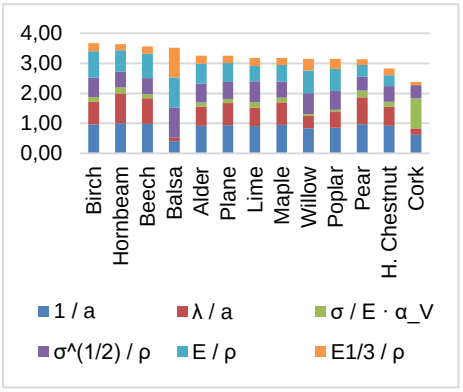

Fig. 3: Material indices for individual wood species

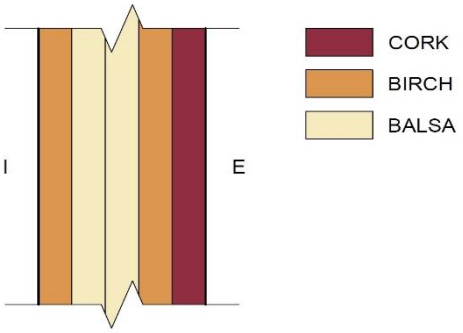

Fig. 4: Theoretical design of wood-based composite panel for CubeSat

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PARTICLE BOARDS WITH BARK PARTICLES ADMIXTURE

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Keywords: acoustic absorption, bark particles, IB, MOE, MOR, particleboard, physical and mechanical properties, sorption of water vapor

1 ABSTRACT

The research deals with the production of single-layer particleboards containing bark particles, which are added to the wooden particles mix with a step of 10% until the representation is 50:50% (bark : wooden particles). The result of the project is he determination of the impact of bark particles on physical and mechanical properties: bending (MOR & MOE), internal bonding (IB), moisture content (MC), thickness swelling (TS), water absorption (WA), density profile (DP), sound absorption coefficient (α) and Transmission attenuation (TL), sorption of water vapor. Complete understanding of the particleboards made from the mixture of bark and wood will improve the utilization of the bark in particleboards with the improvement of the physical and appropriate mechanical properties.

2 INTRODUCTION

A study by (Blanchet et al., 2000) dealt with the possible production of particleboards with additions of bark bonded with urea-formaldehyde resin, meeting the requirements of commercially produced particleboards. Modulus of rupture was a critical mechanical property. The best results were achieved with 50% wood particles. In another work (Pedieu et al., 2008) find out the possibility to replace particles in the surface layers of PB with water-resistant particles of white birch bark *(Betula papyrifera*). The values of the mechanical properties of all mixed particleboards are lower than the values of the wooden reference particleboards, because the bark used in the surface layers of the boards does not have the same structural properties as the grown wood (Ugolev, 1985; Kelly, 1977). The swelling and linear expansion of the mixed particleboards were lower than the reference panel thicknesses. Research by (Papadopoulos, 2007) focuses on the production of a single-layer particleboard with spruce bark content from 25% to 100% bark representation in the mixture. It is clear from the tests that the physico-mechanical properties of the produced boards decreased as the bark content increased.

3 MATERIAL AND METOTDOLOGY

The spruce bark chips (Wotan Forest, a.s.) were disintegrated into leaf particles at the DIEFFENBACHER knife ring flaker MRZ/MSF 1400. The particles were dried in a conventional chamber oven at a temperature of 70 °C to a moisture content of 6% and sieved on a screen sorter for bark particles with size 2-5 mm, wooden spruce particles for core layer Silekol (MUF resin + hardener ammonium chloride DDL Lukavec).

3.1 PRODUCTION OF BOARDS

Particle boards were manufactured in the laboratory (3 bords for each group). The 7% of MUF adhesive was applied by nozzle in a rotary blander. Bark and wooden

particle mats were formed by hand into a mold with dimensions of 600 × 600 mm and pressed to a thickness of 12 mm at a temperature 180 °C. The pressing process has been 240 seconds at a pressure of 3.5 MPa, and then the pressure was reduced by 0.5 MPa in four steps of 20 seconds.

4 RESULTS AND DISCUSSION

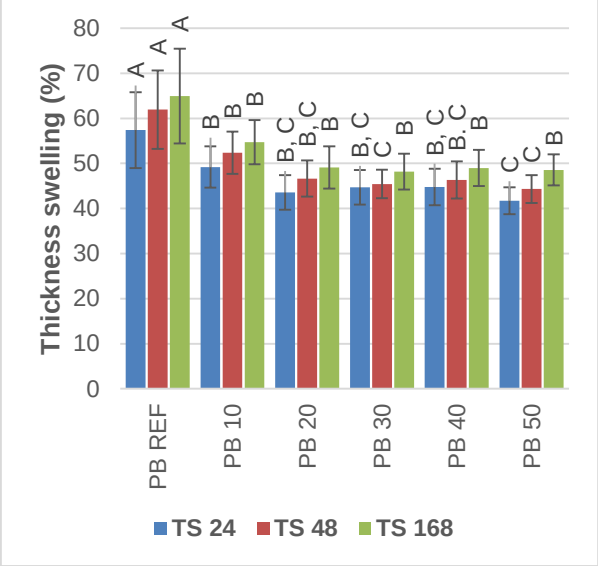

Fig. 1: Thickness swelling – same letter do not differ statistically by the Tukey´s test (α = 0.05). Error bars represent standard deviation.

Fig. 2: Water absorption – same letter do not differ statistically by the Tukey´s test (α = 0.05). Error bars represent standard deviation.

In (Fig. 1) a significant increase in the thickness of the reference samples (100% wooden particles) was visible. The addition of bark particles increased the dimensional stability, but the Tukey HSD test showed that the addition of more bark particles than 10% had no significant effect. Adding 10% bark particles to the mixture already caused the samples soaked in water for 168 h to swell less than the reference samples soaked for 24 h. From (Fig. 2) it is possible to observe a gradual decrease of water absorption with an increase volume of bark particles in the mixture, but Tukey test again showed a low influence of the amount of bark on water absorption, except for the reference samples. This result was expected from the results of previous research (Kelly, 1977).

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INFLUENCE OF THE LAYERS COMPOSITION OF THE LAMINATED STRAND LUMBER

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Keywords: density, laminated strand lumber (LSL), pMDI adhesive, thickness swelling, water absorption, wood-based composites

1 INTRODUCTION

Climate change in the last several decades led to the decline of the natural environment for the occurrence of spruce. It was found that suitable conditions for the planting spruce (*Picea abies* (L.) Karst.) stay only on 11.3% of the Czech Republic Forest area in the period 2041–2060 (Čermák et al., 2021). Spruce could be partially replaced by Larch (*Larix decidua* Mill.) under conditions of global climate change (Zeidler et al., 2022). Laminate strand lumber (LSL) is a type of wood-based composite consisting of oriented strands compressed with adhesive up to 90 mm thick (Moses et al., 2003). Strands thickness ranged from 0.5 to 2 mm and the length is around 300 mm (Zhang et al., 2014). LSL could be produced with different physical and mechanical properties. It depends on the pressing cycle, adhesive, density of the panel, the wood species, and the orientation of strands (Moses et al., 2003). LSL has a large range of use in building construction in horizontal and vertical applications (Wang et al., 2015).

2 MATERIAL AND METHODS

Logs were split to the half, debarked, and cut into 300 mm long cutouts. The length of cutouts defined the length of strands. Strands were manufactured on the laboratory knife ring flaker (MSF 1400, Dieffenbacher-CZ s.r.o., Czech Republic). For the strand mixture, it was sprayed 3% pMDI adhesive and 0.5% paraffine emulsion in a laboratory blender. Four types of LSL board were made 100% larch (RMD), 100% spruce (RSM), a mixture of 60% spruce and 40% larch (MSM), and 3 layers of 20% larch in each surface layer and 60% spruce in core layer (MDV). These four types of board were cut on testing specimens with dimensions 50 x 50 mm, specimens for bending were 800 x 75 mm, and specimens for compression were 30 x 30 x 105 mm. These specimens were tested on Bending properties (flatwise and edgewise), compression, moisture content (MC), Internal bond strength (IB), thickness swelling (TS), water absorption (WA), density profile, and density.

3 RESULTS, DISCUSSION AND CONCLUSIONS

There was not a statistically significant difference in the moisture content of the specimens with average values of 7.8%. The average density was highest in RMD samples (683 kg/m^3), but significant differences were found only in RSM specimens (599 kg/m^3), their density was statistically significantly lower than the density at other specimens. The average values of thickness swelling were 23% for spruce and 43% for larch after one week submerged in the water, which was a significant difference. In contrary water absorption after one week in the water

showed higher values for spruce (87%) and for larch (77%). The thickness swelling and water absorption showed differences in the rate of increase based on the differences in the densities and the compaction ratio of the LSL.

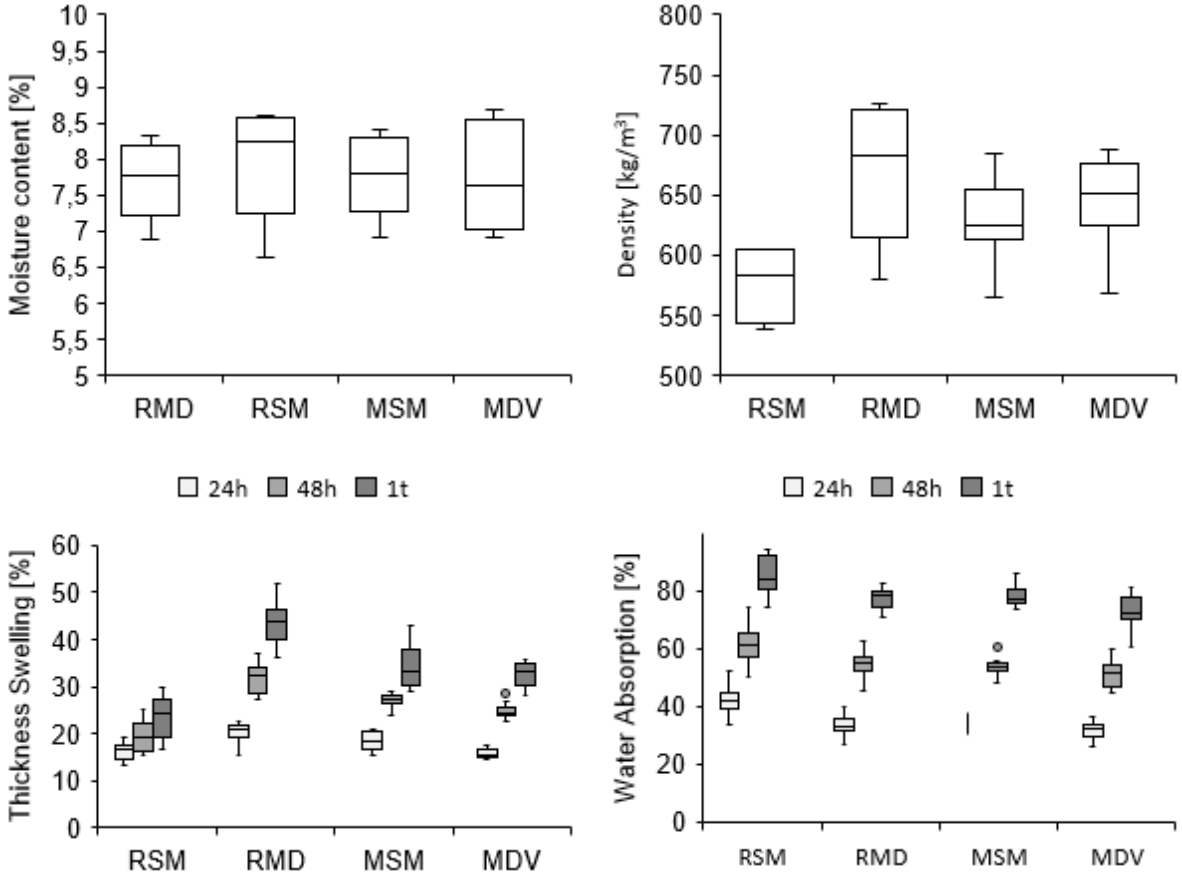

Fig. 1: Physical properties of spruce and larch LSL: RMD (100% larch), RSM (100% spruce), MSM (mixture of 60% spruce and 40% larch), and MDV (3 layers 20% of larch in surfaces and 60% of spruce in core layer).

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ADVANCED TOOL MATERIALS AND THEIR INFLUENCE ON THE PARAMETERS OF CNC MACHINING OF WOOD-BASED MATERIALS (PART II)

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Keywords: CNC machining, cutting force, cutting speed, tool coating, wood-based materials

1 INTRODUCTION

The project is focused on the proposal of a methodology for choosing a suitable tool material or coatings and cutting conditions depending on the machined material, considering energy consumption during milling. The goal of the project is to quantify machining parameters of tools designed for CNC machining of commonly used wood-based materials. In particular, the objective is to analyze the machining process focusing on the cutting forces and energy consumption during machining and to create a methodology for choosing the appropriate tool coating and cutting conditions depending on the machined material.

During the wood machining, the main problem is generally a high proportion of friction during chip formation, which leads to excessive heating of the tool. Wood-based materials have a low thermal conductivity, therefore the heat generated during machining is concentrated in the cutting tool. In the surface layers of the tool, the temperature while wood is being machined can be up to 850 °C. At such high temperatures, some structural changes in the material can occur, such as a decrease in hardness and abrasion resistance resulting in a faster tool blunting. A common solution to reduce the coefficient of friction is to apply a suitable tool coating, which has a positive effect on both the friction of the tool against the material and the easier chip evacuation from the cut. There is a wide range of hard coatings mostly based on carbides and nitrides on the market, which are deposited in a microscopic layer to the surface of the tool. The main advantage of tool coatings is the possibility of application practically on any substrate of any shape of an already finished tool. This can be done by two basic methods, i. e. the chemical deposition (CVD) or more modern physical deposition (PVD). Both methods have many different variants depending on the coating material. CVD and PVD coating are also often used methods to deposit a thin layer of carbon in its hardest sp3 structure, so called Diamond-like Carbon (DLC).

2 METHODS

The machining was performed by CNC milling machine Morbidelli m100 (SCM Group, Italy). The aim of the experiment was to accurately determine the cutting force in the conventional and climb quasi-orthogonal milling of the MDF fibreboard.

There will be five Hard metal tools with different surface modification in the tests in total. Except one reference tool without coating, the simple lapped surface will be tested as well to see an influence of this cheap modification on machining of wood. The rest of the tools is coated by three different coatings with promising characteristics for wood-based materials machining, i.e., Triple Si, DLC, Hyperlox. Promising coatings were consulted and chosen in cooperation with producers and sellers of wood

machining tools. Coatings were applied onto special designed 10 mm router bits with one straight edge manufactured by long term partner Vydona.
During the experiment, the main cutting parameters were methodically changed: feed per tooth and cutting speed. The values of the cutting and feed forces were measured and calculated from the used cutters and milling methods by which the parameters of the calculation model were determined.
Sample and cutting conditions:
Medium density fiberboard (MDF) proportions: 500 x 500 x 18 mm (L x W x T), density: 684 kg×m^{-3}, moisture: 3% at 25° C.
Cutting speed v_c: 8; 10; 12 m·s^{-1}
Feed speed v_f: 6; 8; 10 m·min^{-1}
Feed per tooth f_z: 0.1; 0.15; 0.2; 0.25; 0.3 mm
Depth of cut e: 1 mm
Type of milling: conventional and climb milling
A series of 10 measurements for the present cutting conditions were performed.
The cutting forces measurement was carried out on the three-axis piezoelectric dynamometer 9257B Kistler. The connection of the measuring apparatus was a laptop with evaluation software DynoWare, an A/D converter DAQ system-data bus type 5697A, a multi-channel amplifier Type 5070A, and a piezoelectric three-axis dynamometer Kistler 9257 B. The sampling frequency of the measurement data recording was set to 4,000 Hz due to the possibility analyze the dynamic course of forces on the cutting edge. It was subsequently processed and further evaluated in DynoWare and MS Excel.
The measurement was first carried out by milling the bottom edge of the material with conventional milling, then the milling cutter was adjusted to the top edge of the workpiece and climb milling was carried out.

3 CONCLUSIONS

The measurement of the force components in the X and Y directions using a Kistler dynamometer made it possible to calculate exactly according to the proposed equation using the Ernst-merchant circle diagram. The cutting force (F_c) in the direction of the main movement of the tool was calculated by components of the (F_x) and (F_y) forces in the direction of the cutting force (F_c) and using the trigonometric functions of the ($\psi/2$) half angle of engagement.
The presented methodology can be, after slight adaptations, applied for wide range of materials during processing on other machines with similar cutting kinematics, such as circular saw blades, circular cutter, etc. The model is available not only for woodworking engineers dealing with woodworking processes, but also for the designers when designing new cylindrical cutter or milling machines.

ACKNOWLEDGEMENT
The research was supported by the Specific University Research Fund MENDELU IGA-LDF-22-TP-004: „Advanced tool materials and their influence on the parameters of CNC machining of wood-based materials.“

THERMAL CONDUCTIVITY OF SHEEP'S WOOL WITH PARAFFIN

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Keywords: PCM, PCM for building applications, natural materials, wooden buildings, phase shift, thermal properties of buildings

1 INTRODUCTION

The aim of the contribution is to assess the possibilities of modifying sheep's wool with a phase change material (PCM), which will not reduce the heat-insulating properties of sheep's wool but will improve its thermal absorption and heat accumulation. We consider sheep's wool modified in this way to be a perspective material for the construction industry. Paraffins were chosen as the PCM material. One of the possibilities of implementing paraffin in sheep's wool is the creation of macrocapsules. Macrocapsule formation with paraffin can be an effective way to implement paraffin into sheep wool. These capsules can serve as an insulating material in the construction of buildings and help keep the temperature in the interior stable. The measurement of the thermal conductivity of sheep wool insulation with macrocapsules containing paraffin was carried out. The hypothesis was tested that the macrokpasle of paraffin does not fundamentally increase the thermal conductivity of pure sheep's wool.

2 METHODOLOGY

A literature search focused on organic materials with a phase change, with a melting temperature of around 20 °C, was carried out. The following requirements have been established for PCM for use in the construction industry; latent heat (lt=160-180 kJ/kg), melting temperature (Tt=18-24 °C), thermal conductivity coefficient (λ= min W/m* K), thermal capacities (C=2-2.5 J/kg°C). The group of paraffin waxes came closest to these requirements. Modification of sheep's wool was carried out with paraffin macrocapsules. Macrocapsules are small containers or packages that contain PCM. A PE foil with a thickness of 0.2 mm. The macrocapsules had dimensions of 200x130 mm and were filled with 50 ml of paraffin. The individual macrocapsules were then joined by welding to form a uniform layer and thus a homogeneous structure was achieved (Fig. 2). The melting temperature of paraffin was verified on DSC (Differential Scanning Calorimetry). Subsequently, thermal conductivity was measured on a Heat flow meter. Sheep wool samples with dimensions of 600 x 600 x 60 mm were tested, in which the middle layer was formed by a paraffin macrocapsule.

3 RESULTS AND DISCUSSION

Laboratory tests on a DSC device confirmed the melting temperature of paraffin at a temperature of 22-23 °C, which is indicated by MicroCaps (Fig. 1). The thermal conductivity of pure sheep's wool and sheep's wool modified with macrocapsules was measured at an average sample temperature of 22.48 and 22.50 °C corresponding to the melting point of paraffin. The thickness of pure sheep wool was 60 mm, the thickness of sheep wool with macrocapsules was 59.7 mm. Three measurements were performed.

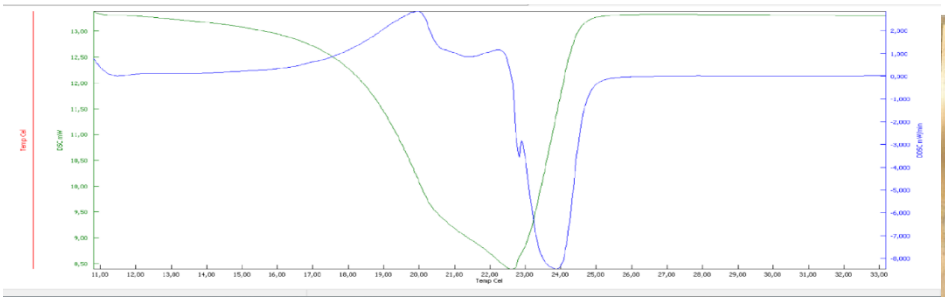

Fig. 1: DSC measurement and verification of the melting temperature of paraffin

Fig. 2: Paraffin macrocapsules

In Fig. 3 is a comparison of the measured thermal conductivity of pure sheep's wool and sheep's wool modified with one layer of paraffin macrocapsules. The thermal conductivity of sheep wool was 0.043441 W.m-1.K-1 (standard deviation was 0.0003 W.m-1.K-1). For modified sheep's wool, the thermal conductivity reached 0.044902 W.m-1.K-1 (standard deviation was 0.00035 W.m-1.K-1). Although the difference between the two values is statistically significant (p=0.05), the increase in thermal conductivity represents only 3.4 %. The measurements showed very little variability (0.8 %), the range of the sample thus roughly corresponds to the significance level of 95% and the accuracy of 99% of the results.

Fig. 3: Comparison of the coefficient of thermal conductivity of pure sheep's wool with sheep's wool modified with one layer of paraffin macrocapsules (error bars correspond to 1 standard deviation)

4 CONCLUSION

Measurements of the coefficient of thermal conductivity of samples of sheep's wool with a layer of macrocapsules with paraffin showed that the addition of a layer of paraffin did not result in a significant increase in the coefficient of thermal conductivity. The measured values differed by 3.4 % and were for pure sheep's wool 0.044902 W.m-1.K-1, respectively. for modified sheep's wool with paraffin macrocapsules 0.044902 W.m-1.K-1. At the same time, we demonstrated the declared properties of paraffin, i.e. the melting point was 22-23 °C. It can be stated that one layer of paraffin macrocapsules increases the coefficient of thermal conductivity of sheep's wool by 3.4 %. We consider this increase to be negligible. The results confirm that paraffin is a promising phase change material suitable for sheep wool modification without affecting its thermal properties.

ACKNOWLEDGEMENT
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ANALYSIS OF THE POTENTIAL OF STUMPWOOD BIOMASS FOR ENERGY UTILIZATION IN THE CONDITIONS OF FORESTRY IN THE CZECH REPUBLIC

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Keywords: circular economy, energy crisis, logging residues, renewable energy source, stump dendromass

1 INTRODUCTION

The current energy crisis together with global climate change requires the search for alternative sources of energy. Fulfilling the concepts of the bioeconomy and circular economy for sustainable development is the cause of an increasingly noticeable societal demand for renewable resources. The share of energy biomass from logging residues is currently at its maximum available limit, and further increases will likely be impossible. Attention is thus focused on utilizing other available sources of forest biomass, with stump mass being one of the possibilities. Current advancements in mechanization and machinery technologies allow extracting and processing of stumps in acceptable quality without damaging the soil or causing negative impacts on the ecosystem. The contribution points to research regarding the assessment of the potential utilization of stump and root part of tree as a renewable source of biomass for energy purposes in the conditions of Czech forestry.

2 MATERIAL AND METHODS

The research aim was analyzing the historical and current state of the given issue and provide an objective and comprehensive view of the stump utilization for energy purposes, taking into consideration the legislative framework, environmental and economic aspects, including the identification of the availability of current production processes and technologies. For the defined objectives, data collection was conducted, including an overview of knowledge and experience related to contemporary theory and practice, as well as the determination and comparison of conditions for the utilization of stump dendromass in the Czech Republic and abroad. As part of field investigations, business entities that use stumps for economic benefit or employ other processing methods were analyzed. Addressing the issue required the integration of relevant information from multiple research areas, and the study builds upon previous projects.

3 RESULTS AND DISCUSSION

3.1 HISTORICAL FACTS AND SITUATION ABROAD

Historically, in our territory, stumps were cleared for the purpose of preparing activities for reforesting pine stands in the Strážnice region. The stump wood was utilized no longer in any way and a practice known as "stump burial" was carried out. Traditionally, stumps are energetically utilized in Scandinavian countries, primarily in Finland, where stump energy use is subsidized and politically it is a part of the renewable energy portfolio (Kangas et al., 2018). Stumps without energy utilization are also buried underground so that the wood decaying process is halted or markedly inhibited in anaerobic conditions (Laitila et al., 2023).

3.2 ENVIRONMENTAL INSIGHTS

Despite the negative influences and opinions of interested groups regarding stump removal, scientific knowledge is positive about this issue. It has been demonstrated that stump extraction can improve the site conditions suitable for both natural and mechanized regeneration. It may result in an interruption of root pathogen chains (*Heterobasidion annosum*, *Armillaria mellea*) and a suppression of conditions for the development of the pine weevil (*Hylobius abietis*) larvae. Another significant factor of stump extraction is positive impact on the soil's hydrological balance and a reduction in the risk of subsurface forest fires.

3.3 LEGISLATIVE FRAMEWORK

Legal regulations and strategic documents related to this issue stem from the area of renewable energy sources from biomass and produced fuels. These primarily include the European Parliament and Council Directive 2018/2001 on the promotion of the energy use from renewable sources, in the Czech Republic, Act No. 382/2021 Coll., and Decree No. 110/2022 Coll.

3.4 ACCESSIBLE TECHNOLOGIES

The design of the grubbing head for excavators was developed to cleave the extracted stump into fragments of the required size and remove unwanted impurities from the stump root system intended for energy chip production. Subsequently, it compacts, levels, and shapes the terrain. This technology is capable of extracting stumps in an environmentally friendly manner without damaging the soil or disrupting the environment.

3.5 ECONOMIC CONSIDERATIONS

The crucial economic aspect of stump mass utilizing for energy is the price of wood chips at the buyer's end. Economic efficiency depends on a range of factors, similar to those in the utilization of logging residues, including the possibility of combination.

4 CONCLUSIONS

In domestic conditions, stumps are not intentionally harvested for energy purposes. This is significantly influenced by the lack of awareness of these relationships, the attitude of foresters, and the influence of conservationists. An exception is the removal of stumps as a technical and quality requirement in Czech construction standards for preparatory work on linear structures, highways, road bypasses, gas pipelines, steam pipelines, and other landscape modifications often including the removal of lands designated for the forest function. From an economic perspective, in these cases, the crucial factor is the efficiency of processes (starting with technological preparation) and the distribution of energy chips, especially the transportation distance from the extraction site to the consumer.

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