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INVITED REVIEW PAPER

Human time in tree rings

Dieter Eckstein*

University of Hamburg, Department of Wood Science, Division of Wood Biology, Germany

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Abstract

'Human time' means time in the context of human culture and activities. It is shown how 'human time' is biologically archived in and dendrochronologically extracted from tree rings. For illustration, examples in the late medieval Hanseatic city of Lübeck are selected.

Keywords: Dendrochronology; Cultural heritage; Human behavior; Socio-economic environment

Introduction

Time passes continuously and invariably. Only by dividing it into intervals does time become perceptible for man. Most trees divide their lifetimes into annual intervals by forming distinct growth rings. In doing so, trees record and archive information about time and environment life-long like in an almanac. It is the task of dendrochronologists to translate this information into an understandable human language.

A single tree-ring series has, without any doubt, a value in itself. But by means of high-tech equipment and powerful computers, it is nowadays easily possible to collect huge amounts of dendrochronological data and to achieve a novel quality of results with them – that is to say, information about past human cultures and behavior as well as on the socio-economic environment.

In the following, I will substantiate some aspects of this topic within a real context but before that, few incipient considerations about tree growth may be helpful.

Incipient considerations

For trees, the pulse generator of the time is the annual alternation between a growing and a dormant season; in our temperate climate this changeover is normally forced by temperature. In other areas of our globe, like in the subtropics, this is caused by the seasonally changing moisture availability. But for trees in ever wet tropical rainforests, such a natural external pulse generator is sometimes missing so that time has to be artificially introduced in a tree, e.g., by wounding the cambium from time to time. These timestamps can be seen after the tree has been felled and opened.

More difficult than to detect the time is to recognize the simultaneously recorded non-chronological information in tree rings, such as information on environmental changes. It may be encoded in the width of a tree ring, or in the latewood and earlywood width, or in wood density and wood structure, or in the chemical composition of the cell wall, and enters a tree through its leaves and roots because these organs are in close contact with the environment. In the end, the environmental input is transformed into new wood through the cambium and its activity, varying from year to year, site to site, and tree species to tree species (Fig. 1). It may be

*Department of Wood Science, Leuschnerstr. 91, D-21031 Hamburg, Germany. Tel.: +49 40 73962 452; fax: +49 40 42891 2835.
E-mail address: d.eckstein@holz.uni-hamburg.de.

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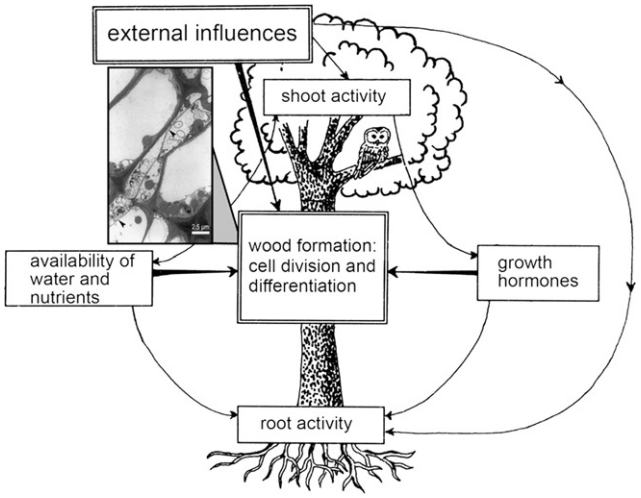

Fig. 1. Interaction between external and internal influences on wood formation, and electron-microscopic photo of cell divisions (arrow heads) in the cambium zone (inset).

worth mentioning that the annual character of tree rings was known and their varying width was interpreted as meteorological almanac long before the nature of the cambium was identified.

The information about past human cultures, such as timber trade, forest management practices, or preferences in timber selection, is recorded in all living trees, but even more exciting, in all trees which lived at earlier times and are preserved either underground or on the sea bottom, or were used as construction timber, or in wooden objects of art (Fig. 2), such as paintings on panels, organs, and other wooden music instruments, furniture, sculptures and the like.

Study object – the late medieval town of Lübeck and its hinterland

Lübeck was the leading town of the Hanseatic League, a network of traders and merchants from late medieval to early modern times around the Baltic Sea including England in the west and western Russia in the east. The UNESCO has declared Lübeck as a World Cultural Heritage site. Old Lübeck was founded as a Slavic stronghold (Fig. 3), dendrochronologically dated to around 800 AD, at the western edge of the Slavic settling activities. About 300 years later, the German King Henry the Lion occupied this area and in 1143 AD his liege, earl Adolf II, founded today's Lübeck only a few kilometers further south of Old Lübeck. Within the subsequent 100 years, a settlement evolved with an orderly system of streets and plots of land, five churches, a monastery, a hospital, and a fortification. From forest history we know that the country between the North Sea and the Baltic Sea was densely covered by mixed deciduous woodlands of mainly beech and oak and that a document from 1188 AD (enacted by the German Emperor 'Barbarossa') safeguarded the right of the citizens of Lübeck to cut and use trees ('Holzungsrecht') within an area of 1500 km^2, but prohibited its utilization for ship building and for export. With the subsequent demographic evolution, the forests were nevertheless increasingly used for producing fodder for animal husbandry, timber production for house building, firewood for heating homes and for daily cooking. Initially, all secular buildings were made of wood. But after two severe fires in 1251 and 1276 AD, a law was enacted prohibiting the erection of solely wooden houses. Due to the fact that the country was poor in natural stones, the fabrication of brick stones became necessary, consuming an additional amount of wood for the generation of energy. As early as 1220 AD, a law ('Sachsenspiegel') disclosed the principle of sustainability ('wood land should remain wood land'). From this year on, a certain extent of forest management could be assumed in the region. This background information about the availability of and the demand for timber must be kept in mind for the following considerations.

Acquisition of building timber from a market or from the forest?

During our dendrochronological studies in and around Lübeck, we were repeatedly confronted by the questions: Was the building timber selected directly among the standing trees in the forest or was there a timber market as early as in the 13th century? No answers to these questions were found in the archives available.

Provided that the standing trees were selected in the forest and then felled and transported directly to the building site, all timbers used within one building are presumably cut in the same year. However, if the trees were first transported to a storage place and only then sold to a building contractor, timbers from different felling campaigns would have been mixed, and different felling years should be expected within one and the same complex of buildings. We found examples for both alternatives (Fig. 4). In one of the houses, originally an ecclesiastic building, four out of seven timbers of the roof construction had bark preserved and their youngest ring was formed in 1317 AD. According to our assumption the building timber would have been selected in the forest, cut and brought to the building plot and built in without any storage time in-between. The alternative example is a merchant's house of the Gothic brick stone architecture. The 15 dated timbers can be grouped into four felling operations, ranging