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NOTES

THE PROBLEM OF THE ALTERNATING DOMINANCE OF DECIDUOUS AND EVERGREEN VEGETATION: ARCHAEO-ANTHRACOLOGICAL DATA FROM NORTHERN MAREMMA

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Abstract – In order to detect land use and forest cover changes from the 3rd century BC to the half of the 13th century AD in a coastal/sub-coastal area of northern Maremma, charcoal analysis were carried out on two archaeological sites dated between Roman period and Late Middle Age. From the 3rd century BC to the end of Roman Age (6th century AD), the vegetation is characterized by a degraded evergreen *Quercus* forest with evergreen sclerophyllous shrubs and low macchia; in the Middle Age, from the 10th century AD to the half of the 13th century AD, a mixed forest with evergreen and deciduous species covers the area. Data show that both evergreen *Quercus* forest and deciduous taxa spread during two warm/dry climatic phases, but respectively in the Roman phase of high human impact and in the Middle Age, characterized by a low presence of settlements and anthropic pressure. The vegetation history is independent from the climatic variations characterizing the studied period: deciduous vegetation increases during phases of low human pressure, while evergreen vegetation is related to intense human impact and it is a response of the vegetation to a period of strong land use. The match of detailed archaeoenvironmental data and archaeological data may allow a more complete interpretation of the changes in vegetation cover that characterised Italy and the Mediterranean in the second half Holocene.

Keywords: charcoal analysis, climate, human impact, Late Holocene, evergreen *Quercus* forest, mixed forest, Tuscany

Introduction

In the debate between palynologists and biogeographers, dealing with the relative influence of climate and humans on the Mediterranean-region land cover over the past 6000 years, the impact of anthropogenic activities during historical times on the vegetation has often been considered by palynologists to have a minor role. Due to the human impacts during the last past millennia, it's difficult to distinguish between changes in the vegetation cover induced by man from those caused by climatic changes (i.e. Pons & Quezel, 1998; Drescher Schenider et al., 2007; Mercuri et al. 2011). Ecological evidence suggest that the Mediterranean vegetation is characterized by great heterogeneity and it's not the climate alone that governs the distribution of species; historical vicissitudes are important as well as edaphic factors (Pons & Quezel, 1998; Quezel, 1999). The anthropisation, initiated in the mid-Holocene and continued during historical times, was mainly characterized by the expansion of sclerophyllous oak to the detriment of deciduous oak (Pons & Quezel, 1998). Nevertheless, comparing the Late Holocene palaeoenvironmental data with the main stages of the history of the circum-Mediterranean vegetation, the climatic changes are frequently considered determining factors of the evolution of the Mediterranean biome (Jalut et al., 1997, 2000, 2009). However, while in the regions of northwest Europe there is a sharp cut in time between the predominantly natural to human-regulated regimes, in Mediterranean region there is no clear and distinct time gap between an early Holocene period of climate-dominated environmental processes and a human- dominated late Holocene period (Roberts et al., 2011); so, the issue is not whether people altered ecosystems but rather at what point this impact became detectable.

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In this study we focus on land use and forest cover changes from the 3rd century BC to the half of the 13th century AD in an area of northern Maremma along the south-eastern Ligurian Sea coast of central Italy (Fig. 1). We use charcoal analysis, as complementary data to pollen analyses, in order to provide a better spatial resolution and a finest identification level of plants. In order to achieve a reasonable spatial pattern and a record of the vegetation changes related to the human activities, charcoal remains come from two archaeological sites spanning between Etruscan period and Late Middle Age.

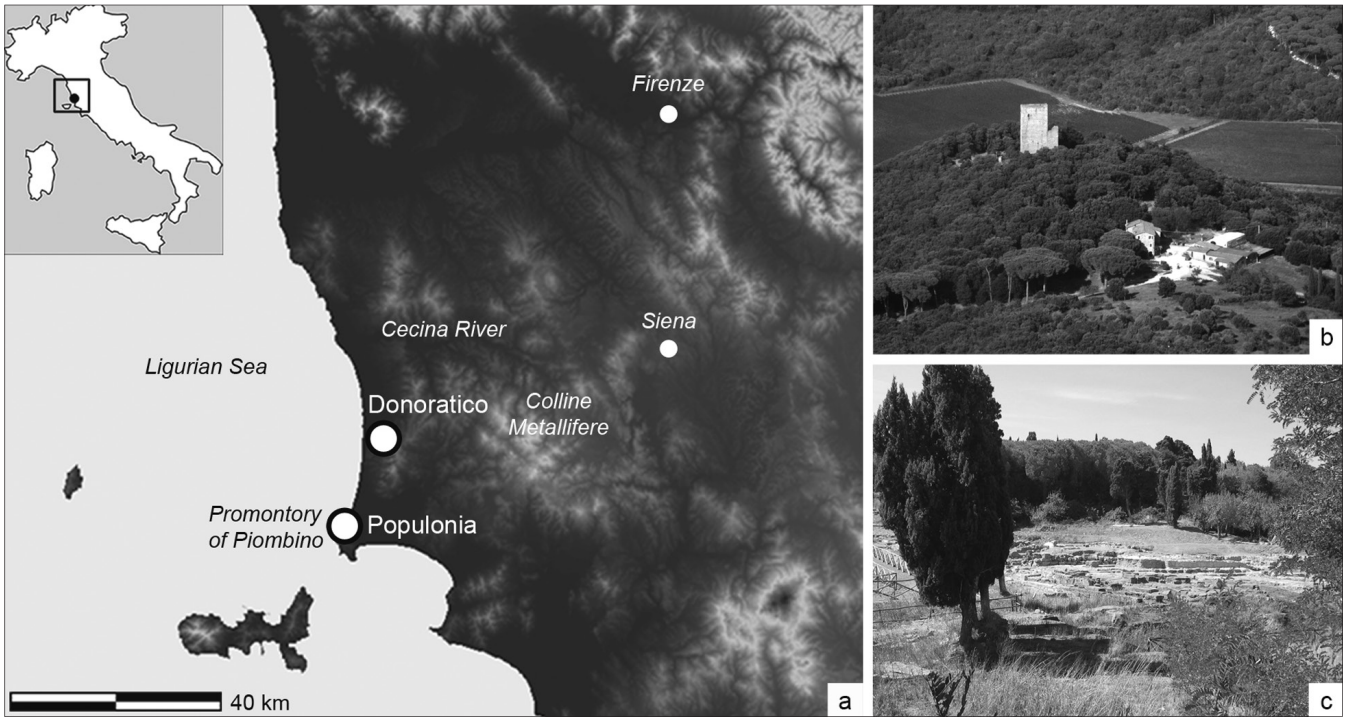

Fig. 1. Study area. a) Location map of the archaeological sites. b) Areal view of the Medieval castle of Donoratico. c) The archaeological area of Roman Populonia.

Although the Tyrrhenian palaeoceanography is characterised from the 5400 cal yr BP by the establishment of the winter convention typical of the modern Tyrrhenian Sea (Carboni et al., 2005), climate reconstruction for the last 3 millennia in central Italy showed an alternation of cool/wet and warm/dry climate phases, well showed by the fluctuations of lake level of Lake Accesa (Magny et al., 2007), by the sediment accumulation in the Ombrone River delta (Bellotti et al., 2004) and by the glacial expansion on the Central Apennines (Giraudi, 2005) (Fig. 2).

For this period, the vegetation history reconstructed at Lake Accesa (Drescher-Schneider et al., 2007) presents convergences with the lake level history (Magny et al., 2007). For the authors, the phases of maximal representation of Mediterranean trees and shrubs developed during periods of generally low lake levels suggesting warm and dry conditions (Fig. 2) and the impact of Etruscan settlement is considered a minor cause of the increase of evergreen shrubs that happened from the 6th century BC (Mariotti Lippi et al., 2000, 2003; Drescher-Schneider et al., 2007; Sadori et al., 2010).

The aims of this work for the considered period are:

- to give a contribution to the debate on the relationship between the vegetation history and the late Holocene climate changes, in particular with the Roman Warm Period and the two wet/cool phases at ca. 1500–1200 and 680–150 cal yr BP (Little Ice Age) recorded in this area by several proxies (Bellotti et al., 2004; Magny et al., 2007; Giraudi, 2005) (Fig. 2);
- to clarify and to deep the role of human activities as driving force of evergreen *vs* deciduous forest alternance.

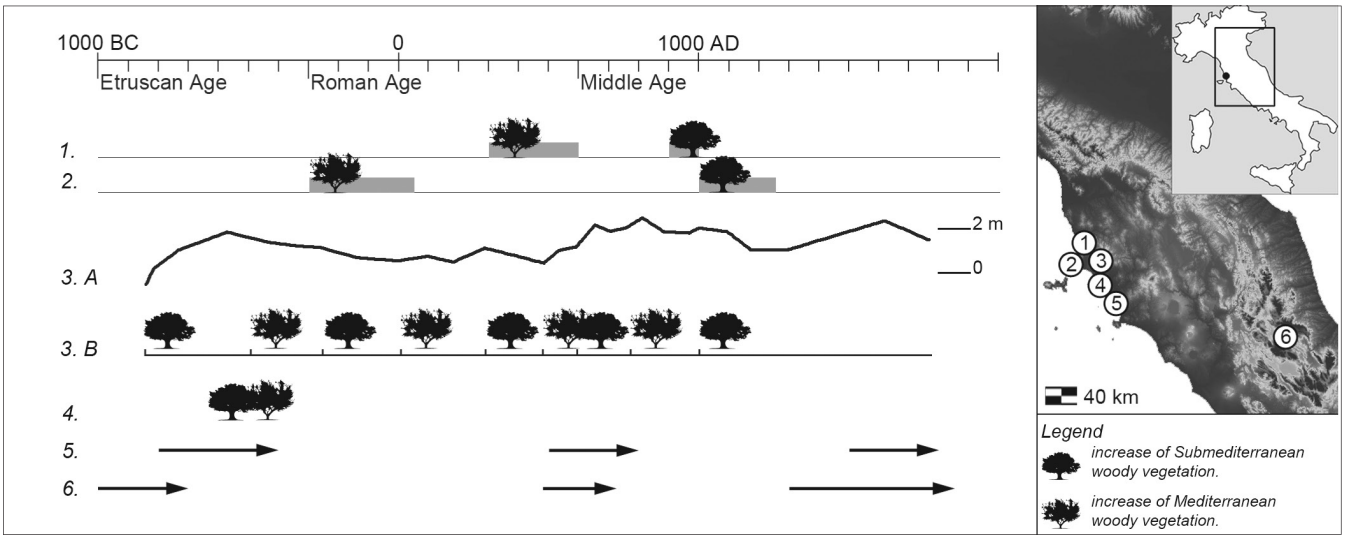

Fig. 2. Comparison of charcoal data and Late Holocene climate changes. 1. Charcoal data of Donoratico. 2. Charcoal data of Populonia. 3.A Lake level fluctuations of Accesa. (Magny et al., 2007). 3.B Late Holocene forest cover at Accesa (Drescher-Schneider et al., 2007). 4. Forest cover at Pian d'Alma (2. Mariotti Lippi et al., 2000, 2003; Sadori et al., 2010). 5. Sediment deposition at Ombrone river delta (3. Bellotti et al., 2004). 6. Glacier expansion on Apennine massif (4. Giraudi, 2005). Arrows indicate phase of sediment increase and glacial expansion. On the right, map of charcoal, sedimentological and pollen analysis. 1. Donoratico (charcoal). 2. Populonia (charcoal). 3. Lake of Accesa (sediments and pollen). 4. Pian d'Alma (pollen). 5. Ombrone river delta (sediments). 6. High Apennine massif (sediments).

Materials and methods

Study area

Two archaeological sites dated between the 3rd century BC and the half of the 13th century AD were selected along the coast of northern Maremma in Tuscany, central Italy (Fig. 1). This area is defined by the alluvial plain between the Ligurian Sea and the south-western reliefs of the Colline Metallifere until the promontory of Piombino. The climate is Mediterranean with an average temperature of the coolest month of 8°-9° C and an average rainfall of 700-800 ml. The coast is characterised by anthropic pine woods (*Pinus pinea* L.), while in the inland, arable crops are present on deep soils of the alluvial plain. The hills have long and steep slopes with deep to shallow soils, generally not calcareous, weakly alkaline, or neutral to slightly acid, well drained and subject to severe erosion (Breteler, 1983; Sevink et al., 1986; Mercati, 2003). The vegetation cover on the hills is characterised by evergreen sclerophyllous forest, with *Arbutus unedo* L., *Viburnum tinus* L., and *Phillyrea latifolia* L., dominated by *Quercus ilex* L. A mixed forest, with evergreen sclerophyllous and deciduous species, such as *Q. pubescens* Willd., *Q. cerris* L., *Ulmus minor* Mill. and *Acer monspessulanum* L., can be present along the cooler slopes. The potential vegetation, of this area is represented by the *Q. ilex* forest and the evergreen shrublands of macchia (Mondino, 1998).

Archaeological sites

The first site is the castle of Donoratico (Fig. 1), located at 129 m asl in the low valley of the Cecina river. During the 7th century BC an Etruscan fortress occupied the hill to defend the coast and the mining district of the Colline Metallifere (Bianchi, 2004). From the 3rd century BC until the Late Roman Age, the settlement was included in the Roman system of villas, villages and farms. During the early Middle Age (7th-9th century AD) the site was a village with wooden buildings, settled by farmers. From the half of the 9th century AD to the 11th century AD the settlement became a manor with a court, a church and huts for the peasant, defended by a stonewall.

The second site is the Etruscan-Roman town of Populonia, at 170 m a.s.l. on the northern side of the Promontory of Piombino. From the beginning of the 9th century BC, the town was an important and thriving site in metalworking, due to the exploitation of the mines of Colline Metallifere and Elba Island (Mascione, 2008). In the 6th century AD Populonia was an important harbour; between the 2nd and the 3rd century BC, the town became an ally of Rome. The decline began in the 1st century BC, with the Roman Civil War between Marius and Sulla, and it was destroyed by Sulla. During the Late Roman Age, squatter reoccupied the site, but in 570 AD Populonia was again destroyed by the Lombards and in 809 AD by Saracen pirates. After that, the human presence was sporadic until the 13th century AD.

Charcoal analysis

Sediment samples were collected from 2 and 30 archaeological layers in the sites of Donoratico and Populonia respectively. Samples referred to the Roman Age are dated between the 3rd century BC and the half of the 1st century BC (Populonia), and between the 3rd and the 6th century AD (Donoratico). Medieval samples are dated to the 10th century AD (Donoratico), and between the 12th century and the half of the 13th century AD (Populonia). In order to reconstruct the local ecological conditions, the contexts to be sampled were carefully selected among those containing scattered charcoal, resulting from long-term activities and processes, few affected by human selection (Chabal, 1997; Figueral & Mosbrugger, 2000).

Samples were floated and charcoal fragments over 4.0 mm were identified by an incident light microscope working between 100x and 1000x magnification, referring both to wood atlases (Greguss, 1955, 1959; Schweingruber, 1990) and to the reference collection of the Laboratory of the Vegetation history and Wood anatomy. A total of 1407 charcoal fragments were analysed (507 and 930 from Donoratico and Populonia, respectively). The percentages of each taxon were calculated for each chronology of the sites.

RESULTS

Charcoal analysis provided the identification of 25 taxa; 13 are common to both sites and suitable to allow the reconstruction of palaeoenvironmental inferences (Fig. 3).

In both sites, the evergreen trees, *Quercus* evergreen type, and sclerophyllous shrubs, *Arbutus unedo*, *Erica* and *Rhamnus/Phillyrea*, are the most attested taxa with Rosaceae. *Quercus* deciduous type, *Fraxinus* and *Ulmus* are the main evidences of deciduous trees. *Myrtus* and *Cistus* are also present.

Evergreen *Quercus* and sclerophyllous shrubs are the most attested during the whole Roman Age; on the other hand deciduous trees are more present from the Middle Age.

Conifers are scarcely represented; *Juniperus* and *Pinus halepensis/pinea* are attested only in the Late Roman phase of Donoratico.

Cultivated or cultivable *taxa* are present in both the sites, but in different phase. *Olea europaea* and *Vitis vinifera* are attested at the end of Roman Age in Donoratico; *O. europaea* and *Castanea sativa* during the Middle Age at Populonia.

Finally, the presence in Populonia of a typical mountain tree, *Abies alba*, is noticeable.

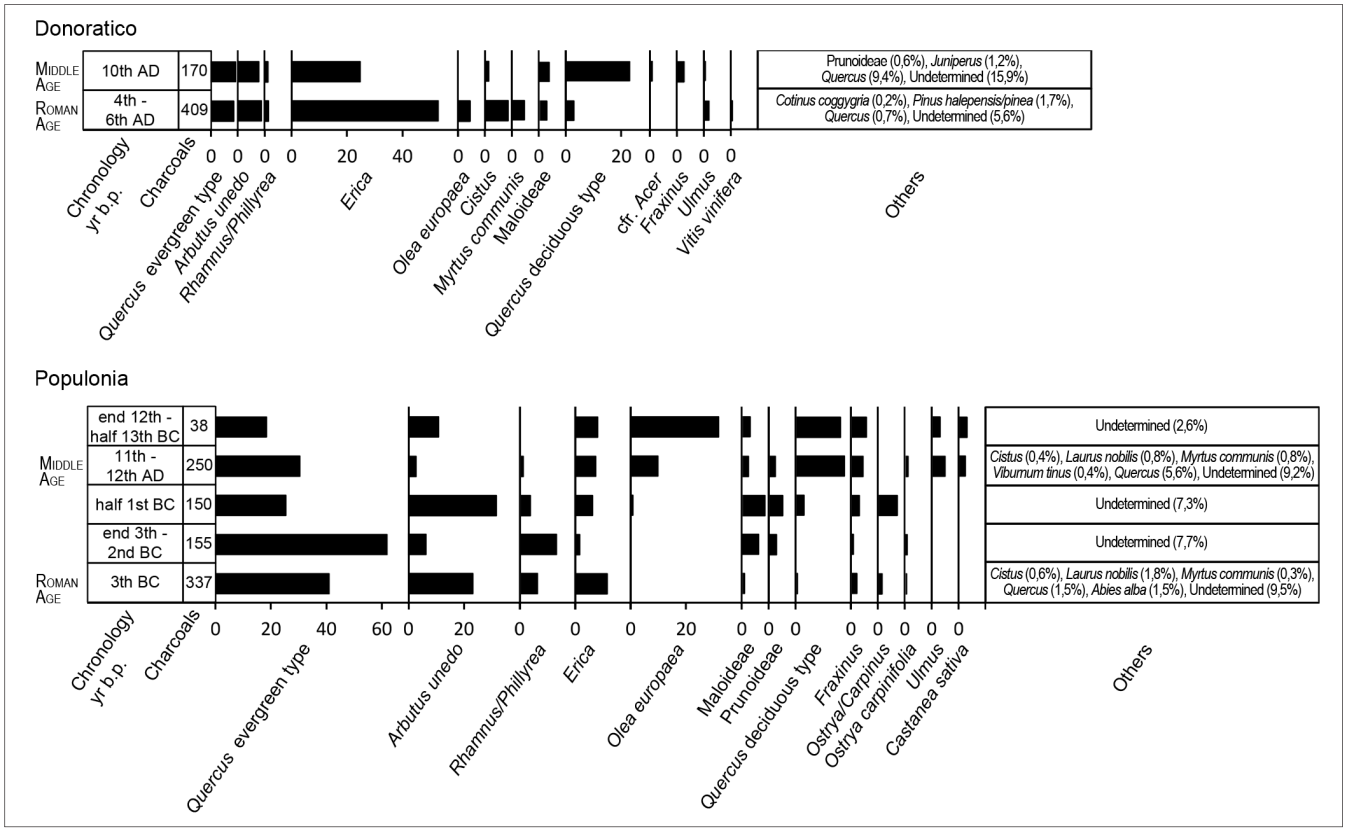

Fig. 3. Charcoal analysis diagrams.

Discussion

At Populonia, between the 3rd century BC and the half of the 1st century BC, data show a forest cover characterised by *Quercus* evergreen forest, with abundant sclerophyllous shrubs, such as *Arbutus unedo* and *Rhamnus/Phillyrea*, probably due to the intensive cutting, and low macchia with *Erica*, *Cistus* and *Myrtus communis* occupying the more degraded areas (Fig. 3). The presence of this vegetation, with deciduous trees scarcely attested, such as deciduous *Quercus*¸ *Fraxinus* and *Ostrya capinifolia*, may support the hypothesis of a warm and dry climatic situation in the Roman Ages (Bellotti et al., 2004; Giraudi, 2005; Magny et al. 2007) that favoured the spread of Mediterranean trees and shrubs like pollen analysis indicates at Populonia (Giachi et al., 2009) and at Lake Accesa (Drescher-Schneider et al., 2007). Furthermore, during this period, Populonia and many other rural settlements strongly exploited the related territory (Botarelli & Cambi, 2007), even favouring the expansion of evergreen trees and sclerophyllous shrubs.

This vegetation persists until the end of the Roman Age as the later data from Donoratico show. Indeed, in the next centuries, evergreen trees, shrubs and low macchia characterise the Roman landscape (Fig. 3). In this period grape vine (*Vitis vinifera*) and olive tree (*Olea europaea*) are present among cultivated species and they can be referred to the Roman agrarian landscape.

From the 10th century AD, in both the sites anthracological data show a mixed forest where deciduous taxa, such as deciduous *Quercus*, *Ulmus* and *Fraxinus* (Fig. 3) are largely present. For at least two centuries before, the lowering of Accesa lake level (Magny et al., 2007), the decrease of the sediment deposition at the Ombrone river delta (Bellotti et al., 2004) and the reduction of the Calderone Glacier (Giraudi, 2005) show a warm/dry climatic phase (Fig. 2), also characterised by an exploitation of Mediterranean vegetation at Lake Accesa (Drescher-Schneider et al., 2007). Thus, one would expect evergreen and sclerophyllous vegetation. If we take in account the progressive abandonment of towns and countryside in northern Maremma, which happened at the end of the Roman Age and the early Middle Age (Arthur, 2004), we could easily attribute the recolonization processes of deciduous oaks and other broadleaves as the result of the decline of human pressure. This phenomenon is also well documented in recent decades in the Mediterranean area where the land abandonment has given way to deciduous oaks, while sclerophyllous oaks have regressed (Mazzoleni et al., 2004). This comparison is through and through conceivable, since during the warm Medieval period around 1300–970 cal yr BP, the minimum winter temperatures were at least 0.9° C higher than at present (Giraudi, 2005).

Finally, it is important to note that olive tree becomes relevant in Medieval Populonia and probably it spreads in the agrarian landscape at the beginning of the 11th century AD; at the same time of the presence of chestnut (*Castanea sativa*). Therefore, two main elements of the current Italian landscape affirm their presence in this period and their spread will characterize the whole rising Little Ice Age (Fig. 2).

Conclusions

Charcoal analysis revealed that, in northern Maremma from the 3rd century BC to the end of Roman Age, the vegetation is characterized by a degraded evergreen *Quercus* forest with evergreen scleropyllous shrubs and low macchia; from the 10th century AD to the half of the 13th century AD a mixed forest with evergreen and deciduous species covers the area. Olive and grape vine are present as cultivated taxa at the end of Roman Age, while the spread of olive and chestnut starts at the beginning of the 11th century at Populonia.

The good spatial resolution of charcoal remains and the opportunity of accurately correlating the vegetation history with the human history allowed to detecting the role of human pressure on the vegetation cover. Our work shows that deciduous vegetation increases during periods of low human impact and it is independent from the climatic variations characterizing the studied period. On the other hand, the evergreen vegetation is related to intense human activity and it is a response of the vegetation to a period of strong land use.

Finally a multi-site approach allowed a more complete interpretation of the changes in vegetation cover characterizing Italy and the Mediterranean in the second half Holocene.

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