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Vertical Resin Ducts in Wood of Black Pine (*Pinus nigra* Arnold) as a Possible Dendroecological Variable

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Summary

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In 22 black pine trees (*Pinus nigra* Arnold) from 2 research plots in the Slovene Karst tree-ring widths were measured, the number of vertical resin ducts was counted and the numerical density of the resin ducts was calculated. The number of resin ducts is positively correlated with tree-ring width (r = 0.58). The numerical density of the resin ducts decreases as the tree-ring width increase. Tree-ring widths and the number of resin ducts decrease with the age of the tree. Using response function analysis 59% of tree-ring width variation could be explained by climate. No significant correlation was found between climate and resin ducts. On the basis of present knowledge we can assume that the occurrence of resin ducts in the wood of black pine is not directly affected by external factors, and so their occurrence cannot be treated as a reliable dendroecological variable.

Introduction

Classic dendroecological and dendroclimatological approaches are usually based on tree-ring widths. More recent studies are not only considering tree-ring widths but also the density profile of the tree-rings. From this profiles one can extract several density parameters from the earlywood and the latewood as well as their widths and relative proportions (SCHWEINGRUBER & al. 1978). Further development of analytical methods has led to an analysis of single tracheids or vessels (VAGANOV 1990, SASS 1993) or contents of different chemical elements in

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tree-rings (KAIRIUKSTIS & KOCHAROV 1990). Other authors have used vertical resin ducts in spruce to study the relationship with climate (WIMMER & GRABNER 1997). Some authors also report that the number of resin ducts increases under certain stress conditions (TORELLI & al. 1992, KOZLOWSKI & PALLARDY 1997, WIMMER & GRABNER 1997).

In this research vertical resin ducts in black pine were analysed and correlated with different external factors in order to proof if resin ducts in tree-rings can be used as a variable in dendroecological and dendroclimatological studies.

Material and Methods

Two research plots were chosen approximately 50 and 70 km SW from Slovene capital Ljubljana. Plots were located between 625 and 800 m a.s.l. They were established by planting black pines 80 to 120 years ago. Beside black pines tree species such as *Quercus cerris* and *Fraxinus ornus* can also be found in stands. The area studied has a mild Mediterranean climate with wet, warm winters and hot, dry summers (average annual temperature 10.8°C; 1440 mm precipitation). The forest stands are threatened by forest fires during the summer.

Analysed trees were dominant or co-dominant, healthy looking and without visible mechanical damages to the stem. We took 2 cores from 14 trees and 8 stem discs from freshly felled trees, in total 22 trees. All the measurements and calculations were done using a TSAP/x program and LINTAB measuring table. The resin ducts were counted in a 4 mm wide window. Numerical density of the resin ducts (NDRD) was calculated as the ratio of the number of resin ducts divided by the surface area of a corresponding tree-ring width.

The pointer years are defined as years where a certain percentage of trees of the given collective reacts either with an increase or a decrease in tree-ring width (SCHWEINGRUBER & al. 1990). The pointer years were ranked and ordinally scaled. A score of 0 was given when less than 75% of the trees respond with either increase or decrease in the tree-ring width, and +/-3 was used for years when 100% of the trees react with an increase or decrease.

The relationship between tree-ring width and climate was calculated using the PRECON program (FRITTS & DEAN 1992) which include the BOOTSTRAPPED method (GUIOT 1991). Prior to response function calculation the tree-ring widths were standardised using ARMA modelling (HOLMES 1994). For the analysis data on monthly mean temperatures and monthly total precipitation were used from the Tomaj meteorological station (15 km NW from the plots). The data available cover the years 1956 to 1996.

Results

In the juvenile period between 1890 and 1920 tree-ring widths do not well coincide among trees - they respond to factors other than climate. After 1920, in the adult growth period, the trees react very well to climate. This period is characterised by high similarity measures such as t_{BP} (t_{BP} is t value after Baillie-Pilcher - it is used as a measure of similarity between two samples) and GLK% (GLK% is Gleichlaeufigkeit - it is a nonparametric measure of similarity between two samples). The following pointer years were recognised: 1947, 1952, 1963, 1979 and 1992. The influence of climate on black pine growth is quiet strong.

Response function analyses showed that 56% of the tree-ring width variability can be explained by June and July precipitation.

Distribution of resin ducts (Fig. 1) in 1353 measured tree-rings shows that 75% of tree-rings have up to 5 resin ducts and 95% up to 7. More than 7 resin ducts occurs rarely. We never found more than 11 resin ducts per sampling window.

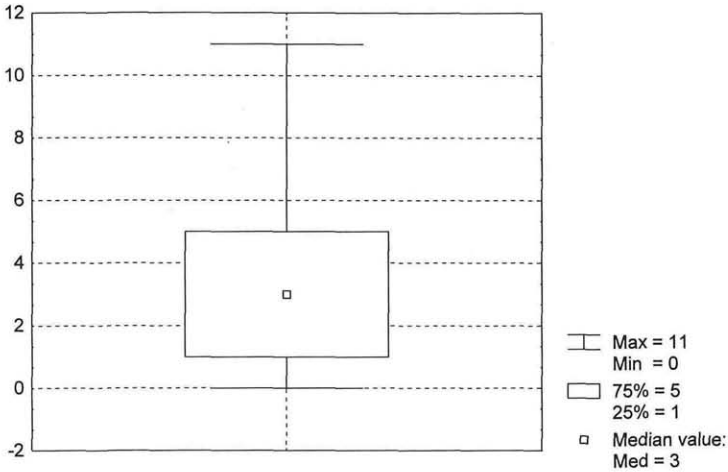

Fig. 1. Box and Whisker plot of number of resin ducts in tree-rings (n=1353).

It was observed that the number of resin ducts decreases with the age of the analysed trees (Fig. 2). NDRD remains more or less stable over time and is independent of the age of the tree and tree-ring width. There is no relationship between NDRD and tree-ring width ($r^2=0.07^{NS}$). In juvenile wood resin ducts are evenly dispersed all over the tree-ring, while in adult wood they are located in transition latewood.

There was no significant response between general climatic condition and number of resin ducts (NRD). Simple analysis of variance gave significant differences between pointer years (hot-dry, mild-humid) and NRD, however detailed investigation with Tukey's HSD tests proved that only 3 out of 7 differences between pointer years were actually significant (Fig. 3).

From the results we can conclude that there is no relationship between the number of resin ducts in a tree-rings of black pine and climate. An analysis of the numerical density of the resin ducts showed that this variable is independent of climate. We could not find any significant differences between pointer years.

Fig. 2. Age trend in resin ducts (n=22 trees).

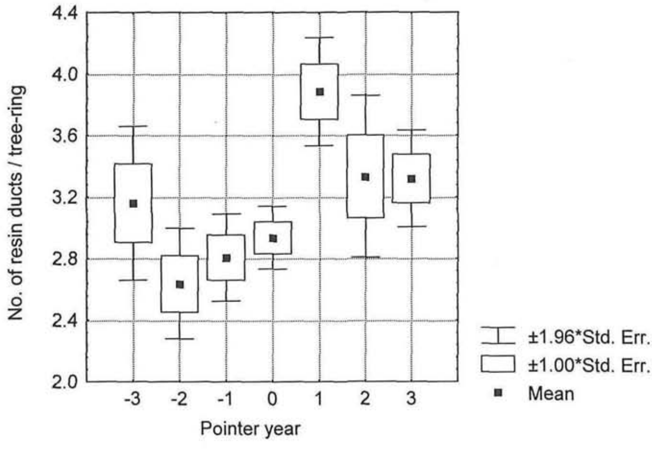

Fig. 3. Frequency of resin ducts in pointer years (n=1353 tree-rings). Pointer years are scored as described in the text.

Conclusions

On the basis of our analysis and the available literature we can conclude that the analysed variables number of resin ducts and numerical density of resin ducts are not suitable for dendroecological and dendroclimatological studies in black pine (*Pinus nigra* Arnold). None of the variables investigated respond to climatic variation, in addition numerical density of resin ducts is also independent from growth rate. Our results conform with the findings of KOZLOWSKI & PALLARDY 1997 and TORELLI & al. 1992. However, they do not conform with results of WIMMER & GRABNER 1997. We assume that the differences are mainly because Wimmer and Grabner have worked with spruce.

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References

FRITTS H. C. & DEAN J. S. 1992. Dendrochronological modelling of the effects of climatic change on tree-ring width chronologies from the Chaco Canyon area, southwestern United States. - Tree-Ring Bulletin 52: 31-58.

GUIOT J. 1991. The bootstrapped response function. - Tree-Ring Bulletin 51: 39-41.

HOLMES R. L. 1994. Dendrochronology program library. - Users manual, Tucson, University of Arizona, Laboratory of Tree-Ring Research, 55 pp.

KAIRIUKSTIS L. & KOCHAROV G. E. 1990. Measuring the chemical ingredients in tree rings. - In: COOK E.R. & KAIRIUKSTIS L.A. (Eds.), Methods of dendrochronology - application in the environmental sciences, pp. 229-232. - Kluwer Academic Publishers, Dordrecht, Boston, London.

KOZLOWSKI T. T. & PALLARDY S. G. 1997. Growth control in wood plants.- Academic Press, New York, London, 641 pp.

SASS U. 1993. Die Gefässe der Buche als ökologische Variable. - Dissertation, Hamburg, Germany, Universität Hamburg, 172 pp.

SCHWEINGRUBER F. H., ECKSTEIN D., SERRE-BACHET F. & BRÄKER O. U. 1990. Identification, presentation and interpretation of event years and pointer years in dendrochronology. - Dendrochronologia 8: 9-38.

— & FRITTS H. C., BRAKER O. U., DREW L. G. & SCHAR E. 1978. The X-ray technique as applied to dendrochronology. - Tree Ring Bulletin 38: 61-91.

TORELLI N., OVEN P., ZUPANČIČ M., KRIŽAJ B. & ČUFAR K. 1992. Schleimzellen in der Rinde und traumatische Harzkanale sterbender Tannen. - Holz als Roh- und Werkstoff 50: 180.

VAGANOV E. A. 1990. The tracheidogram method in tree-ring analysis and its application. - In: COOK E.R. & KAIRUIKSTIS L.A. (Eds.), Methods of dendrochronology - application in the environmental sciences, pp. 63-76. - Kluwer Academic Publishers, Dordrecht, Boston, London.

WIMMER R. & GRABNER M. 1997. Effects of climate on vertical resin duct density and radial growth of Norway spruce (*Picea abies* (L.) Karst.). - Trees 11: 271-276.