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Effect of tree age and diameter on selected parameters of black locust wood fibers

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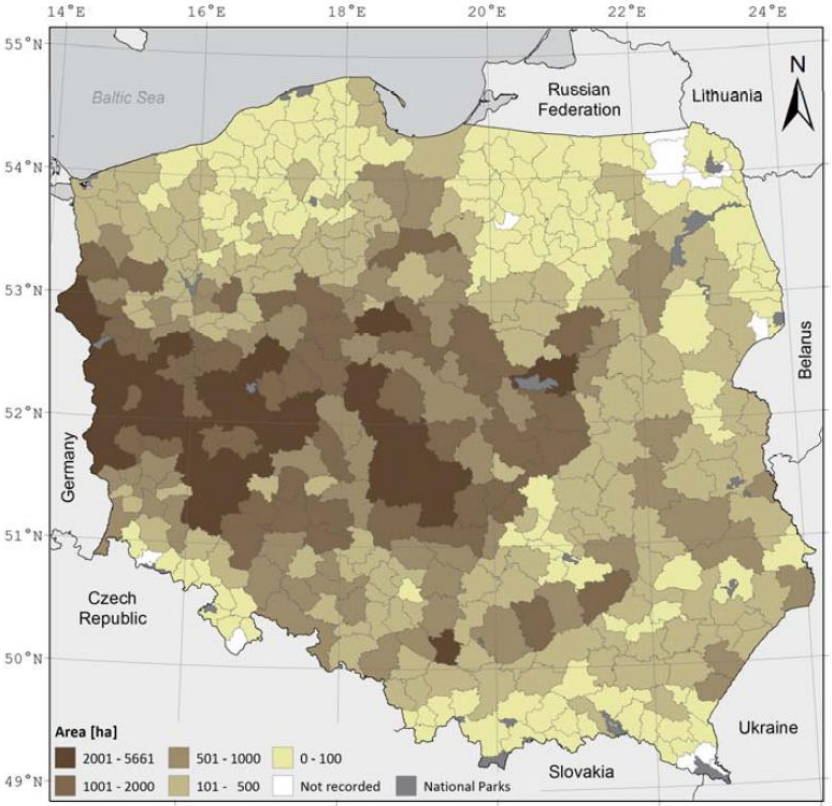
Introduction

Awareness about timber quality is a basic factor for its usage in wood industry as well as it should be important aim of forestry practice.

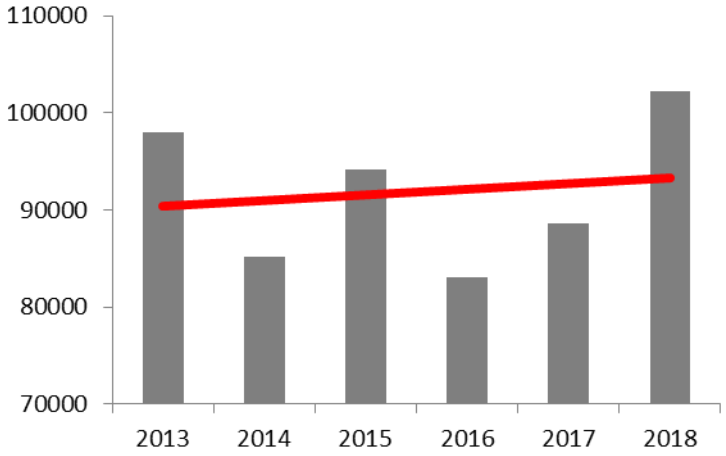
Non-native tree species were brought to Europe because its dendroflora is rather poorly diversified and the demand for highly productive species was very high.

Despite quite long history of introduced tree species in Europe, and in Poland, we still miss substantial knowledge about properties of wood, which is used for construction or other purposes.

Introduction – *Robinia* in Poland



Area covered by black lockust stands in forest districts (Wojda et al. 2015)



Annual harvest of black locust timber [m3] (Bijak & Zastocki 2021)

Brought in 1806, introduced into forests ca. 1860

Long- and short-rotation plantations

Cultivated for its hard wood and as a forage for bees

Reduces biodiversity, but useful during reclamation of degraded lands

Objectives

We investigated the selected attributes of black locust wood fibres.

We hypothesised that:

- age and size of trees significantly influence the fibre properties,
- the older/bigger trees, the better attributes of the wood fibres.

Material & methods

Głogów Forest District
(SW Poland; 51.5-51.7 N, 15.9-16.2 E)

3 stands of different age

- 38 yrs
- 60 yrs
- 71 yrs

3 diameter classes according to Hartig method

- thin
- medium
- thick

2 trees per age-size class

2 samples (20×20×30 mm) per tree (NB! two samples missing)

15 fibres per sample

TOTAL: 510 data records

photo: Karol Bronisz

Material & methods

slices from the tangential plane cut with Leica SM 2000 R sliding microtome

slices macerated and stained with Etzold's dye

photos of single fibres shot under OLYMPUS PROVIS AX70 microscope with the OLYMPUS UC90 camera as well as the cellSens Standard software

ImageJ software used for measuring fibre dimensional parameters

based on the measurements the coefficients characterizing the fibres‘ shape were calculated

Material & methods

Analysed fibre parameters and properties included:

- length
- diameter
- light
- cell wall thickness

- slenderness
- rigidity
- Runkel ratio
- flexibility
- Mühlsteph ratio
- compactness

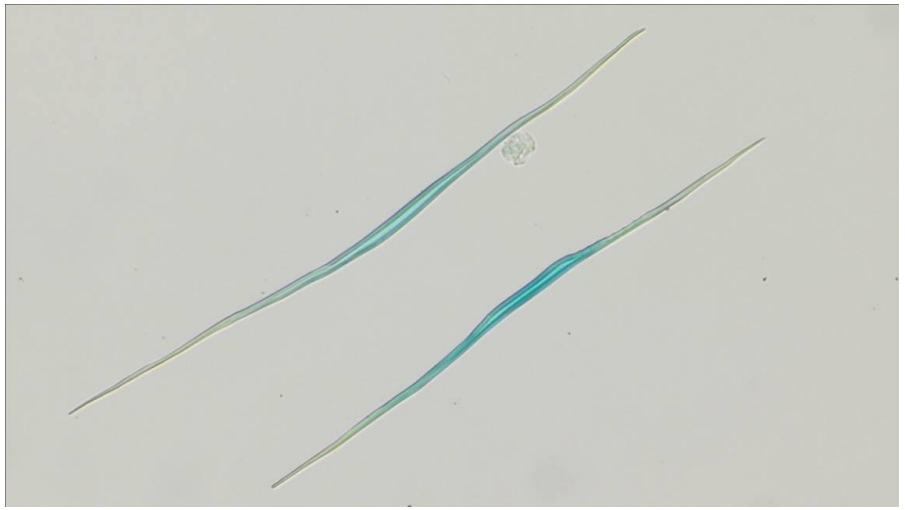
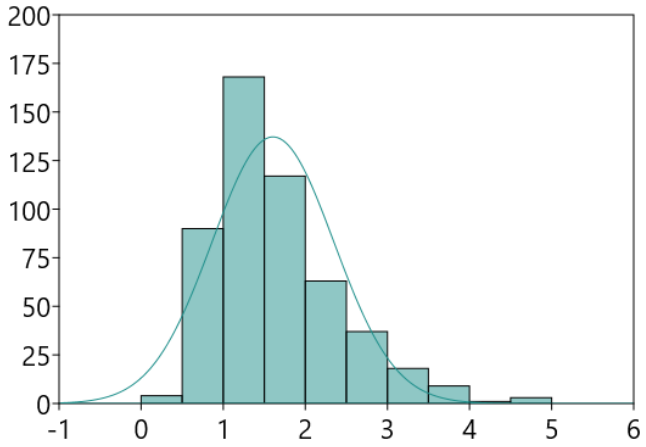


photo: Marta Kądziela

Material & methods



Distribution of Runkel ratio

distribution of all analysed parameters diverged from the normal one (Shapiro-Wilk test)

effect of age or size class assessed with Kruskal-Wallis test (significance level at 0.05)
post-hoc comparisons made with Mann-Whitney test

calculations performer with PAST 4.06 software (Hammer et al. 2001)

Results – characteristisc of fibres

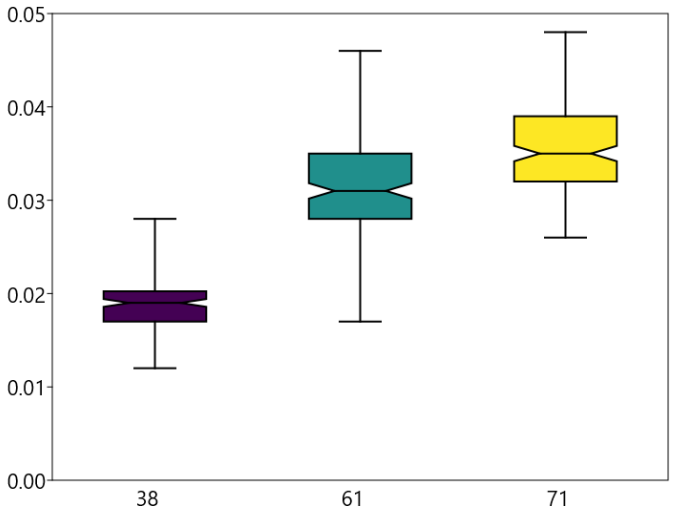
	Mean	Median	CV [%]
length [mm]	1,541	1,621	26,7
diameter [mm]	0,029	0,030	29,1
light [mm]	0,012	0,013	44,9
cell wall thickness [mm]	0,008	0,008	26,5
slenderness	54,0	53,3	16,9
rigidity [%]	1,605	1,460	46,2
Runkel ratio	29,4	29,7	17,9
flexibility	0,819	0,835	11,0
Mühlsteph ratio	0,412	0,406	25,6
compactness	0,0005	0,0004	36,9

Results – effect of tree age

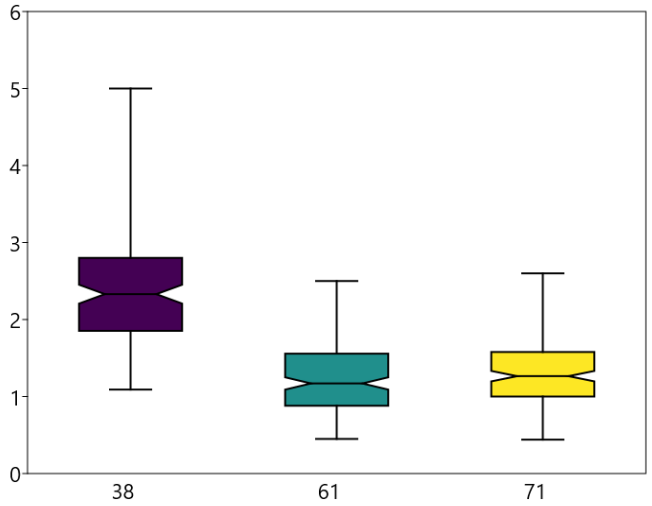
We found a significant effect of age on all analysed fibre parameters

For length, diameter, light, cell wall thickness and compactness all age classes differed significantly one from another

In case of rigidity, Runkel ratio, flexibility and Mühlsteph ratio the youngest trees stood out



Fibre diameter with regard to tree age

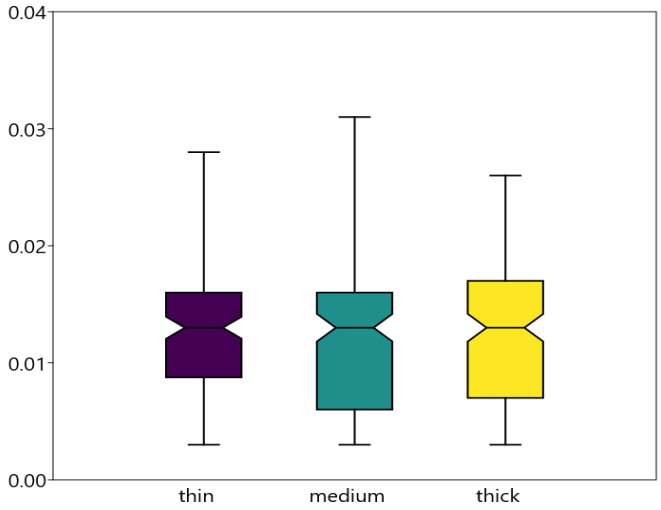


Runkel ratio with regard to tree age

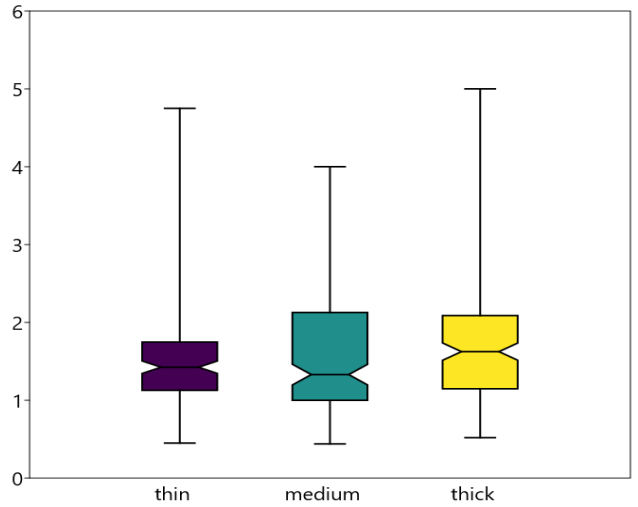
Results – effect of tree diameter

We found a significant effect of diameter on all analysed fibre parameters but fibre light

For majority of the remaining features, values for the thickest trees stood out



Fibre light with regard to tree size



Runkel ratio with regard to tree size

Conclusions

- Age and size of a tree significantly influence properties of black locust wood fibres.
- The youngest wood would be potentially the least useful for the paper industry.

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