

Doctoral Thesis

**Species identification of fossile finds from Bükkábrány and
dendroclimatologic investigation os several species of the
family Cupressaceae**

ANTALFI ESZTER

University of West Hungary
Faculty of Wood Sciences

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University of West Hungary
The Simonyi Karoly Faculty of Engineering, Wood Sciences and Applied Arts
The József Cziráki Doctoral School of Wood Sciences and Technologies

Head: Dr. Tolvaj László DSc.

Program: Wood Sciences

Tutor:
Dr. Fehér Sándor

Abstract

A unique fossil plant remains can be examined, when they were outcropped in the summer of 2007, near Bükkrábrány. The remains were buried for 7,2 million years; the trunks of the marshland forest were standing on their aboriginal locality. The preserved original structured trunks are a curiosity, so they are unique chance for researcher. The aim was to determine the species by complex examination. There is no chance to clarify the taxonomy of the trunks by naked eye, because they haven't got that kind of properties, which help us to answer this taxonomical question. The solution could be found in the inner, cellular structure of the wood, which can be studied by microscopy. The determination of the species mostly by light microscopic sections were done, which were complemented by electron microscopic and density studies.

The dendroclimatologic investigation in the second part of the thesis is not a classical research. It is only an intraductory research on the correlation between the annual ring structure and the climatic factors of several currently occurring species of the family Cupressaceae.

1. Introduction

In Bükkábrány with the appearance of the swamp forest being under the ground for 7,2 million of years a plant fossil examination of supreme importance became possible. The finding was found in the summer of 2007 in the second largest open quarry of Hungary in a depth of 60 meters. The finding consists of 16 stems standing in their original position, which is an imposing sight by their dimensions and age not only for non-professionals, but also for people dealing with paleontology, botany, forestry and wood sciences. The trees did not fossilize, they kept their original structure for millions of years giving a wonderful opportunity for scientists to do examinations.

2. Aim of the research

The thesis is divided into two parts: xylothomic investigation of the stems and the introduction of dendroclimatologic research on the currently living members of the *Cupressaceae* family.

2.1. Wood anatomy research

In the first part of the thesis my aim of research was to do a comprehensive examination of the stems in the swamp forest. The taxonomy of the trees cannot be done by visual investigation since they do not have any characteristics which could make the decision possible undoubtedly.

According to this the main goal of my comprehensive research on the stems of the swamp forest was to determine which species did appear in the plot. The true solution of the species description lies within the inner cell structure of the tree, what we can answer satisfyingly with microscopic examination.

2.2. Dendroclimatology research

For the dendroclimatologic research I took the species of the *Cupressaceae* family living today as a basis. My aim was to examine how the given stems are influenced by precipitation, temperature and other climatic factors in Hungary. This is not a typical dendroclimatologic research, it is simply an introductory examination which can show how strong the growth ring structure of the currently living species in the *Cupressaceae* family (Bald cypress, Coast redwood, Dawn redwood, Giant sequoia) relate to climatic conditions (temperature, precipitation, Nováky climatic index, surface potential evaporation, FAI, amplitude), to which ones it is more sensitive, and how these factors affect stem growth.

3. Research methods

3.1. Wood anatomy research

The research method of fossil remains usually differs from traditional examinations due to its special characteristics, either in the preparation phase of the examined material or during the measurements however it can differ in both. The reason is the difference of physical characteristics of the remains related to normal. The chemical cellwall-structure of the Bükkábrány findings altered and the earlywood of the growth rings got wrecked and crushed because of ground pressure, therefore fixation was needed. Paraffine gave a solid form to the sample which had to be solved out with a xylene solution after cutting.

After the preparation of the samples I put them into a Thermo scientific Microm HM 430 type sledge microtome minding fiber directions and I made thin cuttings (10-12 µm). For the species determination I used a Zeiss optical microscope and a Hitachi S-3400N type electron microscope.

From the 16 stems 9 were identified (7 stems dried out). Three out of them are currently at an exhibition in the Herman Ottó Museum in Miskolc and five are at the fossil footprint showplace in Ipolytarnóc.

3.2. Dendroclimatology research

Two methods had to be used for the sampling of the dendroclimatologic research. Samples from living trees were taken with a Pressler-borer and from fallen stems slices (disks) were cut. After the preparation of the wood samples I measured the growth ring-widths with a stereo microscope and with an AutoCAD software. The samples for the dendroclimatologic examination come from 24 stems which are all members of the *Cupressaceae* family. They originate from 9 different places in Hungary. Eight out of them are arboretums and one is a private owned property. Fourteen stems come from Transdanubia and 10 from Transtisza. For each stem I used the climatic data from its own surroundings which come from the „Agrár klíma 2 (VKSZ_12-1-2013-00-34)” project. The time interval is 50 years from 1961 to 2010 in a 0,1 x 0,1 geographical degree resolution.

The tree specimens were examined and compared with two methods. With linear correlation-analysis at in the CREMIT method and with the traditional graphic diagramme method. In both methods the linear growth ring-widths and circle-increments were compared with climatic data (temperature, Nováky climatic index, surface evaporation, FAI, amplitude and precipitation).

4. Theses of evaluation

1. **With my research I proved that the former forest plot in Bükkábrány was made up of a mix of several species.** I diproofed the theory according to the research done before that the fossil trees were only members of the bald cypress (*Taxodium distichum*) species. That former research was only based on the shape of the stems and bark characteristics. The true solution of the species description lies within the inner cell structure of the tree. With my research I proved that besides bald cypress there was also coast redwood (*Sequoia sempervirens*) present as well as the already extinct species of *Taxodioxyton germanicum*, *Sequoioxylon sp.* and *Glyptrostrobus europaeus*.

2. **With my research I confirmed that for the identification of a given tree species (in this case *Taxodium distichum* and *Sequoia sempervirens*, as well as the ancient *Taxodioxyton germanicum* and *Sequoioxylon sp.*) the size examination and comparison of its courted pits does not supply reliable data. So that cannot be used as a standard for species description.** Evaluation of research data refers to the fact that significance values do not show significant correlation all the time at given tree specimens. On the same specimen however significance values can differ according to the place of sampling so it can show significant differences. The examination of xylothomic marks is indispensably important for species description.
3. **With my anatomic and microscopic examination I proved that two (*Taxodioxyton germanicum* and *Sequoioxylon sp.*) out of the three species determined by me (which were considered extinct) share the same xylothomic characteristics than the currently living *Taxodium distichum* and *Sequoia sempervirens* species.**
4. **With my research I proved that there is no strong correlation between the growth of the examined species in the *Cupressaceae* family (*Sequiadendron giganteum*, *Sequoia sempervirens*, *Taxodium distichum*, *Metasequoia glyptostroboides*) under the local ecologic circumstances.** Besides the examined species, the sampling spots give no clear connection for the growth rate of the mentioned species either.
5. **With my linear correlation-analysis I proved that there is no strong correlation between climatic factors (temperature, precipitation, Nováky climatic index, surface potential evaporation, FAI, amplitude) and the growth ring-width and increment of the examined species (*Sequiadendron giganteum*, *Sequoia sempervirens*, *Taxodium distichum*, *Metasequoia glyptostroboides*).**
6. **With my research I proved that the strongest correlation was shown between the circle increment of the species (*Sequiadendron giganteum*, *Sequoia sempervirens*, *Taxodium distichum*, *Metasequoia glyptostroboides*) and the temperature.** In the growth of the examined non-native species the most significant factor is the temperature among the local growth factors.

5. Use of research results

My research results confirmed that it is important to know xylothomic characteristics of the wood as well in order to be able to determine the species undoubtedly from the stem only and macroscopic examination in itself is not enough. It has been proven as well that the size determination of courted pits gives no sufficient information for species determination. It became clear that microscopic examination is not only recommended, but indispensable for identification.

Dendroclimatologic examinations pointed out that the CReMIT mathematic method in itself is not enough if we are looking for a correlation between climatic factors and growth data. The method is good, but it does not take fake growth rings and measurement errors into consideration therefore the examined factors have to be confirmed by a diagramme as well.

The examination of non-native Cupressaceae species confirmed that a greater emphasis has to be put on temperature factors than on precipitation. Further research is needed in order to get true results on climate change and its forecast.

6. Publications in the research field

Publications in edited scientific journals written in foreign language

1. **ANTALFI, E. - FEHÉR, S. (2015): Anatomic investigation of Hungary's common shrub species, Pro Ligno (in press)**

Publications in scientific journals written in foreign language

1. **ANTALFI, E. - FEHÉR, S. (2013): Xylotomic similarities and natural habitat of the fossil remains of Bükkábrány, Acta Biologica Szegedensis, Volume 57(2) p.:161-166**

Publications in scientific journals written in Hungarian

1. **ANTALFI, E. - FEHÉR, S. (2012): A bükkábrányi fosszilis fatörzsmaradványok fafaj meghatározása mikroszkópos módszerekkel, Faipar – A faipar műszaki tudományos folyóirata, LX. évf. 5-9. oldal**
2. ANTALFI, E. (2012): A fafaj meghatározás modern lehetőségei, Magyar Asztalos és – Faipar, 2012/1, 66-67. oldal
3. ANTALFI, E. (2009): Fosszilis maradványok vizsgálata a Pannon-tó térségéből, FATÁJ - online szaklap, Sopron 2009. június 10.
4. MOLNÁR, S. - FEHÉR, S. - BÖRCÖK, Z. - ANTALFI, E. (2009): Milyen fák éltek a Pannon-tenger partján, Bükkábrányban?, Magyar Asztalos és – Faipar, 2009/1, 88-89. oldal
5. **FEHÉR, S. - ANTALFI, E. - BÖRCÖK, Z. - MOLNÁR, S. (2008): A bükkábrányi ősfák anatómiai és sűrűségi vizsgálata, Faipar – A faipar műszaki tudományos folyóirata, LVI. évf. 9-15. oldal**

Poster presentations written in foreign language

1. ANTALFI, E. – MOLNÁR S. - FEHÉR, S.- BÖRCÖK Z. (2010): A Xylem Topology and Dendrochronology Study: Neocene Cypress and Redwood Forest – Now a Viable Source for Biomass Energy , 64th International Convention (Monona Terrace Community & Convention Center) , Madison, Wisconsin , 2010. June 20-22.
2. MOLNÁR, S. - ALBERT, L. - FEHÉR, S. - BÖRCÖK, Z. - ÁBRAÁM, J. - HOFMANN, T. - ANTALFI, E. (2008): Anatomical and chemical characteristics of Miocene Taxodiaceae species from Bükkábrány (Hungary). Wood Matters - A celebration of the work of John Barnett. The Linnean Society of London, International Academy of Wood Science, International Association of Wood Anatomists, London, 29-30.

Poster presentations written in Hungarian

1. ANTALFI, E. – FEHÉR, S. (2010): Fafaj meghatározás módszertana fosszilis maradványokon, XXXV. Nemzetközi Restaurátor Konferencia, Budapest 2010. november 3-4-5.

Publications in conference proceedings written in foreign language:

1. ANTALFI E. (2009): Examination of fossil remains from the Pannon-lake's area, 50th International Student Scientific Conference, Zvolen, Slovakia, May 5, 2009

Publications in conference proceedings written in Hungarian:

1. ANTALFI, E. (2013): Bükkábrányi fosszilis Taxodiaceae leletek fafaj azonosítása és dendroklimatológiai vizsgálata, Doktorandusz Konferencia, Cziráki József Faanyagtudomány és Technológiák Doktori Iskola, "Talentum program" Hallgatói tehetséggondozás feltételrendszerének fejlesztése, Nyugat-magyarországi Egyetem Kiadó, 2013. 06.07., pp.3., Sopron
2. PAPP Á.J.,ANTALFI, E. FEHÉR S. (2012): Óriás mamutfenyő (Sequoiadendron giganteum) fizikai és mechanikai tulajdonságainak vizsgálata, Hallgatói tudományos konferencia 2012: Tanulmánykötet a "Talentum program" hallgatói kutatásainak eredményeiről, előadásanyagairól : Fafizika, Fakémia, Új kompozit anyagok, Megújuló energia, Nanotechnológia, Nyugat-magyarországi Egyetem Kiadó, 2012. pp. 134-139. (ISBN:978-963-9883-96-3), Sopron
3. KOCSIS Á.,ANTALFI, E. FEHÉR S. (2012): Óriás mamutfenyő szövettani vizsgálata, Hallgatói tudományos konferencia 2012: Tanulmánykötet a "Talentum program" hallgatói kutatásainak eredményeiről, előadásanyagairól : Fafizika, Fakémia, Új kompozit anyagok, Megújuló energia, Nanotechnológia, Nyugat-magyarországi Egyetem Kiadó, 2012. pp. 90-95, (ISBN:978-963-9883-96-3), Sopron
4. ANTALFI, E. (2011): A bükkábrányi ősfák anatómiai és szövetszerkezeti vizsgálata, Országos Tudományos Diákköri Konferencia, Agrártudományi szekció, Erdészeti és Faipari tagozat I., I. helyezés, Keszthely 2011. április 8.
5. ANTALFI, E. (2009): Fosszilis maradványok vizsgálata a Pannon-tó térségéből, XXIX. Országos Tudományos Diákköri Konferencia, Agrártudományi szekció, Erdészeti és Faipari tagozat, II. helyezés, Gödöllő, 2009. április 6-8.