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The water holding capacity of bark in Danish angiosperm trees

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Abstract: The water holding capacity of bark in seven Danish angiosperm trees was examined. The aim of the study was (1) to examine height trends and (2) bark thickness trends in relation to the water holding capacity and (3) to determine interspecific differences. The wet-weight and dry-weight of a total number of 427 bark samples were measured. The water holding capacity was calculated as the difference between wet-weight and dry-weight per wet-weight. The water holding capacity increased with elevation in most tree species and contrary to the expectation, thinner bark generally had a higher water holding capacity. Differences in the water holding capacity of bark may influence the occurrence and distribution of a wide range of bark-living organisms including the distribution of corticolous lichens.

Introduction

The ability of bark to intercept, retain and transport water is of interest because it contributes to maintenance of the internal water status of the tree (Voight 1960).

The water holding capacity of bark can be used to estimate the amount of water intercepted during rain, the stemflow volume and the amount of throughfall that reach the forest floor (Levia et al. 2010).

In general it is accepted that the interception of water depends on the bark thickness and its surface structure. Trees with thick bark intercept a higher amount of water during rain and have a higher bark water holding capacity. (Ilek & Kucza 2014).

Fissured and cracked bark creates a higher surface area for interception of water. On the contrary, smooth bark has in smaller surface area, which results in lower interception (Ilek & Kucza 2014).

Aim of the study

This study aims to determine

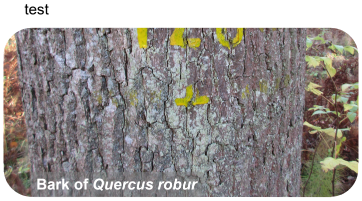
1. whether any changes in water holding capacity of bark occur along the stem of each tree species.
2. any relation between bark thickness and its water holding capacity
3. interspecific differences of the water holding capacity of the bark from Danish angiosperm trees

Material and method

- The bark was sampled at different heights from:
  - *Alnus glutinosa*
  - *Betula pendula*
  - *Fagus sylvatica*
  - *Tilia Cordata*
  - *Acer pseudoplatanus*
  - *Fraxinus excelsior*
  - *Quercus robur*
- All trees were grown in a Common Garden Experiment and 44 years old at the time of study.
- The samples were immediately stored in a freezer at – 18 °C in order to preserve the bark when fresh.
- In total, 427 bark samples were submerged for 72 h and subsequently dried at 103 °C for 24 h.
- Before submergence any remaining xylem was removed and the bark thickness measured at eight points around the sample edge.
- The water holding capacity (WHC) was calculated as:

$$WHC = \frac{(wet_{weight\ (g)} - dry_{weight\ (g)})}{wet_{weight\ (g)}}$$

- The data were analysed with a linear mixed model with random effects and a Tukey's HSD test



Results

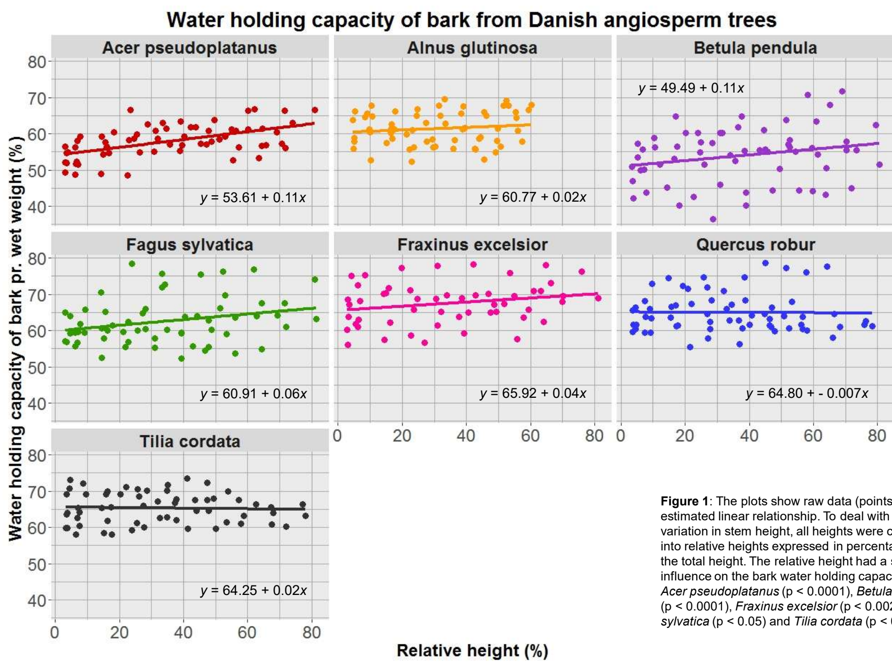


Figure 1: The plots show raw data (points) and the estimated linear relationship. To deal with the variation in stem height, all heights were converted into relative heights expressed in percentages of the total height. The relative height had a significant influence on the bark water holding capacity of *Acer pseudoplatanus* ($p < 0.0001$), *Betula pendula* ($p < 0.0001$), *Fraxinus excelsior* ($p < 0.002$), *Fagus sylvatica* ($p < 0.05$) and *Tilia cordata* ($p < 0.02$).

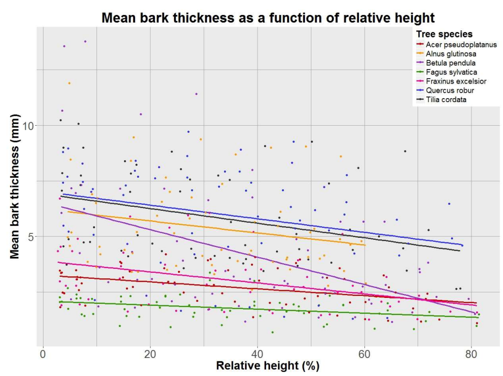


Figure 2: The estimated linear regressions show a decrease in the bark thickness when the relative height increases. The points are raw data.

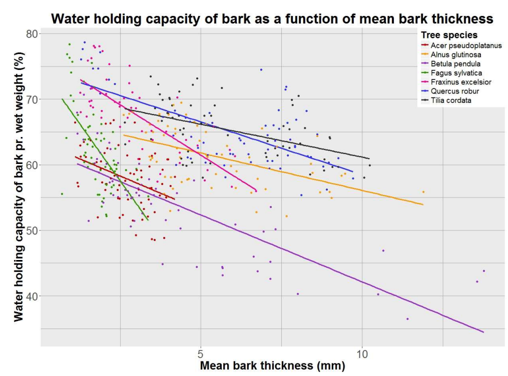


Figure 3: The estimated linear regressions show a decrease in bark water holding capacity when the bark thickness increases. The points are raw data.

Discussion

- The water holding capacity was positively correlated with relative height in *Acer pseudoplatanus*, *Betula pendula*, *Fraxinus excelsior*, *Fagus sylvatica* and *Tilia cordata*, while *Alnus glutinosa* and *Quercus robur* was unaffected by the relative height (cf. figure 1).
- *Fraxinus excelsior* had the highest bark water holding capacity; significant higher than *Acer pseudoplatanus* and *Betula pendula* (cf. the intercepts on figure 1).
- *Betula pendula* had the lowest water holding capacity; significant lower than all other species except *Acer pseudoplatanus* (cf. the intercepts on figure 1).
- The bark thickness differed greatly among the species and decreased with the relative height (cf. figure 2). *Quercus robur* had the thickest bark while *Fagus sylvatica* had the thinnest bark.
- *Fagus sylvatica* had a relatively uniform bark thickness along the stem compared with the other tree species (cf. figure 2).
- A negative correlation was found between the bark thickness and the water holding capacity (cf. figure 3). This finding is contradictory to the general assumption stating that thicker bark leads to a higher water holding capacity (cf. among others Ilek & Kucza 2014).
- A higher cork production in the bark at the lower part of the stem may cause a lower water holding capacity. A high amount of suberin makes the cork relatively water-repellent.
- Differences in the water holding capacity of bark may influence the occurrence and distribution of corticolous lichens along the stem as well as their distribution between the tree species.

References

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