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ORIGINAL ARTICLE

Archaeobotany at Oplontis: woody remains from the Roman Villa of Poppaea (Naples, Italy)

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Abstract The Vesuvius area near Naples, southern Italy, is one of the richest places for archaeological finds from Roman times. The A.D. 79 volcanic eruption also caused the preservation of a huge quantity of archaeobotanical material. In this paper the available wood and charcoal remains from the timber structures as well as from the garden soils of the Villa of Poppea at Oplontis are presented. The analyses provide new evidence of the history of some significant trees of the Mediterranean region, such as *Abies alba* and *Cupressus sempervirens*, and allow us to put forward hypotheses about wood use during the Roman period. The identification of the building material confirms that the Romans had a good knowledge of the technological properties of wood and mainly used local resources. There is also evidence of trade in high quality timber, in particular *Picea abies*. The strong presence of climbing plants and of branches and small size stems of wild trees together with typical ornamental plants in the two gardens of the villa reveals a lack of regular gardening maintenance. This evidence is in agreement with the absence of occupants at the moment of the eruption, since the villa was under restoration after the A.D. 62 earthquake.

Keywords Vesuvius area · Building timber · Villa garden · Abies · Cupressus sempervirens · Smilax aspera

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Introduction

Charcoal analysis in the Vesuvius area

The area surrounding the Vesuvius volcano in southern Italy was one of the most important regions of the Roman Empire: the fertility of its soil, the closeness of the sea and the mildness of the climate made it a favoured place for settlements. In the early empire Pompeii had around 10,000 inhabitants, Herculaneum at least 5,000, the population of Neapolis was many times more numerous and many villas were situated along the Bay of Naples (D'Arms 1970).

Today this area is studied by scholars from all over the world and visited by millions of people. The A.D. 79 eruption preserved the daily life of Pompeii and Herculaneum and of the villas built around Mount Vesuvius as in a snapshot, offering posterity the possibility to investigate every aspect of the past life of the cities, to study architecture and artistic production and to analyse the surrounding landscape of the

volcano. In particular, the layers of volcanic material allowed the preservation of a huge quantity of plant material. Unfortunately, since the first excavation survey at Herculaneum in 1738, the aim of research in the Vesuvius area has been to bring the artistic objects from the villas to light and not to investigate the material culture of daily life. These precious objects were first brought to the Herculanense Museum (Cantilena and Porzio 2008) and then they were moved to the new National Museum of Naples in 1827 together with some botanical remains found during the excavations (Licopoli 1890; Ruggiero 1885). Because of the aesthetic approach to the archaeological finds, few of the archaeobotanical remains were studied or, if they were studied, not analysed in a systematic way and not published. The smallest materials, such as pollen, charcoal fragments and plant seeds were not considered at all. The botanist Alessandro Trotter (1932) pioneered studies devoted to wood identification, but later the lack of systematic investigations and of suitable sampling and analysis methods caused poor visibility of the inadequately published data. Up to now, even though pollen analysis has been applied in several contexts (Ciarallo and Mariotti Lippi 1993; Grüger 2002; Mariotti Lippi 2000; Mariotti Lippi and Bellini 2006; Mariotti Lippi and Mori Secci 1997) together with seed investigations (Ciaraldi 1996, 2000; Ciaraldi and Richardson 2000; Meyer 1989; Ricciardi and Aprile 1989; Robinson 2002), the study of woody remains has not been widely applied yet. The only available data related to this kind of material mostly concern the archaeological contexts investigated by Jashemski (1979, 1993). Some data also come from research carried out in Herculaneum (Fioravanti and Galotta 2005; Mols 2002), in Pompeii (Castelletti 1984; Veal and Thompson 2008) and in Murecine (Gallo 2000). Borgongino (2006) did an appreciable review of the materials from the Vesuvius region, but without any interpretation of the data.

Thus, the large amount of plant material found during the past excavations has been almost completely lost or destroyed. Precious information is endangered or no longer available for modern research. However, the Vesuvius region is still a rich place with regard to archaeological wood. Here, results of the few available charcoal samples from the Villa of Poppaea at Oplontis (Torre Annunziata, Naples) are presented.

The villa of Poppaea

The villa is located along the bay of Naples, south of Mount Vesuvius, in the modern town of Torre Annunziata (40°45′0″N 14°27′0″E, Fig. 1). It is the richest known example of a suburban villa (Ciardiello 2009; Fergola and Guzzo 2000). Its exceptional dimensions, together with some inscriptions referring to figures of the imperial court, allow one to identify it as the property of the wife of Emperor Nero. Systematic excavations in the villa were first started in 1964, although a small excavation was carried out by Michele Rusca on the peristyle and the portico between 1839 and 1840 (Ruggiero 1888). Between 2006 and 2010 the Oplontis Project has carried out excavations beneath the A.D. 79 level in a total of 20 trenches (Thomas and Clarke 2011).

Despite these various excavations, it has proven impossible to bring the whole complex to light, since it is partially covered by the modern town. 98 rooms were discovered together with around 2,000 m^2 of garden and a 60 m long swimming pool, covering about 5,500 m^2 of surface.

The first phase of the villa dates back to the middle of the first century B.C. Later, the villa was subject to alterations during the times of both Augustus and Nero, when a new residential quarter was added to it. The lack of human remains and the finding of building material piled up in some of the rooms have suggested that, at the moment of the A.D. 79 eruption, the villa was probably deserted and undergoing renovation following the A.D. 62 earthquake (Ciardiello 2009; Fergola and Guzzo 2000).

Charcoal and wood analysis: materials and methods

The analysed material consists of charred and uncharred timber from structural elements (frames, beams, planks and poles) belonging to the building, and wood charcoal from the garden soil (Fig. 2). Taxonomic determinations of charcoals were made with an incident light microscope at magnifications 100×, 200× and 500×, using a reference wood collection and wood anatomy atlases (Greguss 1955, 1959; Schweingruber 1990). Wood samples were first prepared in thin sections, then the taxonomic identifications were made using a transmission light microscope at magnifications of 100×, 200× and 400×. For each charcoal and wood fragment a measurement of the minimum diameter according to the curve of the growth rings and the angle of the rays was performed with the help of a stencil (Ludemann and Nelle 2002).

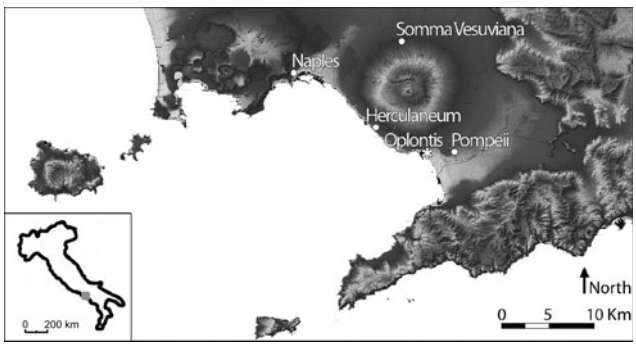
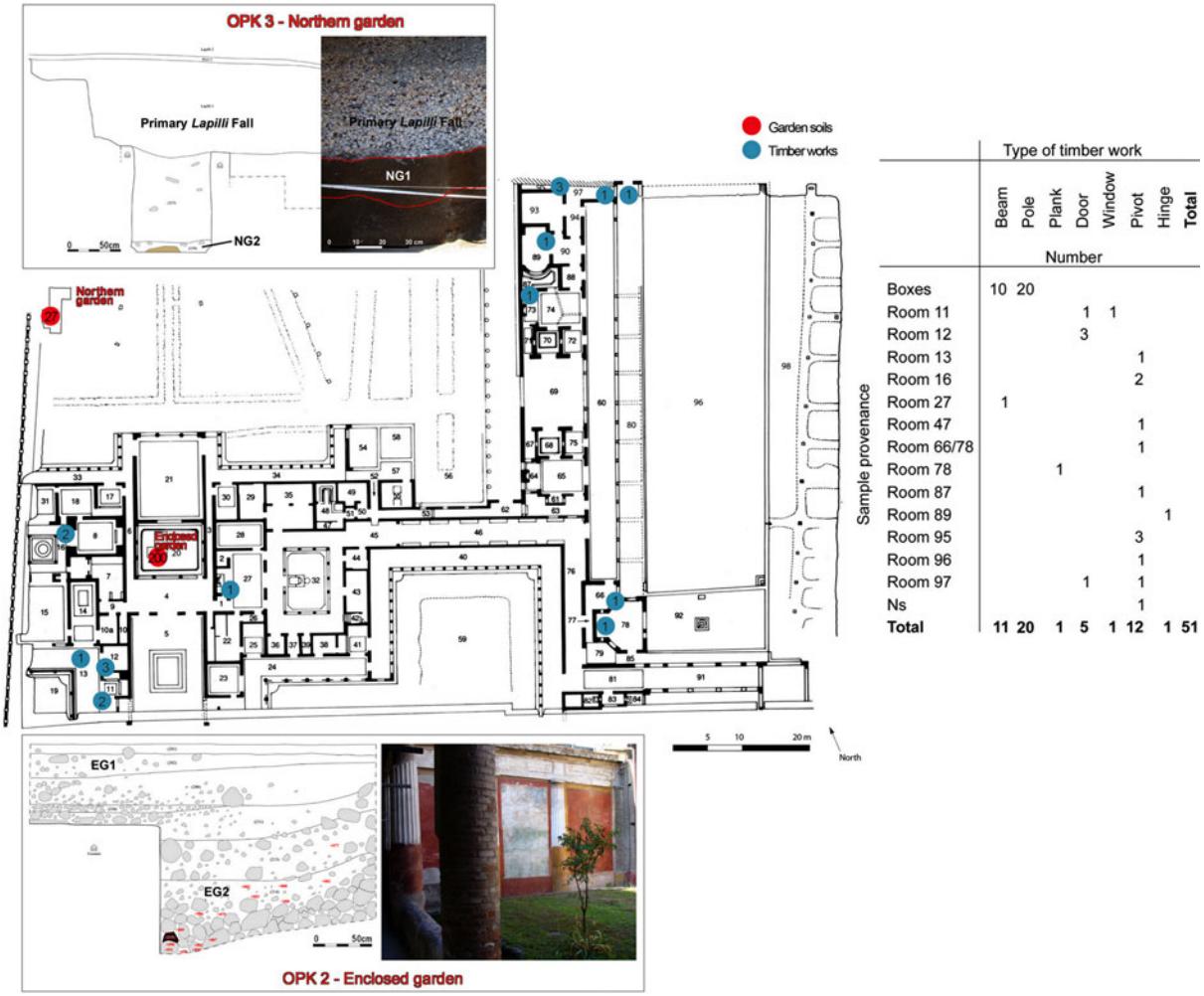


Fig. 1 Map of the main sites cited in the text. *Asterisk*, location of Oplontis, where the Villa of Poppaea is located



	Type of timber work							
	Beam	Pole	Plank	Door	Window	Pivot	Hinge	Total
	Number							
Boxes	10	20						
Room 11				1	1			
Room 12				3				
Room 13						1		
Room 16						2		
Room 27	1							
Room 47						1		
Room 66/78						1		
Room 78			1					
Room 87						1		
Room 89							1	
Room 95						3		
Room 96						1		
Room 97				1		1		
Ns						1		
Total	**11**	**20**	**1**	**5**	**1**	**12**	**1**	**51**

Fig. 2 Locations of the archaeobotanical samples collected in the gardens and of the sampled structural elements still present in situ in the villa. In the *coloured dots* the number of analysed charcoal pieces is indicated. For the two gardens the archaeological stratigraphy is reported and the locations of the collected samples in the stratigraphy are given. The table on the right lists the type and number of sampled structural elements and their location in the villa. Not in situ remains (*Boxes* in the table) are not drawn on the map

The building

51 fragments were analysed (Fig. 2): one charcoal sample comes from the wall of the hexagonal room (room 78); one floor beam found in situ in the *lararium* (room 27) was also sampled. Although their original positions are unknown, 30 samples were taken from pieces of charred beams and poles collected during the past investigations and stored in three boxes (Box 1, 2 and 3, ESM Fig. a) located in the store room of the site. Charred fragments were also sampled from three doors (rooms 11, 12 and 97), and from one window (room 11). After a close reading of the 1970s excavation diary and a careful search in the storeroom of the site, uncharred fragments of door and window pivots pertaining to the rooms 16, 47, 66/78, 87, 95 and 96 and a hinge from room 89 were also found (ESM Figs. b, c, d).

The gardens

The ongoing excavation allowed us to obtain soil samples from the northern garden (56, trench OPK3) and the enclosed garden (room 20, trench OPK2) (Fig. 2).

In the northern garden (Fig. 2), 13 l of sediment were collected (sample OPK3 314, in this paper NG1) and two charcoal fragments were hand-picked by the archaeologists during the excavation (sample OPK3 319, in this paper NG2). In the enclosed garden, sediment was sampled from two stratigraphic layers: 3 l for OPK2 2-3-2 (in this paper EG1) and 1.3 l for OPK2 2-4-2 (in this paper EG2). On the basis of the archaeological record, NG1 is a garden layer referred to the last phase of the villa and it is located just under the primary *lapilli* fall of the A.D. 79 eruption (Fig. 2); NG2 is again a garden layer, but it is older than NG1 and it is dated between the time of Emperor Augustus and A.D. 62.

Table 1 Identification results: frequencies (number of charcoal fragments) of the identified taxa among the structural elements

Type of element	Beam			Pole			Plank	Door			Window	Pivot									Hinge	Total
Room	27	Box 2	Box 3	Box 1	Box 2	Box 3	78	11	12	97	11	13	16	47	66/78	87	95	96	97	Ns	89	
Abies		3	5							1		1	2	1		1	3	1	1		1	20
Picea	1																					1
Pinus group *sylvestris*							1															1
Cupressus sempervirens				17	1	1																19
cf. *Abies*		1	1																			2
Conifer								1			1											2
Indeterminable				1					3						1					1		6
Total																						51

Concerning the enclosed garden, EG1 and EG2 are both layers related to the same activity, dated to the last phase of the villa between the A.D. 62 earthquake and the A.D. 79 eruption, and connected with an attempt to re-organize the garden. Each soil sample was wet-sieved on a sieve column with 1 and 0.3 mm mesh sizes. Taxonomic determinations were made on charcoal fragments larger than 1 mm.

Results

The building

A total of 51 samples were analysed from charred and uncharred wood elements, with the identification of four taxa. The indeterminable fragments represent 12 % of the total. The favourite timber for building was coniferous wood: the beams of the villa were made of *Abies* and *Picea,* while the poles were made of *Cupressus sempervirens*. Timber of *Pinus sylvestris* group was used for the planking which probably covered the wall of the hexagonal room. *Abies* was also used for the doors, windows, pivots and hinge (Table 1).

The gardens

A subtotal of 227 fragments was analysed, of which 199 were identified. In total, 14 taxa have been identified. The indeterminable fragments represent 12 % of the total.

The soil charcoal analysis highlights the predominance of hardwood taxa compared to softwood, with a total of 12 hardwood taxa, together with fir and cypress. Regarding the enclosed garden, the best represented species is *Smilax aspera*, which reaches 81 % of the total identified remains in EG2 and 64 % in EG1. The other identified taxa are *Cupressus sempervirens*, *Abies, Fraxinus ornus*, *Clematis*, *Prunus*, Rosaceae/Maloideae and a conifer in EG1; *Quercus ilex*, *Quercus* dec., *Fagus sylvatica*, *Salix*, cf. *Acer* and *Laurus nobilis* in EG2. In the northern garden only a few charcoal fragments were found: *Smilax aspera*, *Fagus sylvatica,* cf. *Cupressus sempervirens*, *Acer* and *Clematis* in NG1 and *Platanus orientalis* and *Populus* in NG2 (Table 2).

Discussion

Although the charcoals and woody remains found in the Villa of Poppaea represent only a part of the original complex of structural elements and furniture there, they give important insights into the use and occurrence of woody taxa, especially since they are the last available remains from this context.

The timber from the villa

Among the remains of the structures we found mainly beams and poles used in building: in the case of the *lararium* the floor beam was still visible in situ. The dimensions of the fragments found in the boxes indicate their use as structural elements (ESM Fig. a). The timber employed is mostly from *C. sempervirens*, which was used for making the poles, but *Abies* and *Picea abies* were also found in beams. Apart from the structural elements, fragments of the villa's fittings were also found: in particular remains of doors and windows and of pivots and a hinge. 12 of the 19 analysed fragments were successfully identified as *Abies* (Table 1), while the others were too badly preserved for identification at a genus level, but two of them were also conifers. This element confirms the preferential use of coniferous wood rather than hardwood. The growth form of conifers is straight and tall, so they were used as posts or in the form of planks (Giordano 1981; Nardi Berti 2006).

Another charcoal fragment from the bottom of the wall in the hexagonal room was identified as *Pinus sylvestris* group, and the fragment probably belonged to one of the planks used to cover the room's walls.

Table 2 Identification results: frequencies (number of charcoal fragments) of the identified taxa in the enclosed garden (OPK2, EG) and the northern garden (OPK3, NG)

Sample	EG1	EG2	NG1	NG2
Vol. of sediment (l)	3	1.3	13	0
Abies	7			
Cupressus sempervirens	8			
cf. *C. sempervirens*			2	
Abies/Cupressus	1			
Fagus sylvatica		1	1	
cf. *Acer*		1	2	
Fraxinus ornus	6			
cf. *Fraxinus*	1			
Platanus orientalis				1
Populus				1
Salix		1		
Quercus dec.		1		
Quercus ilex		3		
Prunus	2			
Rosaceae/Maloideae	1			
Clematis	5			
cf. *Clematis*			1	
Laurus nobilis		1		
Smilax aspera	64	81	1	
cf. *Smilax*	3	2		
Conifer	1			
Indeterminable	1	9	18	
Total	100	100	25	2

Silver fir

Wood anatomy does not permit a distinction between the different species of *Abies* (fir) present in the Mediterranean (Quézel and Médail 2003). Nevertheless, the identification of our samples as *Abies alba* (Fig. 3a) seems most reliable, due to the wider distribution of this tree in Italian woods.

Silver fir is frequently found in archaeological sites in Mediterranean Italy dating to Etruscan and Roman times: wood remains were found in the Etruscan sanctuary of Pyrgi near Rome (Coccolini and Follieri 1980), at the Colosseum in Rome (Follieri 1975) and at the Roman site of Populonia (Di Pasquale and Terzani 2006), both located along the Tyrrhenian coast in central Italy. Timber of fir was also found in the Roman harbour of Pisa San Rossore (Begliuomini et al. 2003; Bertacchi et al. 2008), where its pollen was also found (Mariotti Lippi et al. 2006). The use of silver fir is also well documented at Herculaneum, Pompeii and Murecine (Gallo 2000; Kuniholm 2002; Mols 2002; Veal and Thompson 2008) and at the "Augustus villa" in Somma Vesuviana (Allevato and Di Pasquale 2009; Allevato et al. 2012), on the northern foothills of Somma-Vesuvius. Silver fir was also often used in shipbuilding (reviewed in Allevato et al. 2010 and Giachi et al. 2003) and in our region its timber was found in the shipwrecks in the harbour of Neapolis (Allevato et al. 2010). The presence of silver fir is also shown by pollen in several areas on the west coast of southern Italy (Di Pasquale et al. 2010; Mariotti Lippi and Bellini 2006; Russo Ermolli and Di Pasquale 2002; Sadori et al. 2010).

Nowadays silver fir grows in mountainous areas of central and southern Europe between 500 and 1,500 m a.s.l., and in Italy it is common on the whole Alpine chain and, in scattered small populations, along the southern Apennine chain above 800 m a.s.l. (Fig. 4). At present, the nearest spontaneous stands of silver fir to the study area are located in high altitude areas on Monte Motola in Cilento (Moggi 1958), where genetic analysis shows the relict status of the fir population (Cennamo et al. 2002), on the Monti Picentini (Moraldo et al. 1981–1982), on the Matese Massif in the Molise-Campanian Apennines (Bianchini 1987) and on the Monti Faiatella and Cervati (Abbate et al. 1997). The archaeobotanical data from ancient Campania (Allevato and Di Pasquale 2009; Allevato et al. 2010; Ciaraldi 2000; Fioravanti and Gallotta 2005; Mariotti Lippi and Bellini 2006; Mols 2002) seems to show that fir was more widespread during the Roman period than today, and ascribe its decline to timber use during historical times (Küster 1994; Quézel and Médail 2003). Its availability in the neighbourhood and its technical properties (Giordano 1981; Nardi Berti 2006) should have made it useful as building timber despite its perishable nature in the open air. Pollen data from the Sele basin area, 60 km south of Naples, moreover, show that fir declines only at the end of the Middle Ages (Russo Ermolli and Di Pasquale 2002), later than in other parts of southern Europe (Colombaroli et al. 2007; Wick and Möhl 2006). This whole set of data contrasts with the hypothesis that silver fir timber found at Herculaneum and Pompeii came from the Alps (Kuniholm 2002). Support for a wider presence of silver fir in Italy in the past can also be found in Latin literary sources. Pliny (*Naturalis Historia* XVI, 195-197; Bostock and Riley 1855) says that those trees "which grow in moist and damp localities are of inferior quality, while in those which grow in warm and sunny spots, the wood is more compact and durable; hence it is, that at Rome the fir is preferred that grows on the shores of the Tyrrhenian Sea to that of the shores of the Adriatic Sea". Pliny reports not only on the presence of fir in the peninsula of Italy, but also indirectly on the use of its timber. On the basis of the whole archaeobotanical record we can assume a strong exploitation of silver fir for timber, which might have caused its slow decline in southern Italy. In particular, silver fir was used for the construction of beams, as is also well documented at Herculaneum (Moser et al. 2012).

Cypress

Cupressus sempervirens (Fig. 3b) is usually thought to be a native of the eastern side of the Mediterranean, having been

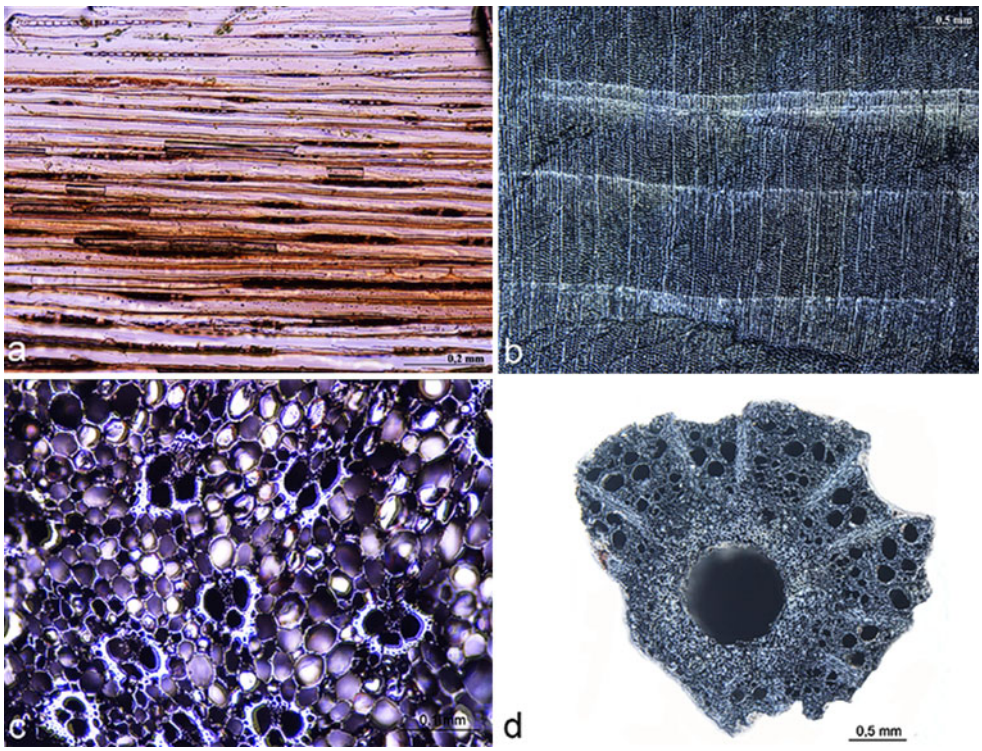


Fig. 3 Microphotographs of some of the identified taxa: **a** Tangential section of *Abies* (uncharred wood); **b** Transversal section of *Cupressus sempervirens* (charred wood); **c** Transversal section of *Smilax aspera* (charred wood); **d** Transversal section of *Clematis* (charred wood)

introduced to Italy by the Phoenicians (Pignatti 1982). However, recent genetic studies have shown that in southern Italy some cypress populations can be considered to be remnants of ancient depleted populations (Bagnoli et al. 2009). At any rate, cypress has probably been grown in Italy since Etruscan times (Pignatti 1982; Quézel and Médail 2003), and gradually it has become a characteristic element of Mediterranean Italy (Di Pasquale et al. 2004). During the Roman period cypress was grown in parks and cemeteries and used for marking boundaries (Meiggs 1982), assuming a strong symbolic-ritual value. Cypress was also grown as an ornamental tree in some Pompeian gardens (Ruggiero 1879). The symbolic value of cypress seems to be confirmed by the finds of its macroremains in a domestic (Robinson 2002) and funerary (Matterne and Derreumaux 2008) burnt offering at Pompeii and in drug preparation (Ciaraldi 2000). A few cones were also found in the Neapolis harbour sediments dated to the 3rd to 5th century A.D. (Allevato et al. 2010).

Nevertheless, clear evidence of cultivation of cypress for timber production comes just from Campania, where it was grown in plantations in the Vesuvius area (Jashemski et al. 2002; Ruggiero 1879), showing its strong economic significance. Recent data show the extensive use of this wood in Roman shipbuilding; in fact, cypress is present among the timber used in three shipwrecks in the Neapolis harbour (Allevato et al. 2010). In the western Mediterranean, previous evidence of cypress as shipyard timber also comes from the central Tyrrhenian coast (reviewed in Allevato et al. 2010 and Giachi et al. 2003). Our data represent the first archaeobotanical evidence of cypress as a significant house building material. Ongoing analysis at Herculaneum is revealing a massive use of cypress for poles and posts (Moser et al. 2011). This evidence demonstrates that the Romans appreciated the good technical properties of this wood (Giordano 1981; Nardi Berti 2006) and allows us to reconsider the economic value of this tree. Evidence of cypress plantations in Italy can be found in the words of Pliny (*Naturalis Historia*, XVI:139–142; Bostock and Riley 1855): "Both the male and the female are permitted to throw out their branches, which are cut and employed for poles and props, being worth, after thirteen years' growth, a denarius a-piece. In respect of income, a plantation of cypress is remarkably profitable, so much so, indeed, that it was a saying in old times that a cypress-wood is a dowry for a daughter". Although determining the extent of cypress plantations would require much more palaeoenvironmental data than is available at present, the economic value of the cypress wood and the high return which came from its plantation clearly appear in Pliny's text and in the archaeobotanical data. On the other hand, the recent studies that show the presence of ancient depleted wild populations of cypress in the central and western Mediterranean (Bagnoli et al. 2009) bring into question the traditional idea of this tree as an exclusively cultivated species in this region.

Norway spruce and mountain pine

Even if we can assume a local provenance for silver fir, this seems highly improbable for *Picea abies* (Norway spruce).

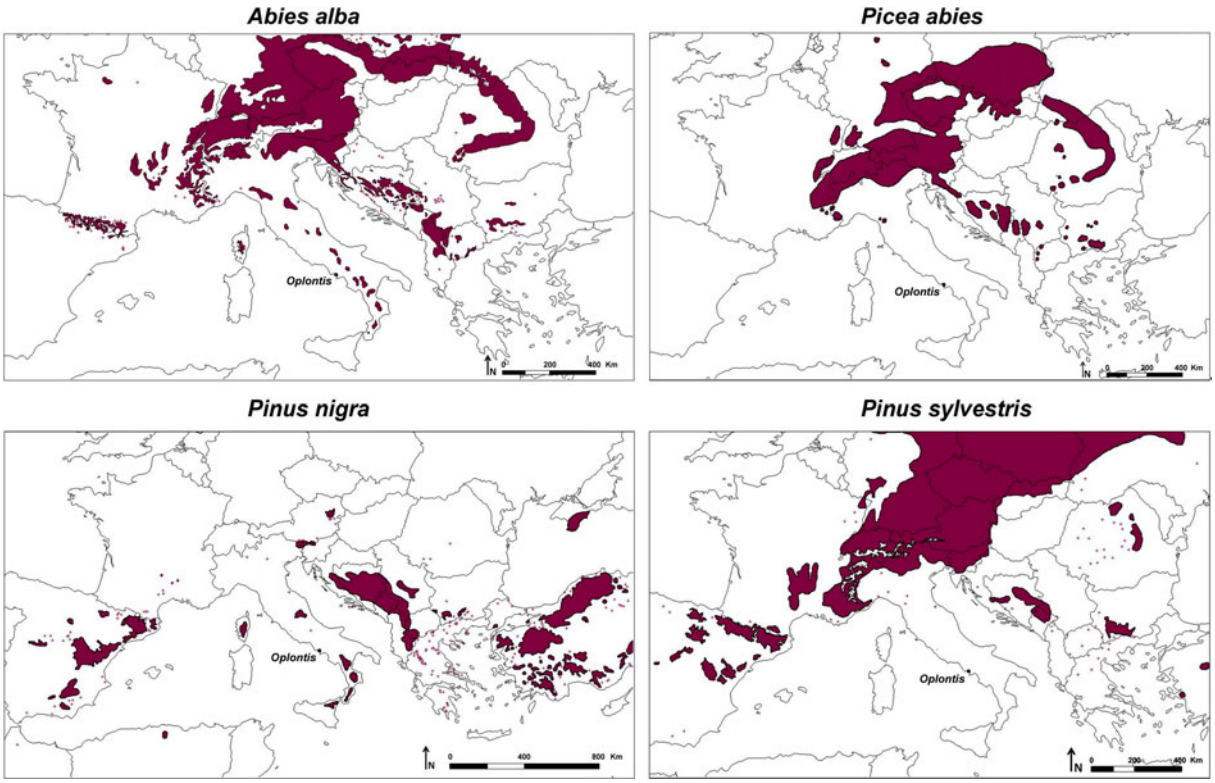


Fig. 4 Distribution maps of *Abies alba*, *Picea abies*, *Pinus nigra* and *Pinus sylvestris* in Italy and in the surrounding regions. Maps have been drawn up with the free software DIVA-GIS (http://www.diva-gis.org) on the basis of the distribution maps available at http://www.euforgen.org/distribution_maps.html

Based on wood anatomy, in most cases it is not possible to distinguish between *P. abies* and *Larix decidua*, the only distinguishing character being the shape of pit exterior borders in ray tracheids (Bartholin 1979); in this case however, the excellent preservation of the charred wood allowed the identification of *P. abies*. Norway spruce never reached southern Italy during the Holocene, as shown by pollen records (Ravazzi 2002). Despite that, trade in spruce timber to southern Italy is shown by the finds not only at the Villa of Poppaea, but also in Pompeii and Herculaneum (Kuniholm 2002; Moser, unpublished data), in the shipwrecks found in the Neapolis harbour (Allevato et al. 2010) and in Pantelleria (Marchesini et al. 2009). The natural range of Norway spruce covers most parts of northern Europe and European Russia; in Italy this tree is common in the Alps between 800 and 2,100–2,300 m a.s.l. The nearest source area for spruce today is a relict area in the northern Apennines (on the Pistoiese Apennine, following Pignatti 1982) (Fig. 4), where pollen analyses also show its presence during the Holocene (Ravazzi 2002 and references therein; Vescovi et al. 2010). Though impossible to tell for certain, these seem to be the most probable areas of origin. Concerning the trade in timber, Latin written sources can give us an indication: Pliny writes about the trade in larch. It is relevant to take account of this tree, since it can often be found in the same vegetation belt as Norway spruce above 1,800 m a.s.l. in the Alps. Pliny (*Naturalis Historia* XVI:190; Bostock and Riley 1855) says that" at all events, it was under these circumstances that Tiberius Caesar gave orders for the larches to be cut in Rhaetia, that were required for the purpose of rebuilding the bridge of the Naumachia after it had been destroyed by fire". Rhaetia was a province of the Roman Empire located between present-day Switzerland, southern Germany, northern Italy and Austria and it corresponds to the nearest source area for larch. It might be possible to suppose the same for spruce; however we cannot exclude the northern Apennines as a conceivable source area.

Pinus sylvestris group includes three different species (*P. nigra*, *P. sylvestris* and *P. mugo*), which cannot be distinguished anatomically. *P. mugo*, anyway, can be ruled out as its shrubby growth form makes it unsuitable for timber. Both *P. nigra and P. sylvestris*, on the contrary, can provide valuable timber for building (Giordano 1981; Nardi Berti 2006). *P. sylvestris* (Scots pine) has a mainly northern distribution in Europe, while in the Mediterranean area it is present in several disjunct areas in Spain and in the Alps (Fig. 4; Tutin et al. 1964–1980; Pignatti 1982). A few Scots pines are present in the Cerbaie hills north of the Pisa plain (Tomei and Zocco Pisana 1994). *P. nigra*

(black pine) constitutes a collective species with a wide and scattered pattern of distribution in the Mediterranean mountains. In Italy, the black pine group is represented by *P. laricio* in Calabria and Sicily and by *P. nigra* in the north-eastern Alps and in the central-southern Apennines (Pignatti 1982). A relict population is present in the Campanian Apennines (Fig. 4; Pignatti 1982). Mountain pine finds in archaeological contexts in the Vesuvius area are not frequent: archaeobotanical data only report a fragment of mountain pine in Pompeii and Murecine (Castelletti 1984; Gallo 2000) and its use in the shipwrecks in the Neapolis harbour (Allevato et al. 2010). For the latter, authors hypothesized the use of *P. laricio* at least for the little ship "Napoli C" (Allevato et al. 2009). At the Villa of Poppea the use of black pine, instead of Scots pine, also seems to be more likely, according to the distribution range of the species, anyway, due to the impossibility of ascribing the samples to either the black or the Scots pine, nothing can be said for certain about the source of this timber.

The gardens of the villa: an unusual plant assemblage

The identified taxa from the charcoal fragments which were found in the two garden soil samples do not represent a homogeneous group of plants: some of them are typical ornamental plants, while others seem to be considered more as wild trees, and yet others are climbing weeds. This makes their interpretation difficult. Are they really the plants which were growing in the gardens as ornamentals, or can their presence being explained in a different way? Considering the identified taxa one by one is indeed necessary.

In the older layer of the northern garden NG2, referred to the garden of the villa between the time of Emperor Augustus and A.D. 62, remains of *Populus* (poplar) and *Platanus orientalis* (oriental plane) have been found. The oriental plane is indigenous to the central-eastern part of the Mediterranean basin, where it grows along rivers together with other plants such as *Nerium oleander*. It also grows wild in some very restricted areas of southern Italy, Sicily and Sardinia. Oriental plane was a widespread ornamental tree in the gardens of the Vesuvian villas, where its pollen has often been found (Mariotti Lippi and Bellini 2006; Mariotti Lippi and Mori Secci 1997). The wide distribution of this tree is shown by several finds, mainly root cavities, such as that found in the Villa of Poppea (Jashemski 1979), and also in representations on wall paintings and mosaics (Jashemski et al. 2002). At the Villa S. Marco in Stabiae the imprint of a plane leaf was found, as reported by Jashemski (1979). Its use as a garden tree was probably introduced by the Greeks, who still use it ornamentally. Ovid in his *Metamorphoses* often speaks about this tree (10.86; 12.1; 13.750; More 1922); Cicero (*De Divinatione* 2.63; Müller 1915) and Vergil (*Georgics* 4.146; Greenough 1883) mention the plane for the useful shade that it provided in gardens.

Populus includes several different species in Italy: *P. nigra*, *P. tremula* and *P. alba*. Identification based on wood anatomy can only reach genus level; however, it is possible to argue that at least both black and white poplars had a use as ornamental elements: the white poplar is quoted by the poet Horace as a garden tree (Bowe 2004) and it was sacred to Hercules (Von Stackelberg 2009). The idea of an ornamental use of poplar can partially be confirmed by the possible representation of this tree in one of the wall paintings of the villa (M. Ricciardi, personal communication).

The layers NG1, EG1 and EG2 are all dated to the last phase of the villa between the A.D. 62 earthquake and the A.D. 79 eruption and, on the basis of the archaeological record, they can be related to an attempt to re-organize the gardens during the restoration of the villa after the damage from the earthquake. The charcoal record of these layers is rich in taxa: some of them can clearly be considered as ornamental, others as wild trees.

For cypress we can hypothesize its use as an ornamental tree in the northern garden, in addition to the use of its timber as a structural element in the villa. In fact, a root cavity attributed to a cypress was found by Jashemski (1987) along the north end of the swimming pool of the villa. Cypress was also found in the EG2 layer of the enclosed garden, but in this case, due to the small size of this area, it probably represents, together with silver fir, fragments of structural timbers of the villa which fell into the garden by accident during the eruption: the wood diameters—larger than the others—confirm that the dimensions of these trees were not suitable for this size of garden.

Laurus nobilis which was also found in the enclosed garden, was very common as an ornamental tree and we find references to it in numerous sculptures, wall paintings and graffiti in the villas. Remains of laurel were also found at Pompeii (Jashemski 1979, p 53; Jashemski et al. 2002). Laurel is an indigenous plant of Mediterranean regions and it has been cultivated since antiquity. Pliny (*Naturalis Historia* XV:127 and 130; Bostock and Riley 1855) tells about the use of laurel in the gardens: "there suspended alone, it graces the palace, and is ever on guard before the threshold" and "in ornamental gardening we also find the taxa employed (…); the spadonia too (…); the Alexandrian laurel".

Salix was also found in the enclosed garden: this taxon includes more than 30 species in Italy, which cannot be distinguished by their wood anatomy, but it is possible to hypothesise its use as ornamental tree in the garden. The poet Martial, describing his *hortus*, reports the presence of a willow in it (Von Stackelberg 2009).

On the contrary, it is not possible to advance a hypothesis about the charcoal fragments from the enclosed

garden identified as *Prunus*, since the poor preservation did not enable us to ascribe them to one of the groups of species which can be identified. The genus *Prunus* includes numerous trees, both wild and cultivated: among the latter we can mention sweet cherry, plum, almond and peach, which were used both as fruit trees and ornamentals. Within this genus, almond, plum and cherry began to be widespread in Europe and Italy from Neolithic times (Zohary and Hopf 2000) or in the case of peach only first during the Imperial Roman age (Sadori et al. 2009). There are numerous finds related to this genus in the Vesuvius area: not only in archaeobotanical material (Allevato and Di Pasquale 2009; Ciaraldi 2000; Jashemski et al. 2002), but also in wall paintings, mosaics and sculptures (Jashemski et al. 2002). An indication of the presence of *Prunus* in the enclosed garden could come from the analysis carried out by Jashemski (1979), who highlights the presence of a root cavity referred to such a tree. The finding of a carbonized peach stone in the enclosed garden in EG2 is also noteworthy. The same applies to charcoal identified as Rosaceae/Maloideae which includes fruit trees such as quince, apple and pear, as well as hawthorn.

The other identified plants cannot properly be considered as ornamental trees, though we cannot completely exclude the possibility that they were considered as such in the past (Caneva 1999). Such is the case of *Quercus* dec. (deciduous oak), *Quercus ilex* (holm oak) and *Fraxinus ornus* (manna ash), which were found in the enclosed garden, and cf. *Acer* (maple) and *Fagus sylvatica* (beech) which were also found in the northern garden. Deciduous oak and holm oak are very common trees in the Vesuvius and Mediterranean landscapes. The representation of evergreen and deciduous oak in several artistic objects shows the strong value of these trees for the Romans. Civic crowns were made out of holm oak and deciduous oak and they represented the highest honour for saving a Roman citizen's life. A carbonized leaf of *Q. pubescens* was found at Oplontis (Ricciardi and Aprile 1989), and *Q. ilex* and deciduous *Quercus* are present in the garden represented on the wall painting in the Villa of Livia at Prima Porta in Rome (Caneva 1999). Manna ash is a typical tree of mesothermophilous woods and is one of the first trees which colonize abandoned fields. Three species of maple are present in Italy, which grow in very different habitats; there is no evidence of the use of maple as an ornamental tree. Beech is also present in both the gardens: nowadays beech grows in mountainous areas both on the Alps and the Apennine chain up to Sicily. During Roman times, beech could have been present at a lower altitude than today (Mariotti Lippi et al. 2006) and clear evidence of this comes just from the Vesuvius region (Castelletti 1984; Allevato et al. 2012). In Pompeii it was largely used as firewood (Veal and Thompson 2008) and in a villa in the Pompeian countryside an assemblage of beech bud scales was also found inside a *dolium* (Ciaraldi 2000).

The archaeobotanical record from the enclosed garden is, therefore, heterogeneous and composed not only of typical ornamentals, but also of wild trees. Moreover, even if we hypothesize that all these plants were used as ornamentals in the gardens, another problem arises: if the northern garden is wide enough to contain the different identified plants (oriental plane, poplar, cypress, maple and beech), this seems unlikely for the enclosed garden. The latter is a relatively small area (10 × 7 m) which could not contain all the identified trees: beech, maple, manna ash, willow, deciduous oak, holm oak, laurel, *Prunus* and Rosaceae/Maloideae. Such a composition of the charcoal assemblage, therefore, leads us to consider a different interpretation.

By inspecting the previous theories proposed for charcoal assemblages in Roman gardens we do not find any convincing explanation for our case.

As argued by Jashemski et al. (2002) and Gleason et al. (2006), the charcoal could be interpreted as residual fragments in kitchen debris or in firewood ash used as fertilizer. In our case the composition of the charcoal record, characterized by taxa which are not good as fuel, allows us to consider this hypothesis less probable.

The charcoal assemblage could be also interpreted as burnt pruning remains (Jashemski et al. 2002) but none of the ornamental trees identified in the original garden (poplar and oriental plane in NG2; *Citrus limon*, *Nerium oleander*, *Olea europaea* and root cavities of oriental plane by Jashemski et al. 2002) was found in the unusual assemblage of the enclosed garden and in the latest layer of the northern garden (NG1).

The analysis of the wood diameters shows the strong dominance of branches and small size stems (0–5 cm) among the charcoals from the gardens, while the structural elements show mainly large diameters (>10 cm) (Fig. 5). This point could be an indication of dense vegetation planted with the aim of giving the idea of a wild garden as documented at the Villa Arianna in Stabiae (Gleason 2010). In the case of the Villa of Poppaea, anyway, the strong presence of climbing plants such as *Clematis* (Fig. 3d) and especially *Smilax aspera* (Fig. 3c), present in all the layers dated to the last phase of the villa and described by Pliny as an *ill-omened* plant (*Naturalis Historia* XVI: 63; Bostock and Riley 1855), widely present in the Mediterranean woods and, as a weed, in our charcoal record, render this hypothesis less probable. The charcoal assemblage could also be composed of plants from different origins, which would exclude any attempt to understand the real aspect of the gardens. The peculiar status of the villa in the investigated period, as inferred from the archaeological data, drives us to try an interpretation, anyway. The fact that the villa and, as shown by the archaeological record, the two gardens were under restoration after

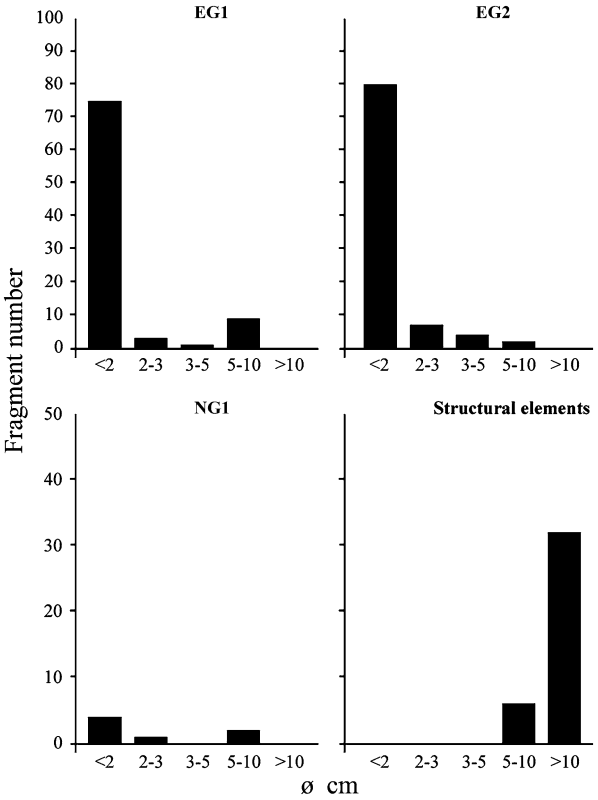


Fig. 5 Diagram showing the different wood diameter classes for the charcoal found in EG1, EG2 and NG1 and for the structural elements

the A.D. 62 earthquake brings us to a plausible interpretation of the charcoal record, which agrees well with the archaeological data: the gardens could have been neglected in the absence of occupants. The presence of the climbing weeds could be the evidence of a lack of regular gardening maintenance, which could have allowed the colonization of the neglected gardens by wild vegetation. The analysis of the diameters of the growth rings showing mainly small to medium size diameters (0–5 cm, Fig. 5) agrees with the time of garden abandonment and further reinforces this hypothesis.

Conclusion

The study of charcoal and woody remains is essential to gain information about past landscapes, the use of wood by past societies and the relationship to woodland resources. In the case of the Vesuvius area this research is even more important since it represents one of the most significant archaeological contexts of the Roman world. Although low in number of analysed fragments, the charcoal analysis carried out at the Villa of Poppaea yielded essential information. Regarding timber for building, the data confirms the massive use of silver fir and suggests that this tree was more widespread in southern Italy during the past than today. The use of cypress confirms that its good technical properties were well-known by the Romans, that it has been used as timber for building and that it was probably more widely present than today, at least in this area. The data show the specific use of different timbers for different structural elements of the villa. The presence of Norway spruce is an indication of an existing trade in high quality timber.

The analysis of the garden soil samples, despite the complexity of the identified assemblage, provides information about aspects of the villa's gardens between A.D. 62 and the moment of the eruption: the presence of both wild trees showing a small wood diameter and climbing weeds together with ornamental trees seems to indicate that the gardens were totally neglected. This is in agreement with the archaeological record which shows that the villa was under restoration after the A.D. 62 earthquake. However, more data from both charcoal/wood analysis and pollen are required to advance well-grounded hypotheses on Roman landscape reconstruction and on the use of timber and its trade during the Roman age.

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