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Lavagnone (Desenzano del Garda): new excavations and palaeoecology of a Bronze Age pile dwelling site in northern Italy

R. C. de Marinis, M. Rapi, C. Ravazzi, E. Arpenti, M. Deaddis, R. Perego

Abstract: Lavagnone is a lacustrine basin, today turned into a peat bog, which was continuously settled for about 1,000 years during the Early, Middle and Late Bronze Ages. Since 1991 research has been carried out under the supervision of R. C. de Marinis (Università degli Studi di Milano) in four different areas of the basin in order to reconstruct the features of the settlement and the changes that occurred over the course of time. Palynological and palaeobotanical analyses, taking place since 2002 in cooperation with CNR-IDPA (Milano), are focused on determining the palaeoenvironmental manifestation, both then and now, of the anthropogenic exploitation of the basin.

Keywords: Bronze Age, pile dwellings, pollen analysis, northern Italy, human impact.

1. Introduction

The former lake at Lavagnone (119 m a.s.l.), nowadays a drained peat bog, is situated in northern Italy (Fig. 1), 3 km south of Desenzano del Garda (Brescia, Lombardy). It has an oval shape with a maximum diameter of c. 600 m. The basin was formed during one of the most recent Quaternary glaciations as an intermorainic basin isolated from the main hydrographic network.

Late Mesolithic as well as Early-, Middle- and Late Neolithic industries have been found along the northern and eastern edges. The basin was probably also settled during the Copper Age, but the best-recorded phases are those of the Bronze Age. The basin was continuously inhabited from the earliest phases of the Early Bronze Age (EBA) to the Late Bronze Age (LBA): thanks to a huge archaeological stratified deposit, Lavagnone is one of the main reference sites for the definition of the chronological periodization of the northern Italian Bronze Age (Perini 1988; de Marinis 2002).

Barbara Barich and Renato Perini carried out first excavations between 1971 and 1979. In 1991 research was resumed under the supervision of Raffaele de Marinis (Università degli Studi di Milano); Peter Kuniholm (Cornell University of New York) provided dendrochronological expertise and the Laboratory of Palynology and Palaeoecology (CNR-IDPA, Milan) carried out the palaeobotanical research.

One of the main goals was to understand the settlement features dating from the Bronze Age, above all, the locations of the dwellings, their sizes and the typology of the houses; these matters were studied through archaeological excavations in four different areas within the basin, while palynology helped to reconstruct the palaeoenvironmental background behind the cultural activities. Fruits and seeds contained in archaeological layers deposited on the ancient lakebed allowed us to distinguish the natural vegetation from anthropogenic plant debris.

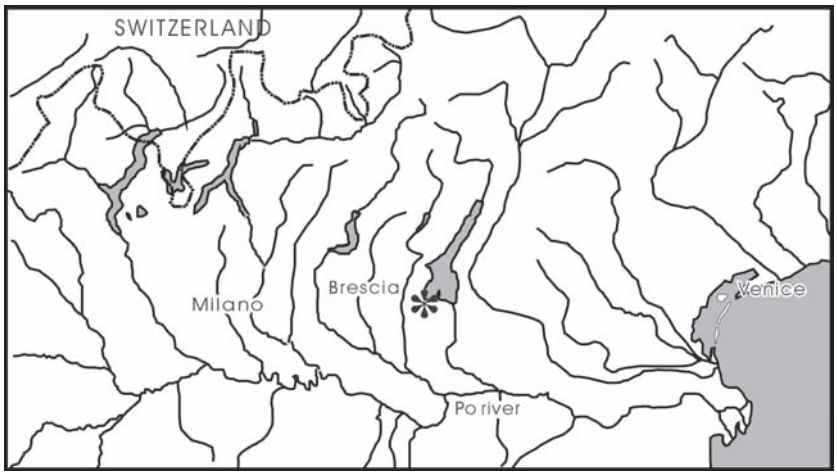

Fig. 1 Lavagnone, geographic location.

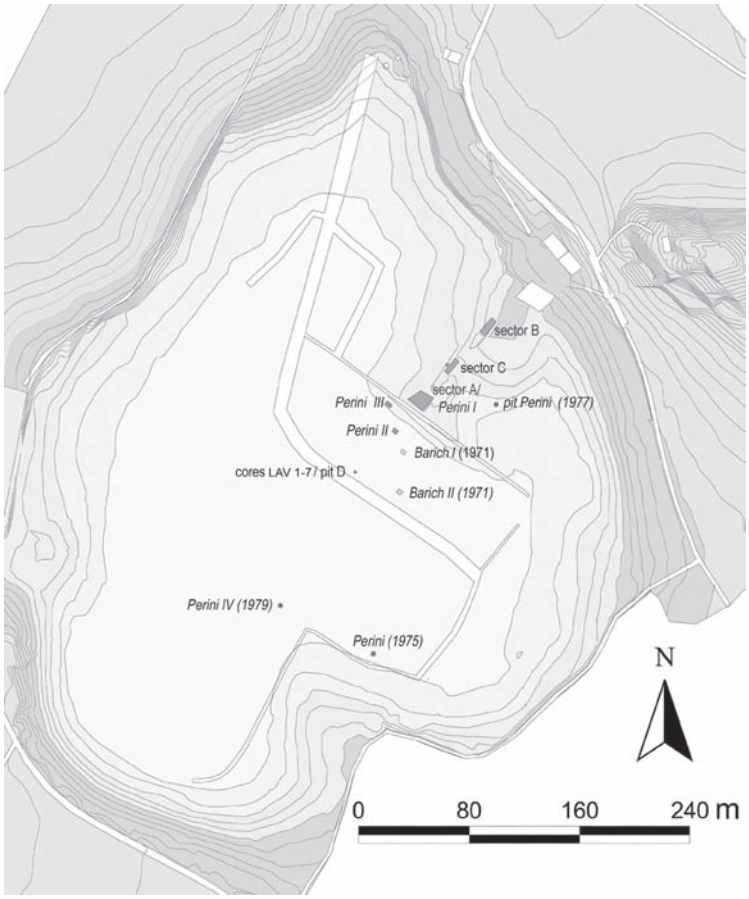

Fig. 2 Topographic map of the Lavagnone basin (topographic map G. Baratti and C. Sidoli, graphic processing M. Rapi).

2. Archaeological research

Our research concerned four areas situated next to each other over a length of about 170 metres (Fig. 2). Sectors A, B, C and D were created in order to enable the examination of the stratigraphic sequences starting from the northeastern edge and extending to almost the middle of the basin.

- Sector A, covering an area of about 90 square metres, is located near the centre of the basin and it includes the previous excavations carried out by Renato Perini (sector Perini I).

- Sector B, also about 90 square metres in size, coincides with the ancient edge of the basin, 70 metres from sector A.

- Sector C is in an intermediate position, linking the two sectors already mentioned; it was located where the ground levelled out (coarse-grained substratum) from the slightly sloped edge.

- Sector D is close to the margins of the swamp area, which nowadays is unused; it is the core-drilling site and also the site of a small excavation trench (two square metres), opened in 2004.

2.1. Cultural and settlement phases

The four sectors showed cultural sequences that were not exactly comparable; in fact, some phases were documented only in certain areas, which suggested that the dwellings were occasionally moved within the settlement area from the middle of the basin to the shore and vice versa.
In the stratigraphic sequence of sector A, for example, there were two phases of pile dwellings dating from the EBA I (IA and IB), followed by a settlement hiatus, which in turn was followed by an EBA II phase; between EBA IB and EBA II all the posts were bent at a 45 degree angle, possibly due to a period of very dry conditions. Later on, there was a Middle Bronze Age phase (MBA I), after which this area seems to have been abandoned for good. Sector B completed this pattern: there, an EBA IC phase followed an EBA I A-B phase; furthermore, the settlement also had phases dated to MBA IIA and MBA IIB (Fig. 3).
Therefore, according to the sequences observed, the settlement incorporated different areas, either consecutively or simultaneously: a marshy damp zone towards the centre and a shore area located on higher and, therefore, drier ground. We believe that this occasional relocation of the settlement could have been due to climatic and environmental factors; ongoing research aims to understand the relationship between the settlement dynamics, the changes in the surrounding landscape and the climatic triggers.

	absolute chronology (±10 BC)	cultural horizon	Sector A	Sector B	Sector C	Sector D
LBA			abandonment	dwelling	abandonment	abandonment
MBA II B		*Lavagnone 7*	abandonment	dwelling (ground house)	abandonment	dwelling (structures to define)
MBA II A			abandonment	dwelling (ground house)	abandonment	dwelling (structures to define)
MBA I		*Lavagnone 5-6*	dwelling (houses on dry land)	bonifica layers	dwelling (structures to define)	*not yet excavated*
EBA II		*Lavagnone 4 late Polada*	dwelling (houses on bonifica layers)	dwelling (structures to define)	dwelling (structures to define)	*not yet excavated*
EBA I C		*Canar and Dossetto horizon*	temporary abandonment	dwelling (structures to define)	*not yet excavated*	*not yet excavated*
EBA I B	1916 1984	*Lavagnone 3*	pile dwellings	timber trackway	fence	*not yet excavated*
EBA I A	1994-1991 2010-2008 2077-2048	*Lavagnone 2*	pile dwellings	timber trackway	fence	pile dwellings

Fig. 3 Comparative scheme of the archaeological sequences identified in sectors A, B, C and D.

2.2. Settlement features

Data obtained thus far allow us to draw up a hypothesis regarding the development of the settlement during the Early, Middle and Late Bronze Ages.

The finds recovered in the places marked in Fig. 4a provided evidence of EBA I A-B phases. At the beginning of the EBA, the water level of the small lake was probably lower than it had been during the Mesolithic and Neolithic periods. A pile dwelling village was set up during this time. It seems that the founding of the village had been somewhat planned, as can be seen in certain aspects that could be classified as "infrastructure". There was a settlement and a passageway separated by a fence.

Two pile dwelling settlements in stratigraphic continuity were identified in sector A: while the earlier dwellings (EBA IA) were dated dendrochronologically between 2048 and 1991 ± 10 BC, the dendrochronological dates for the second settlement were 1984, 1926, and 1916 ± 10 BC (Griggs, Kuniholm & Newton 2001). The two structures were very similar, but did show differences as regards the architecture. While the EBA IA dwellings were simple post constructions, the posts of the dwellings dated to EBA IB rested on perforated wooden base plates (Fig. 5). There was no evidence of the superstructures and perimeters of the individual houses, although some posts with pile points selected by Perini seemed to form rectangles. Research in sector B complemented this pattern. For easier access to the settlement area a timber trackway was built starting from the northeastern edge (Fig. 6). Finds and dendrochronological dates determined that the first construction work on the trackway was carried out 2077 ± 10 BC; the fence, located in sector C, also dated from the same period and probably enclosed the village on its eastern side, where it was exposed towards dry land.

A later phase (EBA IC) was only recorded marginally in sector B: waste dumps were found there, serving as evidence of settlement activity; however, houses are still to be uncovered because they were situated outside the excavated area. No absolute dates for EBA IC were obtained at Lavagnone, but the assemblage was very similar to those found at Canar I (Salzani 2002; Salzani, Martinelli & Bellintani 1996) and Dossetto di Nogara (Belluzzo & Salzani 1999), which were dendrochronologically dated to around the mid 19th century BC (Martinelli 1996).

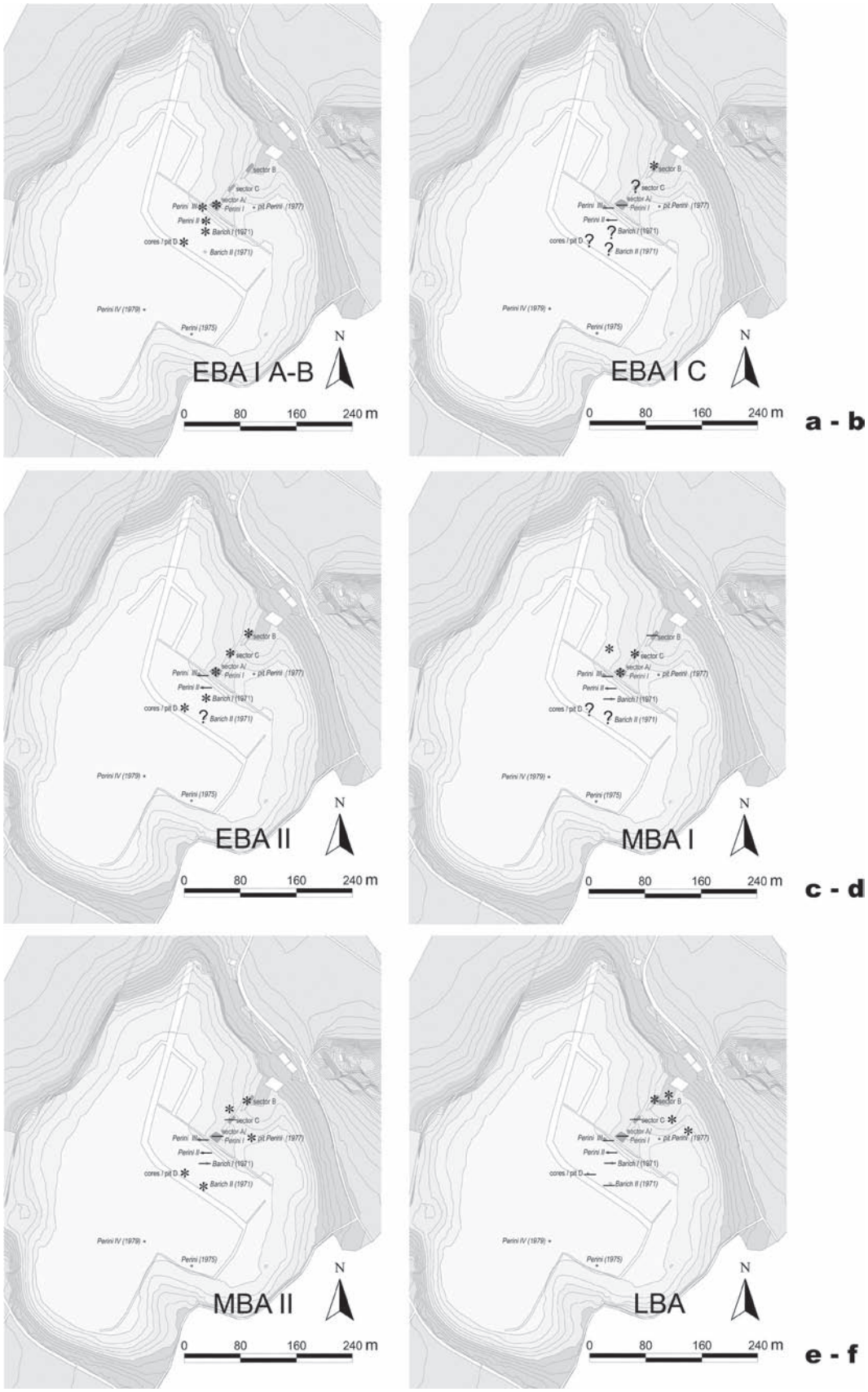

Fig. 4a–f The Lavagnone basin during the Bronze Age phases: settlement evidence is marked by asterisks.

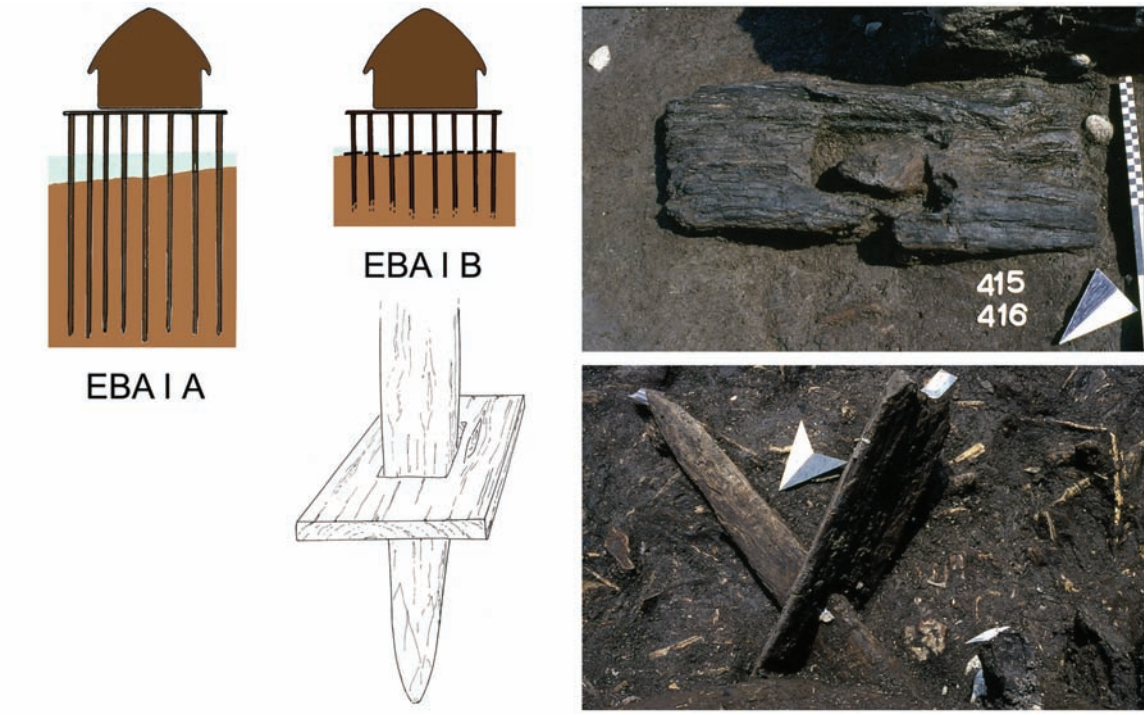

Fig. 5 EBA IA / IB pile dwelling schematic model (left) and piles resting on perforated wooden base plates (right) from sector A (photo R.C. de Marinis).

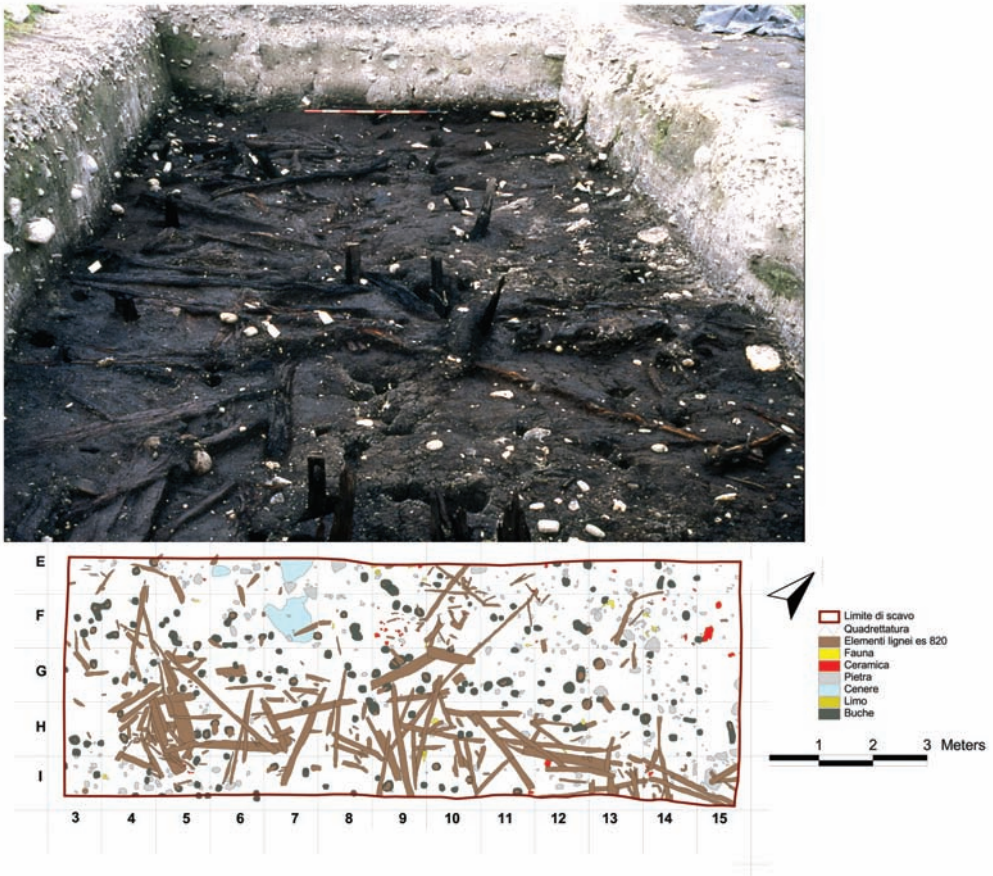

Fig. 6 Lavagnone, sector B, the EBA I A-B trackway (photograph N. Degasperi, GIS processing C. Sidoli).

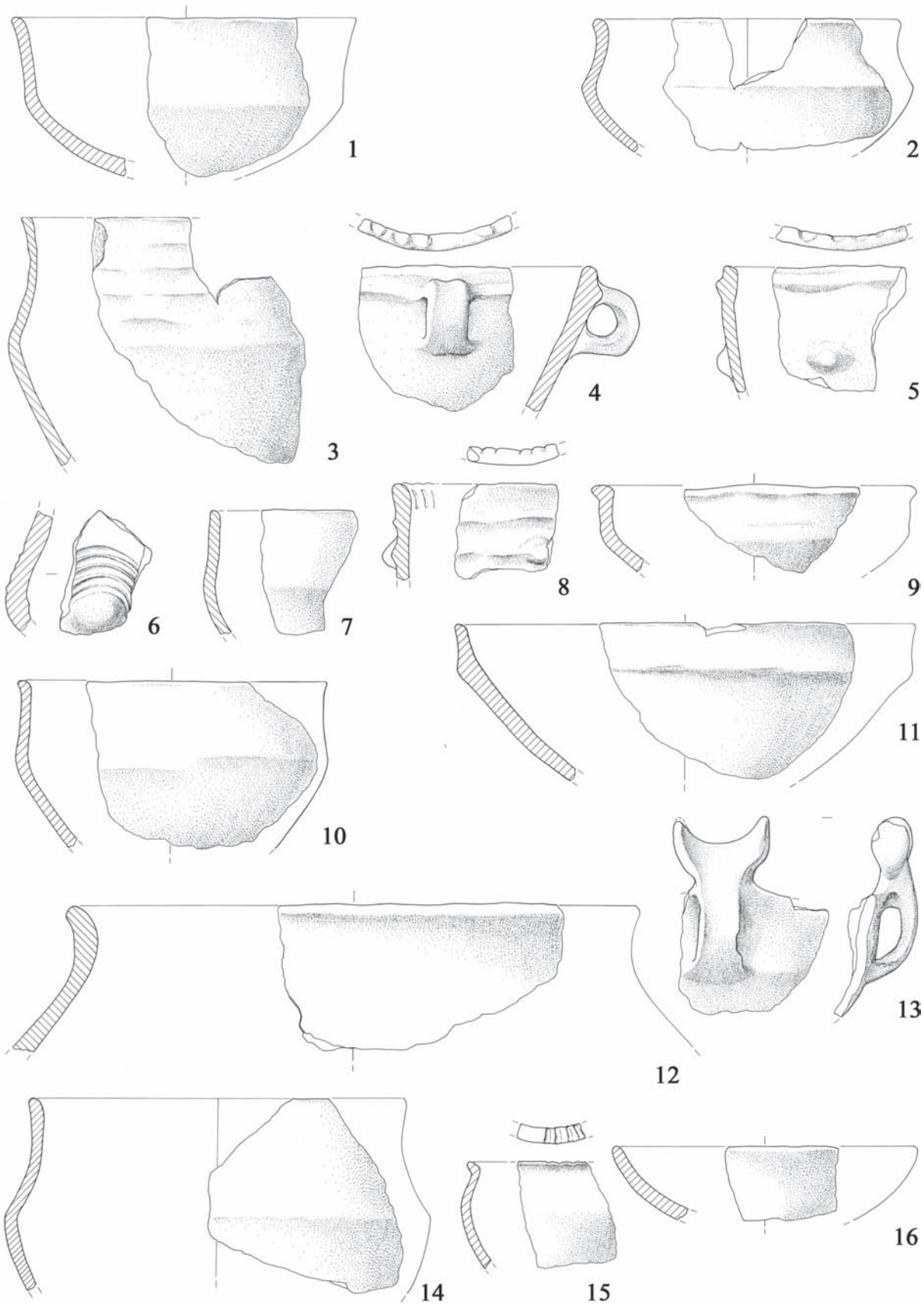

Fig. 7 MBA II pottery from sector D; 1–2): layer 1, 3–11): layer 2, 12–14): layer 4, 15–16): layer 5; (drawings M. Rapi, scale 1:3).

EBA II was present in all the locations marked in Fig. 4c; while in sector B the EBA II finds came from waste deposits, in sector C they were uncovered in occupation surfaces of structures not yet defined. In sector A, after a settlement hiatus during EBA IC, evidence of EBA II was identified in the form of houses built on substructures made of timber planks on consolidated yellow silts.
Finds and radiometric dates consistent with EBA II (Barich 1981) were found in sector Barich I and the same was observed in the area where the coring took place (Fig. 6).
The MBA was the best-documented phase in terms of the amount of finds recovered, both in the excavated areas (sectors A, B, C, D) and from surface surveys on the northeastern and southeastern edges of the basin (Fig. 4d). An MBA IIA house, built directly on dry ground, was marginally unearthed in sector B (de Marinis, Sidoli & Rapi 2002). In February 2004 a more recent MBA phase (MBA II B or C) was also discovered in the middle of the basin (sector D, Fig. 7), which could belong to a pile dwelling or to structures constructed to insulate against the dampness rising from the ground. It is not yet clear if the traces found in sector D and those identified at the eastern edge are contemporary.
We are still in the early stages of our work: data gathered thus far encourage us to continue our research into the many different areas of the Lavagnone basin, in order to correlate the sequences of all the sectors. It is difficult to ascertain the part played by cultural aspects and environmental influence in choosing the settlement site: however, it seems that wet areas were chosen most often (BA IA, IB, II, MB I, II); only in the LBA were traces of settling found exclusively on the northeastern edge (Fig. 4f).
(R. C. de Marinis & M. Rapi)

3. Core drilling, radiometric dating and pollen analysis at the Lavagnone basin

In 2001 and 2002 seven cores (LAV 1–7) were drilled in the central part of the basin (about 200 m west of the archaeological excavations) using a Russian corer sampler.

Depth	*Description of sediments*
0 – 50 cm	arable layer
50 – 157 cm	peat
157 – 331 cm	detritus gyttja with charcoal fragments and seeds of terrestrial plants
331 – 477 cm	carbonatic gyttja and detritus gyttja with seeds of aquatic plants
477 – 570 cm	olive gyttja and clay
570 – 602 cm	olive clay
602 – 605 cm	clay-embedded gravel

Tab. 1 The lithostratigraphical sequence of the LAV 1 core.

Pollen analysis was carried out and five AMS ^{14}C dates were obtained from the master core, LAV 1, which is 6.05 m long. Beyond this depth the gravelly substratum was reached. The lithostratigraphical sequence was subdivided into different lithozones according to their organic matter content (see Tab. 1 for descriptions). AMS ^{14}C dates (Tab. 2) were obtained from terrestrial plant remains at the Laboratory of the Division of Ion Physics at Uppsala University (Sweden). A very high accumulation rate (on average 1.5 mm/year) was estimated for the interval analysed in the master core. The pollen analysed corresponded to the accumulation over a 20-year period.
So far, the master core interval from 353 to 98.5 cm depth has been analysed for pollen. 66 samples with a resolution of 2/3 cm for the interval 343 – 211 cm, and 6 cm for 211 – 98.5 cm were taken. They were prepared for pollen analysis using standard methods. Identifications were based on Moore et al. (1991), Punt et al. (1976–1996), Reille (1992; 1995; 1998) and on the reference collection of the C.N.R. - I.D.P.A. (Istituto per la Dinamica dei

Lab. No.	*Depth (cm)*	*Age (^{14}C y BP, uncal.)*	*Material dated*
Ua-19659	325	3730 ± 45	Charcoal
Ua-19658	262	3385 ± 45	Cornus mas
Ua-22095	215	3360 ± 45	Quercus cupule
Ua-22058	193	3325 ± 45	Vitis seed
Ua-22057	114	3380 ± 45	Quercus cupule

Tab. 2 AMS-radiocarbon dating from core LAV 1.

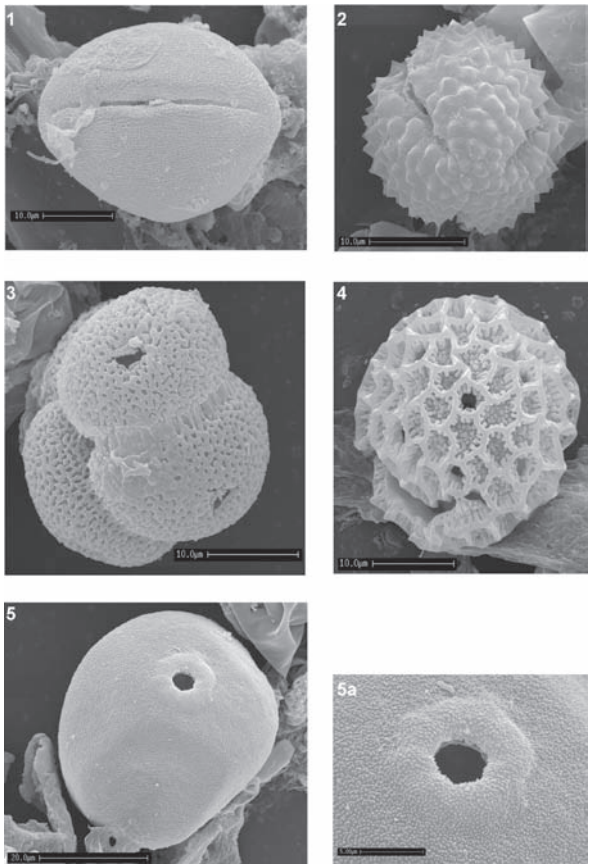

Fig. 8 SEM images of selected fossil pollen grains from the Early Bronze Age, core LAV 1. 1 *Helianthemum* sp., 2 *Centaurea nigra* type, 3 *Typha* sp., 4 *Polygonum persicaria*, 5 Cereal pollen grain, 5a Detail of pore.

Processi Ambientali) in Milan. Pollen nomenclature follows ALPADABA, stored at the Institute of Plant Sciences of the University of Bern. 120 *taxa* were identified (Fig. 9). Pollen counts, excluding the aquatic *taxa* (Fig. 8.3), were between 700 and 1200 grains. The results are presented as TILIA pollen diagrams (Grimm 1992).

4. The interpretation of the palynological record

A detailed pollen stratigraphy of the Holocene sequence is currently being reconstructed. The main features that have emerged thus far are outlined here. At the beginning of the Bronze Age the Lavagnone basin was a closed lake, about 300 m in diameter, and fed by very small watercourses. According to the model of pollen deposition in a closed lake developed by Sugita (1993; 1998), the pollen source area of the Lavagnone basin extended over an area with a radius of about 1 km from the edge of the basin. This suggests that the composition of pollen assemblages may result from the vegetation changes in such a restricted area.

In order to emphasize the value of local *taxa* growing in the lake and along its shores, we plotted a diagram with cumulative curves: for swamp forest trees, wetland terrestrial herbs, palustrine herbs, and aquatic species. Variations in this local composition serve as a record of the human impact on the ecosystem of the lake (Fig. 9).
Our interpretation is also based on anthropogenic *taxa* and microscopic charcoal concentration curves (Fig. 9). At Lavagnone it was, in fact, possible to detect an abrupt change from natural, nearly undisturbed forest to an anthropogenic landscape with crops and grazed fields, meadows, abandoned-ruderal perilacustrine belts and thinned-out forest stands. This occurred at 333–331 cm depth in the master core, where the sediment composition also changed from lake marl to detritus gyttja. Therefore, we inferred that the organic discharge from the pile-dwellings was responsible for the lithological change observed. The sedimentation rate suggests that this change took no longer than 20 years. Furthermore, considering the earliest dendrochronological felling date (2077 ± 10 BC), we correlated this date with the abrupt palaeoecological event. In particular, we focused our attention on the impact that the settlement had on the natural vegetation, on the distribution of the anthropogenic *taxa* and on the micro-charcoal curve. The sudden increase in the concentration of micro-charcoal allowed us to explain this situation as the effect of human settlement on the environment. Indeed, the micro-charcoal peak coincides with the phase when the levels of arboreal *taxa* dropped and the anthropogenic *taxa* in the pollen assemblage expanded. From this point on, both the aquatic and terrestrial ecosystems were under continuous pressure from the human settlement, which did not permit a complete recovery of the vegetation over the entire duration of the EBA and the MBA (i.e. 800 years).
Analysing the cumulative curves of swamp forest trees, wetland terrestrial herbs, palustrine herbs and aquatic species, we were able to define a progressive infilling of the basin, which was also observed in the archaeological stratigraphic sequence, leading to the transformation of the lake into a peat bog at the end of the MBA.

5. Plant macrofossil analysis

A preliminary investigation of the macrobotanical remains in the Lavagnone lacustrine peat succession was carried out on the archaeological layer 338 C/D (Fig. 10). This detritus gyttja was deposited underneath the earliest pile dwelling settlement (EBA IA about 2077 ± 10 BC) in sector A of the archaeological excavations on the northeastern side of the former lake. 6 litres of detritus gyttja were wet sieved through a stack of three sieves with mesh sizes of 2, 1, and 0.5 mm (the last fraction has not yet been analysed). The plant material was very well preserved and almost 75 *taxa* have been identified to date (Tab. 3).

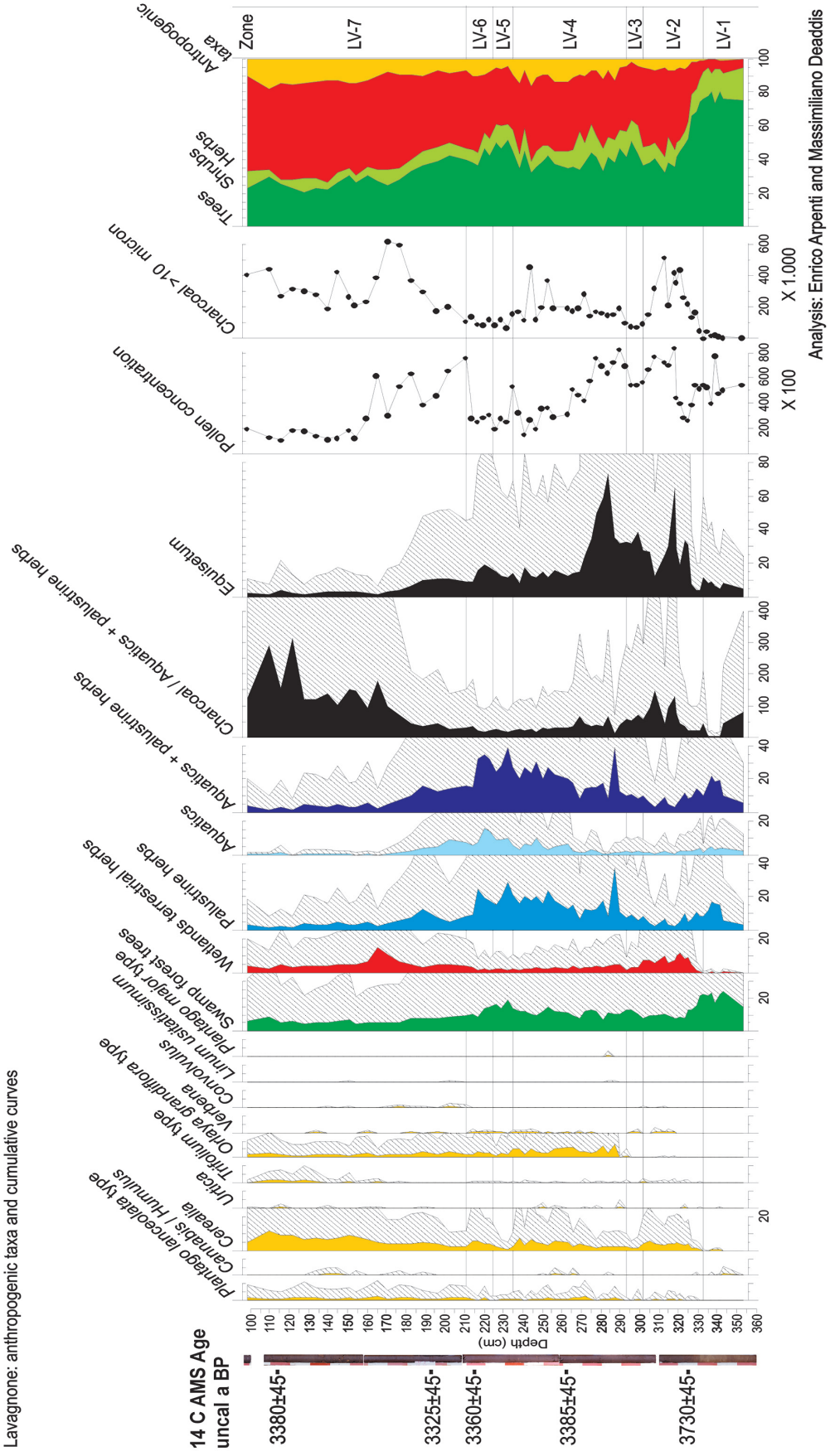

Fig. 9 Simplified pollen diagram from the Bronze Age succession (gyttja) in the central part of the Lavagnone basin (location see Fig. 1). The diagram includes selected anthropogenic *taxa* and cumulative curves of swamp forest trees (*Alnus, Salix*), wetland terrestrial herbs (*Filipendula, Viola, Hypericum, Myosotis-type, Epilobium, Lythrum, Valeriana*), palustrine herbs (*Typha, Sparganium, Polygonum persicaria*, Primulaceae, Cyperaceae) and aquatic species (*Nymphaea, Nuphar, Lemna, Potamogeton, Myriophyllum, Hydrocharitaceae*). The charcoal concentration is considered to indicate phases of *in situ* settlement, as hearth waste was dumped directly from the pile dwellings.

Fig. 10 Sector A, northern section; in the foreground layer 338 (photograph R.C. de Marinis).

The plant material was deposited in a submerged environment underneath the pile dwelling; therefore, the carpofloral association included both terrestrial species accumulated by human activities and aquatic plants. Among the edible plants there was an abundance of *Rubus fruticosus*, *Fragaria vesca*, *Cornus mas*, *Corylus avellana*, *Ficus carica*, *Sorbus domestica*, and *Vitis vinifera* subsp. *sylvestris*. Cultivated plants included: cereals (not yet analysed) and *Linum* cfr. *usitatissimum*. The local flora growing *in situ* was composed of: *Ceratophyllum demersum*, *C. submersum*, *Potamogeton natans*, *Chara* sp., *Myriophyllum spicatum*, *Najas marina, Najas flexilis*, *Nuphar lutea*, *Nymphaea alba*, and among the helophytes: *Cyperus glomeratus*, *Scirpus radicans* and *Schoenoplectus lacustris*. Weeds included *Atriplex patula*, *Chenopodium album*, *Daucus carota*, *Fallopia convolvulus*, *Polygonum aviculare*, *Rumex acetosella*, *Valerianella dentata* and *Verbena officinalis*.

Besides palaeobotanical data, the plant macrofossil investigation of the Lavagnone site can provide information on the biogeography of some species, e.g. *Rumex maritimus*, which has not yet been found in the region of the Garda amphitheatre and only occurs on the Adriatic seashore (Pignatti 1982).

Considering the promising results of this preliminary analysis, a systematic palaeobotanical investigation of the entire Bronze Age sequence at the Lavagnone site is planned.

6. Conclusions and perspectives

The palaeobotanical investigation of the Lavagnone site should be considered preliminary. Pollen analysis has been carried out only in the core section dating from the Bronze Age and only one sample has been analysed for macrobotanical remains.

The human impact exerted by the pile dwellings on the natural forest and aquatic vegetation was clearly documented in the pollen diagram. The comparison of pollen curves and macrofossils gave us the opportunity to quantify the cereal fields and the first use of plants that already occurred in the natural vegetation, but were then favoured by humans for their fruits (e.g. *Vitis, Prunus avium*). The strong peaks of the micro-charcoal curve suggested phases of human activity on the site. Palynological evidence combined with archaeological data pointed to different phases of settlement relocation. This precise correlation between archaeological phases and pollen zones will be the subject of further research.

We are still far from having satisfactory knowledge about these human populations, about their lifestyle and history. Further palaeobotanical research in the Garda morainic

amphitheatre in connection with archaeozoology, malacology, dung analysis and palaeocarpology is called for.
(C. Ravazzi, E. Arpenti, M. Deaddis & R. Perego)

7. Riassunto

Il Lavagnone è uno dei siti fondamentali per l'articolazione cronologica dell'età del Bronzo per l'area padana e centro-alpina. Nelle ricerche in corso, ad opera della cattedra di Preistoria e Protostoria dell'Università degli Studi di Milano in collaborazione con il C.N.R. – I.D.P.A. Sezione di Milano, particolare rilievo assume la ricostruzione dei caratteri dell'abitato nel corso dell'età del Bronzo. Il tema è indagato sia attraverso interventi di scavo in quattro distinti punti del bacino, soprattutto in relazione all'individuazione dell'estensione e della tipologia delle strutture, sia attraverso analisi palinologiche e carpologiche, che concorrono a definire il quadro paleoambientale e a valutare l'impatto antropico in relazione alle fasi archeologiche.

Le analisi polliniche sono state condotte su carote prelevate nei pressi del centro del bacino. Sono state inoltre eseguite cinque datazioni ^{14}C AMS su materiale prelevato dalla carota LAV1.

Le sequenze archeologiche rilevabili nei differenti punti del bacino non sono perfettamente sovrapponibili. Alcune fasi, infatti, sono attestate unicamente in una determinata area e pertanto si deve ipotizzare che si siano verificati periodici spostamenti dell'ubicazione delle abitazioni, dal centro del bacino all'area spondale, e che l'abitato interessò – a seconda delle fasi sia alternativamente che contemporaneamente – aree diversificate: una zona paludosa, episodicamente sommersa, verso il centro del bacino ed un'area spondale posta ad una quota più rilevata e quindi più asciutta. Nella successione pollinica centro-bacinale, le fasi di occupazione *in situ* della palafitta sono segnate da un improvviso incremento della concentrazione delle particelle di microcarbone. Il primo di questi picchi coincide con la fondazione del villaggio palafitticolo, datata dendrocronologicamente intorno al 2077 BC. Questo momento rappresenta un evento abrupto nella trasformazione sia dell'ecosistema acquatico che di quello terrestre.

Allo stato delle ricerche è prematuro pensare di poter delineare un modello che possa spiegare univocamente tali dinamiche insediative: si tratta di valutare l'importanza dei fattori climatici ed ambientali in relazione a fattori «culturali», meno facilmente sondabili; in base ai dati disponibili sembra che l'insediamento al Lavagnone abbia più spesso interessato zone più umide e prossime al centro del bacino: (BA IA, IB, II, MB I, II), rispetto al tratto spondale, che ha offerto riscontri per il BA IC, BM II e il BR, ma questi stessi dati inducono ad ampliare l'aree delle ricerche per ottenere un quadro più attendibile.

1	*Agrimonia eupatoria*
2	*Ajuga reptans*
3	*Anchusa sp.*
4	*Anthriscus caucalis*
5	*Atriplex patula*
6	*Carex sp.: type 1*
7	*Carex sp.: type 2*
8	*Carex sp.: type 3*
9	*Caryophyllaceae: type 1*
10	*Caryophyllaceae: type 2*
11	*type Catabrosa*
12	*Ceratophyllum demersum*
13	*Ceratophyllum submersum*
14	*Chara sp.*
15	*Chenopodium album*
16	*Cornus mas*
17	*Corylus avellana*
18	*Cyperaceae: type 1*
19	*Cyperaceae: type 2*
20	*Cyperaceae: type 3*
21	*Cyperaceae: type 4*
22	*Cyperus cf glomeratus*
23	*Daucus carota*
24	*Dianthus sp.*
25	*Fallopia convolvulus*
26	*Ficus carica*
27	*Fragaria vesca*
28	*Geranium sp.*
29	*Hordeum vulgare*
30	*Hypericum cf tetrapterum*
31	*Hypericum perforatum*
32	*Isolepis sp.*
33	*Lactuca sp.*
34	*Lamiaceae*
35	*Lemna sp.*
36	*Linum cf usitatissimum*
37	*Lycopus europaeus*
38	*Myriophyllum spicatum*
39	*Najas flexilis*
40	*Najas marina*
41	*Nuphar lutea*
42	*Nymphea alba*
43	*Papaver sp.*
44	*Physalis alkekengi*
45	*Picris hieracioides*
46	*Polygonum aviculare*
47	*Polygonum lapathifolium*
48	*Polygonum persicaria*
49	*Potamogeton cf crispus*
50	*Potamogeton natans*
51	*Potentilla sp.*
52	*Prunus padus*
53	*Prunus spinosa*
54	*Quercus sp.*
55	*Ranunculus repens*
56	*Ranunculus sardous*
57	*Ranunculus sceleratus*
58	*Ranunculus subgen. Batrachium*
59	*Rosa sp.*
60	*Rubus fruticosus*
61	*Rumex acetosella*
62	*Rumex sanguineus/conglomeratus*
63	*Rumex maritimus*
64	*Sambucus ebulus*
65	*Schoenoplectus gr supinus*
66	*Schoenoplectus lacustris*
67	*Scirpus radicans*
68	*Silene sp.*
69	*Sorbus domestica*
70	*Stachys cf sylvatica*
71	*Teucrium chamaedrys*
72	*Triticum sp.*
73	*Valerianella dentata*
74	*Verbena officinalis*
75	*Vitis vinifera subsp sylvestris*

Tab. 3 *Taxa* list of plant macrofossils (preliminary results) from layer 338 C/D in sector A.

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