

The reviewer's evaluation of the habilitation thesis

Candidate	RNDr. Lenka Plavcová, Ph.D.
Habilitation thesis	Functional biology of wood: from structure to function
Reviewer	Prof. Dr. Bernhard Schuldt
The reviewer's department, institution	Chair of Forest Botany, Technical University of Dresden, Germany

Dear Prof. Albrechtova,

Thank you for inviting me to review the habilitation thesis of Dr. Lenka Plavcová. I have been aware of her research on the structure and function of xylem for several years now and have met her personally a few times. While I admire her work, especially on the parenchymatic tissue of the xylem, we have so far neither collaborated nor published together.

The submitted thesis focuses on the functional biology of angiosperm wood and includes 11 accepted publications, and Dr. Plavcová was first author on eight and senior author on two of these. I will not explicitly comment on each single publication as they are all published in renowned international peer-reviewed journals and are in general very well cited, which is a quality control of its own. Six of these publications deal with the structure and function of ray and axial parenchyma (topic 1), while five examine the wood biology of fruit trees with a more practical outcome (topic 2). This thesis is a very comprehensive work on the structure and function of the xylem with a general structure that is easy to follow. The introduction (4 pages) provides an excellent overview of the topics covered and leads seamlessly to the main research questions of both topics, followed by the main result of each peer-reviewed publication (14 pages). I very much liked the approach of Dr. Plavcová of summarising the results of each study by answering one single but major research question only. Although the synoptic conclusion with half a page is rather short, the main outcomes have been listed.

The six collected papers for the first topic are meanwhile standard literature for everyone working on xylem parenchyma. This chapter covers the role of xylem parenchyma in storage and utilization of non-structural carbohydrates (NSC), the range of ray and axial parenchyma fractions across species and how these might affect NSC concentrations, distinct anatomical features of vessel-associated parenchyma cells, the effect of xylem parenchyma on mechanical strength and whether the parenchymatic tissue is the sole site of NSC storage in wood. Main results were that parenchyma fractions differ almost 30-fold between woody plants from different biomes and are highest in tropical trees due to its temperature-dependency and parenchyma fractions. Further, the proportion of living fibres are directly associated with NSC concentrations. As the field of quantitative wood anatomy has received growing interest over the last years, the work by Dr. Plavcová will doubtless stimulate further studies on the multiple functions of secondary wood.

The five papers of the second topic, i.e., the wood biology of fruit trees, among others addresses very practical and economically important questions such as the drought resistance of apple trees and how vitality might be affected by the choice of given rootstocks. To my knowledge, this is still an understudied topic from a plant hydraulic perspective despite a massive economic interest. Furthermore, irrigation regime and thus costs should be managed according to given hydraulic thresholds of the varieties grown. If the midday water potentials during the season, for example, stay well above the water potential at turgor loss point, there is no need for irrigation.

While I am not familiar with the provided anti-plagiarism check and would ask the board to recheck this carefully, I did not observe any major problems. Many were caused by cited references or standard phrases used in the field. From my perspective, plagiarism can be excluded.

Overall, the research of Dr. Plavcová presents a convincing body with various degrees of involvement. The research on the structure and function of ray and axial parenchyma is particularly strong and can meanwhile be considered standard literature for everyone interested in the storage function of secondary wood. Throughout her scientific career, Dr. Plavcová has received numerous awards, which additionally demonstrates her scientific excellence. Her numerous collaborations with renowned colleagues highlight her ability for successful collaboration, which are key to success in academic research. After thoroughly reading the habilitation thesis and other materials available to me for review, I rate Dr. Plavcová as an outstanding scientist and strongly recommend the acceptance of her habilitation thesis. It provides ample evidence for her ability to conduct independent scientific research in the field of Plant Physiology.

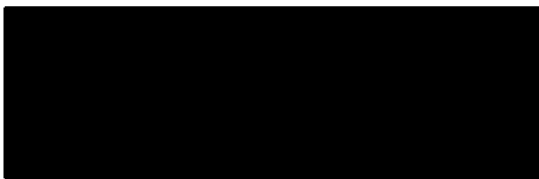
Potential questions of the reviewer on the defence of the habilitation thesis

- Throughout the thesis, Dr. Plavcová refers to the wood of angiosperms. To what extent might her results be transferable to conifers, which are more simplistic in their wood composition and show the lowest parenchyma fractions?
- In her first publication, Dr. Plavcová mentions that many diffuse-porous trees are capable of refilling embolized vessels after drought. In response to the severe 2018/19 drought, however, no embolism repair was observed in European beech. Here, conductivity was restored by growing new xylem tissue. How to explain this controversy, might there be a limitation to what extent soluble sugars can be released into neighbouring vessels?
- It was shown that NSC-concentrations depend on the amount of wood parenchyma and living fibres. Consequently, the wood of tropical trees might show the highest NSC concentration. How to explain this finding from a physiological perspective, why is a high parenchyma fraction beneficial in tropical environments?
- Building upon the last question: do what extent might the water storage capacity of secondary xylem rely on parenchyma fractions and what role - if any - might NSCs play? Wouldn't the lumen-to-sapwood area fraction be more important for water storage capacity?
- According to her experience on the role of rootstock varieties on yield and vitality in fruit trees, does a combination of both exist, i.e., rootstocks that provide high yield and high stress tolerance or does one come at the cost of the other?

Conclusion

The habilitation thesis of RNDr. Lenka Plavcová, Ph.D. "Functional biology of wood: from structure to function" **meets** the standard requirements for habilitation theses in the field of Plant Physiology.

In Tharandt on April 5, 2024.



Signature of the reviewer

The reviewer's evaluation of the habilitation thesis

Candidate	RNDr. Lenka Plavcová, Ph.D.
Habilitation thesis	Functional biology of wood: from structure to function
Reviewer	Assoc. Prof. Priv.-Doz. Dipl.-Ing. Dr.nat.techn. Sabine Rosner
The reviewer's department, institution	University of Natural Resources and Life Sciences, Vienna Department of Integrative Biology and Biodiversity Research, Institute of Botany Gregor-Mendel-Straße 33, 1180 Vienna, Austria

Dear Prof. Jana Albrechtová,

it was a pleasure to review the habilitation thesis of Dr. Lenka Plavcová entitled: "*Functional biology of wood: from structure to function*". Before I continue with the review, I will report on the anti-plagiarism check. The plagiarism check was negative. According to the Ouriginal anti-plagiarism report, only 8.5% similarities were found, whereby most of them are in the citation list. The work is free from plagiarism.

The habilitation thesis of Dr. Lenka Plavcová consists of two parts; one with basic research published in high-impact journals and in a book chapter, the other with a more applied approach with the main aim of a better understanding of wood biology in fruit trees, and an overall conclusion and outlook. The separation of the habilitation thesis in two parts is logical and reasonable; it guides the reader step-by-step from basic to applied research. The thesis is a compilation of in total 11 papers published from 2015 to 2023. The papers rank from moderate-impact (e.g. Irrigation Science, IF 3.0) to high-impact plant physiological/botany journals (e.g. New Phytologist, IF 9.4; Journal of Experimental Botany, IF 6.9).

The text of the habilitation thesis introduces the reader well to the several different plant anatomical and plant physiological research topics with the main focus on water and carbon relations. The reader gets a good introduction into the multifunction of wood, tree hydraulics, including sap flow and cavitation, biomechanics and into tree carbon balance. The scientific work on functional anatomy of ray and axial parenchyma in wood (part I) covers fractional changes along climate gradients, the ultrastructure of pits connecting parenchyma and vessels, trade-offs between transport, storage and biomechanical demands and the storage of non-structural carbohydrates (NSC) in fibres – a so far mostly overseen storage site in wood. Novel research on the functional biology of wood in fruit trees (part II) deals with rootstock-induced mechanisms of growth vigour control and the impact of irrigation on tree hydraulics.

The scientific work summarized in this habilitation thesis is of high scientific impact, it is interdisciplinary, and, moreover, Dr. Plavcová showed that her wood anatomy and plant physiological research can be applied to improve irrigation strategies for fruit trees. The research of Dr. Plavcová is also of high methodological relevance, for instance, it was found that wood anatomical traits can be used as a proxy for the amount of NSC. A surprising finding was, that higher parenchyma fractions are not necessarily related to lower wood density or mechanical stiffness.

I only have minor critic points on the introduction summarizing the excellent work of Dr. Plavcová, e.g. that there is too little information in the figure legends in order to understand them (missing explanations of abbreviations or arrows in photos). Please find below some questions (with remarks on the text) that arose when I was reading the habilitation thesis of Dr. Plavcová.

Questions of the reviewer on the defence of the habilitation thesis

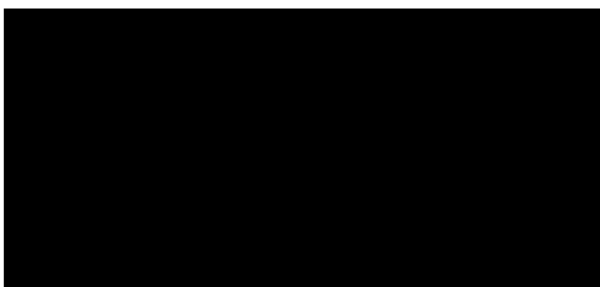
- (1) Can conifer wood have axial parenchyma? In the introduction it is stated that conifer wood (typically) consist of only two cell types; tracheids and ray parenchyma.
- (2) Please give a short overview on the role of parenchyma for plant defence, I felt that this wood biological function was somehow underrated in the introduction (e.g. pages 7 & 9).
- (3) How would a (more) freezing tolerant angiosperm wood be designed? Research on this is mainly focused on conifers, is there research on angiosperms? (page 8)
- (4) Can be carbohydrates solely found in sapwood? Isn't there a transition zone between sapwood and hardwood where water is not axially transported anymore but there are still living cells present? In the thesis it is stated that NSC storage is confined to sapwood (page 9).
- (5) How is it possible that higher parenchyma fractions are not necessarily related to lower wood density or mechanical stiffness? (Publication 5)
- (6) You found that greater carbohydrate storage capacity might be associated with less severe alternate bearing behaviour. Could there be a practical application?
- (7) Publication 11 is dealing with irrigation and the plant physiological results are presented. I was missing the presentation of the anatomy results here, even though measurements were performed. Could you please point out the most important anatomical findings?

Conclusion

The excellent interdisciplinary scientific work of Dr. Plavcová brought many novel insights into the structure and function relationships of ray and axial parenchyma and inspired other scientists to further research in this field.

The habilitation thesis of RNDr. Lenka Plavcová, Ph.D. "Functional biology of wood: from structure to function" definitely **meets** the standard requirements for a habilitation theses in the field of Plant Physiology!

In Vienna on February 20, 2024



The reviewer's evaluation of the habilitation thesis

Candidate	RNDr. Lenka Plavcová, Ph.D.
Habilitation thesis	Functional biology of wood: from structure to function
Reviewer	Univ.-Prof. Dr. Stefan Mayr
The reviewer's department, institution	University of Innsbruck Department of Botany Sternwartestr. 15 6020 Innsbruck

See enclosed review.

The habilitation thesis has been checked with an anti-plagiarism software. The overall similarity was 8.5%, which is probably related to citations and text parts taken from the original publications.

Questions of the reviewer on the defence of the habilitation thesis

Are there general changes in parenchyma structures, functions, relevance during development of trees (from seedlings to mature trees)?

What are disadvantages (if any) of high parenchyma fractions in wood (also considering conifers *versus* angiosperms)?

Which parenchyma functions will be most important (or most affected) with respect to climate change?

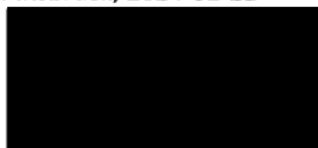
Which experimental and methodological approaches would be necessary to study long-term effects in of climate change on wood physiology?

Which wood structures or functions should we look at (e.g. in the rootstock) when breeding or selecting fruit trees for the future?

Conclusion

The habilitation thesis of RNDr. Lenka Plavcová, Ph.D. "Functional biology of wood: from structure to function" **meets** the standard requirements for habilitation theses in the field of Plant Physiology.

Innsbruck, 2024-01-22



Signature of the reviewer

Univ.-Prof. Dr. Stefan Mayr
Institut für Botanik
Universität Innsbruck
Sternwartestr. 15
6020 Innsbruck

To
Prof. RNDr. Jana Albrechtová Ph.D.
Department of Experimental Plant Biology
Faculty of Sciences
Charles University
Vinná 5, 128 44 Praha 2
Czech Republic

Innsbruck, 22.01.2024

Review Habilitation RNDr. Lenka Plavcová Ph.D.

Dear Ladies and Gentlemen,

I would like to submit to you my assessment of the habilitation thesis "Functional biology of wood: from structure to function" submitted by RNDr. Lenka Plavcová Ph.D. for habilitation in the field of Plant Physiology. I would like to state that I am familiar with Lenka Plavcová's publications, have met her at congresses, but have not carried out joint projects or published with her in recent years.

General aspects

In her thesis, Lenka Plavcová presents a total of ten publications in SCI journals, ranging from an impact factor of 1.9 (IAWA Journal) to 9.4 (New Phytologist). The Journal of Experimental Botany (6.9) had the highest impact factor of the journals in which she published as first author, and Tree Physiology (4.0) as senior author. All journals are related to plant physiology, plant ecology and anatomy or applied botany. In addition, one article has been published in the book "Functional and Ecological Xylem Anatomy" edited by Uwe Hacke.



In addition to the articles included in the habilitation thesis, Lenka Plavcová was the author of several other publications on various topics. Between 2015 and 2022 (the publication period of the thesis), she was co-author on ten, first author on one and senior author on one additional articles published in international journals, again including high-impact journals such as *New Phytologist* or *Plant Physiology*. The articles show not only a broad interest in different plant physiological topics (e.g. flooding effects, liana physiology, isotopic signature in leaves, tree ring analysis, reaction wood), but also collaborations with many renowned scientists (e.g. Günter Blöschl, Uwe Hacke, Günter Hoch, Steven Jansen). Her scientific activity is also documented by the list of conferences and invited lectures, as well as by an impressive number of grants and awards. She has also received several fellowships (although the content and budget/size of the projects are not given in the CV). Last but not least, Lenka Plavcová was also involved in teaching, with courses on a wide range of topics (e.g. anatomy, dendrology, climate change).

Overall, Lenka Plavcová's scientific output is impressive (particularly when maternity leaves are taken into account). Her broad research experience regarding methodology and studies, preparation of publications and presentations at conferences combined with teaching activities is a solid basis for the planned habilitation. I am not able to assess her competence in project acquisition and management or in scientific community services (e.g. membership of editorial boards), as this information was not included in the thesis documents.

Content

Lenka Plavcová's habilitation thesis is entitled "Functional biology of wood: from structure to function". Within this broad topic, she dealt with two aspects of xylem structure and function: First, she studied xylem parenchyma with a focus on its role in tree carbon relations, hydraulics and mechanical support. This part is based on a total of six publications, (i) a general review of xylem parenchyma, (ii) a meta-analysis of parenchyma fractions, (iii) a comparison of parenchyma in roots and stems, (iv) an analysis of vessel-associated cells, (v) a study of mechanical effects, and (vi) a study of the role of living fibres. Second, she analysed structure-function relationships in fruit trees based on five publications on (i) relationships between wood anatomy and growth/yield, (ii) relationships between growth, water and carbon relations during summer drought, (iii) relationships between increment growth and yield, (iv) the effects of rootstocks on carbohydrate storage, and (v) a comparison of irrigation responses of apple cultivars.

The thesis is structured in a short and concise definition of the objectives and a brief explanation of the scientific significance. Then a general introduction summarizes the anatomical and functional aspects of wood. Lenka Plavcová has managed to describe the main xylem anatomical and physiological knowledge in a very clear and structured way in a few pages. This is a perfect overview and a good basis for readers outside of the field to



understand the following, more specific parts on the published articles: the main results of these articles are described, with one main research question formulated per publication. Based on these questions, each publication is described in about half a page and key figures from the publications are presented. Each of these sub-chapters ends up with a short and clear answer to the research question. In the last two chapters of the thesis, a general conclusion is given, synthesizing all the findings of the publications presented, as well as a summary of possible future research activities. In addition to the original publications, the thesis also includes an abstract and another short summary of the included publications.

I enjoyed reading the general parts of the thesis as well as the inspiring set of publications. They form an attractive, coherent scientific story and provided many new and relevant insights, both for basic research (especially part 1) and applied aspects (especially part 2). The presentation of the results in text and figures is very clear, both in the general part and in the specific publications. The focus of the thesis fits perfectly with the habilitation topic of "Plant Physiology".

Methodology

In line with the numerous structural and functional aspects covered (see above), Lenka Plavková's scientific work is based on a broad methodological knowledge. Her main areas of expertise are plant anatomy (as evidenced by the many beautiful microscopic illustrations in her publications), plant hydraulics and carbon storage, where she uses different methodical approaches on different species. Her data analysis is also based on numerous, state-of-the-art mathematical and statistical methods.

This shows that Lenka Plavková is experienced in the design, implementation and management of scientific studies as well as in data analysis. Her experience is/will also be a solid basis for leading a research group.

Relevance

Wood is an important tissue of trees (as it was and will be an important product for mankind) and therefore a key component in water relations, carbon relations and mechanics. Wood anatomy has a long tradition of research, but there are still many aspects that are not sufficiently understood, such as the role of parenchyma, which is one of the foci of the thesis. This is especially true when structures are related to functions, which is a prerequisite for understanding biological processes. In the case of xylem, we see a particularly close link between structures and their functions, and Lenka Plavková's work adds new and interesting insights. Such insights help to improve our general understanding of tree physiology which is especially relevant with respect to stress physiology. A comprehensive understanding of tree physiological processes will be a prerequisite for estimating responses to future stress scenarios related to climate change. Accordingly, there are two important links between the



two parts of the habilitation thesis to be mentioned: First, the general knowledge (and methodological approaches) on structural and functional aspects of the parenchyma contributed to studies on fruit trees and second, the studies on fruit trees link basic research with applied science. Based on these and similar data sets, it may be possible, for example, to optimize irrigation systems or cultivar selection.

Thus, the topic of the habilitation thesis is timely and of broad relevance in terms of both basic research and applied aspects. Lenka Plavková's findings contribute to a better understanding of the structure-function relationships of the complex xylem tissue and its ecological significance, and (as described in the chapter on future perspectives) to the definition of research gaps. The clear way in which the scientific background and results are presented will provide a good basis for teaching and research communication activities.

Conclusion

Lenka Plavková's habilitation thesis is based on a reasonable number of high quality articles published in medium and high-impact journals. The articles focus on structures and functions of tree xylem, which is an important and timely topic. The results contribute to our understanding of xylem physiology, which is important not only for basic but also for applied research. Lenka Plavková synthesized the content of the articles in a well-written general part of the thesis, which demonstrates her sound scientific knowledge, broad methodological experience and ability to communicate research. I would therefore like to express my full support for Lenka Plavková's habilitation in the field of Plant Physiology.

Sincerely,



Stefan Mayr