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NOTES

ECONOMY AND ENVIRONMENT OF THE GREEK COLONIAL SYSTEM IN SOUTHERN ITALY: POLLEN AND NPPS EVIDENCE OF GRAZING FROM THE RURAL SITE OF FATTORIA FABRIZIO (6th - 4th CENT. BC; METAPONTO, BASILICATA)

Florenzano A.[1*], Mercuri A.M.[1], Carter J.C.[2]

[1]*Laboratorio di Palinologia e Paleobotanica, Dipartimento di Scienze della Vita, Università di Modena e Reggio Emilia, viale Caduti in Guerra 127, 41121 Modena, Italy*
[2]*Institute of Classical Archaeology, University of Texas, 3925 West Braker Lane R1500 Austin, Texas 78759 USA*
[*]*Corresponding author: Telephone: +39 0592056019, e-mail: assunta.florenzano@unimore.it*

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Abstract – This paper reports a study case showing integrated analyses of microscopic records from an archaeological site of southern Italy. Pollen and non pollen palynomorphs-NPPs were found in archaeological layers and were basic in reconstructing both the past environment and the economic activities of the site. The site, Fattoria Fabrizio, is a modest 4th-cenury BC farmhouse of the chora (rural territory) of the Greek city (*polis*) of Metaponto (Basilicata). Pollen analyses in addition to the study of NPPs have been particularly worthwhile for palaeoenvironmental and palaeoeconomical reconstructions of this site and others in the chora. The pollen spectra delineate an open plant landscape, with scanty woodlands and presence of local wet environments. *Olea* pollen is fairly well represented in all samples, suggesting that this tree was an important element of the agricultural economy of the chora. Shrubby grasslands and a well-developed macchia characterized the territory, probably as result of grazing activities by sheep and goats. Accordingly, the high percentages of Poaceae and Cichorieae pollen, together with coprophilous fungal spores (such as *Sordaria* type and *Sporormiella* type), suggest that pastoral activities were widely practiced. The low number of Cerealia pollen grains suggests that the inhabitants' fields covered small areas or were quite far from the farmhouse.

Keywords: palynology, NPPs, archaeological sites, grazing, Mediterranean macchia, cultural landscape, Basilicata, southern Italy

Introduction

The natural and human-induced habitats are intimately connected in the preserved biological archives from archaeological layers. The latter preserve plant evidence of human behaviors acting on the environment (Mercuri, 2008). Past cultures operated to improve natural resources and engendered landscapes suitable to human needs (Birks et al., 1988; Faegri et al., 1989). The 4th-century BC Greek farmhouse, Fattoria Fabrizio, is a good example of the continuative human action that shaped the local vegetation around an agrarian site that was part of the agricultural civilization that developed in the Mediterranean regions within the Greek colonial system (Adamesteanu, 1973; Carter, 1980a, 1987, 2006; Lanza Catti, 2011).

Microscopic and macroscopic plant remains play key roles in palaeoecological reconstructions (Pearsall, 2000; Sadori et al., 2010). Among the different plant records, the combined evidence of pollen and non-pollen palynomorphs (NPPs) is especially useful in discriminating land uses and pastoral/breeding activities (Mazier et al., 2009; Cugny et al., 2010; Miras et al., 2010; Ejarque et al., 2011). The plant exploitation, cultivations and agrarian landscapes may be further detailed when data are integrated by macrofossil analyses (Graf & Chmura, 2006; Bosi et al., 2011; Mercuri et al., 2011). Although an increasing number of palaeoecological research projects rely on the combined use of multiproxy records, there are still few examples of simultaneous studies on pollen and NPPs found in samples taken from archaeological excavations (Greig, 1981; Beneš et al., 2002;

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van Geel et al., 2003; Deforce, 2010; Florenzano et al., 2012; Miola, 2012).
The archaeobotanical study that was carried out at Fattoria Fabrizio aimed at improving the knowledge of plants that were used and cultivated in the area during the Greek period (Mercuri & Florenzano, in press). This paper focuses on the importance of palaeoecological evidence from pollen and NPPs in reconstructing both the economy and environment of the site.
The comparison of these local results with those obtained from other sites of the region (Florenzano & Mercuri, 2012; Florenzano, 2013) highlights the botanical features of Fattoria Fabrizio and places its agrarian landscape in the framework of the cultural landscape that developed in the area about three thousand years ago.

MATERIALS AND METHODS

The site

Fattoria Fabrizio (57 m asl; 40°24'46.58"N; 16°44'28.33"E; Fig. 1) was part of the *chora*, the agricultural hinterland of the ancient Greek *polis*, or city, of Metaponto. The chora was occupied by Greek farmers on the coastal plain between the Bradano and Basento rivers, on the Ionian (southern) coast of Basilicata, southern Italy, over a period of about four centuries. The Greek settlement was characterized by well-developed economic activities (agricultural and pastoral practices), and had an organized road network and an efficient irrigation and drainage system (Carter, 1980b, 1990; 2006; De Siena, 2001; Carter & Prieto, 2011).
Fattoria Fabrizio is located on a slope of the Venella valley, a tributary of the Basento River, about 2 km upstream from the river junction. Water was relatively abundant in ancient times, provided by the rivers and by springs that formed at the interface of the layers of sand and clay forming the marine terrace of this area (Folk, 2011). The flow of the Venella, and of the major rivers, however, is today drastically reduced by a variety of factors, including modern irrigation. During the fieldwork of 2010, the Mediterranean shrubland dominated by mastic tree had overgrown the site so densely that the archaeological remains were almost inaccessible. At the base of the hill on which the site stands, orchards of citrus, vineyards and small cereal fields are cultivated.
The site was discovered during survey work (by J.C. Carter and A. Keys), and excavated in 1980. On the basis of the pottery, the earliest phase of the farmhouse was archaeologically dated to the second half of the 6th century BC. The remaining architecture belongs to a second phase from the late 5th through the 4th to the early 3rd century BC (Carter, 2006; Lanza Catti, 2011).

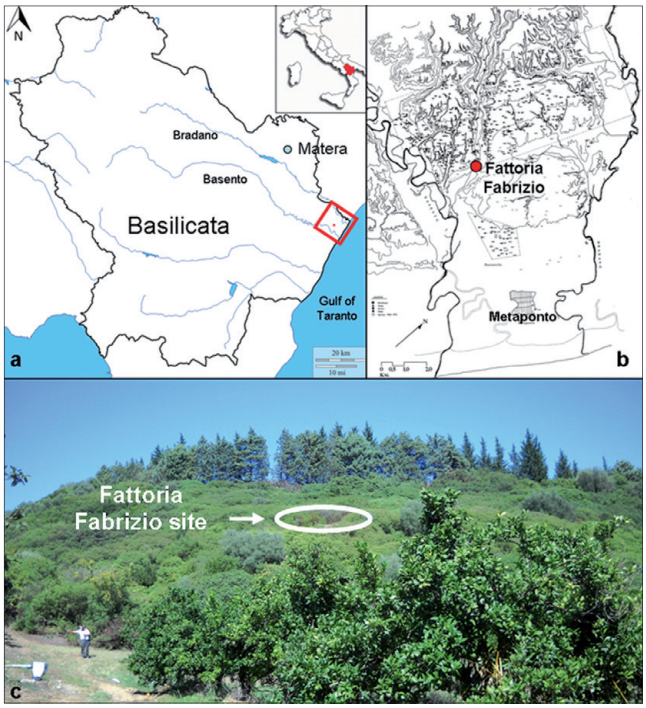

Fig. 1. **a**) Location map of Fattoria Fabrizio in the Basilicata region; **b**) the territory of the chora of Metaponto with the rural sites excavated by the University of Texas (Carter, 1990); **c**) the hill (57 m asl) on which the archaeological site stands.

The samples

The archaeobotanical samples were collected inside the perimeter of the farm building in the summer of 2010, thirty years after the excavation (Carter, 1980a), from unexcavated baulks left *in situ*. Fourteen pollen samples were taken from Rooms 1 and 2 (P3-P12, under the tile falls), and from a black-gloss *kantharos* (P13-P14) (Fig. 2). Based on archaeological evidence (three huge *pithoi* – large storage jars - on the beaten earth surface of the floor; Carter, 1980a), the Rooms 1 and 2 were probably storerooms. Two modern surface soil samples were collected in order to compare past and present pollen rains: P1 was taken just under the *Pistacia* shrubs living in the site, P2 was collected in a vineyard at the centre of the valley, at the feet of the slope where the site lies. One sample for seed and fruit analyses (M15) was taken from Room 1.
Samples of about 8 g of dry sediment were treated, including sieving through a nylon 7-µm mesh, acetolysis and heavy liquid separation; the final residues were mounted on permanent slides in glycerol jelly (Florenzano et al., 2012). *Lycopodium* tablets were added to calculate concentrations (pollen or NNPs per gram = p/g or npp/g). Pollen and NPPs were identified in the same samples. Identification was made

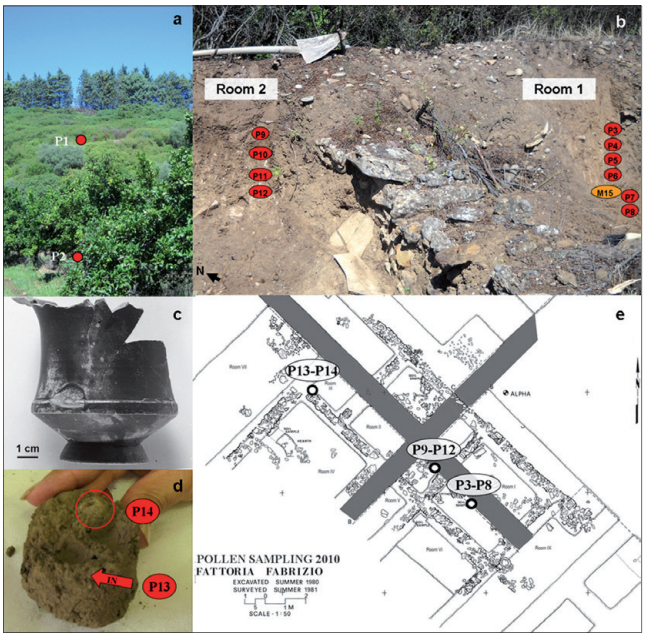

Fig. 2. **a**) Location of the surface soil samples P1 and P2; **b**) the unexcavated baulks left *in situ* with location of the pollen and carpological samples; **c**) the black-gloss *kantharos* and **d**) its infilling sampled for pollen analysis: P13 was collected inside the block of filling material, and P14 at the deep base; **e**) planimetry of the excavation showing the location of the pollen sampling from Room 1 (P3-P8) and Room 2 (P9-P12), and the position of the *kantharos* (P13-14).

at 400x and at 1000x magnification with the help of atlases and the reference pollen collection of the laboratory of Modena. A mean of 540 pollen grains and 102 NPPs per sample were counted. Pollen percentages were calculated on all identified and not identified pollen grains. Diagrams were drawn with Tilia and TGView (Grimm, 1993, 2004). Two pollen groups were calculated which refer to human activities (Mazier, 2007; Brun, 2011): a) Local Pastoral Pollen Indicators (LPPI), including plants strictly correlated to local pastoral activities (*Cirsium*, *Centaurea nigra* type, and other Asteroideae, Cichorieae, Ranunculaceae, *Galium* type and *Potentilla* type); Regional Human Activities Pollen Indicators (RHAPI) including cereals, *Artemisia*, Chenopodiaceae, *Plantago*, *Rumex* and *Urtica* (*U. dioica* type and *U. pilulifera* type).

In order to determine what was distinctive about the taxa and plant features of this site, the pollen spectra of Fattoria Fabrizio were elaborated together with those obtained from other seven archaeological sites of Basilicata (Florenzano, 2013). The Principal Component Analysis (PCA) was performed on 80 pollen taxa from 84 samples by using SPSS Statistic 17.0.

Results

Pollen

In the archaeological samples taken from the rooms, pollen concentrations are variable (P3–P12; from 1 to 35 x 10^3 p/g) and also higher than those found in the *kantharos* (P13–P14; 5 x 10^3 p/g) and the modern soil surface samples (P1–P2; 18 x 10^3 p/g).

A total of 117 taxa, including 27 trees/shrubs, were identified (Fig. 3). Past and present pollen rains show fairly similar diversity, as there are on the average 60 taxa in P3–P14, and 55 taxa in P1-P2. In the *kantharos*, a relatively high number of taxa (total 80) was found. Folded and thinned together with well-preserved pollen grains were recorded in the same archaeological sample. The resistant Cichorieae might be overrepresented but the diversity of pollen flora is so high that selective degradation did not significantly affect the representativeness of taxa in spectra (see also, Mercuri et al., 2010).

Modern surface soils (P1-P2) prevalently contain pollen of herbaceous plants (82%, on average), with Poaceae (32%), Brassicaceae, Fabaceae and Asteraceae (7% each), Ranunculaceae (6%) and Chenopodiaceae, Cistaceae, Plantaginaceae (< 1.5% each). The Mediterranean woods and macchia (18%, on average) are represented by pollen of *Pistacia* cf. *lentiscus* (3%), *Quercus ilex* type, *Myrtus*, *Olea* and *Phillyrea*, with *Helianthemum* and *Juniperus* type (2% each). *Pinus* and deciduous *Quercus* (3% each) represent other woodlands from which also few amount of pollen from *Carpinus betulus*, *C. orientalis/Ostrya carpinifolia* type, and *Corylus* arrived. Plants of wet habitats are represented by some Cyperaceae (1%) and by *Typha* (0.3%) and *Phragmites* cf. *australis* (0.2%). Cichorieae percentage is low (3%) while cereals, which are notoriously under-represented in pollen spectra, have fairly significant presences (*Avena/Triticum* group 1%; *Hordeum* group 0.3%).

Archaeological layers (P3-P14) show a similar content of pollen of herbaceous plants (81%), with prevalence of Poaceae and Asteraceae (19% each). This mirrors the open plant landscape or sparse shrubland surrounding the farmhouse. *Pinus* (5%) and deciduous *Quercus* (3.5%) are the dominant trees. The Mediterranean woods and macchia are represented by *Olea* (2.4%), *Q. ilex* type (2%), *Pistacia* cf. *lentiscus* (0.9%), *Phillyrea* (0.5%), *Myrtus* (0.4%), with *Helianthemum* (2.3%) and *Juniperus* type (1%). Plants of wet habitats are represented by the hygrophilous *Alnus* (0.1%), and by the helo-telmatophytes *Typha* (0.1%) and some Cyperaceae (1.5%).

Human activities are inferred by pollen of crops and pastures. For example, Cichorieae percentage is high within the daisy-family (13%). Cereal pollen was ubiquitous in P3-P14. As in modern spectra, the percentages of *Avena/Triticum*

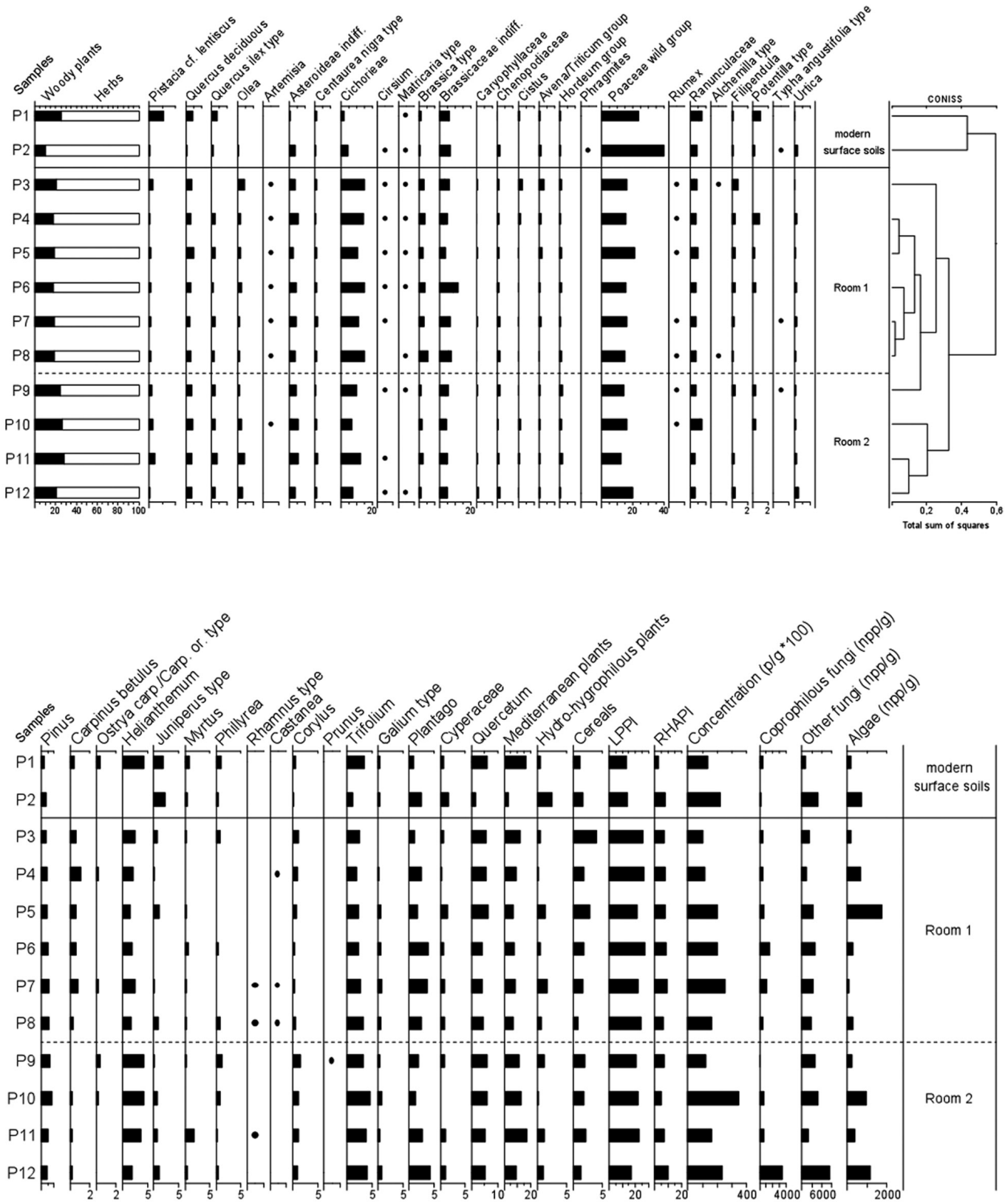

Fig. 3. Percentage pollen diagram of selected taxa from Fattoria Fabrizio, showing the cluster analysis (CONISS Constrained Incremental Sums of Squares cluster analysis; Grimm 2004). LPPI = Local Pastoral Pollen Indicators; RHAPI = Regional Human Activities Pollen Indicators.

group and *Hordeum* group are low but significant (1% on average, each). These data suggests that only small cereal fields were present in the area. Interestingly in P3, a sample taken at the top of the sequence of Room 1, above the floor level, an appreciable value of cereal pollen (4.1%) was found. This evidence may be interpreted as evidence of the movement of cereals inside this room.
In the *kantharos* (P13-P14), samples show a similar of herbs (89% on average; Poaceae 21%; Cichorieae 18%). *Avena/Triticum* group was found only in P13 (0.6%). A significant dissimilarity emerges from plants of wet habitats, including e.g. *Typha* (1%), *Nymphaea* (0.6%) *Lemna* (0.2%), and the hygrophilous trees *Salix* (1%) and *Alnus* (0.5%). Altogether, wet environments are ten times higher than in P3-P12. The peculiar richness of taxa (80) and the abundance of decomposing fungi with respect to the other archaeological samples suggest a different, but unknown, provenance for the sediment that filled the *kantharos*. These spectra, therefore, were not used to reconstruct the plant landscape.

Non-Pollen Palynomorphs

The 21 types of NPPs identified are spores of fungi, algae, and microzoological remains. The lower concentrations of NPPs were observed in the modern surface soil samples (4×10^3 npp/g), while in the archaeological samples from the rooms (5×10^3 npp/g) and the *kantharos* (6×10^3 npp/g) have comparably higher values.
Among fungi, the different genera/types have diverse ecological significance. Some of them, found in almost all samples, occur in deposits formed under eutrophic wet conditions (*Valsaria variospora* type) or in stagnant shallow open water (HdV-181). *Glomus* is an indicator of soil erosion; *Gelasinospora* sp. is a carbonicolous or coal-inhabiting fungus; *Chaetomium* sp. is a cellulose decomposing fungus; *Cercophora* type, *Podospora* type, *Sordaria* type, and *Sporormiella* type are coprophilous fungi (van Geel, 2001). Coprophilous fungi are especially abundant in the rooms (P3-P12; 1×10^3 npp/g).
The algae *Pseudoschizaea,* found in the *kantharos* and in the surface soil sample P2, is a spore of Zygnemataceae (Christopher, 1976; Grenfell, 1995) that is generally interpreted as index of anthropogenic soil erosion or presence of fresh water under seasonal level fluctuations.
Also some microzoological remains are indicators of water bodies: *Testate amoebae*, a shelled protozoan living in aquatic to moist habitats, was found in P6, P7 (Room 1, floor level) and in P10 (Room 2, tile fall), and in the surface soil P2. A different significance has the hair of the abdominal fragment of the larva of *Trogoderma* sp. cf. (Dermestidae), found in P3 from Room 1: this beetle infests dried plant and animal materials, especially stored seeds of cereals.

Discussion

The interpretation of the palynological data must take into consideration that the samples were collected from spaces that were enclosed at the time of use (the rooms). Although pollen spectra from Rooms 1 and 2 are mainly representative of the local flora, the site was, and still is, exposed to extra-local as well as local pollen rains. Sediments with plants and pollen were transported into the rooms by feet and hands or in animal fur, and represented the areas visited by humans and animals. Sediments in and around the rooms were also exposed to pollen arriving from the valley.
The diversity of the pollen list of the site is rich compared with other sites studied in the region (Florenzano, 2013). Accordingly, this diversity suggests that high pollen producing plants, such as many trees (oaks and pines) and Poaceae, were not among the prevalent contributors to the pollen rain. The relevant plants were not so widespread; their pollen emission was not so high to mask low producing species (namely entomophilous species) that thus increased the number of taxa in the spectra (Weng et al., 2006). The plants represented in pollen spectra were part of the woodland and wild vegetation growing around Fattoria Fabrizio. Accordingly, the seeds and fruits found in Room 1 are predominantly wild plants (e.g., *Anagallis arvensis*, *Euphorbia helioscopia* and *E. peplus*, *Genista* sp.) growing near the farmhouse, while crops were not found. Pollen evidences for cultivation and animal husbandry are common from the archaeological samples (P3-P12).
The pollen spectra show that plant landscape of Fattoria Fabrizio was generally fairly similar to that inferred from spectra of other archaeological sites of Basilicata. Pollen points to a comparable environmental setting and the same use of the territory surrounding the sites, i.e. mainly for pastoral/breeding activities, and olive tree and cereal cultivations. However, the PCA of the 8 sites from the region (Fig. 4) suggests that the striking feature of Fattoria Fabrizio is the co-presence of *Helianthemum*, *Avena/Triticum* group, *Trifolium* and Fabaceae undifferentiated, indicating a combination of habitats and land use types (cereals cultivation – *Avena/Triticum* group, and grazing – *Trifolium* and other Fabaceae) within a noticeable Mediterranean landscape (mainly *Helianthemum* in this data elaboration).

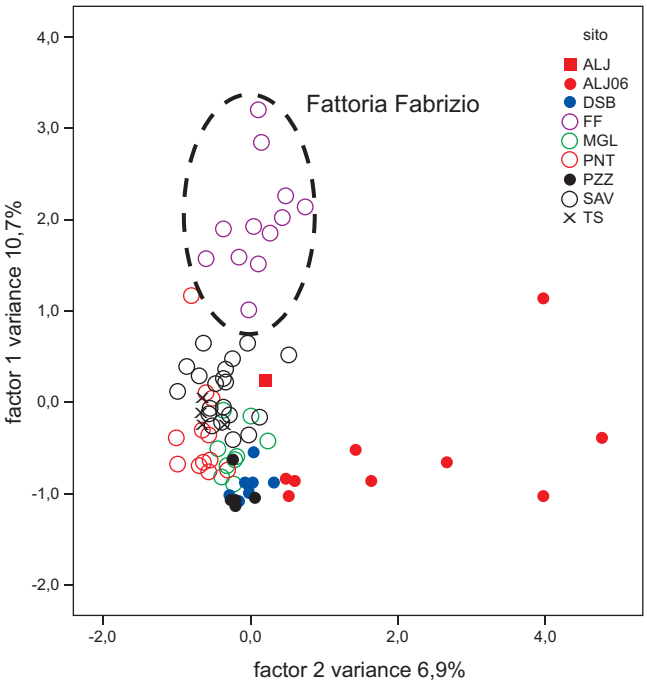

Fig. 4. Principal component analysis (PCA; SPSS 17.0) for 84 pollen samples and 80 taxa from the 8 sites studied from the Basilicata region (Florenzano, 2013).

The plant landscape

With vegetation consisting mainly of evergreen shrubs (7%), i.e. myrtle (*Myrtus*) and *Phillyrea*, trees as holly oak (*Quercus ilex* type), small trees/bushes such as juniper (*Juniperus*) and mastic trees or *Pistacia* (*Pistacia* cf. *lentiscus*), and rare pine trees, the evergreen macchia was important though presumably less extensive than today. In fact, the actual percentage of *Pistacia* pollen is inconsequential in the past samples (< 1%), suggesting that this plant did not constitute the main shrub cover of the site as it does today (5.5% in P1).

The mixed broadleaved oak woods, consisting of the deciduous oaks, and *Corylus*, *Carpinus betulus*, *C. orientalis*/*Ostrya carpinifolia*, was fairly similar to that in the present surface samples (5% vs. 3.6%), and lived quite far from the site, on the wettest slopes of the valley. *Corylus* (0.9%), *Castanea* (0.1%) and *Prunus* (0.02%) point to trees that were probably known for their benefits but the limited pollen evidence does not indicate local orchards in the past as in the present. It was suggested by Mercuri et al. (2013) that the use of chestnut trees for wood attested in several sites of southern Italy (Di Pasquale et al., 2010) made less probable the flowering of these plants in the area.

In archaeological samples, there were traces of the hygrophilous trees (alder and willow) and the helophytes living along the riverbanks or fresh water ponds, but plants floating in water were not found and algae were few. Wet environments are less evident in the past (0.9%) than in the modern samples (1.6%). Although Fattoria Fabrizio was built on the left bank of the Venella valley, and considerably more water flowed in the Venella in the Greek period (Folk, 2011; Abbott, 2011), these data suggest that wet environments were not important elements of the local landscape.

The agrarian landscape

Cereal values are not high on the average, but they are sufficient to hypothesize that fields were present in the area. The mean percentage of oat/wheat in past and modern surface samples is the same (1%). The percentages, however, are lower than those expected in storerooms or sites used for cereal processing (e.g., up to 37% at the bottom layers, inside a house, of the bronze age Terramara di Montale - Mercuri et al., 2006). The case of P3, taken from Room 1, is noteworthy because this sample combines high value of cereal pollen (< 4%) with the record of *Trogoderma* sp. The genus of beetle includes many synanthropic species which are common in agricultural or urban areas, in food or fodder stores. The khapra beetle (*Trogoderma granarium* Everts) is a pest that has a considerable impact on stored foodstuffs, causing loss of seed viability or weight loss of stored grains, even if it is not present in large numbers. The khapra beetle can damage dry animal products, and may cause dermatitis or allergic reactions in humans (Harris, 2006). This larval element in P3 is an important evidence that cereals might have been stored in Room 1.

Woody plants producing fruits are represented by pollen of *Olea*, and *Prunus*. The latter (found in P9, Room 2) is highly indicative of the local presence of this tree, because its entomophilous pollen has a very low representation in spectra (Mercuri et al., 1992). It is noteworthy that *Olea* pollen is about five times higher in archaeological samples than in the modern surface samples (2.6% vs. 0.5%, absent in P1). For this reason, the presence of cultivated olive trees may be probable.

Remarkably, *Vitis* was not found neither as pollen nor pips. This cannot be considered unquestionably a proof of the absence of this plant. In fact, its pollen is known to be under-represented (Turner & Brown, 2004), and it was not found in P2, the modern surface soil sample collected at the border of the vineyard. Although a few wine amphorae were found (Carter, 1980a), the archaeobotanical evidence led us to exclude that grapes were processed on the site.

The Local Pastoral Pollen Indicators and the Regional Human Activities Pollen Indicators (RHAPI; *sensu* Mazier, 2007) are better represented in the archaeological samples

(P3–P12; LPPI = 22%, RHAPI = 6%, on average) than in the modern surface samples (P1–P2; 13%, and 4%). This suggests that human pressure by pastoral and agrarian activities was locally higher in past than in modern times.

Conclusions

The pollen and NPP records evince that, during the Greek phase, the natural environment of the territory of Metaponto was under a high anthropic pressure, that shaped the landscape mainly with pastoral practises and agricultural activities. The farmhouse of Fattoria Fabrizio was located in a fairly complex set of habitats hosting natural, semi-natural and anthropogenic vegetation. The site was in an open plant landscape characterized by a Mediterranean shrubland that extended much like the present one, while grass cover and wet environments were probably less diffused. Mixed broadleaved oakwoods, and some pine trees, lived far away. Fruit trees such as olive and *Prunus* trees lived wild or cultivated near the farmhouse.
Low but significant amounts of cereal pollen indicate the presence of small cereal fields in the area.
According to the geomorphology of the valley, the grazing lands were prevalent and more extensive than cereal fields on the slopes around the site. Pastoral management was a major activity during the 4th century BC, probably continuing traditions that were already established in the area at least as early as the 6th century BC. The development of shrubby vegetation suggests that the browsing should have been done by ovicaprines, and this is confirmed by faunal remains, though they are sparse on this site.
Three features of the archaeological samples suggest that pastoral activity was a prevalent activity at the site:

i) Poaceae from meadows were one third lower in past than in the current samples. This may mean that the grasses were continuously browsed before blooming (Groenman-van Waateringe, 1993);

ii) The sum of pollen from plants correlated to local pastoral activities (LPPI) was decidedly more represented in the past than at present (23% *vs*. 14%);

iii) Coprophilous fungi were found in samples, and in particular there were *Sordaria* type and *Sporormiella* type, which are indicative of the presence of dung of grazing animals.

The shrubby vegetation suggests an intense pastoral activity in the area from the 6th to the 4th century BC, with sheep and goat grazing. The macchia is a drought- and goat-resistant vegetation, and its modern development is largely considered a response to overgrazing in the past. Grazing is generally considered a major factor responsible for deforestation, more so than agricultural clearance, and it has also been pointed out that it prevents the evolution of macchia to forests (Naveh & Whittaker, 1979; Perevolotsky & Seligman, 1998). Though currently mismanagement is considered an element of such degradation, overgrazing by sheep and goats has also changed much of the once-forested areas of the Mediterranean into macchia shrublands. The Mediterranean shrubland so evident from both the archaeological and modern samples of Fattoria Fabrizio reflects the degraded landscape that developed in the area starting from a low-forested environment and under continual grazing pressure.

Acknowledgments

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