THE SUBFOSSIL TRUNK OF CHIARANO (TV)

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1. Introduction

On the occasion of maintenance work by the Consorzio di Bonifica Basso Piave on the banks of the Piavon canal in 2008, a large tree trunk was dug up in the municipality of Chiarano (TV) It was found lying in the mud 3 metres below ground level, on a bend of the watercourse near Villa Zeno (Figure 1).

The trunk is around 15 metres in length, with an approximate diameter of 50 cm, lacking branches and roots, with a carbonized exterior appearance. Its surface is dark and deeply cracked, while the interior is still practically intact despite some cracks that penetrate deeply into the interior of the wood.

The trunk appears to bear signs of felling and debranching, so it cannot be the remains of a fallen tree. The obviously lengthy time it had been buried and its discovery in an area full of Roman (Oderzo is nearby) and Venetian relics, aroused interest in studying the find that, due to the location, may be of archaeological or archaeobotanical interest.

It was recovered by the owner of the surrounding land, Mr.Giovanni Moro, and left in the open prior to being used. Before being cut into planks, he kindly agreed to a cross-section slice being removed for the purposes of this study (Figure 2).

Figure 1. The trunk after its recovery from the canal.

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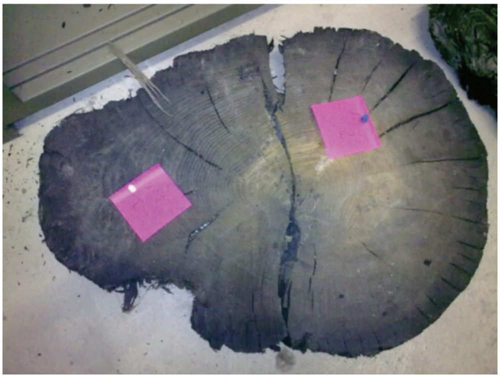


Figure 2. Slice used for the study.

According to the standard UNI 11205:2007 [1], the study involved identification of the woody species, its physical characterization, dating and evaluation of the deterioration.

2. Materials and methods

The slice appears well preserved, with only the outer area being carbonized, friable and deeply cracked. The colour tones vary from black on the outside to natural light brown in the central area.

Samples were removed according to the different tests to be performed (Figure 3). Samples for the anatomical characterization and determination of the woody species, of approximately 1x1x1 cm were taken from the outer area immediately beneath the deteriorated part; for the physical characterization, 2 irregular-shaped pieces were used from the same area in which the samples for microscopic analyses were taken. The ash content was determined on samples taken from the outer deteriorated area and the underlying parts. Determination of ash content was also performed on a control sample taken from a plank of recent common oak.

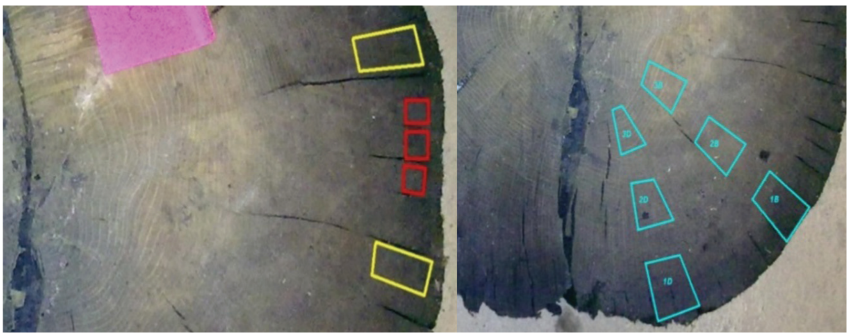


Figure 3. Testing: samples for the anatomical analyses are in red, for the physical characterization in yellow, for the ash analysis in blue. Material was also taken for ash analysis from the outer area (not shown).

The anatomical characterization was performed under the microscope on samples prepared according to standard methods, cutting three sections with a microtome and mounting them on slides without staining.

The physical characterization involved complete saturation of the samples through prolonged immersion in water until they sank, after which the volume was determined according to the Archimedes' principle. They were then dried in an oven at 103°C until reaching constant weight.

The following formulas were then used:

Basic density $BD=P_0/V_{fr}$

Residual basic density $RBD=100*Db/Db_{rif}$, with $Db_{rif}= 0.57gr/cm^3$

Maximum water content $MWC=100(P_u-P_0)/P_0$

The ash content was assessed on finely ground wood coming from different areas of the slice in a muffle kiln at 500°C.

Dating was done using both dendrochronology and radiocarbon dating. The dendrochronological investigation was conducted by measuring the ring widths along 5 different directions with a LEICA S8AP0 Dendrochronograph available at the TESAF Dept. of the University of Padua. The subsequent elaborations were performed at the Dendrodata s.a.s. laboratory in Verona, following classical dendrochronology procedures [2-4], according to the standard UNI 11141 [5], and using TSAP and CATRAS programs [6].

The radiocarbon dating was done at the Centro di Datazione e Diagnostica (CEDAD) of the University of Salento using high resolution mass spectrometry on a sample taken from the outer part of the slice, selected and prepared at the Dendrodata s.a.s. laboratory.

3. Results

3.1 Identification of the woody species and evaluation of the biological deterioration

The anatomical characteristics point clearly to an example of deciduous oak. It is most probably common oak (*Quercus robur* L.), given the diffusion of this species in the area where the trunk was found and on the Veneto plain in general, even if it is not possible on the basis of the wood anatomy to exclude that it is sessile oak (*Q. petraea* L.) (Figure 4) [7]. The colour of the wood is typically blackish and from the outside inwards gradually becomes natural. If it lies in water for a long period of time, oak may develop a black coloration (*drowned oak*) due to the reaction of the tannins with the iron ions present in the water and sediment. This type of oak, typical of wood that remains for a long time in an acid and poorly oxygenated environment, was used in the past as an economic substitute for ebony in marquetry [8], while it is still sought-after for making items of furniture.

Under the microscope the cells appear to be well preserved, even if some areas are visible in which the cells present walls with slight bacterial attacks, surrounded by healthy wood. No soft rot from fungal attacks has been observed (Figure 5).

Figure 4. Transverse section, x40.

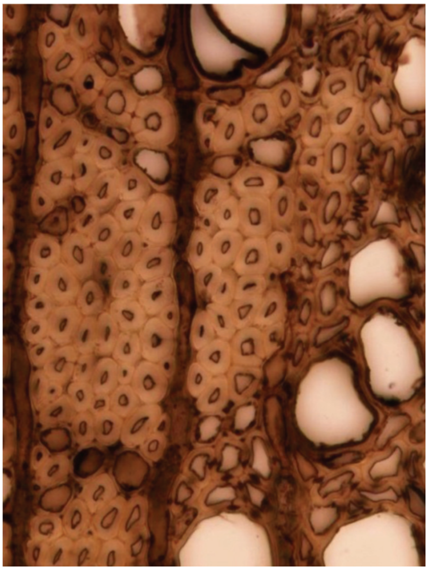


Figure 5. Transverse section, x400.

3.2 Physical characterization

Physical characterization is useful for quantifying the deterioration of archaeological wood that, having remained in a damp and poorly oxygenated environment for a long time, is especially subject to bacterial attacks that slowly consume the cell walls. The weight reduction and increase in the maximum water content, provide useful indications on the magnitude of biological attack [9]. The basic density is determined for saturated archaeological wood which, by measuring the dry weight of the specimen in relation to the saturated volume, eliminates any errors in determining the volume due to disintegration produced by the desiccation of the deteriorated wood [10]. The percentage ratio between the basic density and that reported in the literature for recent wood is an index of diminution of wall matter. Furthermore, if the walls are deteriorated they become thinner, while the porosity increases and consequently the amount of water that can be contained in the wood. So, as wall deterioration increases so does the maximum water content.

The basic density, residual basic density, maximum water content were therefore determined and compared with the data in the literature for the wood of recent common oak.

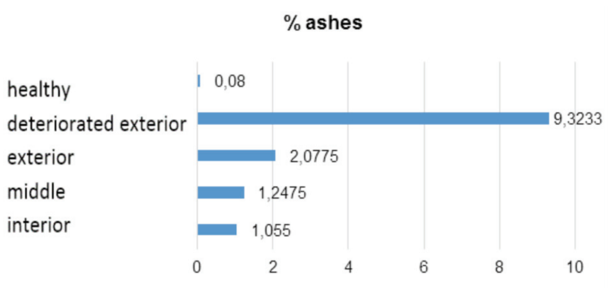
The basic density is just under that of reference, while the residual basic density is 91%, so the weight of the cell walls is only slightly reduced. The maximum water content is therefore lower than that determined on healthy wood (Table 1).

Table 1. Average values of the physical characterization tests. The MWC of healthy common oak was determined using the Tsoumis formula [11], assuming an anhydride density of 0.66 g/cm [12].

Ring middling 10^{-2} mm	Test sample	Current healthy wood
Db (gr/cm^3)	0.5217	0.57
Dbr (%)	91.5	100
MCW (%)	79.89	114.51

This contradictory situation can be explained by hypothesizing that the lengthy stay in the river sediment would have favoured the entry of inorganic matter in the wood, artificially increasing the weight and limiting the space available for water. The ash content, rather high in the outer part and lower in the more internal layers, confirms this hypothesis. Moreover, also in the innermost part values were always higher than in the literature data for recent wood (Table 2).

Table 2. Average values of the ash content in the different parts of the disc.



3.3 Dendrochronological dating

The slice is completely lacking sapwood (i.e. the most external part of the trunk), probably decayed. It provided a definitive sequence, 97 rings long (Table 3), obtained averaging the five directions measured (Figure 6).

Table 3. Dendrochronological parameters of the elaborated sequence.

Ring middling 10^{-2} mm	Standard Deviation	Autocorrelation	Sensitivity average
254.2	98.9	0.674	0.159

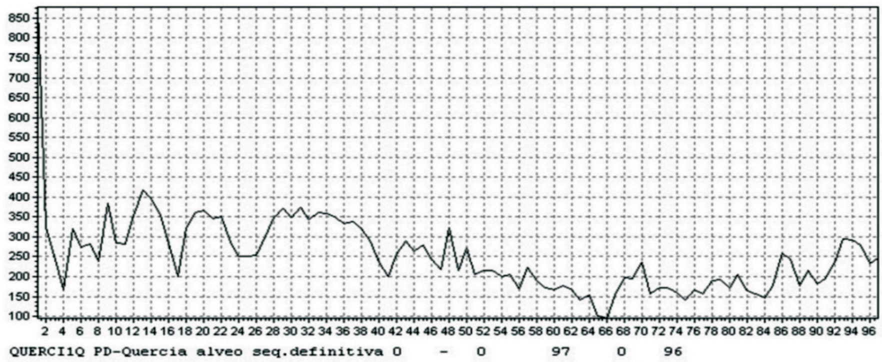


Figure 6. Average dendrochronological curve of the measured ring sequences. Chiarano – oak.

Deciduous oaks are in general particularly suitable for dendrochronological analyses, due to being ring-porous species that do not form false rings. Deciduous oaks also have steady features that facilitate dendrochronological elaboration and synchronization procedures, even between specimens with different origins [13]. Nonetheless, there are no available standard centuries-old curves of the oak valid for Italian regions. The synchronizations performed with chronologies and local curves present in the Dendrodata s.a.s. databank and the attempts to link up with the chronologies beyond the Alps have not allowed the find to be dated. However, good synchronization has been obtained with some curves, still not dated, elaborated for the city of Venice and ascribable to the 12th-14th century. The curve elaborated for the trunk from Piavon will be added to the Dendrodata s.a.s. databank (Veneto, recent centuries) for the future creation of an oak reference chronology [14].

3.4 Radiocarbon dating

In order to obtain a precise dating, radiocarbon dating of the outer rings of the disc was performed using high resolution mass spectrometry. The test provided a radiocarbon age of 795 ± 35 years B.P., corresponding to a calibrated chronology in the period between the second half of the 12th century and second half of the 13th century A.D. (2 s) (Figure 7).

4. Discussion and conclusions

The wood remains in the bed of the Piavon are those of a common-oak trunk of more than a century old, even if it cannot be precisely aged due to the absence of the outer sapwood rings. The last rings present on the find date to the period between the second half of the 12th and second half of the 13th century A.D. (2 s); the tree could therefore have been felled between the end of the 12th and early 14th century A.D.. It

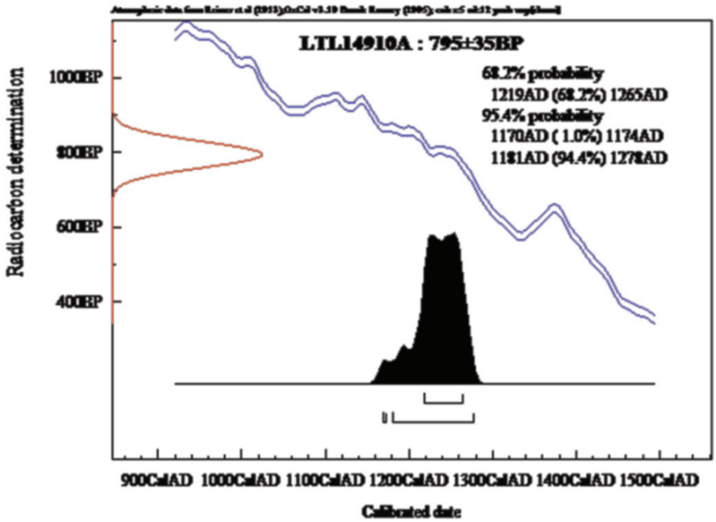


Figure 7. Calibration of chronology by radiocarbon data [15, 16].

clearly demonstrates signs of a very long stay in the mud, due to the carbonized appearance of the outer layer and the typical change in colour towards black.

The presence of signs of felling and debranching exclude that it fell by chance into the river. The straight shape and the dimensions are those of a trunk destined to be used in carpentry, whole or divided in planks.

The territory where the trunk was found is agricultural-rural land crossed by numerous irrigation canals. Nowadays, the Piavon is one of these, but it was formerly an important branch of the Piave, made up in succession by the Piavesella, Lia, Navisego and then the Piavon. In Roman times it was navigable, as proved by the discovery of structures of consolidation, consisting of wooden caissons and other riverbank systems, as well as a wharf in the south-western part of the town of Oderzo and was the means of communication of Oderzo with the lagoon [17]. After a disastrous flood in 589 A.D. which disrupted the hydrography of the entire low-lying plain, the Piavon was reduced to a small affluent of the Piave and was no longer utilizable. Around the 13th century, the Caminesi family, the local feudal lords and later the Republic of Venice reopened a channel, starting from a diversion of the river Lia, with the aim of reactivating the Piavon which by that time was almost atrophied, and reconnecting it with the old bed of the Piave. The Republic of Venice ordered the dredging and maintenance of the Piavon more than once: in the Venice State Archive there is a Decree dated 23 June 1447 that orders the cleaning and dredging of the Piavon canal to make it once again navigable and useful for the transport of timber to the area of Lido di S. Nicolò [18].

In medieval times much of the Veneto plain was covered by mixed woodlands, in which the main tree species were common oak (*Quercus robur*), together with hornbeam, ash, sycamore, poplar and elm. The Piave and Piavon flowed through these woodland areas. The Republic of Venice took an active interest in the plains woodlands after 1400, as they supplied the important oak assortments (both common and sessile oak, *Q. petraea*) required for shipbuilding. The management of these woodlands was regulated by laws that specified the methods for the various types of timber required: straight planks, or "*stortame*" (twisted) for the uses that required curved pieces (Figure 8).

Figure 8. Shape and proportion to give the oaks to produce the shipbuilding assortments. From the Atlante della Terminazione del 1777 (Tip. Pinelli, Venezia 1778) [18].

The oaks were carefully listed in the cadastres, used to census the woodlands of the Republic of Venice, from the 15th century. The oaks were sorted into branded, i.e. destined for the naval industry, and non-branded, for other uses. In the Oderzo area, 8684 branded oaks and 11499 non-branded were registered by the Surian cadastre (1569-70). In particular, the villa at Chiarano had an oak woodland of 18 hectares (Figure 9).

CATASTO SURIAN (1569-70)

Territori	Ville e località con bosco	boschi	roveri* bollate	roveri* non boll.	sparsi e in boschetti**	superficie, Ha*** tot.	superficie, Ha*** media bosco
Padovano, Vicentino, Mirano	83	150	59.640	2.555	787	622	4,1
Mestre e Castelfranco	32	106	31.108	13.035	–	442	4,1
Treviso	77	160	124.221	70.881	11.966	1.950	12,2
Noale	12	21	1.866	7.820	sì, n.r.	97	2,1
Conegliano	16	58	27.707	–	16.855	277	10,7
Serravalle	1	1	8.156	3.838	18.853	120	120,0
Feltre e Belluno	25	31	21.189	9.607	1.777	308	10,0
Portobuffolè	14	42	31.524	18.791	55	503	12,0
Oderzo	19	25	8.684	11.499	sì, n.r.	202	8,3
Motta di Livenza	21	59	28.972	30.129	sì, n.r.	591	10,0
Friuli	86	213	171.582	10.031	22.798	1.816	8,8
medie	386	766	514.649	178.186	73.091	6.928	9,04
Montello, ettari						6.230	
Montona (Istria), ettari						1.738	
Totale dell'intero Dominio						14.896	

* esclusi tolpi e semenzali
** contate; frazioni della consistenza reale stimabile di almeno un terzo superiore
*** posta una densità media di 100 alberi adulti (≥ 35 cm di diametro) ogni ettaro

Figure 9. Surian cadastre [18].

The cadastres also cited the distances between the woodlands and the nearest watercourses, fundamental for transporting the trunks to the lagoon by floating. The Venetian maps also report these woodlands and their position with respect to the rivers (Figure 10) [19].

Figure 10. Part of a map of 1561 showing the woodland areas between Oderzo, Piavon and Ceggia [19].

Floating was a mode of transport via river widely utilized for timber in the past since Roman times and even until recently. In the case of the Piave, the first testimony of floating with rafts dates back to 1308. Venice required vast quantities of timber for building both houses and ships and for heating. The transport of timber from the mountain areas to the coast was entrusted to specialists, the *zattieri* (rafters), who exploited the small rivers and canals with a regular flow, including the Piavon, to transport the wood needed by the city. The trunks were assembled in rafts that were then loaded with other timber, animals and also passengers. At destination the raft was dismantled, the trunks were cleaned and sold with the cargo and the *zattieri* returned home on foot or in carts [20].

The trunk at Chiarano may have been part of a load of timber destined for Venice that was lost during the journey.

Acknowledgements

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Biographical notes

Tiziana Urso graduated in Biological Sciences at the University of Padua, she is a researcher and lecturer in xylology and wood technology at the same University. Her research interests are in the sectors of wood anatomy and technology, the characterization of woods and artifacts of historical, artistic and architectural interest, the anatomy and ecophysiology of forest plants. She has been the scientific head of various research programmes at local and national level. She is author and co-author of numerous publications in scientific journals, monographs and Italian and international conference proceedings.

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Tobia Scortegagna graduated in Biology (ordinary degree) in 2008 and Evolutionary Biology (master’s degree) in 2015 at the University of Padua. An expert artisan and passionate connoisseur of wood, he currently devotes himself to artistic woodwork in his small workshop on the hills above Vicenza.

Summary

This paper reports the results of the characterization of a subfossil trunk found buried in the mud of the Piavon canal, at Chiarano (TV), when dredging took place in 2008.

The trunk, of imposing dimensions, lacking branches and bark, has a black, deeply cracked and strongly deteriorated outer surface with a carbonized appearance, while internally it has the typical blackish colour of the so-called drowned oak. The studies have demonstrated that it is a tree belonging to the genus *Quercus*, common oak or sessile oak, that may have been felled between the end of the 12th and early 14th century A.D.. Determination of the MWC and residual basic density indicate that the deterioration decreases from the outside inwards; the ash content is high externally and diminishes moving toward the centre.

Nowadays, the Piavon is an irrigation canal, but in Venetian times it was navigable and was used for the transport of goods and timber. There were extensive woodlands of common oak and sessile oak all along the Piavon, the size and composition of which is documented in the Venetian cadastres, which also report the distances between the woodlands and the nearest water courses, proof of the importance of river transport for the timber. In particular, an 18 hectare oak woodland is recorded in the Surian cadastre (1569-70) for the villa at Chiarano. The oaks were used by the Republic of Venice mainly for the construction and maintenance of the shipping fleet.

The Chiarano trunk, given its age and the area where it was found, may therefore be a trunk felled in Venetian times, perhaps destined for naval use, which was lost during its transport by floating.

Riassunto

In questo lavoro si riportano i risultati della caratterizzazione di un tronco subfossile rinvenuto in profondità nel fango del canale Piavon, a Chiarano (TV), in occasione dei lavori di scavo del canale nel 2008.

Il tronco, di imponenti dimensioni, privo di rami e corteccia, presenta la superficie esterna profondamente fessurata, nera, fortemente degradata, dall'apparenza carbonizzata, mentre internamente ha la tipica colorazione nerastra della cosiddetta quercia annegata. Gli studi hanno dimostrato che si tratta di un albero appartenente al genere Quercus, farnia o rovere. La datazione al radiocarbonio e le analisi dendrocronologiche hanno collocato il periodo di crescita della pianta in epoca medievale, intorno al XIII secolo. La determinazione della MCW e della densità basale residua indicano che il degrado decresce dall'esterno all'interno; il contenuto delle ceneri è elevato esternamente, e diminuisce andando verso l'interno.

Il Piavon è attualmente un canale di irrigazione, ma in epoca veneziana era navigabile e veniva utilizzato per il trasporto di merci e legname. Tutta l'area lungo il Piavon presentava boschi di farnia e rovere di notevole estensione, la cui dimensione e composizione è documentata dai catasti veneziani, che riportano anche le distanze tra i boschi e i corsi d'acqua più vicini, a testimonianza dell'importanza del trasporto fluviale del legname. In particolare, nella villa di Chiarano, nel catasto Surian (1569-70) si trova censito un bosco di roveri di 18 ettari. I roveri erano utilizzati dalla Serenissima soprattutto per la costruzione e manutenzione della flotta navale.

Il tronco di Chiarano, considerata la collocazione temporale e la zona di ritrovamento, può essere quindi un tronco abbattuto in epoca veneziana, forse destinato all'impresa navale, andato perduto durante il trasporto per fluitazione.