

DENDROCHRONOLOGICAL STUDY OF A WOODEN BELFRY FROM SZOKOLYA-KIRÁLYRÉT, HUNGARY

DENDROKRONOLÓGIAI VIZSGÁLATOK A SZOKOLYA-KIRÁLYRÉTI FA HARANGLÁB ANYAGÁN

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Abstract

A 94 years long floating oak chronology has been developed from four samples obtained during the reconstruction works of a belfry at Szokolya-Királyrét. Cross-dating against 7 nearest oak reference chronologies unambiguously dated the youngest ring found in the timber to 1901 AD. The earliest possible felling date of the wood was estimated to 1914 AD taking into account the missing sapwood. The strength of synchrony between the belfry's chronology and the nearby reference ones indicates local timber source. The fact that these samples improved the replication over the poorly covered 19th century period of the Central Hungarian Oak Master Chronology, coinciding with the overlapping period of living and historical material lends special significance to them.

Kivonat

A Szokolya-királyréti harangláb a Magyarország, illetve Kárpát-medence történeti faépítményeit bemutató művekben eddig nem került említésre, noha archív fénykép is igazolja hogy közel száz éve már állt. A harangláb rekonstrukciós munkálatai során nyert négy minta dendrokronológiai vizsgálata során sikerült az évgűrűszélesség sorokat szinkronizálni és egy 94 év hosszúságú lebegő tölgy kronológiát hoztunk létre. A mintákon szíjács évgűrűt nem lehetett megfigyelni. Nyolc környező tölgy alapkronológiával tett összehasonlítás egyértelműen 1901-re keltezte a legutolsó mért évgűrűt. Ennek a fának a lehetséges legkorábbi kivágási dátuma 1914-re becsülhető, figyelembe véve az eltávolított szíjácsévgűrűk miatt szükséges korrekciót. A statisztikai értékelés eredményei alapján a harangláb mintáiból épített kronológia a közeli referencia kronológiákkal mutatja a legszorosabb hasonlóságot, amit úgy értelmezhetünk, hogy helyben kitermelt faanyagot használtak a harangláb építéséhez. A minták épp a Közép-magyarországi Tölgy Alapkronológia kevés mintával fedett, 19. századi szakaszához, az élő és történeti minták átlapolási tartományához illeszkednek. Ez kiemelt jelentőséget kölcsönöz a vizsgált anyagnak, hisz a harangláb mintái egy rendkívül kritikus szakaszon erősítik meg a leghosszabb hazai tölgy referencia kronológiát.

KEYWORDS: HISTORICAL OAK TIMBER, DENDROPROVENANCING, WOODEN BELL TOWER, BÖRZSÖNY MTS

KULCSSZAVAK: TÖLGY ÉPÜLETFA, DENDROPROVENIENCIA, FA HARANGTORONY, BÖRZSÖNY

Introduction

Systematic dendrochronological research has been initiated relatively recently in Hungary (Grynaeus et al. 1994, Grynaeus 1995). Due to its dominance in the archaeological material and to the continuous use through historical times, similarly to the usual European trends (Haneca et al. 2009), Hungarian research also focussed on oak species (*Quercus* spp.). After the first well replicated master chronologies were developed and the major dendrochronological zones outlined (Grynaeus 1996, 2002; Dávid & Kern 2007) archaeological (Ilon et al. 2001, Szántó et al. 2007) and art

historical (Morgós 2006, Grynaeus & Sarkadi 2007) applications could have also started.

The longest and best replicated regional master chronology in Hungary for *Quercus* spp. spans 1370-1994 AD (Grynaeus 2011). Although the Mediaeval and early Modern periods are relatively well replicated owing to the wealth of successfully synchronized archaeological findings, weirdly, the 19th century, coinciding with the overlapping period of living and historical material, remained most poorly replicated (Grynaeus 2011). This transition period is always critical and needs special attention in composite chronologies (Tegel et al. 2010).

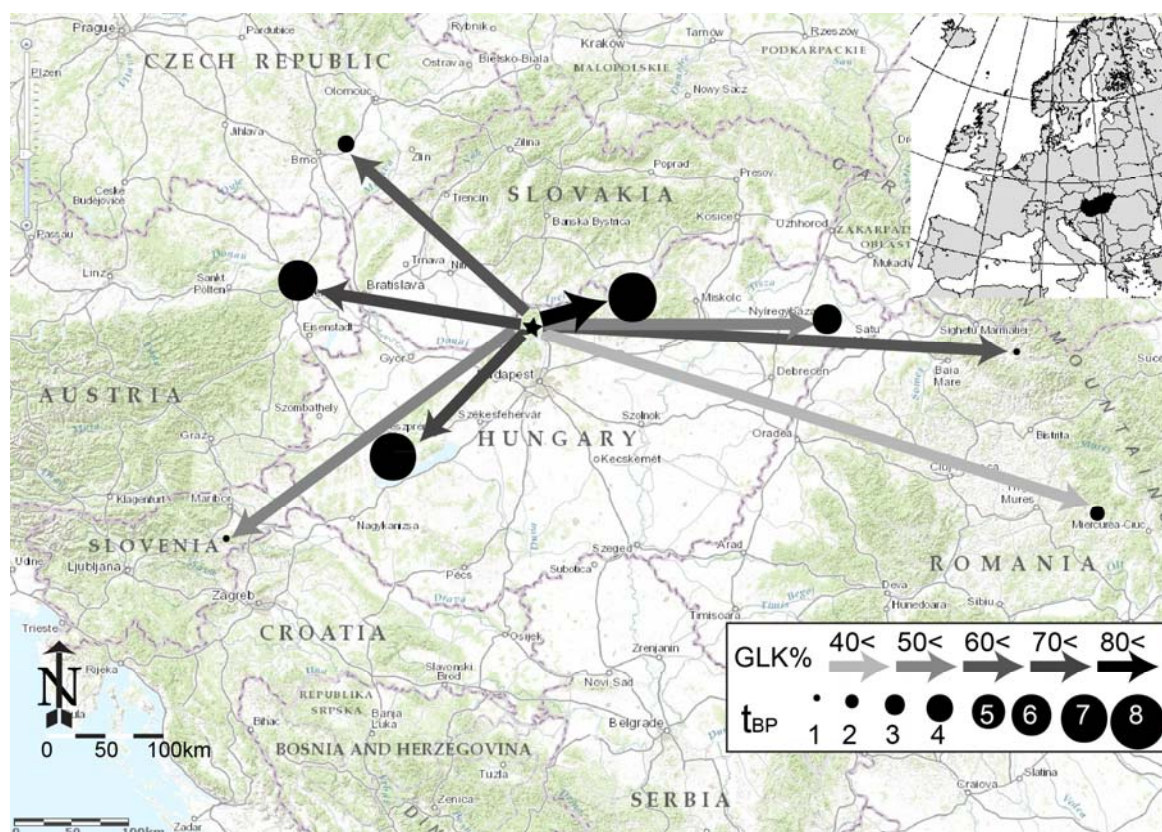


Fig. 1: Location of Szokolya-Királyrét (black star) and the cross-dating statistics for the 1897 AD end-date of the truncated floating chronology of derived from the four trunk posts of the wooden belfry. Each dot represents a qualified nearby oak master chronology. Dot size visualize the modified t-value (t_{BP} , Baillie & Pilcher 1973) while gray arrows show percentage of agreement (GLK%, Eckstein and Bauch, 1969) in decimal steps. Inset map shows the location of Hungary (black) within Europe. (The base map has been created by the web-tool provided by ArcGIS.)

1. ábra: Szokolya-Királyrét (fekete csillag) elhelyezkedése és a fa harangláb négy oszlopából készített csonkolt évvűrűszélesség kronológia keresztdatálási statisztikái az 1897-es végdátum esetén. Minden pont egy ellenőrzött közeli tölgy alapkronológia érvényességi területének központját jelöli. A pontok mérete a módosított t-értéket (t_{BP} , Baillie & Pilcher 1973), míg a nyilak az együttfutási százalékot (GLK%, Eckstein and Bauch, 1969) szemlélteti, szürkefokozatos skálával, tízes lépésekben. (Az alaptérkép egy az ArcGIS honlapon elérhető térkép-megjelenítő szolgáltatás segítségével készült.)

To strengthen the chronology with additional qualified samples should be obviously rewarded.

There are a few regions in Hungary and the adjacent border zone where wooden constructions are usual, primarily in rural/vernacular architecture. These constructions are highly valued both as elements of the cultural heritage and from ethnographic viewpoint. The paper briefly reports dendrochronological findings of a recently reconstructed wooden belfry from Börzsöny Mts. which region was a “white area” in all recent inventories listing the remarkable historical wooden constructions of Hungary or the surrounding Carpathian Region (Kovács 1999, 2006, Sisa 2001) despite photographic evidence proved the studied belfry’s almost centennial history. Dendrochronological analysis on four disk samples obtained from the main trunk posts during the reconstruction activity helped to prove the local

origin and to estimate the earliest possible felling date of the used timber.

Material and Methods

Belfry of Szokolya-Királyrét

The site (N 47.894°, E 18.977°) is located in the Börzsöny Mts. (**Fig 1.**). The construction has a classical structure with four trunk posts reinforced with Andrew’s cross beams (**Fig 2.**). Used timber is oak. A historical photograph affirms that the belfry has already been erected between 1926 and 1931 (**Fig. 2.**).

Reconstruction was completed in 2012. The structure was placed on a new pedestal and the partially rotten basal part of each post was removed. These four disk samples provided the material for dendrochronological analysis.

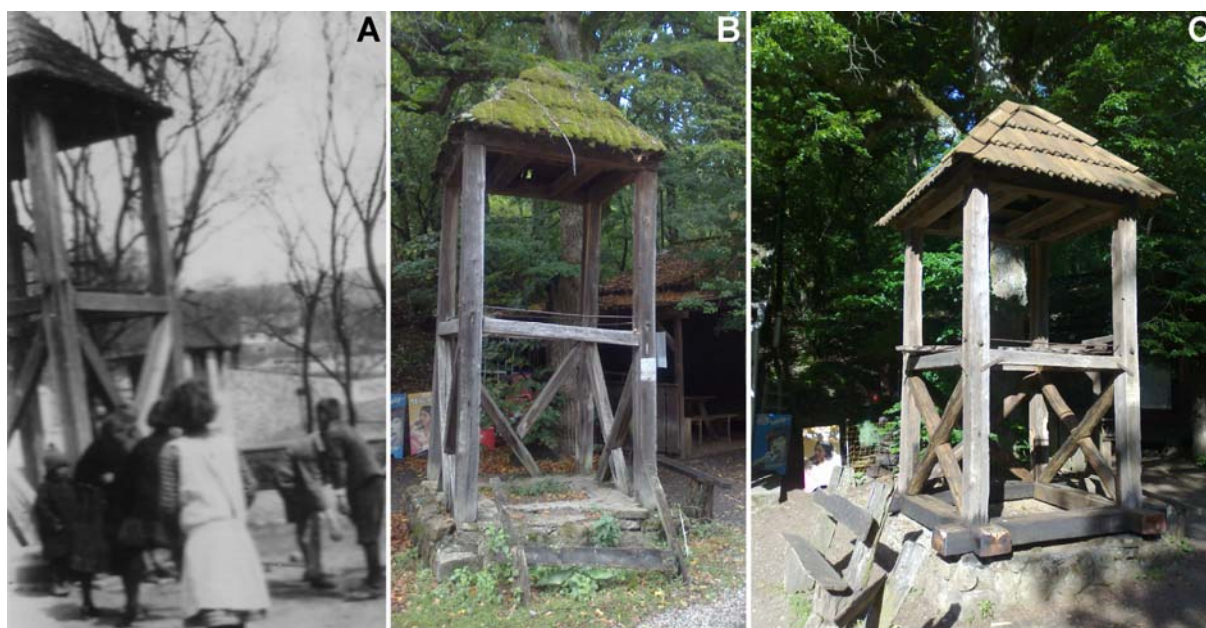


Fig. 2.: Wooden belfry of Szokolya-Királyrét. A) Historical photograph from Cuno Hoffer's inheritance. The date of the historical photo can be between 1926 and 1931. The belfry before B) and after C) the reconstruction works (courtesy of Mr. Zsolt Barton).

2. ábra: A Szokolya-királyréti fa harangláb. A) Archív felvétel Hoffer Cuno fényképi hagyatékából. A kép készítési dátuma 1926 és 1931 között lehet. A harangláb a felújítási munkálatok megkezdése előtt B) és után C) (Barton Zsolt jóvoltából)

Sample preparation and cross-dating

Disks' surface was processed by machine operated abrasive belts with gradually finer grit size until tree-ring structure became clearly visible. Samples had neither bark nor any sapwood rings. Tree-ring sequences were carefully checked and rings were counted (Stokes and Smiley, 1968). A LINTAB digital-positioning table and TSAP Win 4.68 software (Rinn, 2005) were used to measure the annual ring widths with a precision of 0.01 mm, as well as for cross-dating the growth series by graphical comparison against each other. Two radii were measured on each disk. Measurement and cross-dating was done using the facilities of the Budapest Tree-Ring Laboratory (Eötvös University, Dept. of Palaeontology) (Kázmér & Grynaeus, 2003).

The built chronology was compared to nearby oak master chronologies to date and trace the potential distal/proximal origin of the used timber. Eight quality checked oak master chronologies were involved (**Table 1.**):

This spatial synchronization was managed by the Hungarian Dendrochronological Laboratory. The *a priori* knowledge provided by the historic photo was respected and latest date was constrained not to be later than 1931.

Standard dendrochronological statistics such as percentage of agreement (Gleichläufigkeit%, Eckstein & Bauch 1969) and modified t value (t_{BP} ,

Baillie & Pilcher 1973) were used to evaluate cross-dating results.

Results and Discussion

Assessment of the belfry sample

Number of counted complete rings in the disks ranged between 82 and 93 (**Fig. 3.**). Nevertheless an additional, incomplete, ring was also observed on the edge of each disk. Lack of sapwood rings proved that the raw material was processed before utilization and sapwood was removed. Extended overlap of the four samples' synchronised series spanned 98 years. Regarding that both ends of the established floating chronology are covered by sole series and visual comparison has already shown that common signal is still lacking at the juvenile rings, the full chronology was truncated. A 88-ring section only (see **Fig. 3.**) was entered into the cross-dating procedure to minimize the risk of spurious statistical significance.

Dating the timber, estimating the construction date

Cross-dating against the oak master chronologies provided clear indication for the origin of the wood both for time and space. The best synchrony was found when the youngest cross-dated ring was assigned to 1897 AD. Obtained statistics with the nearest master chronologies were: i) Central Hungarian Oak Chronology (GLK%=80.5; $p<0.001$; $t_{BP}=7.25$) ii) Balaton Oak Chronology (GLK%=75; $p<0.001$; $t_{BP}=6.9$).

Table 1.: Cross-dating statistics with nearby oak master chronologies when last ring of the truncated chronology build from the Szokolya-Királyrét belltower is set to 1897 AD. Overlapping period is equal to the full length (88 yrs) of the except Udvarhelyszék chronology (33 yrs).

1. táblázat: A Szokolya-királyréti harangláb tölgymintáiból készített kronológia és a közeli tölgy alapkronológiák között számított szinkronizálási statisztikák. Az átfedő évgűrűk száma 88 év kivéve az Udvarhelyszék kronológia esetében ahol csupán 33.

Master chronology	Ref.	GLK% / p-value	t _{BP}
Central Hungarian	Grynaeus 2011	80.5 / p<0.001	7.25
Balaton Highlands	Kern 2007	75 / p<0.001	6.9
Vienna Basin	Geihofer et al. 2005	69.5 / p<0.001	5.95
Maramureş	Baboş & Eggertsson, 2002	63 / p<0.05	1
Moravia	Kolár et al. 2012	61.5 / p<0.05	2,51
Nyírség	Kern et al. 2013	53 / -	4.4
East Slovenia	Čufar et al. 2008	53 / -	0.6
Udvarhelyszék	Botár et al. 2013	50 / p<0.1	2.2

Mapped distribution of t_{BP} and GLK% values further emphasize the waning similarity against farther references (**Fig. 1., Table 1.**). The strongest statistical agreement was found with the Central Hungarian Oak Chronology which represents an oak dendrozone covering also the Börzsöny Mts. (Grynaeus 1996, 2002). The Central Hungarian Oak Chronology in this period pools samples dominantly from the Buda Hills. Therefore this result suggests that the used timber cannot be transported from a remote region more likely locally exploited timber was used in the construction.

Taking into account that the 1897 AD date was obtained for the youngest ring of the truncated chronology, we assign the date of the unmeasured incomplete outermost ring as 1902 AD. In order to estimate the felling date of the tree we had to employ a correction due to the lack of sapwood rings. The average number of rings in sapwood of oaks in Hungary was estimated as 17 +2/-5 (Grynaeus 1996, 2002).

Recent local samples suggest that this general rule is valid also in the Börzsöny area (Grynaeus 1997). Consequently, the possible felling date of the youngest tree can be estimated between 1914(=1902+(17-5)) and 1921(=1902+(17+2)) taking into account the most probable range of normal sapwood rings.

The potential date of construction is between 1915 and 1930. Since one of the trees used as trunk post most probably was still alive at 1914 (i.e. the earliest possible felling date) and the archive photo constrains the construction date before 1931.

Importance of the samples

Studied samples fit a relatively poorly covered 19th century period of the Central Hungarian Oak Master Chronology. Sample depth was critically weak, especially from 1872 and 1890 when less than five samples supported the chronology (**Fig. 3.**). This weak replication not only hampered any potential (dendro)climatological application (Boa 2010, Grynaeus, 2011) but even the robustness of the master chronology could have been questioned. The 1880s, represented by only two series, was definitely the poorest covered decade of the entire chronology. Owing to the belfry sample set, replication remarkably improved (**Fig. 3.**). The minimum replication increased to five and only a triannual period is covered by this low sample depth. It is worth to emphasize that the improved section coincide with the overlapping period of living and historical material (Tegel et al. 2010) lending additional importance to them.

Acknowledgement

Thanks for support from “Lendület” program of the Hungarian Academy of Sciences (LP2012-27/2012). Zsolt Barton (IPOLYERDŐ Zrt.) is acknowledged for the provided samples while Mihály Gyurcsik (mayor of Szokolya) is acknowledged for the electronic copy of the archive photo used in **Fig. 2.** Constructive review from András Morgós and Miklós Kázmér helped to improve the quality of the paper. This is contribution No. 10 of 2ka Palaeoclimatology Research Group and No.23 of Budapest Tree-Ring Laboratory.

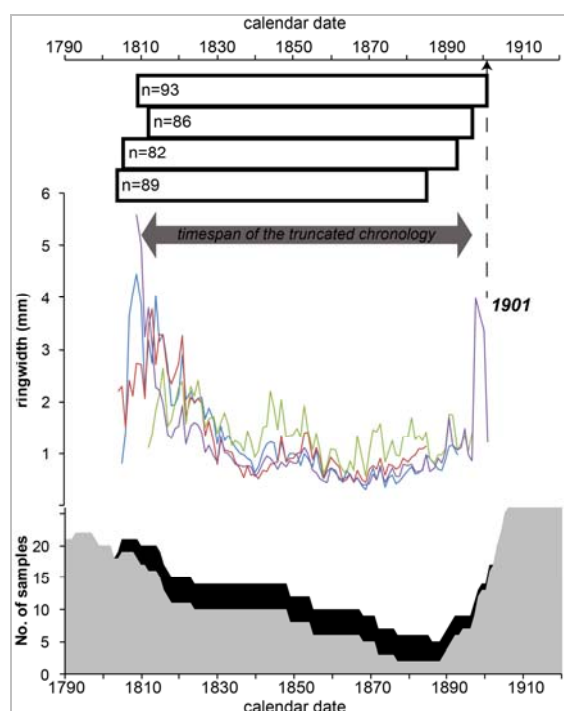


Fig. 3.: Measurement series of four trunk posts of Szokolya-Királyrét wooden belfry. Gridbeam plot shows the span of the series. The date assigned to the last measured ring is also indicated. Number of measured rings is given in each grid. Mean ringwidth series of each sample are plotted in the middle graph. Belfry's replication (black) has been shown as cumulated on sample depth chart of the Central Hungarian Oak Chronology (gray) over the 1790-1920 period in the bottom graph.

3. ábra: A Szokolya-királyréti fa harangláb négy oszlopának mérési adatai. A sáv diagram a faminták által fedett időtartományt mutatja. Az utolsó mért évgyűrűhöz rendelt dátumot is feltüntettük. A mért évgyűrűk száma a mintát jelző téglalapban olvasható. Az átlagos évgyűrűszélesség sorokat a középső grafikon mutatja be. A legalsó ábra a harangláb négy mintáját (feketével) és a Közép Magyarországi Tölgy Alapchronológia 1790-1920 közötti időszakára vonatkozó mintaszám adatait (szürkével) ábrázolja halmozott módon.

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