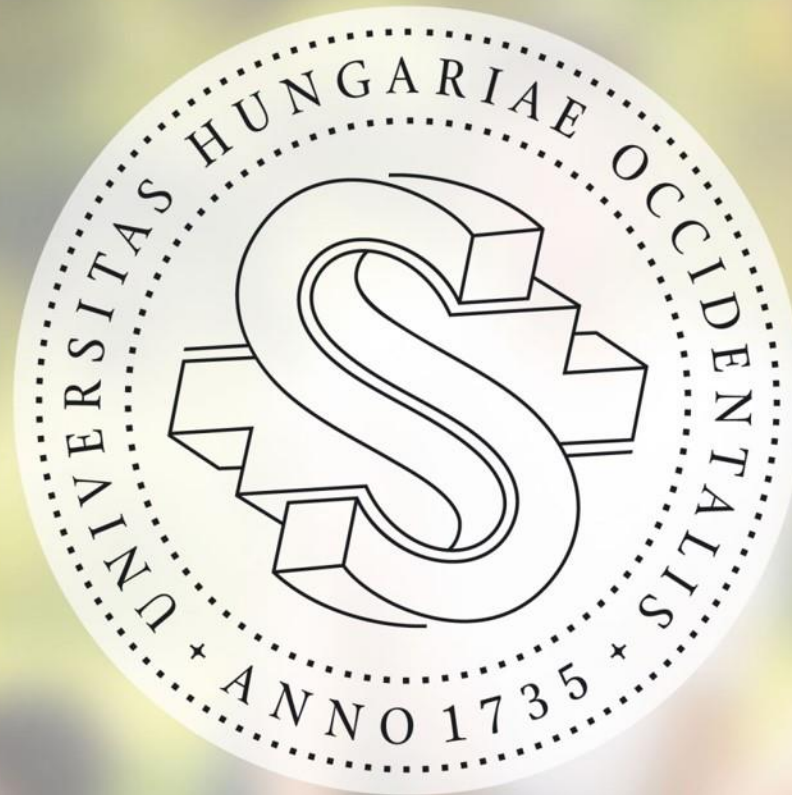


Róbert Németh
Dimitrios Tsalagkas
Miklós Bak

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WOOD SCIENCES AND APPLIED ARTS

Changes in the modulus of elasticity of beeswax impregnated wood
during soil contact



Introduction

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- It is a highly versatile material and as such has been utilized in building and construction for millennia.



<http://www.amusingplanet.com/2013/08/10-spectacular-wooden-churches-of-russia.html>



http://www.e-architect.co.uk/images/jpgs/spain/house_steel_wood_ecosistema080208_8.jpg



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- The demand for timber is continually increasing, especially in slower growing hardwood and tropical species. Such species offer a greater durability and higher aesthetic qualities than many of the faster growing softwood species.



<http://www.wood-database.com/lumber-identification/hardwoods/american-beech/>



http://sterrittlumber.com/product_category/poplar

<http://www.golfrtribute.com/shop/soft-touch-brass-flange/>



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- It is well known that there are grave ecological and environmental concerns over current 'virgin timber' demands, and various attempts are underway to prevent the demise of many of the biologically diverse regions where these timbers originate.





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- A greater emphasis is now being placed in sustainable harvesting of timber species, though the slow growth of many species means a slow turnover in materials and profits. Thus it is necessary to encourage the use of faster growing timbers which may be readily gained from such sustainable plantations.



http://milstory.blog.hu/2011/05/09/266_virtualis_jaror_szolgalat



<http://enfo.agt.bme.hu/drupal/en/node/1498>



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- But wood is a biodegradable material. Degradation leads to the reduction in strength and the increased risk in structural decay through fungal infestation.



<http://mysandiegohomeinspector.blogspot.hu/2012/01/mold-and-wood-decay.html>



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- Many traditional protection treatments currently exist to prevent these deteriorations, but often they are based on toxic materials.
- Apart from the risks involved in using such materials for treatments, there is increasing concern over the problems arising in the disposal of the timbers after the end of their commercial lifetime.



<http://www.valleybox.com/green-business/wood-scrap-recycling/>



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- The advantage of beeswax is its biological origin and its nontoxic nature.
- It is in general not biologically stable.
- Beeswax is often used as conservation agent for wooden artifacts → under appropriate conditions beeswax is suitable for wood protection
- Water repellent → It can delay the decay.
- As a result of the hydrophobic properties and the lumen filling, fungi can decay wood only slower.





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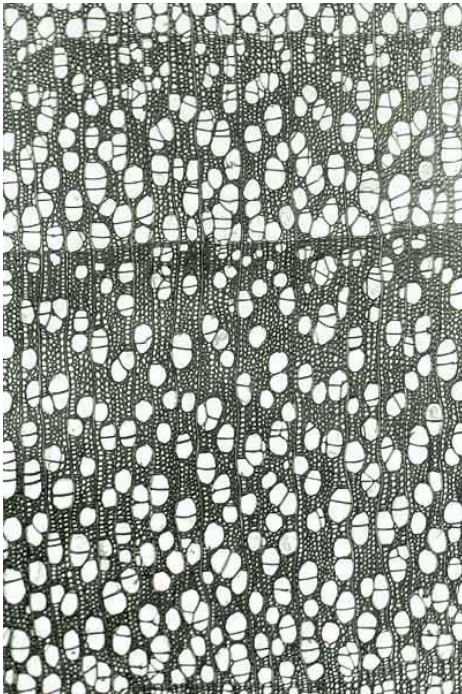
- Another advantage of wax impregnation is the improvement of mechanical properties (e.g. hardness)
- Hazard class of soil contact is ranked to very high among the exposure classes.
- Use class 4, according to EN 335 → very effective protection or/and durable wood species are needed.
- Effectiveness of beeswax impregnation against the degradation of less durable wood materials?



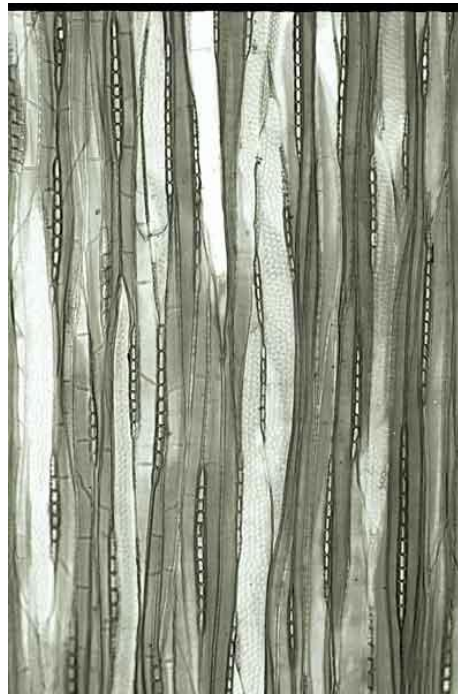
Materials and Methods

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- Focus on hardwood species (resistance class 5)
- Plantation grown timber → poplar (*Populus × euramericana*)



<http://www.woodanatomy.ch/>



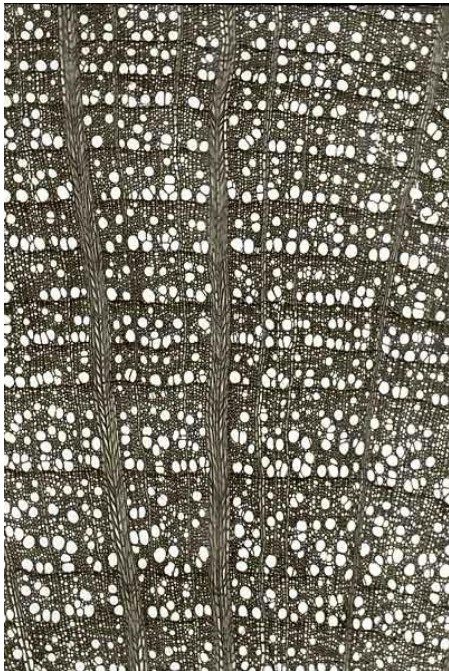
www.abh-system.hu



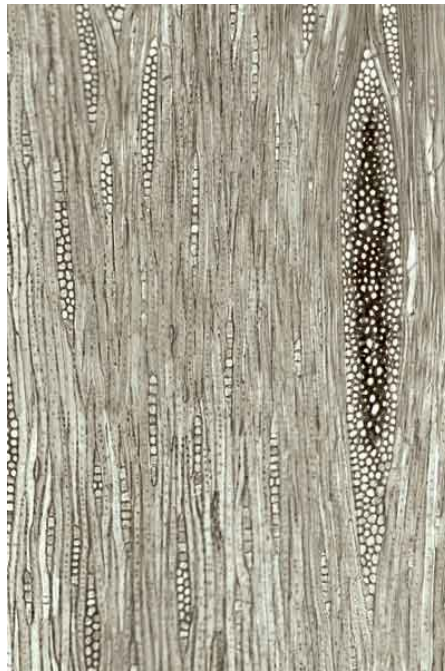
Materials and Methods

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- Commonly used timber → beech (*Fagus sylvatica*)



<http://www.woodanatomy.ch/>



<http://www.wood-database.com/lumber-identification/hardwoods/american-beech>



Materials and Methods

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- Impregnation at 80°C (over melting point)
- Sample MC: 0%
- Vacuum for 4 hours (150 mbar)
- Atmospheric pressure for 20 hours
- Samples separated to 3 groups according to the calculated degree of pore saturation (DPS)

Group	Poplar1	Poplar2	Poplar3	Beech1	Beech2	Beech3
DPS (%)	20-40	40-55	55-70	60-75	75-90	90-100



Materials and Methods

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- Modulus of elasticity (MOE) was determined initially at absolute dry state both on the unimpregnated and impregnated samples.
- Standard 3-point bending method was used.
- Sample dimension was 20×20×300 mm.
- MOE was determined at a defined load. 400N for poplar and 600N for beech.
- After 1 month in soil MOE determination with the same loads
- After 18 months in soil MOE determination with 300N load for poplar and beech as well.



Materials and Methods

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- Laboratory conditions (based on ENV 807/2001).
- Soil in plastic boxes → samples into soil to a depth of its 2/3 length.
- Boxes were seal up with plastic foil.





Results – visual inspection

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Unimpregnated (left) and impregnated (right) poplar samples after 18 months



Unimpregnated



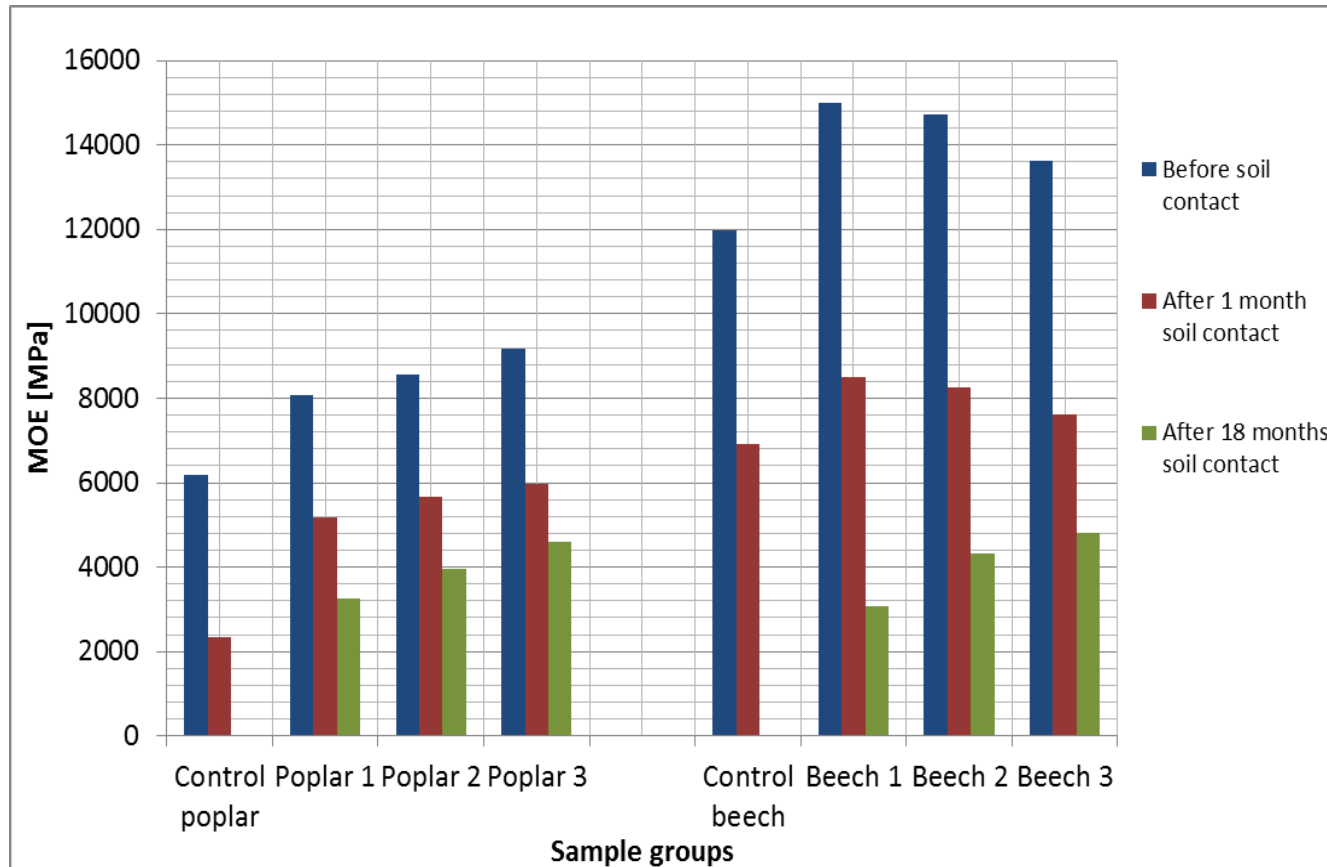
Impregnated



Results – MOE

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MOE of poplar and beech samples in the investigation periods

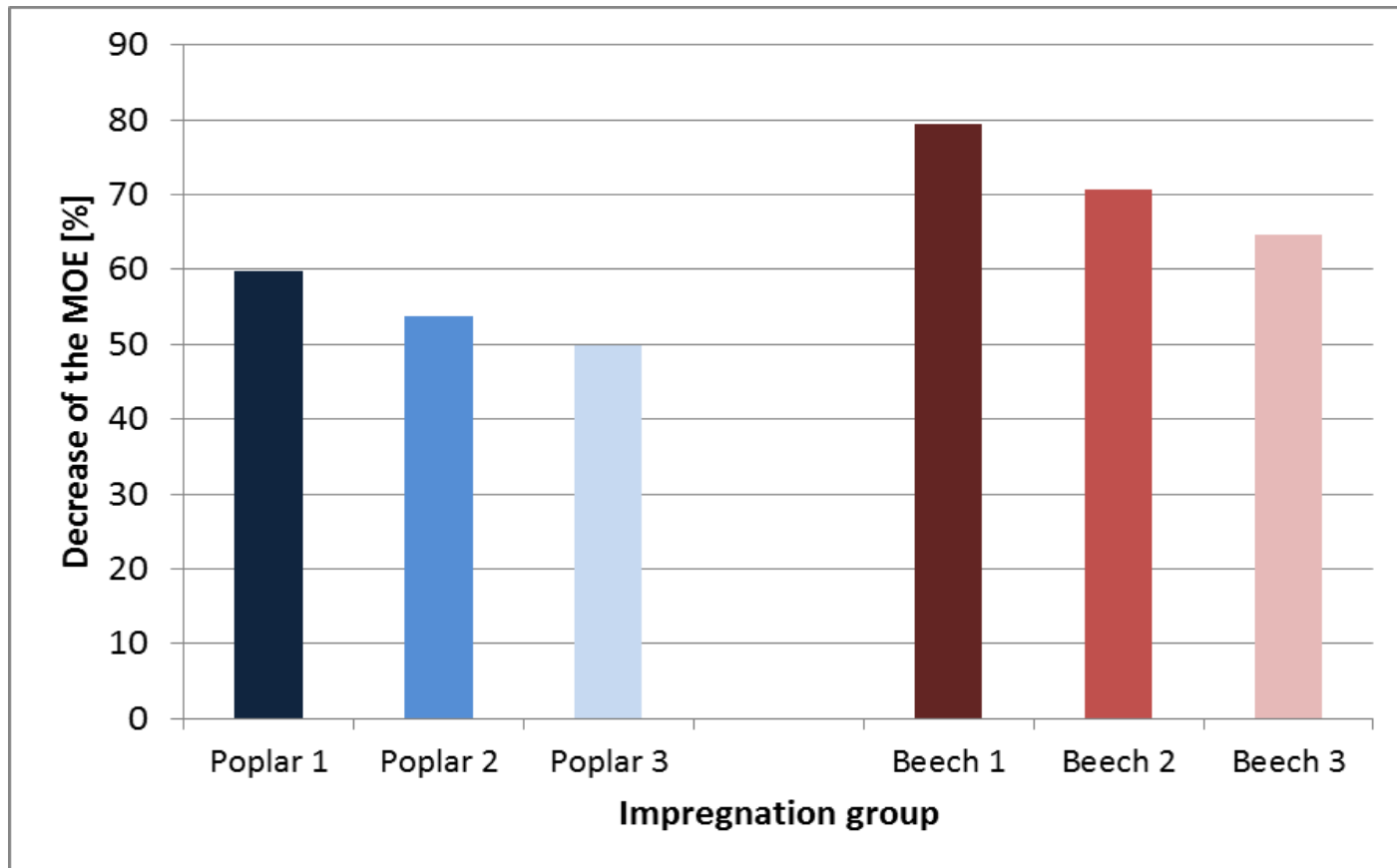




Results – MOE

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MOE decrease of beech and poplar samples after 18 months



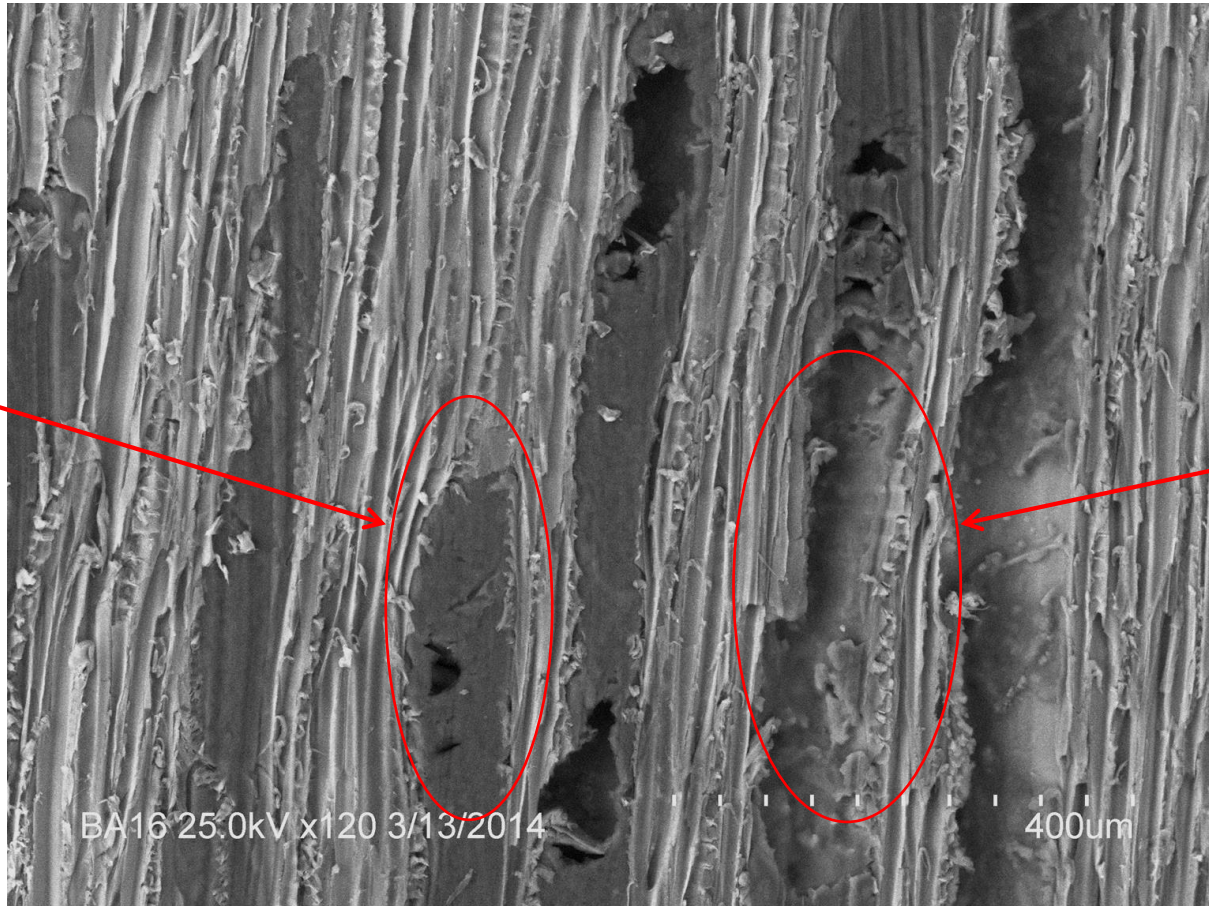


Results – SEM

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Beeswax in the cell lumens of poplar wood

Lumen
filling



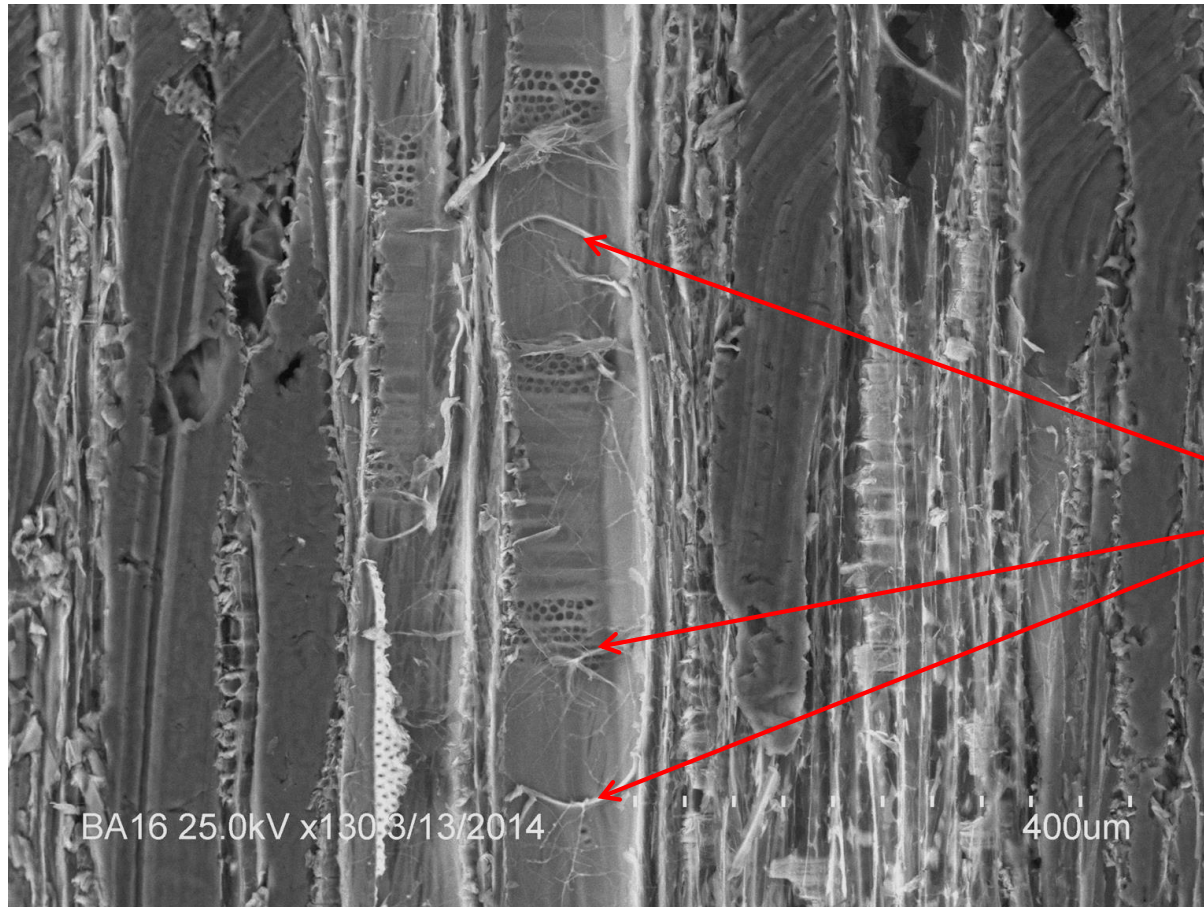
Only on the
lumen
surface



Results – SEM

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Hyphae in a beeswax free cell lumen of poplar wood



Hyphae –
only in the
open lumens
present



Conclusions

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- Beeswax impregnation increased MOE of beech and poplar wood
- Unimpregnated beech and poplar samples were decomposed completely during the 18 months soil contact.
- Damage of the impregnated samples was significantly lower.
- Remarkable remaining MOE of impregnated samples after exposure.



Conclusions

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- Higher DPS resulted in lower decrease of the MOE during the investigated period.
- Beeswax fills the lumens and separates the most of the cell walls from the hyphae, which slows the spreading of the fungi in the wood.
- Beeswax impregnation could only slow the decay.
- Promising environment friendly preservation method for wood, but mainly for applications without soil contact



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Thank you for your attention!