3.2 = *QUERCUS ROBUR* L. TREE-RING ANATOMY AND DENDROCLIMATOLOGY: AN IMAGE ANALYSIS APPROACH

P. NOLA, P. BIELLA, S. ASSINI, F. BRACCO
University of Pavia, Dept. of Earth and Environmental Sciences, Italy

In trees, changes in environmental conditions cause metabolic processes variations that result in vessel density, width and general wood structure of annual rings (1). By means of tree ring-anatomy, an approach based on dendrochronology and quantitative wood anatomy, it is possible to assess cell anatomical characteristics (such as vessel size, density and tissues percentage) along a series of dated tree-rings and to analyse them through time in order to characterize the relationships between tree growth and various environmental factors, such as climate (2).
Herein we present the preliminary results of a tree-ring anatomy investigation, based on image analysis, conducted in the "Siro Negri" Forest Reserve (Pavia, N-Italy), a natural broadleaves mixed forest dominated by oak (*Quercus robur* L.).
Within the Reserve, we sampled ten dominant oaks by a 5-mm increment borer (1 or 2 cores per tree). After dendrochronological preparation, tree-ring measuring and cross-dating, a core from each tree was scanned at 1,500 dpi resolution and 48-bit colour depth using an Epson Expression 10000 XL scanner. Digital images were processed by means of ROXAS, automated image analysis system, which allows the extraction of xylem vessels according to morphometric criteria and the detection of annual rings by pattern algorithms that analyse the local anatomical context of each vessel (3). Among the variables furnished by ROXAS, the following were chosen: within earlywood the number of vessels (VNo), mean vessel diameter (MVD) and total area of all counted vessels (VTA), linked to water conduction; total ring area (TRA) and net wood (NW), roughly estimating tree productivity (fig.1). Variables autocorrelations were eliminated using ARSTAN (4). Correlation analyses were performed between tree-ring variables and climatic variables obtained from HISTALP data-base (monthly precipitation and monthly temperature, 5).
Significant relations are detected mostly between tree-ring variables and temperature. In fact monthly precipitations are scarcely correlated with all the variables, expressing both water conduction capacity and tree productivity. This may be expected, being the Reserve sited in the Po river alluvial plain where water supply is guaranteed regardless of precipitations. Temperatures result to be constraining mainly conduction variables. In fact, the number of vessels (VNo) and vessels total area (VTA) are positively correlated with temperatures of the previous autumn and negatively correlated with winter temperatures. In addition, higher spring temperatures positively influence vessel dimensions (MVD). Thus it is likely that temperatures are crucial for plant metabolism: mild autumn temperatures lead to a higher vessel-cells production. Their development is favoured by higher spring temperatures, while colder winters block the carbohydrates consumption of the reserve that would be used for the vegetative growth.
Surprisingly, a positive relation is obtained between vessels total area (VTA) and net wood of the previous year (NW_{t-1}), suggesting that processes governing the big earlywood vessels production were influenced not only by environmental conditions at the moment of their formation, but also by anatomical features of wood formed in the preceding season. This may be linked to water transport capacity of small conduits widespread within latewood. In the future it will be interesting to model and eliminate this previous-year wood signal from vessels chronologies in order to enhances their response to climate and better understand the role played by temperature on earlywood vessels formation.

Fig. 1 - Example of earlywood vessel extraction and tree-ring detection by image analysis on oak wood

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