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Pollen and macroremains from Holocene archaeological sites: A dataset for the understanding of the bio-cultural diversity of the Italian landscape

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ABSTRACT

Over the last millennia, the land between the Alps and the Mediterranean Sea, characterized by extraordinary habitat diversity, has seen an outstanding cross-cultural development. For the first time, this paper reports on the census of the Holocene archaeological sites that have been studied as part of archaeobotany in Italy (continental Italy, the Italian peninsula and islands) over the last quarter in a century. Pollen, non-pollen palynomorphs, seeds and fruits, woods/charcoals and other plant remains have all been analysed in multidisciplinary researches. A list of 630 sites has been provided by more than 15 archaeobotanical teams. The sites are located across the 20 regions of Italy, and in the Republic of San Marino (356 sites in northern Italy, 118 in central Italy, 156 in southern Italy and on the islands). They belong to several cultural phases: 321 sites are only pre-Roman, 264 are Roman/post-Roman, and 45 sites cover a broader range of time, present in both time spans. Site distribution is plotted in maps of site density according to geographical districts and the main chronological phases. The reference list helps to find analytical data referring to the descriptive papers that may be scattered throughout monographs and specific books on the matter.

1. Introduction

The land between the Alps and the Mediterranean Sea has been characterized by extraordinary habitat diversity and outstanding cross-cultural development over the last millennia. Today this is evident through the richness of archaeological sites preserved throughout Italy, the nation with the highest number of sites inscribed on the UNESCO's World Heritage List. They cover a large time scale, from the prehistoric right up to the modern times, and a variety of contexts that make this land one-of-a-kind. Therefore it is not surprising that a huge number of studies of plant records from archaeological contexts are carried out in Italy, and that archaeobotanical research has been probably more developed in these geographical districts than elsewhere. Nevertheless,

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the fragmentary nature of literature and study approaches makes it difficult to adopt an overview on this research.

The multiproxy and integrated archaeobotanical approach centred on archaeological sites is especially fruitful in Italy, being one of the most specific and developed applications of the joint botanical–archaeological science across Europe. But how many sites located in Italy have been investigated by archaeobotanists? Where are the sites located, and when were they in use? Valuable archaeobotanical (Follieri and Castelletti, 1988) and palynological (Magri, 2007) reviews, and annotated bibliographies (Caramiello et al., 1993, Caramiello, 2001; Mariotti Lippi, 2001–2010 online) have been usefully made but they are not centred on archaeological sites. A comprehensive synthesis with such a database giving the basis for the future study of the bio-cultural diversity in Italy has not been attempted before now.

The first step that must be carried out is to report lists of sites, their location, chronology, culture, archaeological contexts, and how many types of botanical analyses have been performed. Notes on what kind of information arose from data may also be added because researches have been focused on different issues. This paper sets out to provide an updated overview of the studies carried out in archaeological sites. This basic step is essential to understanding how extended this research is, how many analyses have been done, how many human-modified settlements (on-sites) are distributed near human-influenced records such as lake and other terrestrial sedimentary sequences (off-sites), what potential this field of science has for the purposes of environmental restoration and habitat preservation, and for the cultural heritage of Italy.

1.1. The modernity of a classical science

There are many ways to refer to the science that studies botany applied to human-related contexts. Though the analysis of plant records is a common feature, the emphasis may be more on one aspect or the other, like subfields with an overlapping of the same knowledge. The word 'bioarchaeology' is often used to indicate human skeletal remains but may also be used in a more general sense of biological (zoological and botanical) records from archaeological sites. The word 'archaeobotany' has a wide meaning of the study of plants found in archaeological contexts; classically, it concerned macroremains, mainly seeds/fruits and charcoal, and focused on domesticated plants (Peña-Chocarro, 1999; Colledge and Conolly, 2007; Zohary et al., 2012); however, it also includes microscopic remains from human-influenced deposits (Behre, 1986; Bottema and Woldring, 1990; Cummings et al., 2000; Mercuri et al., 2010a; Ravazzi et al., in press). 'Palaeoethnobotany' not only mainly deals with past plant uses such as food and fuel (Helbaek, 1971; Renfrew, 1973; Chabal et al., 1999; Pearsall, 2000; VanDerwarker and Peres, 2010), but it is also used in a more general sense (van Zeist et al., 1991). 'Palaeoecology' focuses on the reconstruction of ecosystems of the past (Chambers, 1993; Vernet, 1997; Cappers and Neef, 2012; Mercuri et al., 2013a). The role of human impact on the development of vegetation and on the shaping of the cultural landscape is instead a topic specific to 'archaeopalynology' (Faegri and Iversen, 1989; López Sáez et al., 2003), 'environmental archaeology' (Branch et al., 2005; Campbell et al., 2011), and 'historical ecology' having to do with a long-term ecology and including an ecology of historic times for the most recent chronology (De Pascale et al., 2006; Moreno and Montanari, 2008).

The difference in the mental attitudes of single researchers has caused – or allowed for – the deepening of diverse aspects of the significance of plant micro- and macro-remains in archaeological layers. Therefore the natural plant cover and ecosystems, land use and landscape, plant uses, cultivation and processing are among the topics that are investigated in more or less detail by the broadly-inclusive science that we shall refer to as 'archaeobotany' in this paper.

The main aims of the archaeobotanical research are to reconstruct the human environment, both as *status quo* and evolution, its long-term transformations into a cultural landscape (Birks et al., 1988; Birks, 2012; Mercuri and Sadori, 2012), flora, vegetation cover and land-use (Figueiral and Mosbrugger, 2000; Pearsall, 2000), history of both natural and planted woody plants (Figueiral and Mosbrugger, 2000; Thiébault, 2002; Asouti and Austin, 2005; Fiorentino and Magri, 2008; Allevato et al., 2012), dietary habits, consumption and trade (van der Veen, 2011), and human behaviour (Mercuri, 2008).

Despite most of modern sciences having increased interest in subcellular level investigation, modern archaeobotany cleverly combines classical morphological diagnostics with image analysis (Pollmann et al., 2005; Depypere et al., 2007; Burger et al., 2011), and with molecular and genetic analyses (Terral et al., 2004, 2010; Boscato et al., 2008; Schlumbaum et al., 2008; Lister and Jones, 2013). Furthermore, the statistical and ecological methods are incorporated into multiproxy analyses backed up with modern reference data (Ejarque et al., 2011; Allevato et al., 2013; Davis et al., 2013; Pelle et al., 2013), stable isotope analyses by IRMS and radiocarbon dating by AMS (Fiorentino et al., 2008a, 2010a,b, 2012; Caracuta et al., 2012; Masi et al., 2013).

As a peculiar field of applied archaeobotany, the study of urban sites (Orser, 2002; Bosi et al., 2009a; Majewski and Gaimster, 2009; Beneš et al., 2012; Rinaldi et al., 2013; Święta-Musznicka et al., 2013) especially focuses on the links between cultural history and plants (Prance and Nesbitt, 2005). An integrated scientific–humanistic perspective – involving archaeologists, botanists, historians, geographers and geologists – is particularly fruitful when documentary sources (e.g. archives, maps and registers) and the archaeological data are coupled with biostratigraphic sources (Cervasco, 2007; Menozzi et al., 2007; Moreno and Montanari, 2008; Molinari, 2009; Bal et al., 2011).

The broad dissemination of archaeobotanical data produced in Italy encounters, however, some obstacles: a) *sampling*: analyses are calibrated on costs, and limited by funds rather than by scientific necessities; sometimes, the number of samples from one site is so restricted that data cannot be published alone; b) *timing*: environmental reconstructions may be obtained in a time shorter than complete archaeological reconstructions but archaeobotanists need to wait for correct chronologies in order to interpret and publish their results definitively; c) *publishing*: following the archaeological practice, data must generally be published in monographs and books. This is due to two main reasons: one is that the huge amount of data obtained from one site deserves to be published in full; another is that funds are often dedicated to thematic publications that may better increase an archaeologist's reputation. Some books take years to be finished, and most work does not enter international circuits rapidly.

All these are the weaknesses of archaeobotany as a science entering the modern circulation of information, and risk reducing its attractiveness to young naturalists and biologists. Most of this research field and expertise may be swept away little by little under pressure from so-called 'modern research'. Networks and projects on bio-cultural issues dealing with landscape evolution, ethnography and ethnobotany, the application of biology to archaeology, the application of archaeology to ecology, botany and nature conservation are among the best tools to develop this multifaceted science. The way to do and use a classical science in a modern fashion is possible, as is shown beyond doubt by the increasing amount of updated research published in peer-reviewed journals and books.

2. Previous syntheses of botanical records from archaeological sites in Italy

Previous archaeobotanical syntheses of Italian sites focused on one-type records (seeds/fruits, pollen), on one multi-regional macroarea, or on one chronological phase. These syntheses strongly support the idea that plant remains from archaeological sites mirror the impressive bio-cultural diversity of Italy.

Vegetation history of the Emilia Romagna region was reconstructed on the basis of pollen data from 52 sites, including 19 archaeological sites (Accorsi et al., 1999, 2004). First syntheses centred on food history and seeds/fruits included sites located in: i) northern Italy: Mesolithic to Medieval ages — Hopf (1991); Neolithic — Castelletti (1976); Neolithic to Medieval ages — Castelletti et al. (2001); Mesolithic to Iron ages — Rottoli (2002); ii) central and southern Italy: Neolithic (c. 40 sites) — Costantini and Stancanelli (1994); Neolithic to Iron ages (c. 30) — Costantini (2002); iii) islands (Sardinia): early Bronze age to Medieval ages (9) — Bakels (2002).

More recently, thematic syntheses have focused on seeds and fruits from northern Italy:

- Cultivation and gathering, Neolithic to Chalcolithic settlements (41 sites) — Rottoli and Castiglioni (2009);
- Food plants and diet, Neolithic to Medieval ages in Piedmont (>100 sites) — Castelletti and Motella De Carlo (2006); from Neolithic to Iron ages in Liguria (12) — Arobba and Caramiello (2006); Roman times in Emilia Romagna (11, 4) — Bandini Mazzanti et al. (2001); Bosi et al. (2013); Early Medieval age (31) — Castiglioni and Rottoli (2012);
- Cereals and other food plants in Medieval ages in Italy (c. 60) — Grasso and Fiorentino (2009);
- Plant landscape and economy from Neolithic and Iron ages of north-western sites — Motella De Carlo and Gambari (2004); Motella De Carlo and Venturino Gambari (2004); Bronze age in eastern Emilia Romagna — Carra (2013); Roman age (9) in Emilia Romagna, including pollen — Marchesini and Marvelli (2009);
- Palaeoecology of wet environments from Palaeolithic to post-Medieval age in Liguria (32 sites) — Guido et al. (2006); Roman age in Emilia Romagna (4) — Bosi et al. (in press);
- Plant offerings from Roman cremations (27 cemeteries) — Rottoli and Castiglioni (2011);
- Urban contexts from the Roman Palatino in Rome — Coletti et al. (2006); the Roman *Mutina*-Modena (4) — Rinaldi et al. (2013); the Medieval-Renaissance Ferrara city and surroundings (9) — Bandini Mazzanti et al. (2009); Bosi et al. (2009b).

Fiorentino et al. (2004) reported on seeds and fruits from 68 sites distributed across Italy, and demonstrate the great availability of plant resources during the Bronze age. There was a clear tendency towards the diversification of plant cultivation, including cereals, legumes and fruit trees, the introduction of new species, and the development of olive trees especially in southern Italy, since at least the 4th millennium BP. A recent review of charcoal data dealing with *Abies alba* Mill. in central-southern Italy was carried out to trace fir history over the last 3000 years, as a further example of a promising contribution to the bio-geographical history of Mediterranean trees (Di Pasquale et al., accepted for publication).

2.1. Morpho-biometry of selected taxa

At regional level, purslane seeds (*Portulaca oleracea* L.) belong to several microspecies during Roman and Medieval ages (Emilia Romagna; Bosi et al., 2009c; Danin et al., 2013); abundant flax (*Linum usitatissimum/bienne*) and weld (*Reseda luteola* L.) from the Roman-Imperial town of *Mutina*-Modena mark the importance of fibre and dye plants (Bosi et al., 2011a); minor cereals such as broomcorn millet (*Panicum miliaceum* L.), foxtail millet (*Setaria italica* (L.) Beauv.) and sorghum (*Sorghum bicolor* L. Moench) were common in Early Medieval sites of northern Italy (Castiglioni and Rottoli, 2013).

At national level, the introduction and diffusion of peach tree (*Prunus persica* L. Batsch.; Sadori et al., 2009) and of the genus *Citrus* (Pagnoux et al., 2013) in Italy were followed through morphobiometry of endocarps and seeds, respectively. The history of these important economic trees was reconstructed by carpological and pollen evidence besides written sources and documents. Modern and archaeological remains of pips founded in a Phoenician-Punic amphora (4th–3rd BC) were studied from the Coltellazzo-Pula island seabed (Cagliari, south Sardinia; Orrù et al., 2013). Besides seeds, grapevine pollen, woods and charcoals from the Epigravettian to the Bronze age (112 sites) are reported by Marvelli et al. (2013). For Medieval ages, grape remains from c. 39 sites were compared with the historical sources to reconstruct the variability of the cultivated plants in southern Italy (Grasso and Fiorentino, 2012).

2.2. Multi-site researches

The history of pollen as a 'culture-plant indicator' has been traced through the evidence of both the key trees for the economy – olive, walnut and chestnut trees (*Olea-Juglans-Castanea*), or the OJC group – and other anthropogenic pollen indicators produced by cereals, hemp and synanthropic plants — Anthropogenic Pollen Indicators, or the API group (26 archaeological sites, and 300 samples dated from c. 4200 to 500 cal. years BP; Mercuri et al., 2013b,c). This approach demonstrates that pollen data from archaeological sites are particularly useful for studying local and regional environmental transformations.

Two research papers propose on-site (archaeological sites)/off-site (marine cores) comparisons. Mercuri et al. (2012) integrated the pollen sequence of one archaeological site (Terramara di Montale, Middle Bronze age) into a long marine core sequence (last 7000 years, RF93-30, Adriatic Sea). The same marine core, together with other marine and terrestrial off-site cores, was taken as a reference sequence by Fiorentino et al. (2013) to interpret seeds/fruits and charcoals from 35 Neolithic settlements.

Other multi-site studies were carried out in Tuscany (pollen/charcoals, Roman-Medieval ages, Buonincontri et al., 2013; pollen/seeds and fruits, Roman, Rattighieri et al., 2013), in Campania (charcoal, Late Roman, Allevato et al., 2012; charcoal/pollen, Roman, Di Pasquale et al., 2010), and in Basilicata (pollen, Hellenistic, Caramiello and Siniscalco, 1997; Florenzano and Mercuri, 2012). A synthesis on archaeobotanical research carried out on plant remains from sediments of ancient Italian ports of Roman age dealing with pollen, plant macroremains and shipwreck timber can be found in Sadori et al. (2015).

3. Materials considered and sites selection

This paper reports on the census of botanical studies that have been carried out in archaeological sites attributed to the Holocene and distributed across an area covering continental Italy, the Italian peninsula (including the Republic of San Marino) and the islands, hereafter referred to as 'Italy'.

Most of the studies reported in this paper were published from the end of the '80s onwards. They were selected as being on-sites similar for excavation and recovery methodologies. Human-modified contexts, in fact, include human-settlements (on-site), and human-influenced records such as lake and other terrestrial sedimentary sequences (off-site), two typologies of sites that are fairly different in terms of sampling strategies and interpretation.

The selected sites concern Holocene layers brought to light in trenches or floors during archaeological excavations, or during coring in the archaeological stratigraphy of sites discovered throughout Italy. Sites are typical on-site contexts where samples for botanical analyses were collected during stratigraphical excavation fieldwork. In a few cases, sequences collected close to archaeological sites were also included when sedimentation showed a clear input of human activities (waste deposits, hut poles, etc.). Off-site deposits unrelated to specific archaeological sites were excluded even if they contain anthropogenic signals. Also, special contexts such as burial site and coffins with their grave goods, content of basketry or infilling of pots, isolated tools and objects were excluded because they represent limited or strictly selected plant materials. We are aware that the census may be not complete and that it

is hard to know how many sites have been archaeobotanically investigated over the last quarter-century. However, the set of laboratories and institutions that contributed to this paper is sufficiently broad to cover most of the studies that have been performed in Italy.

Site locations were precisely identified using the geographical coordinates incorporated into Google Earth™, a free programme, very useful to create basic maps. Visual representation of the distribution of the sites was traced on the basic maps with Adobe Illustrator. The more

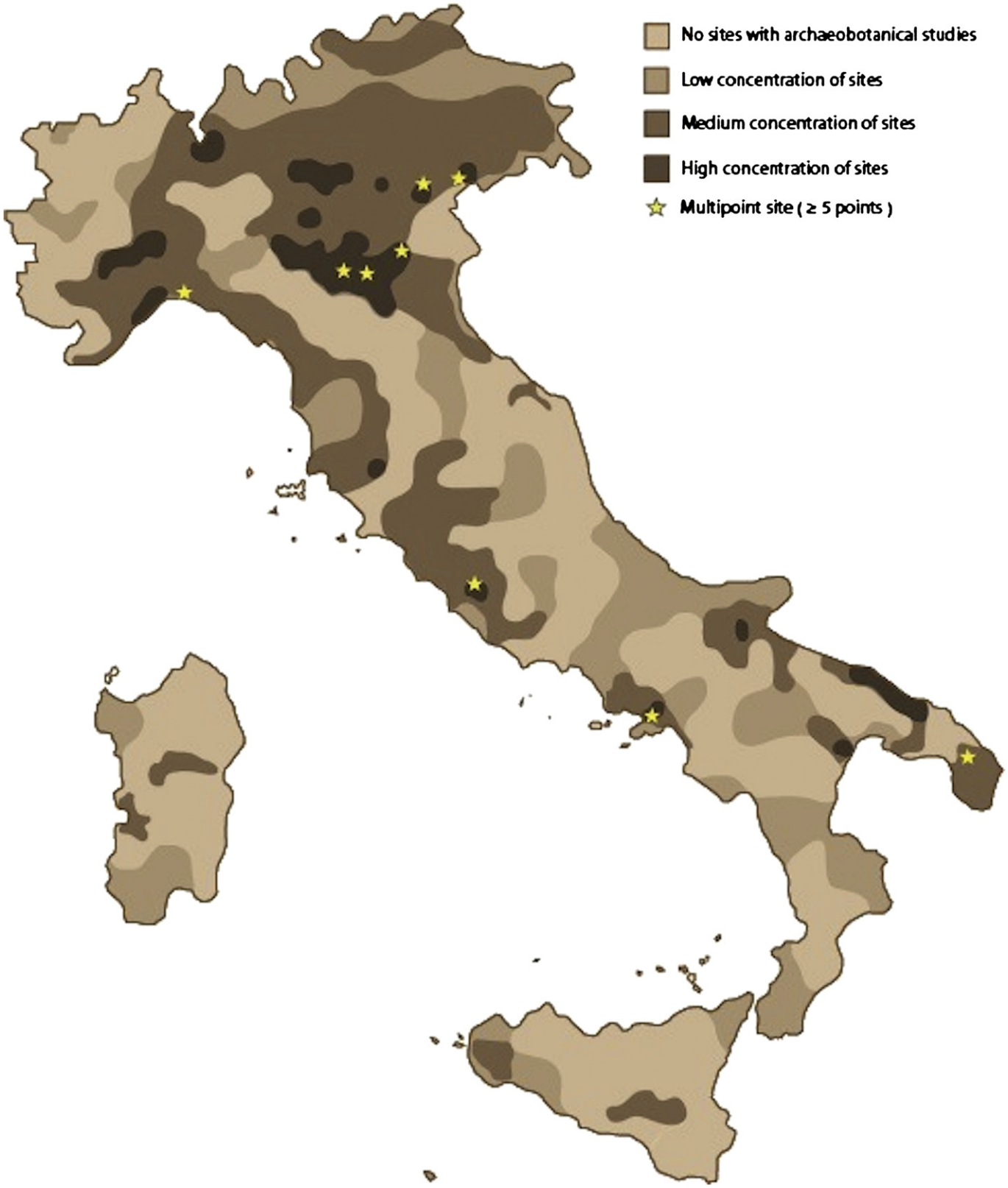

Fig. 1. Distribution map density of archaeological sites with archaeobotanical analyses; dark colour refers to the highest number of sites (drawing by Serena Ferretti).

number of sites are present in an area the darker colour was used in Fig. 1. The exact location of each site is plotted in Fig. 2 according to the chronological phase; as the Roman period divides two periods characterised by critically different land-use and mentality (in the past) and different archaeological approach (in the present), the sites are distributed into two main groups: left, pre-Roman; right, Roman and post-Roman sites.

A full list of sites is reported as Electronic Supplementary Information in Tables 1–3 with the relevant list of references. Sites are subdivided into three macroareas (NI — northern, CI — central and SI southern Italy and islands), and the order of regions follows Istituto Geografico De Agostini (2013).

4. Results: the archaeological sites with archaeobotanical analyses in this synthesis

In the Annexes, this paper presents a complete as possible list of the archaeological sites studied for pollen, non pollen palynomorphs, charcoal particles, seeds and fruits, wood/charcoal or other plant remains, especially those published since end of the '80s. The full list includes 630 sites, provided by more than 15 archaeobotanical teams. The teams are prevalently Italians, but many foreign colleagues have also carried out excavations and archaeology projects in Italy (see the Acknowledgements). The relevant references in the Annex include 730 titles of journal papers and book chapters, but part of that research only found in unpublished reports is also included.

There are 356 sites located in northern Italy, 118 sites in central Italy, 156 sites in southern Italy and the islands. The general site distribution map is plotted per site density according to geographical districts (Fig. 1). It shows that there are nine areas of high concentration site density in northern Italy, two in central Italy, and four in southern Italy. Nine *multipoint sites* (very close sites within a city/town) have been identified. From north to south, they include: Padova/Padua (5 sites), Venezia/Venice (7), Genova/Genoa (5), Ferrara (6), Modena (11), San Giovanni in Persiceto-Bologna (5), Roma/Rome (28), Pompei/Pompeii (9), and Lecce (8).

The sites attributed to the pre-Roman and to the Roman/post-Roman main chronological phases are placed side by side in Fig. 2. In our analyses, 45 sites cover a large range of time entering into both the time-spans (large points in the maps). Moreover, 321 sites are only pre-Roman, and 264 are only Roman/post-Roman. Their distribution well corresponds to what is expected from archaeology, with a number of sites higher in pre-Roman than in subsequent ages in southern Italy, and a high interest of prehistoric archaeology in archaeobotany. Contexts are highly diversified and largely include caves, open-air settlements, rural areas, necropolises and rubbish pits.

4.1. Geographical distribution (Fig. 3)

The sites are located throughout the 20 regions of Italy and in the Republic of San Marino, a small state within the Emilia Romagna region. Site distribution is wide, and thus embraces all the macroareas (north, central ad south). Northern Italy covers 56% of the sites investigated, with a high density of research carried out in Emilia Romagna, Lombardy and Veneto. South Piedmont and central Liguria also present some high-density areas. As for the other macroareas, in central Italy (18%) the highest number of sites was studied in Latium and Tuscany, while in southern Italy (25%) the research was concentrated in Apulia and in small spots throughout Campania and Basilicata.

The northernmost site is San Candido-San Lorenzo di Sebato in Trentino (Castiglioni and Rottoli, in press).

The easternmost site is Grotta dei Cervi in Apulia (Fiorentino et al., 2008b).

The southernmost site is Baia di Scauri, in Pantelleria-Sicily (Marchesini et al., 2009).

The westernmost site is Tharros, in Sardinia (Acquaro et al., 2001).

4.2. Chronologies (Fig. 4)

The sites cover the full Holocene range of dates corresponding to the time span from the Mesolithic to Renaissance ages, right up to modern times in a few cases. Obviously, cultural attributes do not correspond to exactly the same chronology, and therefore the same cultural phase (e.g. beginning of the Neolithic) is known to have time discrepancies in various geographical districts, from the South (e.g. 80th cent. BC, i.e. *c.* 8000 cal. years BP, the settlement of Pulo di Molfetta — Primavera and Fiorentino, 2011) to the North (e.g. 70th cent. BC, i.e. *c.* 7000 cal. years BP, the settlement of Vela di Trento — Mottes and Rottoli, 2006).

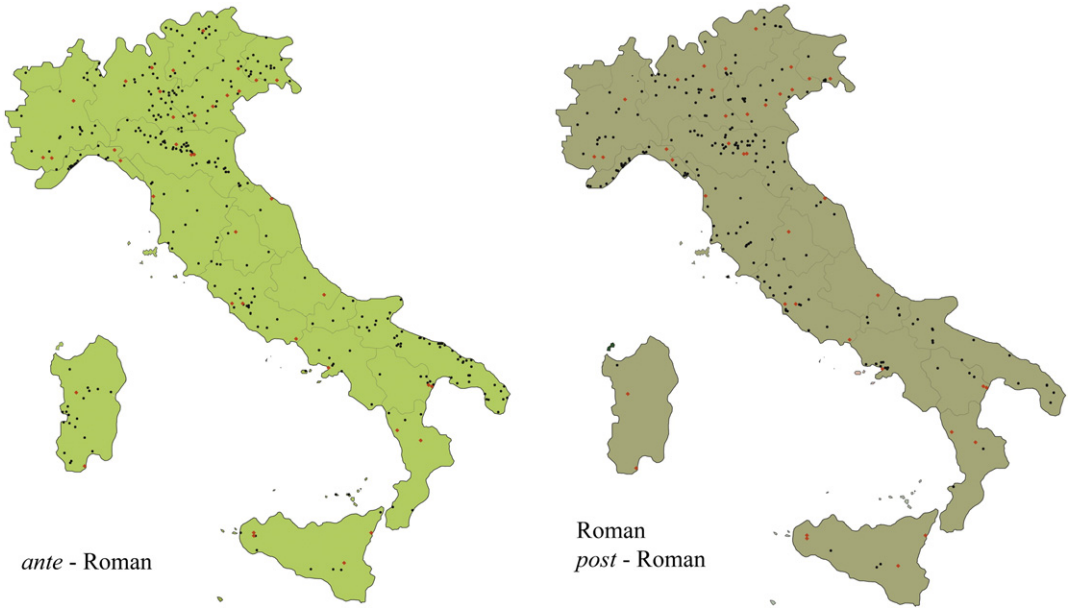

Fig. 2. Distribution map of Holocene sites dated to *ante*-Roman and Roman/*post*-Roman chronological phases surveyed in this paper (drawing by Serena Ferretti). *Ante*-Roman phases include Mesolithic, Neolithic, Chalcolithic, Bronze age, Iron age, Etruscan-Archaic, Hellenistic periods. Roman/*post*-Roman phases include Roman, Medieval, Renaissance and Modern periods. Grey spots mark sites present in the two phases. The whole list of sites is reported in Annex Tables 1 to 3.

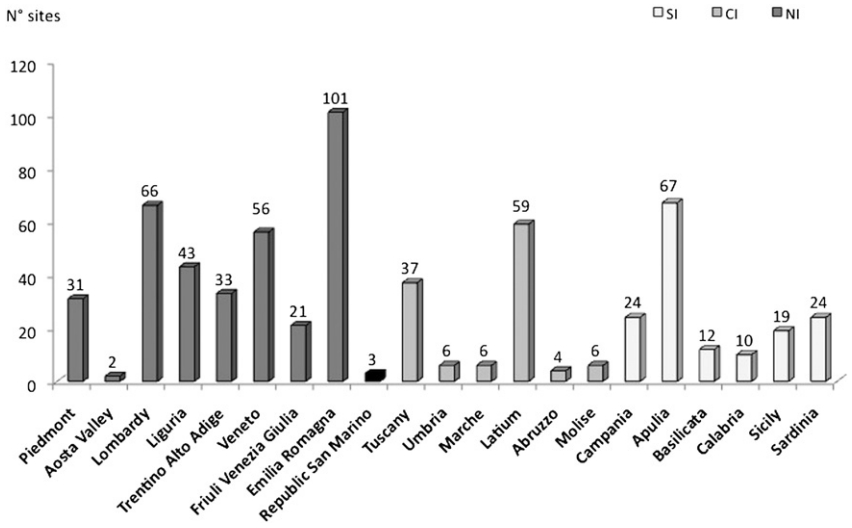

Fig. 3. Number of sites per region. Macroareas: NI = Northern Italy; CI = Central Italy; SI = Southern Italy and Islands.

As expected, the oldest sites are often caves or rock shelters, inhabited even before Holocene times:

- Grotta delle Mura and Grotta S. Maria di Agnano, two caves in Apulia, have been used from Middle Palaeolithic, right up to Middle Neolithic or to the historical age, respectively (Fiorentino, 1998, 2012)
- Grotta delle Arene Candide, in Western Liguria, with Palaeolithic to post-Roman deposits (Maggi, 1997)
- Su Carroppu, a rock shelter in Sardinia, with a deposit dated to 90th–52th cent. BC (*c.* 11,000–*c.* 7200 cal. years BP; Gassin and Lugliè, 2012)
- Grotta dell'Edera, a cave and seasonal hunting camp discovered in Friuli Venezia Giulia, dated to 78th cent. BC (*c.* 9800–*c.* 4600 cal. years BP; Nisbet, 2000)
- Grotta d'Ernesto, a cave and fireplace in Trentino Alto Adige, dated to 70th cent. BC (*c.* 9000 cal. years BP; Nisbet, 1991).

At the other side, the most recent sites include Renaissance to Modern ages rural/garden or castle sites:

- Testaccio–Nuovo Mercato in Roma, in Latium, farmhouses, *horreum*, 1st–18th cent. AD (*c.* 1900–200 cal. years BP; Stellati et al., 2013)
- Gorfigliano–Lucca, in Tuscany, castle, 8th–20th cent. AD (*c.* 1200–0 cal. years BP; Montanari and Scipioni, 2004)
- Lecce–Castello Carlo V, in Apulia, castle, 12th cent. AD- today (*c.* 800–0 cal. years BP; Grasso, 2012)
- Castello Locella–Savona, in Liguria, rural settlement, *c.* 500–100 cal. years BP (15th–19th cent. AD; Arobba et al., 2004)
- Milano/Milan–Giardino Ospedale Maggiore, in Lombardy, pharmacy garden of a city, 17th–18th cent. AD (*c.* 300–200 cal. years BP; Bosi et al., in press).

4.3. Types of records studied (Fig. 5)

In the majority of sites (70%–422 sites), seeds and fruits, which in general receive the best consideration by archaeologists, are important part of archaeobotanical studies. They are at the centre of diet and food production issues. Charcoal analyses, basic elements in the completion of information on subsistence strategies and plant exploitation, are also common (53%–336 sites) while those on woods (15%–93 sites) are probably limited by preservation problems. One third of the sites (34%–211 sites) include pollen analyses, suggesting that also this type of evidence is often sought after especially for reconstructing the landscape and the environment. Interestingly, many sites include other microscopic remains, such as non pollen palynomorphs and charcoal particles. The interest in phytoliths is still limited.

Only around 20% (122 sites) of the studies include combined micro- and macroremains (Table 1; Fig. 6). However, there is an evident tendency in recent bibliographies towards the increasing consideration of combined botanical analyses.

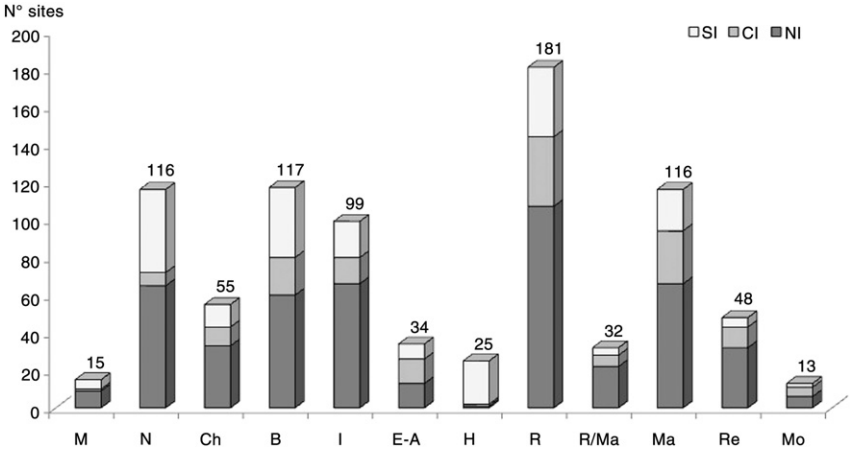

Fig. 4. Number of sites per culture. Macroareas: NI = Northern Italy; CI = Central Italy; SI = Southern Italy and Islands. Labels: M = Mesolithic; N = Neolithic; Ch = Chalcolithic; B = Bronze age; I = Iron age; E-A = Etruscan-Archaic period; H = Hellenistic period; R = Roman age; Ma = Medieval ages; Re = Renaissance; Mo = Modern age.

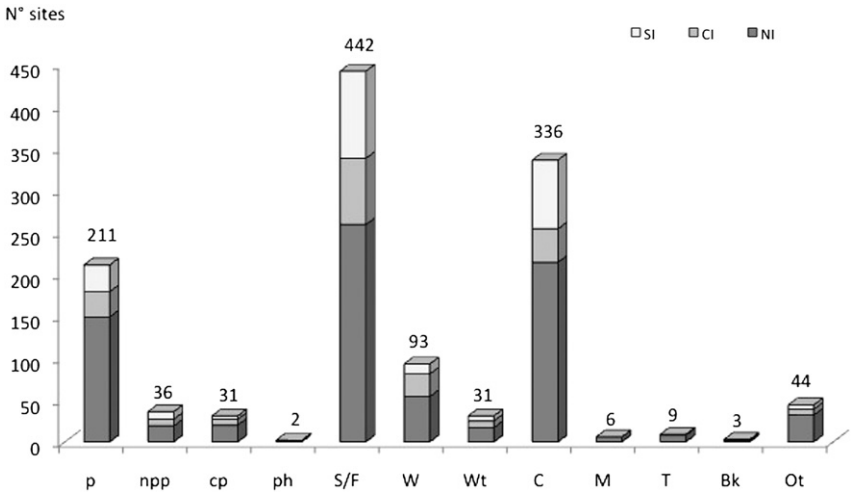

Fig. 5. Number of sites per type of botanical record. Macroareas: NI = Northern Italy; CI = Central Italy; SI = Southern Italy and Islands. Labels: p = pollen; npp = non pollen palynomorphs; cp = micro-charcoal particles; ph = phytoliths; S/F = seed and fruit; W = wood; Wt = wood tool; C = charcoal; M = mould; T = textiles; Bk = basketry; Ot = adobe, bread or similar food, leaves and microsporophylls, mastic, moss, plant tissues, ropes, straw, wick.

5. Discussion

Though biological archives are largely accepted and considered as invaluable documents by prehistoric archaeology, the impressive monuments and artefacts of proto-historic and historical archaeology in Italy often attract the attention of archaeologists who can rely also on walls, art and written sources. Archaeobotanical information, however, completes classical archaeological evidence, and the set of research papers here collected demonstrates that even in Italy plants help to highlight everyday aspects not reported in official documents.

5.1. Aims and results of the archaeobotanical researches in Italy

Many questions on the 'hows' and 'whys' of plant/land use are at the heart of the archaeobotanical research in Italy. In summary, these researches focus on (see the list of references in the Annex):

- *Environmental reconstructions*: depend on the past natural habitats, chronology and culture of each site; studying the environment *before–during–after* the settlements shows environmental transformations;
- *Environmental sustainability*: habitats have different degrees of attractiveness for people depending on geomorphology, vegetation and natural resources; lands may be more or less suitable for humans and their cultural development;
- *Long-Term human impact*: human presence and activities, the depletion and erosion of soils, deforestation and the change in flora composition, the shift of ecological parameters from natural to anthropogenic environments, all transforms the natural plant cover; therefore, also the study of archaeological sites is a key factor to understanding the human impact on the past: it especially marks an ideal line linking 'our environments' from past settlements to the modern towns;
- *Knowledge on the uses of plants*: plant accumulation/transport in archaeological sites is evident from high amounts of macroremains or pollen that may represent a selection of particular species for food, fodder, fuel, textiles, construction or other uses. The matching of different types of data over the time (i.e. charcoal vs. fruits) can be usefully employed to detect cultural changes in the use of multipurpose species (i.e. timber vs. food).
- *Food history and diet*: the history of species with high nutritional values, such as cereals, is again one of the top arguments that today might find great application in the research on 'ancient' species or 'drought-resistant varieties' of plants of agrarian interest. Through food history, details of the social status of past human groups/families, of popular traditions and typical plant products in different territories constitute important pieces in the puzzling agrarian vocation of the modern-day regions of Italy.

5.2. Examples and case studies along the Italian transect

Below, a brief overview on case studies is reported in order to shed light on important archaeobotanical results; the key sites are illustrative of the diversity of distribution, chronologies and topics mentioned in the previous sections, and were selected along a general north-to-south, and roughly wet-to-dry transect of Italian habitats, regions and macroareas of Italy (see information in Tables of Annex).

Along the inner Alpine chain, the multi-layered site of Villandro/Villanders (Trentino Alto Adige, South Tyrol), with macro-remains spanning from the Mesolithic to the Early Medieval age, has provided exceptional data on the spread of early agriculture in the Eastern Alps during the Early Neolithic (Nisbet, 2006–2007). Barley grains from this site, with calibrated radiocarbon dating to between 5260 and 3940 years BC, are the earliest evidence of cereal cultivation in the inner areas of the Eastern Alps from the southern side. This supports the hypothesis that barley was introduced to the northern side of the Alps from the Mediterranean valleys, and the Adige Valley could well have been one of the natural paths leading towards continental Europe.

Rich palaeobotanical documentation, coupled with robust chronostratigraphic control, was obtained from the small intramorenic lake basins hosting pile dwellings in the Lake Garda region of northern Italy. At the onset of the Bronze age culture, between the 21st and 17th centuries BC, this region experienced a sudden expansion of lacustrine villages, most of which located along lakeshores or on swamplands. Palaeobotanical and sedimentological studies are fruitful in these waterlogged sites, given the stratigraphic continuity and the excellent preservation of organic remains. The site of *Lavagnone* (Desenzano del Garda, Lombardy) provided a high resolution palaeobotanical stratigraphy, spanning from the pre-anthropic condition to the rural landscape, coupled with the preservation of both charred and waterlogged plant remains in the cultural layers. This allowed for detailed investigations of the Bronze age palaeoeconomy (Perego et al., 2007; Perego and Jacomet, 2013) and the highlighting of a substantial break from the prevalent natural evolution towards human-driven changes (de Marinis et al., 2005). The Bronze age impact was dramatically evident even in the southern side of the Po plain, in Emilia Romagna, where the Terramare civilization developed between the 17th and 12th centuries BC (Santa Rosa di Poviglio, Montale, Baggiovara). Strong

Table 1
List of sites (geographical location, archaeological context) selected because both micro- and macro- remains were analysed; the archaeological context refers to the main cultural phase studied; labels of the laboratories are in alphabetical order; references are in Annex. Pompeii was reported as one multipoint site to include the varied set of analyses and teams who studied it (see Table 3 in Annex). Chronology is reported as century of calibrated ages BC/AD.

Site	Coordinates	m asl	Archaeological context	Chronology (archaeological data, and '*' 'radiocarbon dates)	Culture	Plant record	Lab
Piemonte (Piedmont)							
Alessandria							
1 Solero - Cascina Urbana	44°51'10"N 8°30'25"E	96	Settlement	14th-13th cent. BC	B	p, C	fl, to
Cuneo							
2 Cherasco - Castello di Manzano	44°39'07"N 7°51'30"E	280	Urban settlement	11th - 13th cent. AD	Ma	p, S/F, C	co, mo
3 *Augusta Bagiennorum* (Bene Vagienna)	44°33'34"N 7°51'17"E3	342	Urban settlement	1st cent. BC - 6th cent. AD	R, Ma	p, S/F, C	fl, to
4 Mondovi - Montaldo	44°19'11"N 7°51'53"E	810	Rural settlement; floor hut;	4th cent. BC - 16th cent. AD	I, Ma, Re	p, S/F, C	fl, rn
5 Peveragno - Loc. Castelvecchio	44°19'20"N 7°39'04"E	642	Urban settlement	6th-5th cent. BC; 5th-6th cent. AD	I, R/Ma	p, S/F, C	co, to
Torino							
6 Balm'Chanto	45°01'27"N 7°07'11"E	1450	Seasonal pastoral rockshelter	30th - 18th cent. BC *	Ch	p, S/F, C	rn
Vercelli							
7 Trino Vercellese	45°11'46"N 8°18'17"E	130	Rom Roman settlement to medieval castle	2nd cent. BC - 13th cent. AD	R, Ma	p, S/F, W, C	fl, mo, to, rn
Valle d'Aosta (Aosta Valley)							
Aosta							
8 Saint Martin de Corleans	45° 44'07.66"N 7°17'49.69"E	594	Megalithic site	c. 30th cent. BC - 10th cent. AD *	Ch, B, I, R, Ma	p, npp, cp, S/F, C	mi
Lombardia (Lombardy)							
Bergamo							
9 Bergamo - Palazzo Podesta	45°42'13.72"N 9°39'44.53"E	379	Wet colluvial deposits close to the settlement	14th cent. BC - 16th cent. AD *	B, I, R, Ma, Re	p, npp, cp, S/F, C	mi
Brescia							
10 Polpenazze del Garda - Lucone D	45°32'53.12"N 10°29'39.69"E	249	Pile dwelling settlement	c. 40th cent. BC - 16th cent. AD *	N, Ch, B, I, R, Ma, Re	p, npp, cp, S/F, C	bs, mi
11 Desenzano del Garda - Lavagnone	45°26'12.67"N 10°32'16.75"E	101	Pile dwelling settlement	c. 40th cent. BC - 14th cent. BC *	Ch, B	p, npp, cp, S/F	bs, mi
12 Laghetti del Crestoso	45°51'14"N 10°18'38"E	2000	Hunting camp	c. 56th cent. BC *	M	p, C	rn, ot
Cremona							
13 Castellaro del Vho di Piadena	45°07'45.97"N 10°23'05.12"E	21	Perifluvial settlement	c. 50th - 40th cent. BC *; 16th-13th cent. BC	N, B	p, cp, S/F, W, C	co, mi
Mantova							
14 Castellaro Lagusello	45°22'09.88"N 10°38'10.33"E	99	Pile dwelling settlement	16th - 10th cent. BC *	B, I	p, npp, cp, S/F	bo, mi
15 Forcello di Bagnolo San Vito	45°06'35.38"N 10°50'06.91"E	15	Settlement and harbour	14th cent. BC - 11th cent. AD *	B, I, E-A, R, Ma	p, npp, S/F, C	co, mi
Milano							
16 Milano - Cortile dell'Universita Cattolica	45°27'51"N 9°11'25"E	122	Necropolis	3rd cent. AD	R	p, S/F, Ot	co, mo
17 Milano - Giardino Ospedale Maggiore	45°27'51"N 9°11'25"E	122	Medicinal/aromatic (pharmacy) garden	17th-18th cent. AD	Re, Mo	p, S/F	co, mo
Liguria							
Genova							
18 Genova - Foce Torrente Bisagno	44°24'02"N 8°56'42"E	10	Open air settlement	c. 50th - 20th cent. BC	N, Ch, B	p, S/F, W, C	fl, to
Imperia							
19 Golfo Dianese	43°54'37"N 8°06'17"E	−40	Shipwreck	1st cent. AD	R	p, W, Ot	fl
20 Imperia - Foce Torrente Prino-Porto Maurizio	43°52'03"N 7°59'47"E	14	Rural settlement	9th - 14th cent. AD	Ma	p, S/F, W, Wt, C	fl, to
21 *Albintimilium* (Ventimiglia)	43°47'20"N 7°37'30"E	25	Urban settlement, grave, ritual gift, balsamarium	1st - 6th cent. AD	R, R/Ma	p, S/F, C, T	fl
Savona							
22 Riparo dell'Alpicella	44°24'18"N 8°32'12"E	350	Rock shelter	c. 50th - 1th cent. BC	N, Ch, B, I, R	p, S/F, C	fl
23 *Vada Sabatia* (Vado Ligure)	44°16'11"N 8°26'12"E	11	Well in roman settlement	1st - 4th cent. AD	R	p, S/F, Wt, Bk	fl, to
24 Arma dell'Aquila - Orco Feglino	44° 12'12" N 8°19'49"E	320	Cave settlement	c. 55th cent. BC	N	p, S/F, C, M	fl, to
25 Riparo di Pian del Ciliegio	44°11'60"N 8°22'50"E	280	Cave settlement	c. 49th - 44th cent. BC	N	p, S/F, C	fl, to
26 Sant'Antonino di Perti	44°11'40"N 8°19'20"E	280	Castrum	6th - 15th cent. AD	Ma	p, S/F, C	co, fl
27 Arene Candide	44°09'47"N 8°19'22"E	60	Cave pastoral settlement	c. 58th cent. BC - 15th cent. BC *	N, Ch, B	p, ph, S/F, C, M	co, fl, rn, ot

(*continued on next page*)

Table 1 *(continued)*

Site	Coordinates	m asl	Archaeological context	Chronology (archaeological data, and '*' 'radiocarbon dates)	Culture	Plant record	Lab
Trentino Alto Adige							
Bolzano							
28 Laces/Latsch-Vinschsgau	46°37'21"N 10°51'54"E	620	Settlement (Iceman)	45th - 29th cent. BC *	N, Ch	p, S/F, Wt, C	ot
Trento							
29 Peciapian - Segonzano	46°11'23"N 11°16'38"E	1209	Smelting site	14th - 10th cent. BC *	B	p, S/F, W, C	sg
Veneto							
Padova							
30 Padova- Palazzo Roccabonella	45°24'20"N 11°52'49"E	19	Channel of rural settlement	10th cent. BC - 9th cent. BC *	I	p, npp, S/F	pd
31 Montegrotto - Via Neroniana	45°19'23"N 11°47'34"E	8	Channels of rural settlement,	1st cent. BC - 1st cent. AD; 9th - 12th cent. AD *	B, I, R, Ma	p, npp, S/F	pd
Rovigo							
32 Badia Polesine	45°04'02"N 11°31'06"E	11	Well of settlement	4th - 8th cent. AD *	R, Ma	p, S/F, Wt	sg
33 Canar di S.Pietro Polesine	45°03'00"N 11°20'00"E	7	Pile dwelling settlement	22th - 18th cent. BC *	B	p, S/F, Wt, C	co, mo, rn
34 Narde - Fratta Polesine	45°01'44"N 11°39'13"E	5	Necropolis	12th - 9th cent. BC *	B, I	p, C	sg, rn
Treviso							
35 Treviso - Piazza San Pio X	45°39'52"N 12°14'28"E	19	Settlement	10th - 9th cent. BC	B, I	p, S/F, C	sg
Venezia							
36 Caorle - Ex-Bafile	45°35'52"N 12°53'17"E	1	Settlement	c. 8th - 16th cent. AD	Ma, Re	p, S/F, W, C	sg
37 Maerne di Martellago-Spinea - Via Zigaraga	45°30'28"N 12°08'32"E	4	Rural roman villa, channel	4th cent. BC - 17th cent. AD *	E-A, R, Ma, Re	p, S/F, W, C	sg
38 Isola Santa Cristina	45°30'27"N 12°27'21"E	3	Well of settlement	9th - 11th cent. AD *	Ma	p, S/F, W	sg
39 Venezia - Palazzo Carminati	45° 26'24.38"N 12° 19'42.98"E	1	Settlement	12th - 17th cent. AD *	Ma, Re	p, S/F, W, C	sg
40 Venezia - Palazzo Genovese	45°25'51.08"N 12° 20'0.56"E	1	Settlement	6th - 15th cent. AD *	Ma, Re	p, S/F, W, C	sg
41 Venezia - Lazzaretto vecchio	45° 24'22.35"N 12° 21'33.48"E	1	Pest hospital (lazzaretto)	12th - c. 17th cent. AD *	Ma, Re	p, S/F, W, C	sg
Verona							
42 Nogara - Mulino di sotto	45°10'50"N 11°03'28"E	18	Settlement	9th - 11th cent. AD *	Ma	p, S/F, W, C	co, sg
Vicenza							
43 Monte Summano	45°45'36"N 11°23'22"E	1296	Sacred area (sanctuary?)	8th - 5th cent. BC *	I	p, C	sg
44 Recoaro Terme - Basto al Campetto	45°40'13"N 11°12'05"E	1553	(Seasonal?) settlement	15th - 17th cent. AD *	Ma, Re	p, C	sg
45 Fimon - Le Fratte	45°28'49.04"N 11°32'21.35"E	24	Hearths (settlement?)	c. 50th - 40th cent. BC *	N	p, npp, cp S/F, C	mi
Friuli Venezia Giulia							
Pordenone							
46 Palu di Livenza	46°01'04.07"N 12°28'39.23"E	30	Pile dwelling settlement	c. 50th - 40th cent. BC *	N	p, npp, cp, S/F, W, C	co, mi
Udine							
47 Forgaria - Castelraimondo	46°12'60"N 12°58'00"E	420	Fortified site	c. 2nd cent. BC - 7th cent. AD	R, R/Ma	p, C	mo
Emilia Romagna							
Bologna							
48 Sant'Agata Bolognese - Viadotto Crocetta	44°40'42"N 11° 10'10"E	14	Settlement	14th - 13th cent. BC	B	p, S/F, C	sg
49 Sant'Agata Bolognese	44°39'54"N 11°08'06"E	21	Castrum	10th - 11th cent. AD *	Ma	p, S/F, W	mo, sg
50 Sant'Agata Bolognese - Montirone	44°39'18"N 11°06'56"E	21	Settlement	17th - 13th cent. BC	B	p, C	sg
51 Calderara di Reno - San Vitale	44°32'42"N 11°18'04"E	35	Rural villa	1st - 2nd cent. AD	R	p, S/F	sg
52 Casteldebole	44°30'58"N 11°15'59"E	53	Rural villa	1st - 4th cent. AD *	R	p, S/F	mo, sg
53 Medicina - Localita Luogo Pozzo	44°30'56"N 11° 36'48"E	17	Rural villa	1st cent. BC - 6th cent. AD *	R	p, S/F	mo, sg
54 Bologna - Via D'Azeglio	44°29'19"N 11°20'23"E	38	Settlement, well and drainage channel	7th cent. BC - 1st cent. AD	E-A, R	p, S/F, W, C	sg
55 Casalecchio di Reno	44°29'00"N 11°15'59"E	61	Settlement	c. 80th-60th cent. BC; 50th - 40th cent. BC *	M, N	p, C	sg
56 Monte Castellaccio	44°21'00"N 11°42'00"E	76	Settlement	26th - 12th cent. BC *	B	p, S/F	mo
57 Pianella di Monte Savino	44°19'40"N 11°24'20"E	550	Settlement (etruscan-celtic)	4th - 2nd cent. BC	E-A	p, S/F, C	bo, mo
Ferrara							
58 Ferrara - Giardino delle Duchesse	44°50'11.83"N 11°37'06.19"E	9	Este court's garden	15th cent. AD	Re	p, S/F	mo
59 Ferrara - Porta Paola-Via Bologna	44°49'53"N 11°36'58"E	9	Ship	16th - 17th cent. AD	Re	p, W	sg
60 Portomaggiore - Gambulaga	44°44'25"N 11°49'01"E	2	Necropolis	1st - 3rd cent. BC	R	p, S/F, C	sg
61 Argenta - Via Vinarola/ Aleotti	44°37'55"N 11°50'01"E	4	Reclaimed channel, monastery (latrine)	13th - 16th cent. AD	Re	p, S/F, Wt	mo

Table 1 *(continued)*

Site	Coordinates	m asl	Archaeological context	Chronology (archaeological data, and '*' 'radiocarbon dates)	Culture	Plant record	Lab
Forli-Cesena							
62 Forli - Via Navicella	44°15'12"N 12°05'11"E	15	Settlement	c. 50th - 40th cent. BC *	N	p, S/F, C	sg
63 Cesena - Provezza	44°11'02"N 12°10'53"E	26	Settlement	c. 30th - 20th cent. BC *	Ch	p, S/F, C	sg
64 Forlimpopoli - Via Canalazzo	44°11'00"N 12°06'19"E	30	Settlement	c. 30th - 20th cent. BC *	Ch	p, S/F	sg
Modena							
65 Mirandola - Arginone	44°54'29.20"N 11°13'5.99"E	9	Settlement (etruscan)	7th - 5th cent. BC	E-A	p, C	mo
66 Mirandola - Miseria Vecchia	44°54'8.60"N 11°11'46.29"E	9	Settlement (etruscan)	5th cent. BC	E-A	p, C	mo
67 Carpi - Fossoli-Discarica AIMAG	44°49'08"N 10°53'53''E	23	Filling channel, well	2nd cent. BC - 1st cent. AD	R	p, W	sg
68 Modena - Cittanova	44°39'00"N 10°50'00"E	41	Sanctuary, productive area	1st cent. BC - 2nd cent. AD	R	p, S/F	mo
69 Modena - Area Novi Sad	44°39'2.84"N 10°55'22.92"E	34	Necropolis, settlement, woodland	4th cent. BC - 12th cent. AD *	E-A, R, Ma	p, npp, cp, S/F	mo
70 Modena - Palazzo Boschetti	44°38'46.21"N 10°55'47.90"E	34	Villa, house	1st - 7th cent. AD	R, R/Ma	p, S/F	mo
71 Modena - Ex Cinema Capitol	44°38'41.22"N 10°55'41.40"E	34	Domus	2nd cent. BC - 4th cent. AD	R	p, S/F	mo
72 Modena - Viale Amendola	44°38'0.12"N 10°54'27.47"E	34	Water drainage system, woodland	2nd cent. BC - 6th cent. AD *	R	p, S/F, W	mo
73 Cognento	44°37'56"N 10°52'12"E	34	Well of settlement	6th - 18th cent. AD	Ma, Re, Mo	p, S/F, W, Wt, C	mo
74 Castelfranco Emilia - Forte Urbano	44°36'03"N 11° 02'42"E	39	Settlement	5th - 3rd cent. BC	E-A	p, C	sg
75 Casinalbo	44°35'00"N 10°52'00"E	60	Necropolis near a settlement	18th - 7th cent. BC *	B, I	p, cp, C	mo
76 Terramara di Montale	44°34'34"N 10°54'38"E	71	Settlement	17th - 12th cent. BC *	B	p, cp, S/F, W, Wt, C	mo
77 Spilamberto - Cava Ponte del Rio	44°33'03"N 11°01'10"E	43	Well	1st - 2nd cent. AD	R	p, S/F, W, C	sg
78 Spilamberto - Via Macchioni	44°33'02"N 11°01'12"E	69	Settlement	c. 60th-50th cent. BC	N	p, S/F, C	sg
79 Montegibbio	44°30'48"N 10°47'09"E	350	Settlement, villa	2nd cent. BC - 6th cent. AD	R	p, S/F	mo
Parma							
80 Fontanellato - Cannetolo	44°52'51"N 10°08'51"E	48	Roman villa	1st cent. BC - 3rd cent. AD	R	p, S/F, W, C	sg
81 Fidenza - Via Bacchini	44°51'55"N 10°03'36"E	75	Settlement including houses and storages	10th - 11th cent. AD *	Ma	p, S/F, W, C	sg
82 Noceto - Vasca votiva	44°48'02.96"N 10°10'19.35"E	81	Sacred area	16th - 14th cent. BC *	B	p, npp, cp, S/F, W, Wt, C	mi, co
83 Parma - Piazza Garibaldi	44°48'05.49"N 10° 19'40.59"E	55	Sacred area, market square	3rd - 2nd cent. BC; 10th - 11th cent. AD*	R, Ma	p, npp, S/F, W, Wt, C	mo
84 Parma - Via Guidorossi	44°47'08"N 10° 17'46"E	57	Settlement	c. 50th - 20th cent. BC *	N, Ch	p, S/F	co, sg
Piacenza							
85 Travo - Via Sant'Andrea	44°51'48"N 9°32'53"E	176	Settlement	c. 40th - 30th cent. BC *	N	p, S/F, C	lc, sg
Ravenna							
86 Faenza - Via Bisaura	44°17'23"N 11°52'38"E	34	Settlement	c. 30th - 22th cent. BC *	Ch	p, C	sg
Reggio Emilia							
87 Terramara S. Rosa di Poviglio	44°51'48.71"N 10° 34'00.79"E	21	Settlement including houses and storages	16th - 12th cent. BC *	B	p, cp, S/F, W, C	co, mi, sg
88 Casale di Rivalta	44°39'02"N 10° 34'20"E	90	Settlement (etruscan)	5th cent. BC	E-A	p, C	mo
Rimini							
89 Riccione - Via Berlinguer	43° 59'48"N 12° 38'48"E	12	Settlement	c. 60th - 50th cent. BC *	N	p, C	sg
90 Verucchio - Necropoli Lippi	43°59'04"N 12°25'07"E	300	Tomb	7th cent. BC	E-A	p, W	sg
Repubblica di San Marino (Republic of San Marino)							
91 Domagnano	43° 56'52" N 12°28'08"E	255	Settlement (roman/gothic)	2nd cent. BC - 6th cent. AD	R, R/Ma	p, S/F, W, C	mo
Toscana (Tuscany)							
Firenze							
92 Firenze - Via de' Castellani	43°46'06"N 11°15'23"E	47	Rural area close to the city wall and the river arno	5th - 16th cent. AD	R, Ma	p, S/F	fi, na
93 Firenze - San Lorenzo a Greve	43° 45'55"N 11°11'50"E	41	Settlement	c. 40th cent. - 15th cent. BC	N, Ch, B	p, S/F	fi
Grosseto							
94 Follonica	42°55'58"N 10°46'28"E	20	Furnaces for iron reduction	6th - 5th cent. BC	E-A	p, C	fi
95 Poggio Tondo, Pian d'Alma	42°51'33"N 10°50'50"E	70	Farmhouse	6th - 5th cent. BC	E-A	p, S/F, C	fi
96 Podere Marzuolo	42° 57'27.08"N 11° 24'25.41"E	108	Farmhouse	1st cent. BC	R	p, npp, cp, S/F, C	mo
97 S. Martino	42° 56'42.89"N 11° 23'04.97"E	130	Small farmhouse	1st cent. BC - 1st cent. AD	R	p, npp, cp, S/F	mo

(*continued on next page*)

Table 1 *(continued)*

Site	Coordinates	m asl	Archaeological context	Chronology (archaeological data, and '*' 'radiocarbon dates)	Culture	Plant record	Lab
98 Poggio dell'Amore	42° 56'37.21"N 11° 23'34.08"E	123	Small farmhouse	1st cent. BC - 1st cent. AD	R	p, npp, cp, S/F	mo
99 Podere Terrato	42°55'39.00"N 11°22'32.00"E	159	Small farmhouse	1st cent. BC - 1st cent. AD	R	p, npp, cp, S/F	mo
100 Case Nuove	42°53'29.33"N 11°20'45.39"E	318	Rural farm and processing area	1st cent. BC - 1st cent. AD	R	p, npp, cp, S/F, C	mo
101 Colle Massari	42°53'35.83"N 11°20'37.69"E	130	Small farmhouse	1st cent. BC - 1st cent. AD	R	p, npp, cp, S/F	mo
Pisa							
102 Bientina	43°46'16"N 10°38'30"E	6	Pile-dwelling settlement	10th cent. BC	B	p, W	fi
103 Pisa - San Rossore	43°43'19"N 10°23'13"E	0	Ship site	10th cent. BC - 6th cent. AD	I, E-A, R	p, W	fi
Umbria							
Perugia							
104 San Marco	43°07'49"N 12°21'41"E	435	Settlement	c. 60th - 40th cent. BC *	M, N	p, S/F	lc, ot
Lazio (Latium)							
Latina							
105 *Privernum - Domus* della Soglia Nilotica	41°29'23.42"N 13°11'03.44"E	36	Garden, drainage system	1st - 2nd cent. AD *	R	p, S/F, C, Bk	ro
Roma							
106 Roma - Valle del Colosseo	41°53'25"N 12°29'26"E	10	Sewer	3rd cent. BC - 1st cent. AD *	R	p, S/F, W, Ot	ro
107 Fiumicino - Lingua d'Oca	41°49'50"N 12°16'30"E	2	Chalcontnic settlement, etruscan saltworks, roman saltworks and reclamation	34th - 31th cent. BC *; 6th cent. BC *; 5th BC - 3rd cent. AD *	Ch, B, I, E-A, R, Ma	p, npp, cp, S/F, W, Wt, C	ro
108 Fiumicino - Portus	41°46'37.84"N 12°15'29.92"E	9	Port	1st cent. AD - Middle age *	R, Ma	p, cp, S/F, Wt	ro
109 Tivoli - Villa Adriana	41°56'27.01"N 12°46'25.47"E	91	Temple, villa rustica	Republican age - 2nd cent. AD *	R	ph, C	ro
Viterbo							
110 Valentano - Rocca Farnese	42°34'5.20"N 11°49'8.98"E	535	Garbage pit	15th - 16th cent. AD	Ma, Re	p, S/F, C	ro
Campania							
Napoli							
111 Castel Nuovo - Piazza Municipio	40° 50'21"N 14°15'12"E	15	Harbour	1st - 3rd cent. AD	R	p, Wt	na
112 Longola	40°47'40"N 14°34'29"E	15	Settlement	c. 16th - 6th cent. BC	B, I	p, W	fi
113 *Pompeii* (9 sites)	40°44'53.67"N 14°29'23.44"E	21	Town	1st cent. AD	R	p, S/F, Wt, C	co, fi, le, na, to, ot
Puglia (Apulia)							
Taranto							
114 Terragne	40°23'30.85"N 17°37'14.79"E	96	Settlement	c. 80th - 40th cent. BP *	M, N	p, S/F, C	le, mo
Basilicata							
Matera							
115 Pantanello (Pizzica Pantanello)	40°23'21"N 16°47'11"E	8	Sacred area, waste area from a furnace of pottery	4th - 1st cent. BC	H, R	p, npp, S/F	lc, mo
Potenza							
116 Torre di Satriano	40° 34'12"N 15°38'15"E	930	Chief's palace	6th - 5th cent. BC	H	p, npp, S/F	mo, ot
Calabria							
Cosenza							
117 Jure Vetere di San Giovanni in Fiore	39°15'51.98"N 16°38'17.31"E	1100	Church	12th - 13th cent. AD	Ma	p, cp, S/F, W, C	le, mo
Sicilia (Sicily)							
Enna							
118 Piazza Armerina - Villa del Casale	37°21'49.00"N 14°20'03.00"E	550	Rural villa, rural settlement	1st - 5th cent. AD; 10th - 15th cent. AD	R, Ma	p, cp, S/F, C	mo, ot
119 *Philosophiana* (Sofiana)	37°19'03.10"N 14°16'26.68"E	628	Rural settlement	3rd - 12th cent. AD	R, Ma	p, C	mo
Sardegna (Sardinia)							
Cagliari							
120 Nora	38°59'03.38"N 9°01'01.68"E	1	Settlement	6th cent. BC - 4th cent. AD	I, R	p, npp, cp, S/F, C	ge, pd
Oristano							
121 Tharros	39°52'22"N 8°26'28"E	6	Settlement	5th - 1st cent. BC	I, E-A, R	p, C	fl, to
122 Terralba - Sa Punta	39°43'43.88"N 8°30'13.11"E	1	Settlement	c. 55th - 51th cent. BC	N	p, S/F	ot

demographic pressure deeply transformed the areas of influence near the settlements into a cultural landscape where cereal fields alternated with pasturelands, and limited woodlands were formed the basis for subsistence (Ravazzi et al., 2004; Mercuri et al., 2006, 2015).

In the town of Padova and in the Euganean Hills (Veneto), though clear archaeological evidence was lacking, the signs of Iron and Roman age human activities were detected in the sediments of the Roccabonella and Montegrotto sites. The combined archaeobotanical

Fig. 6. Location map showing the 122 archaeological sites where researches on both micro- and macro- plant remains were performed (drawing by Serena Ferretti). The numbers correspond to the sites listed in Table 1.

(pollen, non-pollen palynomorphs, fruits and seeds) and geomorphological investigations in fact cast light on the intense development of the local cereal and vineyard agrosystems (Miola et al., 2011).

In Piedmont, the Roman site *Augusta Bagiennorum* (Bene Vagienna), dated from the 1st century BC to the 6th century AD, was established amidst a fairly open and diverse plant cover. The archaeobotanical evidence (pollen, seeds and fruits, charcoal) shows the presence of naked grains and the spread of the important economic trees *Castanea* and *Juglans*. As the ratio between forested and cultivated areas did not change during the period, a significant productive equilibrium was inferred from early on, and no substantial modifications to such equilibrium occurred in the site during the Roman period (Caramiello et al., 2013).

In Liguria, the well-known archaeological key-site of *Arene Candide* coupled studies on micro- and macro-remains (pollen, Branch, 1997; palaeocarpology, anthracology, coprolites and phytoliths, Nisbet, 1997a,b; Arobba et al., 1999), providing reference data on the history of the Mediterranean vegetation at the end of the Neolithic, in connection with human exploitation and revealing the use of the cave as a cattle-shed.

During the Roman Imperial age, *Vada Sabatia* (Vado Ligure) was an important hub for trade and travel of the *IX Regio*, i.e. Liguria, according to the organization of the territory under the Roman Empire. Plant macroremains from the Roman pit, dating to the 1st–4th century AD, represent an exceptional record of cultivated trees, cereals and vegetables (*Castanea sativa* Miller; *Secale cereale* L.; *Beta vulgaris* L., *Cucumis sativus* L., *Linum usitatissimum* L.), and exotic plants (*Prunus persica* (L.) Batsch, *Phoenix dactylifera* L., *Ziziphus jujuba* Miller; Arobba et al., 2013). In the same region, the site of Mogge di Ertola (Genova) was studied as an environmental archaeology site, i.e. by stratigraphic excavations and by analysing micro-and macroremains (including large trunks with evidence of fire and possibly pruning). Besides the evidence of anthropogenic activities, this study contributed to the understanding of the disappearing of silver fir (*Abies*) from the North-Western Apennines (Guido et al., 2003, 2013; De Pascale et al., 2006; Menozzi et al., 2010).

In southern Tuscany, in Roman times there were alternated cereal fields and pasturelands, and small farmhouses dotted the territory with production and processing sites (such as Case Nuove, Vaccaro et al., 2013). The Medieval rural settlement Miranduolo suggested continuity with the agricultural tradition of the Roman world disproving the general idea of a regressed Medieval agrarian economy. At the same time, the growing of *Triticum monococcum* L. was probably the consequence of the Lombard cultural influence (Buonincontri et al., in

press). The coupled carporemains and charcoal analyses allowed for detection of a change over time in chestnut use, from timber to food (Di Pasquale et al., 2008).

In Latium, near Rome, a huge amount of exceptionally well-preserved seeds, food or waste remains, charcoals, poles and wooden artefacts were found at the La Marmotta site (Anguillara Sabazia), which constitutes a unique site for the understanding of the Neolithisation of central Italy. Intact ears of several cereal species and the whole capsules of *Papaver somniferum* L. are but a few examples of the exceptional archaeobotanical records, being of fundamental importance for piecing together the history of domestication of these species in Italy (Rottoli, 2002).

Several examples from urban sites, including some of the most best-known Italian cities are home to remarkable archaeobotanical studies.

Impressive amounts of well-preserved seeds and fruits, often waterlogged, have been found in pits, channels and houses of urban sites from Emilia Romagna. They traced the settlement history of Parma (Bosi et al., 2011b), Modena (Rinaldi et al., 2013) and Ferrara (Bandini Mazzanti et al., 2009), from Roman to the Renaissance and Modern times. Town foundation phases were followed by land transformations, as well as changes and decreases in plant diversity. The high social status of the Este family was evident from their table waste (Bosi et al., 2009a). The development of agricultural traditions was marked by the dynamics and reclamation phases of wet environments of the Po Plain. Moreover, features and goods of the Medieval market at the centre of Parma were enlightened by vegetal waste and the high amounts of parasite eggs found in rubbish pits (Florenzano et al., 2012).

In the pre-Roman period the area where Venezia is located had a scanty population because there was a wide lagoon with some large sandbanks, and areas covered with oak woods and alder forests. During the Roman age, initially human pressure led to woodcutting and increase in agricultural activities; then, woods expanded and human pressure decreased (D'Agostino et al., 2008; Bortoletto et al., 2011). In the Medieval age, the landscape became open once more, and signs of commercial trade and a varied diet are evident in the botanical record including exotic species (Cester et al., 2008). This trend was to continue until the beginning of the Modern age, with botanical remains giving evidence of the refined tastes and richness of Venetian society (Fozzati, 2005).

During the Neolithic period, the Arno basin where Firenze is located was a prevailingly open, damp plain, interrupted by swamps and patches of woodland mostly formed by deciduous oaks and hygrophilous trees. Agriculture is evident by the recovery of drainage canals (Benvenuti et al., 2011). The few available data do not indicate significant changes during the following Bronze and Iron ages (Etruscan period). The Roman colony of *Florentia* was founded around 59 BC, surrounded by an open landscape. Soil exploitation is signalled by the presence of anthropogenic indicator plants, including cereals, pulses, grapevines as well as walnut and olive trees. The Medieval record clearly shows that the urbanization process had advanced a great deal: field weeds and ruderal plants were predominant, while much cultivation or food processing took place within the city walls, as shown by the abundance of cereals, walnuts, figs and grapevines, widespread in the 13th century (Mariotti Lippi et al., 2013).

The great history of the *Caput mundi* may also be reconstructed through its plant remains. Archaeobotanical research in Roma started with Hans Helbaek (1953), who analysed seeds and fruits from the archaic settlements located in the area of the Roman Forum. Maria Follieri in the '60s began to cooperate with classical archaeologists. This relation led to the publication of a study on the wood remains of Republican age from the area devoted to Vesta (Follieri, 1970–71) and on macroremains (seeds, fruits, woods and leaves) deposited in the sediments of the Imperial age from the western sewer of the Coliseum (Follieri, 1975). Recent studies from the centre of Roma (*Capitolium*, *Palatinum*, Roman Forum and the archaeological area of the Imperial Fora) have focused on plant remains from the Iron, Archaic, Republican and Imperial contexts (Sadori et al., 2011, and references therein), and to modern times (Stellati et al., 2013). The scarce attention paid by classical archaeologists to plant remains is lamentable. By contrast, prehistoric archaeologists have shown great interest in archaeobotanical studies, which have allowed for palaeoenvironmental reconstructions in Neo-Eneolithic settlements in the suburbs (Anzidei et al., 2010; Gioia et al., 2010).

The towns of Pompei and Ercolano/Herculaneum, along with other sites scattered throughout the surrounding Vesuvius area, are among the most renowned archaeological sites of Europe. Their archaeobotanical records have been studied by Italian and foreign teams investigating food, traditions, building-timber use and gardens during Roman times in great detail (Caramiello et al., 1996, 2001; Mariotti Lippi, 2000; Ciarallo, 2004; Borgongino, 2006; Fiorentino and Marinò, 2008; Di Pasquale et al., 2010; Ciarallo and Giordano, 2012; Moser et al., 2013). In the same region, major information on timber use in Roman shipbuilding techniques and the availability/provenance of tree species come from Napoli/Naples, where both well-preserved pollen stratigraphy and three shipwrecks were found at the ancient harbour of *Neapolis* (Allevato et al., 2010).

The focus on the Mediterranean arid climate habitats and their transformation under intense demographic pressure in proto-historic and classical times are especially relevant to southern Italy.

In Basilicata, the palynological study of the main archaeological sites of the eastern part of the region (e.g. Difesa San Biagio and Altojanni; Mercuri et al., 2010b) point to the major role that pastoralism has had as an agent in shaping the Mediterranean landscape over the last three thousand years. Intense agricultural activity, mainly based on cereals, olive trees and vineyards, is testified by the uniquely well-preserved macroremains in the area of the Greek colony of Metaponto (Pizzica Pantanello; Costantini, 1983, 2007). In Calabria, also the ancient town of Locri Epizephirii rendered important details on the productive economy of the Greek colonists who settled in the territory (Caramiello et al., 1992).

A unique discovery of a well at the Byzantine village Supersano enhances our knowledge of agriculture and the landscape of the 8th century AD in Salento, in south-eastern Italy (Arthur et al., 2012). The muddy deposit was rich of wooden artefacts and many unusually well preserved grape pips. Besides morphological and morphometric examination (Grasso and Fiorentino, 2010), proteomic and genetic analyses were compared with a database of present grape varieties and provided indication on the Aegean origin of the variety of grape (Cappellini et al., 2010).

In Sicily, the long and continuous sequence of Grotta dell'Uzzo showed an expansion of food resource exploitation during the late Mesolithic and Early Neolithic periods: fishing, hunting and gathering, with wild legumes becoming a part of the diet, were observed along with the inception of food production (Costantini, 1989). An intense programme of archaeobotanical analyses – charcoal, pollen, seeds and fruits – was carried out in the last years in the Aeolian Archipelago, focusing on the Bronze age occupation of the islands (Fiorentino et al., 2010b; Martinelli et al., 2010; Rattighieri et al., 2012), and the palaeoclimate reconstruction coupled carbon stable isotopes with AMS datings (Caracuta et al., 2012). The rural settlement of Villa del Casale (Piazza Armerina) was settled in a fairly treeless area, exploited continuatively throughout Roman and Medieval times (Terranova, 2007; Montecchi and Accorsi, 2010). The landscape was mainly characterized by olive grooves and pastures, and fresh-water plant communities along with species cultivated or exploited in the wild.

In Sardinia, archaeobotany has been little developed until very recently. The earliest site with plant remains is Su Carroppu (Ucchesu, unpublished results) where a limited number of plant remains was recovered from early Holocene contexts. Domesticates (cereals and legumes) are attested in Neolithic sites from the 5th millennium BC which demonstrate an early arrival of agriculture to the island. The Bronze Age site of Grotta di Monte Meana (Tanda et al., 2012; Ucchesu et al., 2014) has produced a remarkable assemblage of plant

remains, which suggest a well established agriculture in which cereals and legumes played an important role. On-going research at several waterlogged contexts is evidencing an extraordinary richness of plant material – cereal, legumes, fruits and wild plants – even from Sardinia.

6. Concluding remarks

The census of sites reported on this paper shows how much the archaeobotany is a consolidated research field in Italy. Hoping that archaeologists will consider plants as a bridge between nature and culture more and more, this vast set of data presents archaeobotany as a self-informative science, and proposes the establishment of a reference database.

Existing data tend to be highly fragmented – drawing on one single site or one single age – and this may limit the comprehension of both common and different paths of development of the plant landscapes of various different areas. The state of archaeobotanical research on past diet, plant uses and cultural landscapes in Italy, however, is highly developed, and it is ready to be broadly considered as a key factor in the future of research into the understanding of the bio-cultural diversity and conservation of the central Mediterranean landscape. Elaboration of data (one single taxon, specific archaeological periods, and plant remain types) will follow in articles that will necessarily use this first dataset to proceed.

On-site studies from a network of regionally distributed archaeological sites are fundamental to understanding the long-term impact of human activities, allowing us to recognise the onset and typologies of cultural landscapes in different regions. Besides this, the diverse types of land use and settlements, the great number of sites and the demographic pressure that this complex country offers makes it possible to introduce the concept of categories of archaeological sites that are fairly news for Italian archaeology, being added to traditional ones. They are already commonly included among archaeological contexts in other European countries, especially when clear human evidence is otherwise lacking. They are, for example, peat bogs, temporary agricultural or pastoral sites, charcoal burning sites, and so forth. Plant remains may be therefore interpreted as independent indicators of agro-forestry-pastoral practices, and compared with the strictly local, unquestionable, cultural evidence found in archaeological sites. The framework of these integrated researches is very promising with a view to defining fairly precisely the onset and development of human-influenced landscapes from which the cultural landscapes and most of our current tangible and intangible 'green heritage' has derived. The contribution of this research is ever more widely recognized in biological science applications, for understanding on how best to anticipate human-environment interactions and how to guide nature-conservation policy in the future (Dearing et al., 2006; Birks, 2012; Mercuri and Sadori, 2014).

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