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Prehistoric pile-dwellings in northern Italy: an archaeological and dendrochronological overview

Nicoletta Martinelli*

Abstract

Northern Italy is one of the territories affected by the “Alpine pile-dwelling phenomenon”, with about 120 settlements across the southern slopes of the Alps, from the regions of Piedmont (west) to Friuli (east). The villages were built on lake shores, in marshy areas and also in river-channel depressions, from the Neolithic to the end of the Bronze Age. The greatest and most extensive diffusion of pile-dwellings took place between the 22nd and 14th centuries BC during the Early and Middle Bronze Age and endured until the first phase of the Late Bronze Age.

Dendrochronology has enabled the construction of many site chronologies, spanning the period from the 22nd to the 15th century, which can be dated by the wiggle-matching technique, based on a combination of radiocarbon and dendrochronology. The advances made in tree-ring research in Italy are of great importance for the study of pile-dwellings throughout the Alps, because of the different periods of settlement in wetland environments. The flourishing of Italian pile-dwellings occurred in two periods from around 2050 to 1900 BC and from 1500 to 1300 BC, when north of the Alps the lake shores seem to have been abandoned.

Keywords: pile-dwellings, Neolithic, Bronze Age, dendrochronology, oak (*Quercus* spp.), prehistoric human occupation, northern Italy.

Résumé

L'Italie du Nord, avec ses 120 sites palafittes, distribués depuis la région périalpine du Piedmont à l'ouest, jusqu'au Friuli à l'est, est au cœur du phénomène palafittique alpin. Du Néolithique à la fin de l'âge du Bronze, ces sites occupaient les rives des lacs, des marais asséchés ainsi que les lits des cours d'eau. L'essor des palafittes se situe entre les XXII^e et XIV^e siècles av. J.-C., au cours de l'âge du Bronze ancien et moyen, et continue jusqu'à la fin de l'âge du Bronze. Grâce à la dendrochronologie, nous avons construit de nombreuses chronologies de sites qui couvrent la période allant du XXII^e au XV^e siècle av. J.-C. Ces chronologies sont datées par la méthode du *wiggle-matching*, basée sur la combinaison du radiocarbone et de la dendrochronologie. Les différentes périodes d'occupation de ces milieux humides, ainsi que les progrès faits par la dendrochronologie en Italie, sont très utiles pour l'étude du phénomène palafittique dans toutes les Alpes. L'essor du phénomène palafittique en Italie est daté de deux périodes: entre 2050 et 1900 av. J.-C. et entre 1500 et 1300 av. J.-C. Les rives des lacs du nord des Alpes sont occupées de manière contemporaine à la première période italienne, alors que durant la deuxième période, elles semblent abandonnées.

Mots-clés: palafittes, Néolithique, âge du Bronze, dendrochronologie, chêne (*Quercus* spp.), occupation humaine préhistorique, Italie du Nord.

1. INTRODUCTION

The chronological and geographical range of prehistoric pile-dwellings in Italy is ample: sites are known both in northern and central Italy, from the early Neolithic (La Marmotta on Lake Bracciano (Rome) dates to the second half of the 6th millennium cal BC) to the Iron Age, a couple of sites on the lakes of Latium date from the first

half of the 1st millennium BC¹. Pile-dwelling villages were built on lake shores, in marshy areas and also in depressions along valley floors and in ancient lagoons, but proper lake-dwellings are grouped into two main areas: the piedmont lakes of northern Italy and the volcanic lakes in central Italy. This paper focuses on northern Italian pile-dwellings, which belong to the “Alpine pile-dwelling phenomenon” and form part of the UNESCO transnational site *Prehistoric*

1. Museo Civico di Storia Naturale 1982, Baioni et al. 2014.

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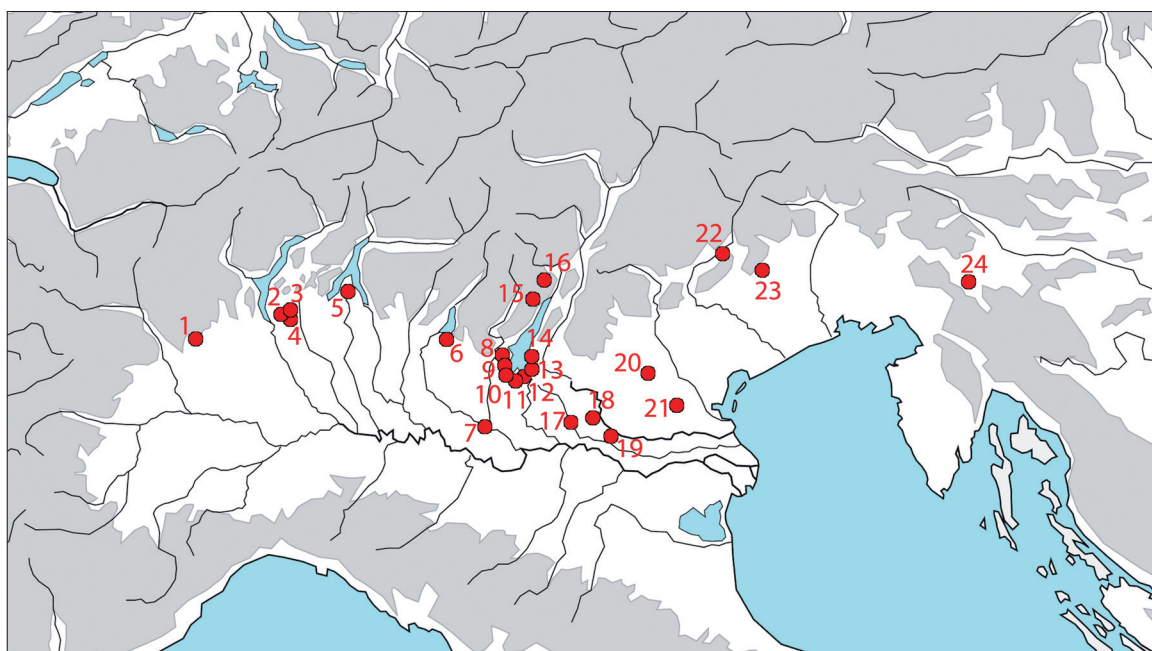


Fig. 1 – Location of pile-dwelling settlements in northern Italy; sites mentioned in the article and respective regional curves: 1) Viverone Vi1, 2) Il Sabbione, 3) Isolino Virginia and Bodio centrale, 4) Lagozza, 5) Torbiere di Bosisio Parini, 6) Iseo, 7) Castellaro del Vho, 8) Lucone di Polpenazze (GARDA1), 9) Padenghe, 10) Lavagnone (GARDA1), 11) Barche di Solferino, Bande di Cavriana (GARDA1) and Pezzalunga (GARDA3), 12) Belvedere di Peschiera (GARDA1) and Frassino (GARDA3); 13) Ronchi del Garda (GARDA1) and Bosca di Pacengo (GARDA3), 14) Cisano and La Quercia (GARDA1), 15) Molina di Ledro, 16) Fiavé-Carera, 17) Dossetto di Nogara (GARDA1), 18) Tombola di Cerea, 19) Canà di San Pietro Polesine, 20) Valli di Fimon (Molino Casarotto and Arcugnano-Le Fratte), 21) laghetto della Costa di Arquà Petrarca, 22) Laghi di Revine and Paluch di Ponte nelle Alpi, 23) Palù di Livenza, 24) Hočevrca.

Pile-dwellings around the Alps. Italy possesses 19 of the constituent sites and shares the management of the UNESCO site with Switzerland, France, Germany, Austria and Slovenia².

2. ITALIAN PILE-DWELLINGS: A UNIQUE ARCHAEOLOGICAL RESOURCE

Pile-dwellings are mainly concentrated in northern Italy where about 120 settlements are known, spread across the southern slopes of the Alps, from the regions of Piedmont in the west to Friuli in the east, including Lombardy, the Veneto and the Province of Trento (fig. 1). The 19 villages that belong to the UNESCO site are grouped into 7 macro-regions named as follows: Small lakes and bogs of Piedmont, Region of Lake Maggiore and Lake Varese, Small lakes, bogs and rivers of eastern Lombardy, Region of Lake Garda, Small lakes and bogs of Trentino, Small lakes and bogs of the Berici and Euganei Hills, Small lakes and rivers of the eastern Veneto and Friuli.

The high number of known sites is due to the wide distribution of this settlement type during prehistoric times and Italy's long history of archaeological investigations into the remains of pile-dwellings. The first fortuitous finds of pile-dwellings in Italy occurred between 1830 and 1850 in Peschiera del Garda (Verona) on the occasion of digging work for the renovation of the Austrian fortress, but only after the 1854 discoveries in the Swiss lakes did both Italian and Swiss researchers begin the exploration of the southern Alpine lake basins, discovering dozens of pile-dwelling sites, both submerged and located on the shores above the water-line, or in peat bogs in morainic hollows. The Italian word *palafitta* was coined just after the first discoveries by Ferdinand Keller and comes from the German word *Pfahlbauten*. Among Italian archaeologists a strong interest in the topic continued till the beginning of the 20th century, when the sites of Arquà-laghetto della Costa (Padua), Molina di Ledro (Trento) and Barche di Solferino (Mantua) were discovered, but the turning point for the field – not only in Italy, but the whole Alpine region – was the excavation by Renato Perini at Fiavé-Carera between 1969 and 1976³.

2. Nomination Dossier 2011.

3. Guidi, Bellintani 1996, Marzatico 2004.



Fig. 2 – Belvedere di Peschiera (Verona) – Sampling of the piles for dendrochronology during underwater investigations (Photo: G. Merighi, Reproduced with permission of the © Ministero per i Beni e le Attività Culturali e del Turismo - Soprintendenza Archeologia del Veneto. All rights reserved (Rif. prot. n. SETT.FOTOG 3801 23/03/2015 Class. 34.16.19/2) reproduction forbidden).

A more recent group of sites can be considered a model for modern research methods, both underwater and on dry land. In recent decades underwater investigations have been carried out in Lake Viverone, in the sites of Peschiera-Belvedere and Lazise-La Quercia (Verona), and in Lake Garda, where precise positioning of the piles was accompanied by the cataloguing and sampling of the dense array of posts (more than 20 posts per square metre at Belvedere (fig. 2) and more than 10 per square meter at La Quercia)⁴. The stratigraphic sequence (from the beginning of the Early Bronze Age to the end of the Middle Bronze Age) present at Lavagnone di Desenzano del Garda (Brescia) allows us to follow the technological and cultural evolution of the communities living in the area⁵. More recently still at Lucone D (Lucone di Polpenazze del Garda, Brescia), the excavation was re-opened in 2005 and by summer 2015 had reached an extension of more than 300m², with the identification of more than 1000 wooden structural remains, pertaining to houses built on load-bearing timber posts with raised floors from 2034 to 1967 cal BC (± 10 y.), during the early phases of the village⁶. As well as vertical posts, there are plenty of horizontal components (planks, beams, large and small branches) preserved because they fell down during a big fire (fig. 3). The vertical posts are made exclusively of oak, while the other elements reflect the variety of tree species that grew nearby: alder, ash, beech, hazel and maple are present⁷.



Fig. 3 – Lucone di Polpenazze (Brescia) – elements of the carpentry coming from the raised part of the houses collapsed because of a fire occurred after 2031 cal BC (Photo: Museo Archeologico della Valle Sabbia di Gavardo, Reproduced with permission of the © Ministero per i Beni e le Attività Culturali e del Turismo - Soprintendenza Archeologia della Lombardia. All rights reserved (Rif. prot. n. 2965 24/03/2015 Pos. 28.13.10/3) reproduction forbidden).

4. Aspes et al. 1998, Capulli et al. 2012.

5. De Marinis 2007.

6. Baioni et al. in press.

7. Pignatelli et al. in press.

From a chronological point of view, lake dwellings have been built in northern Italy since the Neolithic: Isolino Virginia is the oldest in the whole Alpine region and dates to around 5000 BC. Built in the centre of the small island in Lake Varese, it preserves seven superimposed consecutive wooden platforms. Later the village expanded towards the peripheral zones of the isle: during a marked low-water level in 2005 on the western shore some different Middle Neolithic structures were discovered, with vertical posts and other constructions made of stone and plant material.

The existence of Middle and Late Neolithic lake-dwelling villages is recorded also in the nearby Lagozza pond (Varese), in Trentino-Alto Adige at Fiauvé-Carera, in the Veneto at Molino Casarotto, not far from Lake Fimon (Vicenza), at Colmaggione di Tarzo by the Revine lakes (Treviso), at Paluch di Ponte in the Alps (Belluno) and Palù di Livenza (Pordenone) in Friuli⁸.

The widest and fastest spread of pile-dwellings, however, took place between the 22nd and 14th centuries BC, during the Early and Middle Bronze Age; these endured until the first phase of the Late Bronze Age. This was the very period (from 2100 to 1900 BC and from 1500 to 1300 BC) when in the other Alpine regions lake-dwellings decreased and then vanished. The settlements spread all around the lake basins of the Alpine foothills, reaching the northern part of the Po plain in the advanced Early Bronze Age (see also the section on dendrochronology). The area where the pile-dwellings are more dense, and also better known, is around Lake Garda, where more than 40 pile-dwelling sites have been investigated, in zones including the southern shores of the main lake and the surrounding morainic hills, where scattered small lakes occur⁹.

Italian pile-dwellings are prehistoric settlements characterized by different kinds of wooden buildings, which sometimes coexisted within the same village, such as in Fiauvé-Carera where buildings with both raised floors and ground-level floors were brought to light, even at intermediate levels on the shore slopes. The great variety of Italian pile-dwelling structures was classified by Balista and Leonardi; they proposed to divide them in two main groups: *palafitta su elevato* (i.e. pile-dwellings *sensu stricto* on raised floors) and *bonifica*. The term *bonifica* refers to all structures built at ground level on top of different sorts of foundations – which might be made of wood, branches, timbers, stones, gravel, sand, lime, or proper planks and beams, more or less well-arranged. They date from the Neolithic until the end of the Bronze Age. Special types

of *bonifica* are those with caissons, found at Barche di Solferino, and those on beams with holes at Bande di Cavriana (Mantua)¹⁰. Despite their differences, the crucial feature that distinguishes pile-dwelling sites is their location in wetlands and the consequent preservation of wood. The choice of particular architectural techniques was caused by technological or cultural considerations, as well as by environmental factors.

With regard to “stilt houses”, vertical posts suitable for bearing a raised floor are found in Late Neolithic contexts, such as Isolino and Palù di Livenza, but their presence is known with certainty only since the beginning of Early Bronze Age. From the 21st century BC fields of posts are documented in Lake Maggiore and the Varese area, at Bosisio Parini, in Lake Garda, in the Trentino Alps, and in the Euganei and Berici hills region, reaching the plain north of the River Po towards the middle of the 20th century. At the same time, ‘post-shoes’ begin to be used for fastening the piles to the ground, but only in few settlements such as Lavagnone 3 and Canàr di San Pietro Polesine (Rovigo). During the Middle Bronze Age, in the later village of Fiauvé 6, the system for fastening piles and sharing the weight between the vertical posts became more complex: here the well-known *platea reticulata* was brought to light, a unique wooden structure consisting of a grid made of a pair of horizontal beams parallel to the shore with perpendicular beams at regular distances. The few most completely known villages, that have been investigated in their entirety, contain thousands of vertical piles – often belonging to different settlement phases – surrounded by one or more concentric palisades, and were connected to dry land by a walkway¹¹.

Finally, it should be remembered that waterlogged conditions often allow the preservation not only of the remains of wooden buildings, but also of a multitude of organic items and tools made of perishable materials. These give us the chance to make a true-to-life reconstruction of these prehistoric communities. The wooden finds from Italian pile-dwellings are numerous: containers (bowls, ladles, vats, trays), handles for tools and weapons (axes, hatchets, daggers) and spinning instruments (spindles, spools, spatulae); a striking example is the wooden plough from Lavagnone dating to the Early Bronze Age, one of the oldest ploughs in the world. In 1990 at Lazise-La Quercia a small charred bread loaf was found. These rare tools, and multidisciplinary research, reveal an economy based on a sedentary agriculture and animal raising.

8. Martinelli 2007b.

9. Martinelli 2007a, Baioni et al. 2014.

10. Balista, Leonardi 1996.

11. Marzatico 2004, Baioni et al. 2014, Menotti et al. 2012.

3. DENDROCHRONOLOGY AND PILE-DWELLINGS¹²

The chronological attribution of Italian pile-dwellings relies mostly on typo-chronology and radiocarbon determination, but since the 1990s the application of dendrochronology has allowed a definitively higher precision in absolute dating. The importance of the preservation of wooden structures in wet environments – and the consequent possibility of applying dendrochronology – was highlighted in the UNESCO Nomination Dossier itself (*Criterion V*) as a unique tool for absolute dating and construction analysis. To date, more than 40 pile-dwelling villages have been analyzed by the Author; the related dendro-sequences span from the late 5th millennium BC to the end of the 14th century BC, but the majority are Bronze Age sites, especially Early and Middle Bronze Age (EBA and MBA) from the region around Lake Garda, the most densely inhabited during this period.

From a general perspective, oak was the most important wood in Italian proto-history; due to the widespread occurrence of deciduous oak forests in the hilly regions and plains of northern Italy and its particular suitability for building purposes, it was the most widely used timber in pile-dwellings: more than 90% of the Bronze Age vertical posts were made of deciduous oak, namely *Quercus* sp. sectio *ROBUR*, as described by Cambini (1967). Only in the high-Alpine villages of Trento province, Ledro and Fivà, were coniferous woods used. Oak is a very suitable wood for dendrochronology, but nevertheless we have to cope with the absence of millennia-long Italian oak chronologies that would allow the local series to be cross-dated with annual resolution. This is due to the lack of ancient living oak forests and the rarity of samples from recent times, as a consequence of deforestation and landscape clearance during proto-historic and historical times. Important also is the absence of very long regional oak tree-ring chronologies that would allow the local series to be cross-dated against the oak master curves from Southern Germany, which reach the 9th millennium BC. Recent research conducted in collaboration with colleagues André Billamboz (Germany) and Katarina Čufar (Slovenia) has shown that successful trans-Alpine teleconnections from south to north can be performed only on chronologies more than 400 years long (Martinelli *et al.* in press). The only successful teleconnection established thus far for prehistoric northern Italy is that between the Slovenian HOC-QUSP1 chronology and the chronology established for Building 1 at the Neolithic pile-dwelling of Palù di Livenza. Cross-dating between the Italian oak series and the other southern-

Alpine sequence – namely that from the Slovenian site of Hočevarica – yielded a more precise date for the Italian structure: the first half of the 4th millennium BC¹³.

From the Neolithic period, we have also analyzed a few samples from the ancient village of Isolino di Varese, where structures from the 5th and 4th millennia were investigated¹⁴, and Padenghe sul Garda (Brescia) on the western shore of Lake Garda, which dates to the early centuries of the 4th millennium cal BC¹⁵. Samples from Fimon-Le Fratte (Vicenza), a village near the shore of a small lake in northeastern Italy, might constitute the only series available for the Copper Age, when Italian lake shores seem to have been almost abandoned. Unfortunately it was possible to investigate only a few samples from these Late-Neolithic/Copper Age sites, because their timber consists of very young trees of various species, while oak components make up less than 50 %, which is not very suitable for dendrochronology¹⁶.

Quite different is the situation for the Bronze Age: the cross-dating of oak site chronologies with the support of radiocarbon wiggle-matching techniques – based on the combination of radiocarbon and dendrochronology, which generally allows dating with an error of just ± 4 to ± 29 years (at 68.8% confidence) – offers accurate dates for sequencing the history of wetland occupation, often with one-year precision. The major concentration of dendrochronological data concerns the region around Lake Garda. At present, the respective mean tree-ring series from different settlements in the region have been cross-dated, enabling the construction of two main oak regional chronologies, GARDA 1 (22nd -19th centuries cal BC, 11 settlements) and GARDA 3 (19th - 17th centuries cal BC, 4 settlements)¹⁷.

The creation of the regional chronology GARDA 1 was a major result of research carried out in the 1980s and 90s. The absolute dating at high resolution (2171 - 1837 cal BC ± 10 y) of a first group of 7 pile-dwelling villages in the Lake Garda area was a turning point for the Early Bronze Age chronology of northern Italy and surrounding regions¹⁸. Thanks to dendrochronology we know that the Early Bronze Age had already begun by around 2050 cal BC, since felling dates have been identified that range from 2070 to 2030 cal BC in pile-dwelling villages in the Lake Garda region belonging to the Polada Culture. Moreover

12. Illustrated data are up-dated to 2015.

13. Čufar, Martinelli 2004.

14. Banchieri *et al.* 2009.

15. Poggiani Keller *et al.* 2005.

16. Martinelli, Pignatelli 2012.

17. Martinelli 2007a.

18. Fasani, Martinelli 1996, Martinelli 1996.

the GARDA 1 chronology allowed the identification of the oldest Early Bronze Age pile-dwellings in the Alps, at the sites of Bande di Cavriana, Barche di Solferino, Lavagnone and Lucone D, founded before the year 2000 cal BC. Only in around the middle of the 20th century do pile-dwellings seem to spread southwards along the rivers of the higher plains.

GARDA 3 is a more recently developed regional chronology regarding the 18th and 17th centuries BC, constructed from samples from the submerged sites of Frassino I (Laghetto del Frassino, Peschiera), Bosca di Pacengo (Lake Garda, Lazise), Belvedere di Peschiera (Lake Garda, Peschiera) and one series from Pezzalunga (Mantua).

Recently both chronologies were re-calculated following the insertion of new samples. Most of the new series included in the regional chronology GARDA 1 come from samples collected during re-excavation of the site Lucone D (2004-2014). Others have been obtained from the recently investigated submerged settlements of Belvedere di Peschiera and Ronchi del Garda. Although the amount of samples from both the sites is small, they however demonstrate that villages already existed on the shores of Lake Garda in the 21st century BC. As already mentioned, Belvedere has also yielded samples from a later village, the series of which were inserted into the GARDA 3 chronology.

Through the identification of the different felling phases for the sites included in the same chronology, we can follow the parallel development at a timescale of one-year precision. It was therefore possible to construct a provisional model of settlement dynamics: the oldest sites seem to be those on the western part of the morainic amphitheatre (such as Lavagnone, founded in 2070), but already in around 2050 pile-dwellings were present on the southern shores of the main lake. These villages consisted of houses built on vertical piles with raised floors, and seem to have been abandoned about every 50-80 years. Many pile-dwelling sites were founded in the region from the 21st until the end of the 20th centuries, for which period they are almost the only type of settlement known. Later they seem to decrease; in the 19th and 18th centuries a contraction in the number of sites – together with their enlargement in size – is attested both for pile-dwellings and for contemporaneous dry sites. Dendrochronology allows the introduction of post-shoes to be dated to around 2000-1950 cal BC; it is, though, more difficult to determine the beginning of the *bonifica*-type constructions with caissons, since we do not know the provenance of the dated samples from Barche di Solferino, the only investigated site where these structures are attested.

It should also be remembered that a number of site chronologies cannot be cross-matched with the regional chronologies, dated by means of independent wiggle-matching. Examples are two pile-dwellings in the southern plain of the Veneto region: Canàr di San Pietro Polesine (Rovigo, chronology span: 2040 – 1871 cal BC \pm 10 y.) and Tombola di Cerea (Verona, 1520 – 1413 cal BC \pm 15 y.). The list also includes the series from single samples from Fiavé-Carera 4 in Trentino (2066 – 1823 cal BC \pm 25 y.), and Castellaro del Vhò (Cremona, 1660 – 1577 cal BC \pm 29 y.) and Iseo (Brescia, 1440-1320 cal BC \pm 9 y.) in Lombardy¹⁹.

Along the south-western slopes of the Alps, investigations have focused on two sites: “Il Sabbione” on Lake Monate (Varese) and “Viverone Vi1” on Lake Viverone (Biella-Turin). The first belongs to the EBA-MBA transition, with felling episodes in the 17th century cal BC, the latter to the MBA. Research recently conducted at the submerged site Viverone Vi1 (2011-2013) was part of a project (“The end of the lake-dwelling phenomenon: cultural versus environmental change”) funded by the Swiss National Science Foundation, under the direction of Francesco Menotti (University of Basel – Institute of Prehistory and Archaeological Science), with the principal aim of determining the absolute chronology of its occupation. A total of 77 oak piles were sampled under water, enabling the creation of a 151-year site chronology. Absolute dating was performed by means of the wiggle-matching technique; felling phases dated to between 1465 – 1387 cal BC and 1443 – 1365 cal BC (2σ)²⁰.

Although there exists a continuous series of regional or site chronologies from 2200 to 1400 cal BC (fig. 4), the insufficient overlap between these sequences, or the different provenance of wood types, inhibit the creation of a long, gapless, oak master chronology. In 2013 the data were improved by the re-calculation of all the wiggle-matches in accordance with the new calibration curve IntCal13²¹ and the new release of the software OxCal (v 4.2) (Bronk Ramsey, 2009). Concerning the data assigned to GARDA 1 (data older than 1800 BC), the results of this revision are only slightly different from the previous version. In contrast, more significant differences are found for the chronologies spanning from the 18th to 16th centuries, including GARDA3 which seems now to be older by several decades²².

19. Martinelli 2005, Poggiani Keller et al. 2005.

20. Menotti et al. 2012.

21. Reimer et al. 2013.

22. Martinelli, Valzolgher 2013, Billamboz, Martinelli 2015, Martinelli unpublished data.

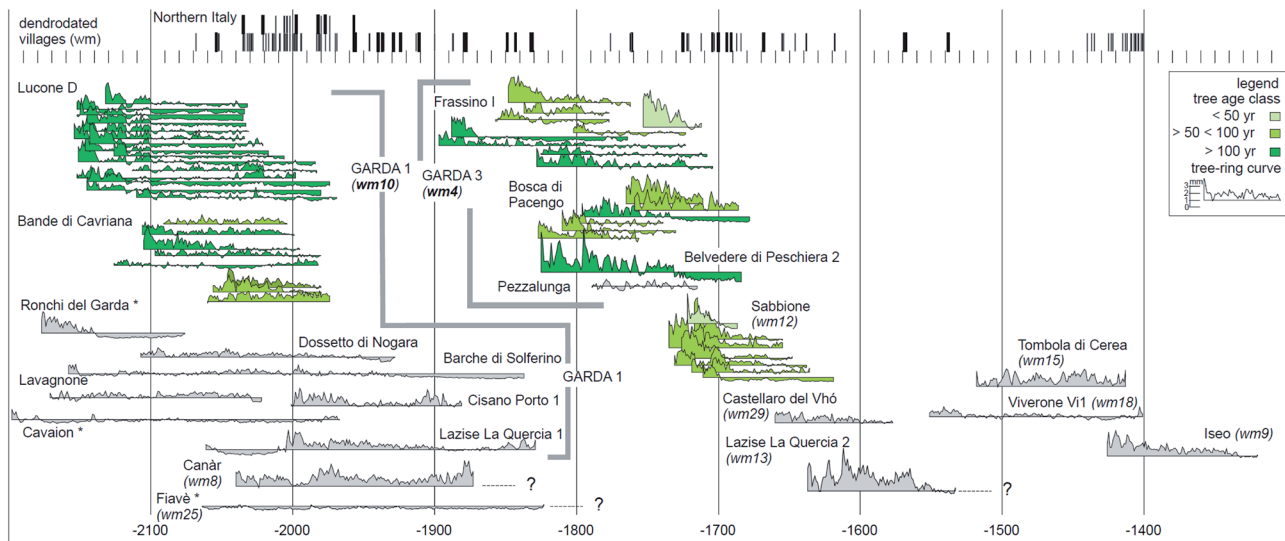


Fig. 4 – Time spans of tree-ring regional and site chronologies from pile-dwelling villages in northern Italy from 2200 to 1300 cal BC; short vertical bars represent the felling episodes with indication of the range of the wm precision, e.g. wm10 = wiggle matching with a precision of ± 10 years at 68.2% probability); oak dendrotypology: the dendro-groups are in green colour scale, according to three main classes of tree age, while site tree-ring chronologies are in grey colour; the curves are presented in synchronous position to the dendrodates indicating the main phases of building activities (re-elaborated from Billamboz, Martinelli 2015).

Other interesting elements for the Middle Bronze Age absolute chronology (17th century BC) emerged during the latest underwater excavation in the submerged lake-dwelling of Bodio Centrale in Lake Varese (Varese. IT-LM-10), dated to the 17th century BC. It has been possible to recognize the plan of part of a building made of elm, and repaired with oak timbers at two-year intervals. The building was located within a field of posts of which more than 250 vertical wooden elements have been detected and analysed²³.

Besides absolute dating, dendrochronology is an extraordinary tool for understanding the shape and size of pile-dwelling structures in plan, through identification of the load-bearing posts prepared by craftsmen at the same time. Results are achieved when all the posts from selected areas are investigated, and on the samples the bark-edge or the almost-complete sapwood is preserved: identification of posts made from trunks felled at the same time (year or season) gives a picture of the main structure of the huts. The dimensions and shapes of the houses were determined, for example, at Bande di Cavriana, which was settled between 2006 and 1952 cal BC (Martinelli 2007b, Martinelli 2017) (fig. 5). At the “Il Sabbione” site on Lake Monate (Varese), dendrochronology was part of a project of underwater investigation and interdisciplinary research, including the topographic survey and mapping of the site.

Tree-ring analysis focused on a well-defined area, along two transects extending from the centre to the western limit of the village, and led to the construction of a well-replicated chronology dated by wiggle-matching, indicating felling episodes between 1687 and 1618 cal BC ± 12 y. (1σ). The results made it possible to comprehend the progressive enlargement of the inhabited area, bounded by the successive construction of palisades that were continually lengthened and approached closer to the shore; the presence of two houses was also recognized. The houses were built on three rows of supporting piles, with frameworks of 3 x 4 and 3 x 5 posts, and dimensions of 3 x 5 metres (the earlier one) and 4 x 8 metres (the later one)²⁴.

In Italy a new challenge in dendrochronology consists of the application of dendrotypology to prehistoric samples. This new dendro-archaeological discipline, more widely applied on Southern German and Swiss pile-dwellings, analyzes the dendro-dated samples considered as the original trees selected by men in patches of forest, thus allowing the extraction of the whole information potential from tree-ring series and strengthening their connection with wood and forest sciences²⁵. Following Billamboz’ steps, a couple of pile-dwelling sites have recently been investigated in Italy, which led to our first such insight into woodland management in Bronze Age northern Italy: at the begin-

23. Grassi, Mangani 2014.

24. Martinelli 2003.

25. Billamboz 2011.

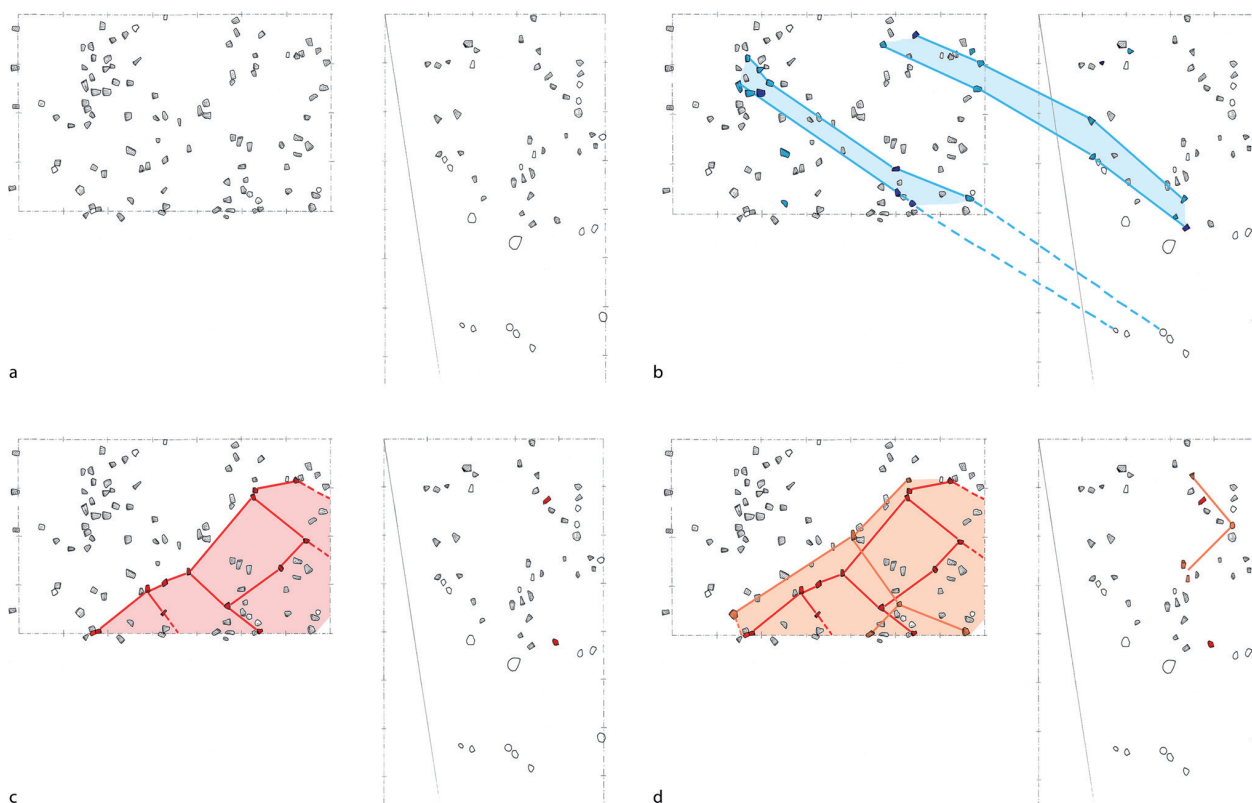


Fig. 5 – Bande di Cavriana (Mantua) - plan of the 1981-83 excavations in the Early Bronze Age village; location of the structures built in oak wood: a) general distribution of piles b) walkways from 1999 to 1994 cal BC; c) rectangular building in 1980 cal BC; d) building repair in 1974 cal BC; the posts felled at the same time are identified on the basis of tree-ring analysis (re-elaborated from Baioni et al. in press).

ning of the Early Bronze Age (a little later than 2050 cal BC) nearly natural, dense mixed oak woodland was used for the foundation of the first houses in the villages in Lucone D; this was followed by periods of reforestation occurring during later phases of minor building activity. A greater differentiation of timber sources and also changes in the woodland structure are attested in the sequence from Bande di Cavriana in the first half of the 20th century, but a stronger environmental impact on the forest can be detected only since the 17th century BC, as may be seen at Sabbione, where the practice of understory thinning is attested²⁶. At Frassino village e.g. the inhabitants had to abandon their principal source of good timber, an oak forest growing on the plain near the site, probably because of its depletion due to intensive use, and began to fell trees in a turkey oak wood (actually from wood analysis only the less precise identification of *Quercus* sp. section *CERRIS* is possible) on nearby hills, where that less distinguished timber was available. Dendrotypology provides a deeper insight into the complex relationship between the proto-historic human communities and their environment and can detect both the human impact on that environment and the strategies adopted by humans in the face

of periods of subsistence crisis. Therefore dendrotypology could also help us to understand the typical pile-dwelling patterns of lake occupation with phases of intensive lake-shore activities alternating with occupational hiatus, in terms more complex than simplified environmental determinism²⁷.

4. CONCLUSION

Advances in dendrochronological research in northern Italy are of great importance for the study of the development of the pile-dwelling phenomenon as a whole in the Alps and surrounding areas, because of the different periods of settlement in wetland environments. In the region we find that pile-dwellings flourish throughout almost the entire Bronze Age, even in the periods from around 2050 to 1900 BC and 1500 to 1300 BC, when north of the Alps the lake shores seem to have been abandoned.

However, the results from dendrochronological reconstructions, together with the information from the few sites where almost the whole village has been investigated, suggest a strong similarity between the better-known structures

26. Martinelli 2013.

27. Billamboz, Martinelli 2015.

from north of the Alps and those found in northern Italy, both with regard to the spatial organization of the villages and the main structural elements of the houses.

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