

STSM - Scientific report
Cost Action FP1106 – STReESS



“Identify IADFs in *P. halepensis* using an automatic algorithm in colour images and density profiles multiscanner”

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Introduction

During the last decades of increasing temperatures and drought risk in the world, environmental fluctuations have been recorded in tree rings, making of great interest the use of intra-annual records for studying ecological and climatic issues, especially in the Mediterranean area where climate change is faster and more extreme. Responses to climate will depend on factors such as tree species, age or genetic material. Aleppo pine (*Pinus halepensis* Mill.) is one of the main Mediterranean conifer species, geographically wider distributed and high sensitive to climate variation. Thus, the possibility of measuring environmental fluctuations on tree rings from a range of populations across the Mediterranean area is a key question in tree breeding programs.

Besides classical anatomical studies (which require high-quality thin sections), X-ray techniques and the visual analysis of the X-ray images provide a promise approach to assess the wood anatomical feature of intra-annual density fluctuations (IADFs). Nonetheless, some methodological constraints still remain to estimate accurately these anatomical structures. The visual identification of IADFs is very time-consuming and depends on the capacity of the researcher to follow the criteria used to classify IADFs. Therefore, automatic methods to identify IADFs would provide more reliable and accurate results, and speed up the process.

Purpose of the STSM

The aim of the STSM was to identify IADFs by an automatic algorithm based on R-scripts developed by Filipe Campelo, to analyze available X-ray images of *P. halepensis* from the Mediterranean area and to compare intra-annual features between different genetic material.

Description of the work carried out during the STSM

The work was two methodological approaches: visual and semiautomatic analysis of the X-ray images using WinDENDRO™ (Regent Instruments, 2009), and automatic assessment of wood density profiles using R (R Development Core Team, 2016).

Core samples (12 mm) from around sixty trees of *P. halepensis* were previously collected in a common-garden test, and then processed at CETEMAS where thin laths were cut by a twin-bladed saw and X-ray scanned of samples by an Itrax Multiscanner (Cox Analytical Systems, Sweeden) were done (Figure 1a). X-ray images obtained were used during the STSM.

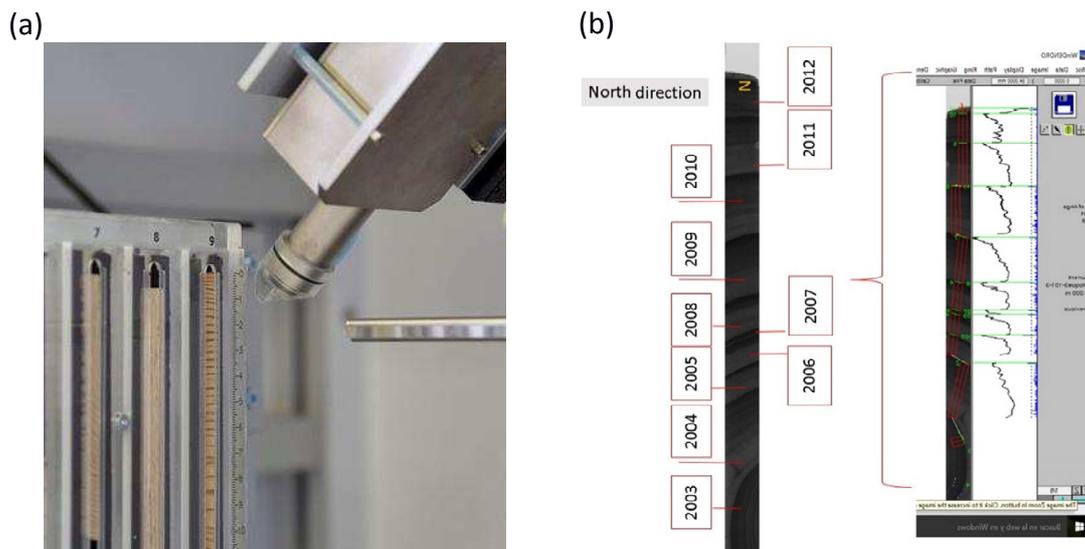


Figure 1. Some of the research steps (a) before the STSM at CETEMAS, and (b) during the STSM at the University of Coimbra.

Tree-ring width (TRW), earlywood and latewood width (EW, LW), percentage latewood (% LW), minimum and maximum densities (MND, MXD), earlywood and latewood densities (EWD, LWD), and total ring density (TRD) were obtained visually by using WinDENDRO™ (Figure 1b) and automatically by the R-script (unpublished code written by F. Campelo) (Figure 2). Finally, tuning of parameters to convert automatically density profiles (input) of *P. halepensis* into frequency of IADFs (output) was also done using a routine in R.

Description of the main results obtained

The automatic quantitative method based on R-scripts, identified correctly the tree-ring characteristics (TRW, EW, LW, % LW, TRD, ED, LD, MND, MXD). Furthermore, this free (no cost) method showed to be an accurate option to characterize tree ring data, with the advantages of reducing the time consuming in the analysis as well as the automatic detection of tree-ring features in comparison with the WinDENDRO analysis.

Regarding the identification of IADFs, this R program showed good results for most of the three types of IADFs: "Type E" with latewood-like cells within earlywood, "Type L" with earlywood-like cells within the latewood and "Type L+" with earlywood-like cells between earlywood and latewood (Campelo et al., 2007). However, since *P. halepensis* present a higher frequency of IADFs than other conifer species tested before with this R function, further improvement of this function is need to better identify all types of IADFs, especially IADFs in earlywood.

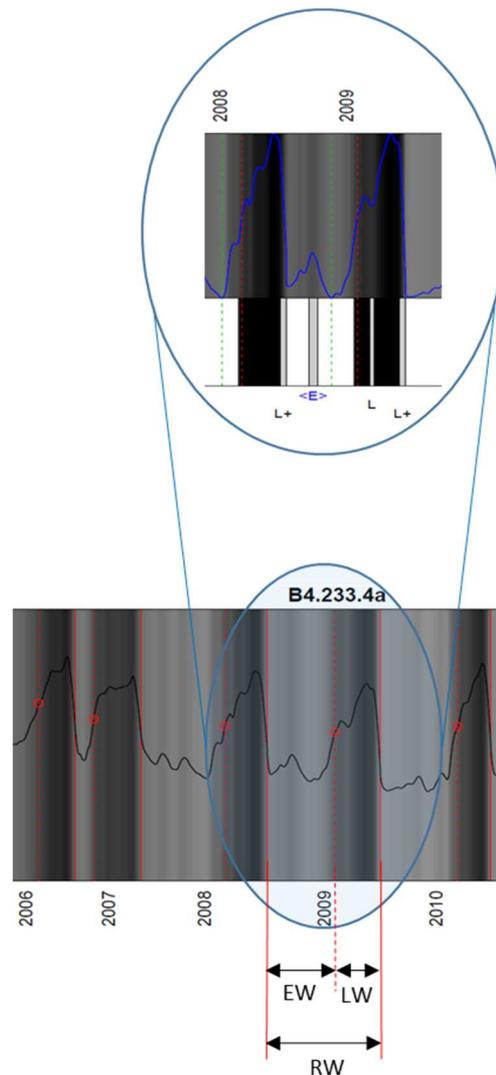


Figure 2. Output of the automatic method used during the STSM.

With this STSM, we demonstrated the potential of using automatic methods to analyze X-ray images, and particularly the R-script developed by F. Campelo.

Future and collaborative work will be necessary to improve the tuning of the parameters defined during this STSM for the automatic identification of IADFs in *P. halepensis*.

Future collaboration with the Host Institution

We expect this work to result in a common international publication and we will continue working together in the future on these topics.

Description about how the results contribute to the Action aims

During this STSM we tested a function in R to identify IADFs using wood density profiles, making possible the use of X-ray density databases of *P. halepensis*, which is of great interest to Topic Group 5.

Confirmation by the host institution of the successful execution of the STSM

The letter of confirmation by the host institution of the successful execution of the STSM is attached in a separate file.

Acknowledgements

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References

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