DENDROCHRONOLOGY IMPROVES UNDERSTANDING OF THE CHARCOAL PRODUCTION HISTORY, INCREASING THE TOURIST POTENTIAL IN THE DRAHANY HIGHLANDS

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Abstract

Over the last two years, three selected forest sites from Drahany Highlands were examined for traces of human activity. The most frequent traces found, and common to all three sites, were remains of charcoal production. This paper provides an anatomical and dendrochronological analysis of the charcoals found in two charcoal pile remains from each site. The species composition of the charcoals at the southern site was dominated by oak, followed by birch and hornbeam. Fir was more common than oak, beech, poplar, birch and hornbeam at the central site. Fir and beech were found at the northern site. By using dendrochronology, 23 fir, oak and beech charcoals were dated with the oldest sample coming from a central site and dated from the period 1753–1758. Charcoals from the three other charcoal piles fell into the first half of the 19th century. Radiocarbon dating of charcoals selected gave a very wide age range (1640–1955), except for one case (1399–1435). Providing information on the age of a charcoal pile can help raise public awareness and interest in viewing the sites where charcoal burners used to be active in the forests.

Key words: Charcoal pile, culture heritage, tree rings, wood species, tourism

Introduction

Traces of human activity in forests have been searched for in three selected sites in the Drahany Highlands during the last two years. Most frequently, ponds, fortified as well as unfortified settlements, extraction sites, sites of raw material processing and agricultural management have been identified. The most frequent sites, common to all the three sites examined, were remains of charcoal production - charcoal piles or rather charcoal pile remains, proving that charcoal production was a frequent activity in the area, even in recent times (Bobek et al., 2021).

When tourists hike through the forests, they hardly ever have a notion that the remains of charcoal piles can be quite easily distinguished within the countryside. Such sites are of an oval or round shape, usually recessed in a slope, and their surface consists of a mixture of crushed charcoals, soot and dirt (Matoušek and Woitsch, 2020). However, as the charcoal piles were made in managed forests, where the management activities still continue, their remains are gradually disappearing.

That might be the reason why the research into charcoal piles has recently started to be of more interest in Central Europe. Most often, their number, location in the terrain, size and charcoal species composition have been documented (e.g. Raab et al., 2015; Matoušek and Brejcha 2017; Matoušek and Woitsch, 2020). Although a suitability of dendrochronological dating for carbonised wood is supposed (Blondel et al., 2018), it has scarcely been used to date charcoal piles in the Czech Republic (Matoušek and Brejcha 2017; Bobek et al., 2021). The main aim of this paper is to present the dendrochronological dating of six selected charcoal pile remains in the Drahany Highlands as a tool to increase the tourist potential of the area and to propose the protection degrees of the sites of traditional charcoal production.

Materials and methods

Three sites, each 5 km^2 in area, have been selected in the Drahany Highlands (Fig. 1), based on the forest cover, terrain modularity, altitude gradient between the sites, the differing ownership structure in the past, and the existence of archived information on the occurrence of historic structures and relicts of management activities.

For a detailed investigation, two charcoal piles have been chosen from each site (Fig. 1) so that they represented the site as regards the dominant forest type, average charcoal pile size along and perpendicular to the contour line, the mean slope gradient; additionally, a thick layer of charcoals was

detected on them and their borders were easily identified. The charcoal piles damaged by windfalls or forest machinery passage, those along the roads and paths or a steep terrain break were excluded.

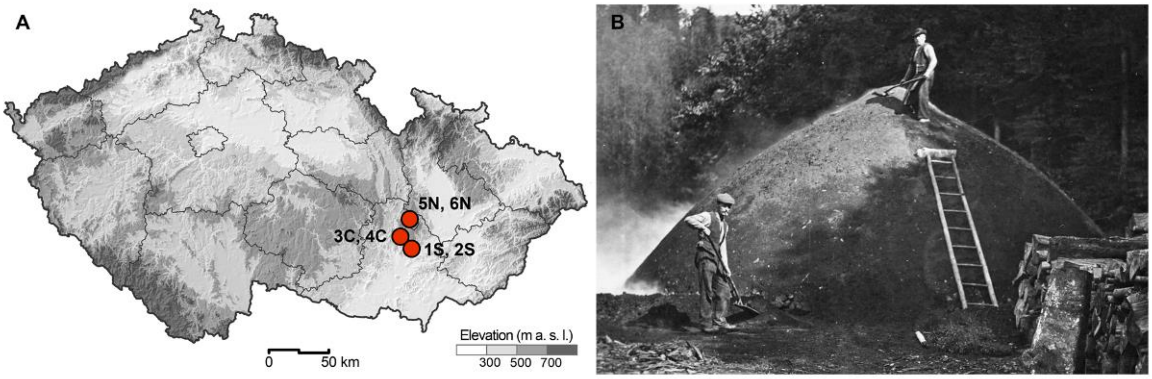

Fig.1: (A) The investigated charcoal piles on a map of the Czech Republic, (B) Thonet's charcoal pile, Halenkov-Dinotice (photo archive of the Wallachian Regional Museum, photo: K. Puszkailer).

The archaeological survey of the selected charcoal piles was conducted in a form of a longitudinal half-metre-wide probe, which led from the approximate centre of the pile beyond the fill (a slope formed by charcoal raked away from the pile). The stratigraphic layers were uncovered mechanically and each separately. The charcoals for anatomical and dendrochronological analysis were taken from the uncovered layers and the fill.
The charcoals were deposited in a moist environment and those that contained at least 10 tree rings were then chosen for dendrochronological dating. The cross section of the samples was worked with a razor blade or a break was made for a good visibility of the tree rings. The samples were processed in compliance with the standard dendrochronological methodology (Cook, Kairiūkštis 1990). The mean TRW series were dated according to the Czech fir, spruce and oak TRW chronologies (Kyncl, 2016). The samples were taxonomically identified based on wood anatomical features characteristic of the species (Schweingruber, 1990) under an episcopic microscope. At the same time, samples of charcoals from the charcoal piles were selected randomly and sent for ^{14}C analysis.

Results
The charcoal piles were located at an altitude of 346–586 m asl. All the charcoal piles we have investigated were recessed in the slope, had an oval shape and a size along the contour line of 6–13 m. Their distance from the nearest road and the nearest water current was 10–76 m and 14–105 m, respectively (Tab. 1).
In total, 1016 charcoal fragments have been analysed anatomically. The charcoal piles at site SOUTH were dominated by oak charcoals (49 %), followed by birch (34.5 %) and hornbeam (13 %). The highest variability of charcoals (6 species) was recorded at the CENTRAL site - with dominance of fir (40.7 %), oak (22 %) and beech (17.7 %). By contrast, only two species were observed at site NORTH, fir (70.2 %) and beech (29.8 %) (Fig. 2).
100 charcoals from all charcoal pile remains were analysed by dendrochronology. Out of them, 23 charcoals were dated successfully (JIH 0, CENTRAL 12, NORTH 11) (Tab. 1, Fig. 2). The oldest samples dated by dendrochronology came from the period after 1676; the most recent were from the first half of the 19th century (Tab. 1). The samples successfully dated most frequently were fir (11 samples), oak (10) and beech (2). By contrast, radiocarbon dating yielded a very wide range of results, from 1640 to 1955, except for one sample, which was dated to the first half of the 15th century with a calibrated age tolerance of 36 years (Tab. 1).

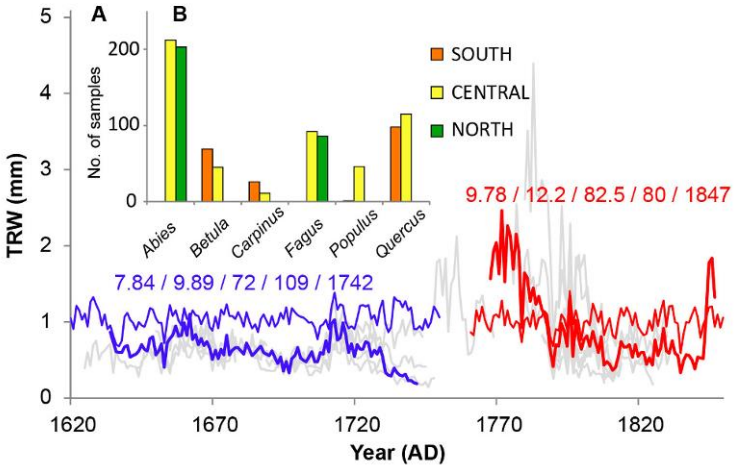

Fig. 2: (A) Synchronization of oak (blue) and fir (red) mean TRW series (bold) from charcoal piles with Czech TRW oak (blue) and fir (red) chronology (T-test according to Baillie & Pilcher (TBP), T-test according to Hollstein (THO), synchronization of tree-ring series in % (Gleichläufigkeit), overlap and date year, (B) the results of anatomical identification of charcoal from each site.

Tab. 1: A detailed overview of all 6 charcoal piles (S – SOUTH, C – CENTRAL, N – NORTH) including GPS, altitude, size, distance form the road and water, slope, current type of forest, number of dendrochronological analysed samples, species, number of dendrochronological dated samples, the youngest dendrochronological dating, and ^{14}C dating of the charcoal piles.

charcoal pile (site)	GPS	altitude (m asl)	size - fall line	size - counter line	dis. from the road (m)	dis. from the water (m)	Slope (°)	current type of forest	no. of analysed charcoals	no. of dendro. dated samples	the young. dendro. dating	^{14}C dating
1S	N 49°14'0.67"; E 16°49'33.13"	446	4	6	26	54	8.8	mixed	2 (oak 1; beech 1)	0	undated	1399–1435
2S	N 49°13'34.81"; E 16°49'3.73"	390	6.5	8.5	10	14	19.6	mixed	2 (oak 2)	0	undated	1700–1955
3C	N 49°20'44.54"; E 16°39'44.17"	346	10	12.5	30	56	9.3	mixed	68 (fir 12; oak 55; beech 1)	10	1753–1758	1640–1954
4C	N 49°20'22.15"; E 16°40'58.34"	446	10	12	17.5	62	9	mixed	9 (fir 2; beech 7)	2	after 1807	1666–1950
5N	N 49°25'11.13"; E 16°46'24.38"	549	10.5	13	76	18	8.6	conifer.	7 (fir 6; beech 1)	3	after 1848	not analysed
6N	N 49°25'24.82"; E 16°46'3.29"	586	12	12	32	105	7.7	conifer.	12 (fir 12)	8	after 1832	1667–1950

Discussion

Most of the charcoal pile remains were located away from the main transport routes, often in places with poor access – e.g. below a hill top, on a slope – and because of the high density of charcoal production sites, we assume the wood burnt in them was gathered from nearby (Rybníček et al., in review). Therefore, the anatomically identified charcoals provide us with very good evidence that the species found used to grow there, in the vicinity of the piles. Additionally, the results agree with the potential species composition, as the representation of oak decreases from the south towards the north, gradually favouring fir and beech.

The dendrochronological dating of charcoals from individual charcoal pile remains can precisely identify the season of the pile use only if several dated samples with a waney edge from the same period are found in one pile (Rybníček et al., in review). Such a situation did not occur in any of the six investigated charcoal pile remains. That is not surprising as the waney edge is rarely preserved in charcoal samples (Raab et al., 2015). Dating can be relatively precise if the samples contain sapwood tree rings as their number is typical of individual regions and it ranges from 5–25 in the Czech Republic (Prokop et al., 2017). Charcoal pile 3C, where oak samples dominated, yielded three successfully dated samples with sapwood tree rings. Therefore, the period when the trees were felled could be specified (1753–1758) (Tab. 1). Another case where a charcoal pile can be dated quite precisely even without a waney edge is when the youngest tree rings of several samples demonstrate approximately the same period (charcoal pile 6N). Although the exact number of missing tree rings in samples cannot be identified with certainty, they provide a good idea of the period when the charcoal pile was used (Tab. 1). In the case of two charcoal piles (4C and 5N), the samples were dated from a wider period, therefore, the time of their use could not be determined more exactly. No samples from charcoal piles 1S and 2S could be dated - however, only two samples had been taken from them (Tab. 1).

In the case of charcoal pile 1S, radiocarbon dating has yielded a very specific period (1399–1435). However, in all the other cases, radiocarbon dating produced a very wide range of results, from 1640 to 1955 (Tab. 1). Beyond 1650, the radiocarbon calibration curve is characterised by strong wiggles, followed by a broad plateau, and finally a sharp drop (Světlík et al., 2019). As a result, the calibrated age probability distributions for these post-1650 piles are very wide and it is not possible to differentiate between the age of piles postdating 1650 CE (Deforce et al., 2021).

Conclusion

Out of the six charcoal piles investigated within the Drahany Highlands, four were successfully dated using dendrochronology. In two of them, the period when they were used for charcoal production could be specified more precisely. Dating of charcoal piles can help raise tourist attraction of the site given, as the people can see the place where the traditional charcoal production craft was conducted not so long ago. The results of this research can also help to propose a protection degree of these sites so that the remains and reminders of charcoal production could be maintained for next generations.

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Souhrn
Na třech vybraných zájmových územích v oblasti Drahanské vrchoviny byly hledány relikty hospodářské činnosti člověka v lesích. Nejčastějším objektem, který byl společný pro všechny tři území, byly plošiny po výrobě dřevěného uhlí, které nazýváme milířiště. Příspěvek se zabývá anatomickou a dendrochronologickou analýzou uhlíků, které byly odebrány vždy ze 2 vybraných milířišť na každém zájmovém území. V druhovém složení uhlíků na lokalitě JIH dominoval dub, dále bříza a habr. Na lokalitě STŘED se nejčastěji vyskytovaly jedlové, dále dubové, bukové, topolové, březové a habrové uhlíky. Na lokalitě SEVER byly pouze jedlové a bukové uhlíky. Dendrochronologicky se podařilo datovat celkem 23 jedlových, dubových a bukových uhlíků ze čtyř milířišť. Nejstarší datovaný uhlík pocházel z lokality STŘED a byl datován do období 1753–1758. Vzorky z dalších tří milířišť byly datovány do období první poloviny 19. století. Radiouhlíkové datování, s výjimkou jednoho případu (1399–1435), poskytlo velmi široký interval datování (1640–1955). Určení stáří milířišť může pomoci zvýšit zájem turistů o návštěvu lokalit, kde se ještě v nedávné minulosti běžně provozovalo tradiční uhlířské řemeslo. Výsledky tohoto výzkumu mohou přispět při případném návrhu stupně ochrany těchto lokalit, tak aby mohly být dochovány pozůstatky po výrobě dřevěného uhlí i pro další generace.

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