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Pollen-wood analysis at the *Neapolis* harbour site (1st–3rd century AD, southern Italy) and its archaeobotanical implications

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ABSTRACT

Three Roman shipwrecks (*Napoli A* and *Napoli C* – 1st cent. AD; *Napoli B* – 2nd century AD) were recovered in the sandy-silt sediments representing the infilling of a protected inlet of *Neapolis* harbour (Naples, southern Italy). Extensive wood analysis suggests that a very attentive selection of species was made in shipbuilding, the choice of timber being related to wood technological properties and to the structural uses of the construction elements. Pollen data obtained from the coeval sedimentary layers revealed that all the timber *taxa* (apart from *Picea/Larix*) were present in the surroundings of the study area. The identified forest *taxa* are very common in the Mediterranean basin and thus the pollen-wood comparison was not able to define the location of the shipyards. Broad comparison with western Mediterranean wrecks evidenced the peculiarity of the *Neapolis* ships where the systematic use of both *Juglans regia* and *Cupressus sempervirens* was highlighted. Archaeological, biogeographical and archaeobotanical considerations suggest the local provenance of the ship C and constrain the possible origin area of both the ship Napoli A and Napoli B to central-southern Tyrrhenian coasts.

1. Introduction

In 2004, part of the Roman harbour of *Neapolis* was discovered in the excavation area of Piazza Municipio, a few hundred metres behind the present-day docks of Naples (Fig. 1). The presence of the harbour at that site had been hypothesised by different authors since the 19th century but the evidence of its existence and extent was not provided until 2004 (Giampaola et al., 2005; Carsana et al., 2009). Historical sources (Capasso, 1905) and archaeological finds (Giampaola et al., 2005) have extensively documented the prosperity of the *Neapolis* harbour and the complexity of its trade. Three Roman shipwrecks (Fig. 2, Table 1) were recovered in the sandy-silt sediments, representing the infilling of a protected inlet in the harbour. Two of them (*Napoli A* and *Napoli C*) were abandoned at the end of the 1st century AD, while the third ship (*Napoli B*) was wrecked between the end of the 2nd and the beginning of the 3rd century AD (Giampaola et al., 2005). The onset of harbour activity at *Neapolis* dates back to the end of the 4th century BC; evidence of dredging testifies to the systematic maintenance of the harbour basin until the 2nd century BC. Thereafter the sea floor was only sporadically dredged in order to keep the water depth suitable for ship transit (Amato et al., 2009; Carsana et al., 2009). The entire sedimentary succession, about 6 m thick, is almost continuous and chronologically well constrained by numerous datable archaeological artefacts, between the end of the 4th century BC and the beginning of the 5th century AD (Fig. 3), when the site was definitively buried due to overfill (Giampaola et al., 2005; Amato et al., 2009; Carsana et al., 2009). The anaerobic conditions and nature of the sediments allowed good preservation of organic matter, giving the opportunity to study both wood and pollen content.

Ancient shipwrecks, harbours and submerged sites have been widely found in the Mediterranean Sea, providing valuable data for ancient maritime, economic and naval history studies (Gianfrotta and Pomey, 1981; Pomey and Rieth, 2005). The finding of shipwrecks gives the opportunity to know which tree species were chosen and processed in the shipyards and to supply information about timber resources. For the western Mediterranean, xylological analyses were performed on the shipwrecks recovered along the

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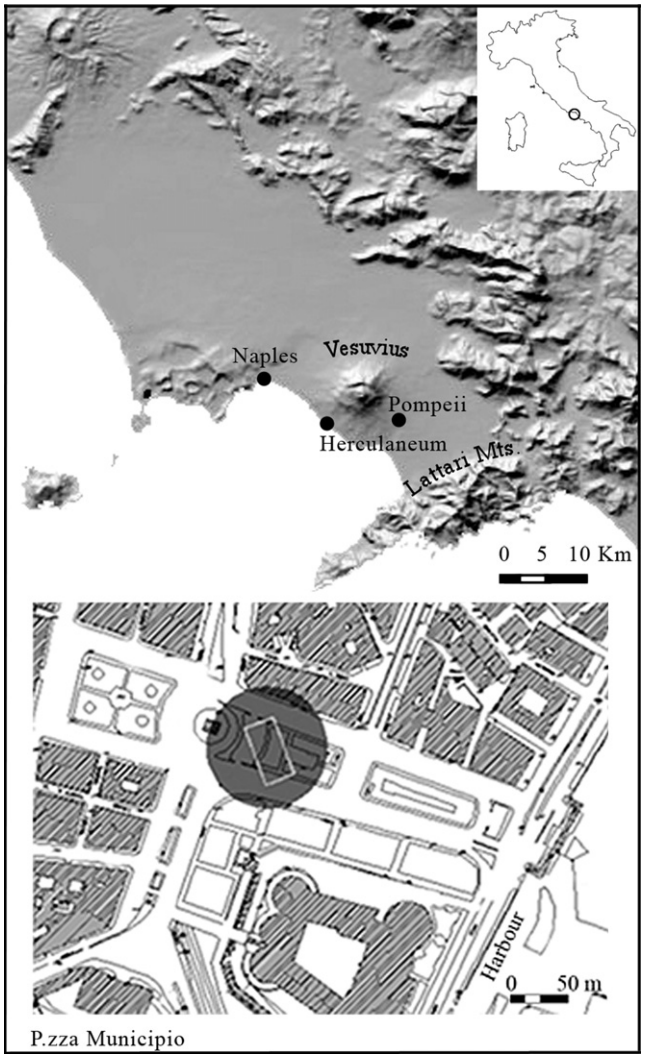

Fig. 1. Location of the main sites cited in the text and excavation area of Piazza Municipio.

coasts of France (*i.a.* Bourquin-Mignot and Guibal, 1999; Guibal and Pomey, 1998, 2003; Wicha et al., 2003) and Italy (*i.a.* Abbate Edlmann et al., 1989; Abbate Edlmann and Giachi, 1989; Steffy, 1994; Giachi et al., 2003; Boetto, 2006; Beltrame and Gaddi, 2007). However, few studies have involved both pollen and wood analysis (Giachi et al., 2003; Muller, 2004; Allevato et al., 2009a). Extensive wood analysis of the *Neapolis* shipwrecks (Fig. 2) allowed the relationship between wood properties and their functional role to be explored. Moreover, by means of pollen analysis of the sediments in which the wrecks were recovered, the regional availability of wood was assessed. Biogeographical distribution of identified wood *taxa* as well as their archaeobotanical evidence in the study area were discussed with the aim of verifying whether the shipbuilding timber could have had a local provenance.

2. The study site

The terrestrial excavation of the Roman harbour took place in Naples (southern Italy – 40°50′23″N, 14°15′10″E; Fig. 1), about 250 m inland with respect to the present-day docks (Fig. 1). The climate is Mediterranean, mean annual precipitation is 1012 mm. The city is now almost all built-up and wild vegetation only covers a few patches on the hillsides and valleys in the most inland sectors. Chestnut woodlands and mixed deciduous forests partially cover the northern and the gentler slopes with greater water availability; *Quercus pubescens*, *Q. ilex* and evergreen shrublands occupy the sunnier southern slopes.

3. Materials and methods

3.1. The shipwrecks

The ships *Napoli A* (*NA*) and *Napoli C* (*NC*) were probably abandoned due to poor condition, inferred by archaeologists through the detection of several repairs (Boetto, 2005). The ships were eventually buried from view by natural sediment deposition in the 2nd century AD, when their hulls were damaged by the pile-driving of wooden poles during the construction of a dock (Giampaola et al., 2005). The third ship *Napoli B* (*NB*), with its cargo consisting of limestone blocks and lime (Fig. 4), probably wrecked near the mole in a period between the end of the 2nd and the beginning of the 3rd century AD. *NA* and *NB* are medium tonnage maritime cargos belonging to the smallest category of maritime cargo ships, suitable for coastal sailing only.

Comparison with iconographic sources and similar boats found in the Toulon harbour allowed wreck *NC* to be attributed to the *horeia* type of vessel (Boetto, 2005 and 2009a), a craft for harbour service or, less probably, for fishing with a keeled flat bottom and a transom bow facilitating loading and unloading at docks (Fig. 5); its local construction is strongly probable (Boetto, 2009a) due to its function and geographical transport zone. All the ships were built according to the shell-first method. The planks are fitted edge to edge, fastened by mortise-and-tenon joints (Boetto, 2005).

3.2. Wood identification

Wooden elements were sampled from the shipwrecks and labelled according to their structural role; the terrestrial condition of the excavation facilitated sampling accuracy. Samples were stored in fresh water in order to maintain their waterlogged status and prevent decay. Thin sections of about 20–25 μm were obtained with a frozen microtome. A total of 189 wood samples were analysed from *NA* and 104 from *NB*. Preliminary results concerning the wooden samples (207) from *NC* have already been discussed (Allevato et al., 2009a). The good preservation of wood anatomy features (Greguss, 1955, 1959; Schweingruber, 1990) allowed *taxa* identification.

3.3. Pollen analysis

Pollen analysis was performed on 11 sandy-silt samples taken from the sedimentary layers in which the shipwrecks were found (Fig. 3). Chemical (HCl, HF) and physical (sieving, floating) treatments were used in order to concentrate pollen grains in the residue. All samples were acetolysed. At least 300 pollen grains were counted for each sample where *Lycopodium* tablets had been added for concentration estimates. The pollen content of the harbour sediments should be considered as the sum of the local pollen rain (≤500 m away), the pollen transported to the basin by sheet washing from the adjacent slopes (≤2 km away) and a smaller amount can be considered as distance transport both via wind and sea-water transport (≥10 km away). Despite the sandy nature of the sediments, almost all samples were rich and pollen grains in a good preservation state. This was probably favoured by the presence of *Posidonia* beds all along the sequence, which acted as pollen traps in sediments (sands) which are not normally suitable for pollen grain preservation. Eight pollen spectra covering the