

# Multicentennial regional oak chronologies for northern Italy: an updating

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**Abstract** – The Author describes the construction of 3 regional chronologies based on crossdated tree-ring series from woods coming from archaeological sites in north-eastern Italy.

The series have been dendrochronologically cross-dated and the chronologies dated by <sup>14</sup>C wiggle-matching. Two of them belong to prehistory: the time span of GARDA 1 is 2204-1829 ± 10y. cal BC and the time span of GARDA 3 is 1897-1678 ± 14y. cal BC. The early medieval chronology VENETO 1 spans the period 447-773 ± 21y. cal AD.

They allow to date exactly building activities on the Bronze Age pile-dwelling villages in the region of the lake Garda and the Early Medieval land-reclamation structures in the Lagoon of Venice and the Venetian plain.

## I. INTRODUCTION

In northern Italy, as well as in the rest of Europe, oak is the main wood species for prehistoric and historical archaeology, but the building of long and well-replicated oak chronologies is a long, exhausting and thankless work, mostly due to the absence of specific research projects.

Progress in the work relies mostly on woods recovery during large excavations in wetland or underwater contexts: therefore, the availability of suitable oak samples depends on the choice of settlement locations from ancient populations.

Moreover, the absence of primary or at least old forests in the region makes the creation of series anchored to the present a real challenge. At the present the only supraregional oak series, made from trees living in 4 stands from northern Italy, reaches back only the year 1815 AD (Martinelli, unpublished data).

## II. MATERIALS AND METHODS

The samples included in the regional chronologies were identified as deciduous oak, *Quercus* spp. but more often *Quercus* sp. Sect. *ROBUR*, *sensu* Cambini [1]. Almost all come from construction timbers from settlements investigated through wetland or underwater archaeology. Wood identification was carried out (mostly by Olivia

Pignatelli), according to microscopic features of Italian oaks, according to Cambini [1], who grouped 3 species in the Section *ROBUR* (*Quercus* sp. Sect. *ROBUR*): *Quercus robur* L., *Quercus petraea* Liebl., and *Quercus pubescens* Willd., hard to distinguish from each other solely on the basis of their wood anatomy.

Standard dendrochronological methods were followed [2,3,4]. Tree rings were measured from pith to bark-edge using the LINTAB device (F. Rinn, Heidelberg, Germany), to a precision of 0.01 mm. Data were recorded and processed using the software TSAP® [5] and CATRAS® [6]. The cross-dating of the sequences was performed both statistically and visually, at first between samples of the same structure, then between structures of the same site.

The building of regional chronologies was then accomplished through the comparison and the cross-dating between different site chronologies; subsequently, the selected original individual tree-ring width series were elaborated without any standardization, only removing the fast-growing early youth phase in some series, when necessary [7]. The average process was testes at every stage of the elaboration with the COFECHA program of the DPL - Dendrochronology Program Library package [8].

## III. THE REGIONAL CHRONOLOGIES

The oak regional chronologies illustrated in the paper were previously published by the Author in former versions, but have been recently improved in terms of length and replication thanks to still-ongoing tree-ring investigation at the Laboratory Dendrodata.

Due to the absence of a master oak chronology for northern Italy, their absolute date was attempted at first through teleconnection against the available oak master curves and regional chronologies north of the Alps, but unfortunately, none of the comparisons gave acceptable cross-matches [9].

Therefore all the chronologies, both prehistoric and historical, have been dated by means of <sup>14</sup>C wiggle-matching, which consists in the <sup>14</sup>C dating of selected group of tree rings [10,11,12].

The chronologies are presented in a chronological order, starting with the oldest one, belonging to the Bronze Age. Ironically, the prehistoric Italian chronologies are the

longest and best replicated ones, thanks to the increase of multidisciplinary research on pile dwellings in the last decades and the inscription of the serial and transnational site “Prehistoric Pile Dwellings around the Alps” in the UNESCO World Heritage List in 2011.

The GARDA 1 chronology was first published in 1996, covering the period 2171-1837 ± 10y. cal BC, built with the series coming from 7 different Early Bronze Age pile-dwelling villages in the region of the lake Garda [13].

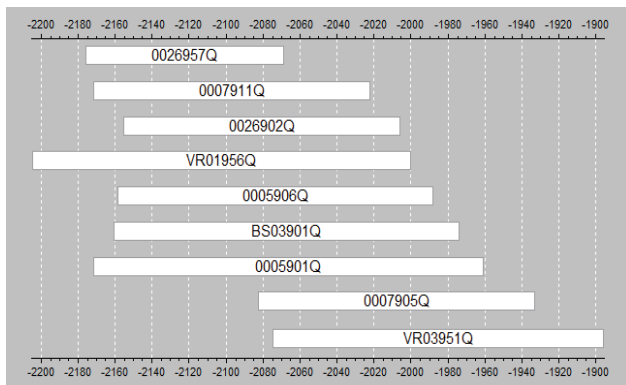


Fig. 1. Time spans of the nine tree-ring site chronologies from pile-dwelling villages in the regional chronology GARDA 1 – 1<sup>st</sup> part.

Actually the oak series was split in two sequences for dating purpose, GARDA 1 – 1<sup>st</sup> part (2171-1961 ± 10y. cal BC) and GARDA 1 – 2<sup>nd</sup> part (2061-1837 ± 10y. cal BC), because of their weak overlap between the years 2000 and 1960 cal BC. At present the new two series are as follow:

- The GARDA 1 – 1<sup>st</sup> part spans the period 2204 -1896 cal BC and includes 163 component series from 9 pile-dwelling sites in the provinces of Brescia, Mantua and Verona; the main contribution to the upgrading of the series comes from the settlements of Oppeano-sites 4C [14], the new site at laghetto del Frassino [15], and the recent excavations at the site Lucone D [16].

Other series from sites on the southern shores of the lake Garda (Corno di Sotto and San Francesco) [17, 18], or in the morainic region (Ca’ Nova di Cavaion) are dated against the chronology GARDA1-1st part; moreover the cross-dating and the subsequent insertion of series from the sites of Oppeano-site 4C and Dossetto di Nogara testify that the regional chronology is suitable for the absolute dating of oak samples both from the region around the lake Garda and the plain south to Verona (Media Pianura Veronese).

- The GARDA 1 – 2<sup>nd</sup> part spans the period 1993-1829 cal BC and includes 59 component series from 4 underwater pile-dwelling sites situated along the shores of the lake Garda, both in the southeastern part

(in Veneto) and the southwestern part (in Lombardy); the main contribution to the upgrading of the series comes from the site of San Sivino-Gabbiano (Brescia).

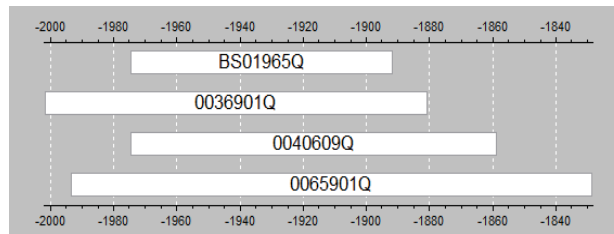


Fig. 2. Time spans of the four tree-ring site chronologies from pile-dwelling villages in the regional chronology GARDA 1 – 2<sup>nd</sup> part.

The overlapping between the two new series is now significantly shorter (1993-1896 cal BC), because of the removal of one series from Lazise-La Quercia, which alone constituted the first part of the old version of the curve. Actually, the cross-dating had been based on two long individual curves: the already quoted post from Lazise and the post 23 from Barche di Solferino [13].

The low statistical values of the cross-dating (GI. = 62% GSL=99% TV=7,7 TVBP= 2,2 TVH=2,2 CDI=11) prevents to definitively confirm the overlap between the two parts of the chronology. This uncertainty is likely to be attributed to the poor replication of the two series at both ends.

The same poor replication of series can explain the absence of overlapping also between the GARDA 1 – 2nd part and the GARDA 3 chronology which is dated from 1897 to 1678 ±14y. cal BC, following the wiggle-matching results elaborated on the IntCal13 calibration curve [19]. The GARDA 3 spans the period 1897-1678 cal BC and includes 46 component series from 4 pile-dwelling sites, in the south-eastern part of the lake Garda, all in the province of Verona.

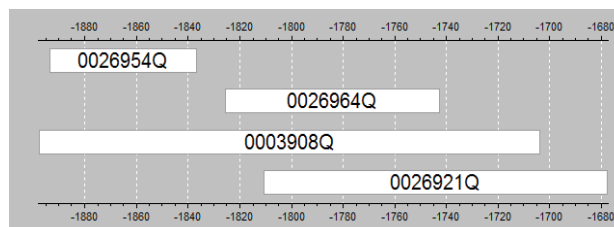


Fig. 3. Time spans of the four tree-ring site chronologies from pile-dwelling villages in the regional chronology GARDA 3.

A new contribution to the upgrading of the series comes from a new site investigated in 2014 on the western shore of the small lake Frassino, near Peschiera del Garda, in front of the well-known submerged site Frassino I. In this

pile-dwelling village posts of *Quercus* sp. Sect. *CERRIS* and *Quercus* sp. Sect. *ROBUR* (*sensu* Cambini) have been discovered, but only the series of Sect. *ROBUR* have been integrated in the chronology, although both the oak woods cross-date. Some series from two other sites in the southern part of the lake Garda area (Pezzalunga and Peschiera-Setteponti) are dated against the chronology GARDA 3.

For the period between 1550 BC and 500 AD, only single-site chronologies (even sometimes very long series) are available, despite the large number of investigations carried out on the archaeological sites in northern Italy.

However, the new longer version of the oak early medieval chronology for the Veneto region represents an important achievement. The VENETO 1 chronology was at first published in 2002 [11]; now it spans the period 447-773  $\pm$ 21y. cal AD and includes 64 component series from 9 archaeological sites. Built at first with series mostly from land reclamation structures in the Lagoon of Venice (Venice, Isola della Cura and Torcello) has been recently integrated with oak series from 2 sites with similar structures in the city of Treviso and from archaeological sites in the Paduan and Venetian plain. A pirogue found in the river Bacchiglione south from Padua was dated against the chronology too.

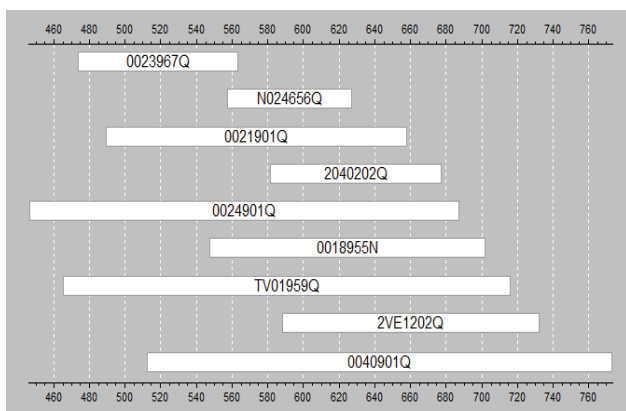


Fig. 4. Time spans of the tree-ring series from 9 archaeological sites in the regional chronology VENETO1.

The chronology proved to be useful for dating elm samples of the same provenance, which includes the provinces of Padua, Treviso and Venice [11]. We are currently working on promising tests on oak series from sites in the Emilia region.

These chronologies are very useful for archaeologists, as they allow to date exactly building activities on the Bronze Age pile-dwelling villages in the region of the lake Garda and the Early Medieval land-reclamation structures in the Lagoon of Venice and the Venetian plain.

#### IV. DISCUSSION AND PERSPECTIVE

Despite the validity of cross-matching between Italian oak series and Swiss and German reference chronologies for the last 2 millennia seemed to have been documented in few cases [20] no other Italian series could be dated through teleconnection till now [9].

Looking at the reasons of this failure together with foreign colleagues, we could highlight two main aspects: I) the comparison of modern oak chronologies from northern Italy and Slovenia shows similarity in the dendrochronological behaviour for the last two centuries; II) only the ca. 500 years long Slovenian oak chronology well teleconnects with the South German reference chronology [21]. Therefore, teleconnection between both sides of the Alps can be ascribed to supra-regional common factors affecting trees in a wider area, which can be recognized only from long and well replicated tree-ring series. The teleconnection, moreover, cannot work with short tree-ring chronologies, especially from trees which are highly affected by local growth (i.e. grazing, pollarding etc.) [9].

The lack of transregional cross-dating could be ascribed to ancient woodland management too: prehistoric people obtained timber from different stand structures and particularly from the understorey. Cross-dating is difficult, when analyzing both very narrow tree rings of trees grown in non-anthropized forests and very young trees from coppice-managed forests. The employment of suppressed trees with extremely narrow tree-rings for timber supply makes the crossdating work difficult; on the other side coppice may imply the use of young trees with few tree rings, which is hard to cross-date too [22]. However, because of the great difficulties in creating master curves anchored to the present in northern Italy, the teleconnection with the European oak references is the only possibility to absolutely date the floating Italian regional chronologies. In order to gain this challenge, the regional chronologies should be enlarged and reinforced with new series.

As already stated, the progress in the research mostly relies on the occasion of large excavations in wetland or underwater contexts. The availability of adequate oak samples from the different prehistoric and historical periods depends on:

I) the choice of settlement environment made by ancient populations, whereas only wet locations guarantee for the preservation of wood;

II) the opportunity of exploiting oak forests with large and old-aged individual trees, whereas old trees provide long tree-ring sequences.

That's the main reason why the elaborated oak regional chronologies refer to Early Bronze Age pile-dwellings and Early Medieval foundations in Padua, Treviso and Venice [23]. In both situations the exploited old woods seem to arise from a renovation, maybe from natural causes in Bronze age, almost surely from the

abandonment of intensive agriculture in the 4th-5th Centuries AD after the collapse of the Roman Empire in the second case.

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