Plant uses in different Bronze and Iron Age settlements from the Nuoro province (Sardinia). The results of phytolith analyses from several ceramic fragments and grinding stones

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1. Introduction

Ceramic vessels and milling stones are important components of the archaeological record in several Nuraghi from the Pranemuru Plateau (Sardinia). To obtain information on the possible uses of the milling stones and the content vessels is of great interest to understand the economical activities carried out in these sites by these populations.

One of the approaches to obtain information on the plant uses was the phytolith analyses of the sediment adhered both to the surface of the milling stones and to the surface of the vessel content. In total we analyzed eleven archaeological samples and two control samples collected from five different Nuraghi in the Pranemuru Plateau (Nuoro Province, Sardinia). The Nuraghi were located in an area of 10 km radius from nuraghe Arrubiu and were chronologically ascribed to the Bronze Age and one site -Pranu Illixi- to the Iron Age.

2. Materials and methods

The phytolith extraction process took place at the Department of Prehistory, Ancient History and Archaeology of the University of Barcelona. The methods used to carry out the phytolith analyses are similar to those described in a study of Tabun cave (Albert *et al*. 1999). A weighed aliquot of about 1g of air-dried sediment was treated with 10 ml of an equivolume solution of 3N HCl and 3N HNO_3 for 30 min and then centrifuged at 3000 rpm for 2 min. After washing the pellet with water the organic material was oxidized with 10 ml of 30% hydrogen peroxide at 70°. The sample was dried and the remaining sediment was weighed. This is referred to as the inorganic acid insoluble fraction (AIF). Note that carbonates and phosphates are eliminated during the hydrochloric and nitric acid attack.

The mineral components of the AIF were then separated according to their densities in order to concentrate the phytoliths. The AIF was transferred to a 15 ml polypropylene centrifuge tube and 5 ml of sodium polytungstate solution $[Na_6(H_2W_{12}O_{40}).H_2O]$ of 2.4 g/ml density was added. The suspension was thoroughly dispersed by vortexing and sonication, and was then centrifuged at 3000 rpm for 5 min. The supernatant was transferred to another centrifuge tube, 1.0 ml of deionized water was added and the tube was vortexed and again centrifuged as above. This cycle was repeated until no visible mineral particles remained in the supernatant. The heavy liquid was then diluted by filling the centrifuge tube with deionized water, so as to ensure that even the lightest minerals are recovered. After each centrifuge step the sediment deposited at the bottom of the tube (pellet) was washed in a microcentrifuge tube, by resuspending in deionized water and centrifuging at 4500 rpm for 4 min.

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Sample number and location	% AIF	% organic matter	N. phytoliths 1 g AIF	Description
MF1-UE9	61,29	0,03	125.000	**Gasoru** (comune Orroli). Sediment adhered internal wall from a ceramic fragment. Later Bronze Age/Final Bronze Age
MF2-UE9	74,10	0,80	120.000	**Gasoru** (comune Orroli). Sediment adhered internal wall of a ceramic fragment. Later Bronze Age/Final Bronze Age
MF3-UE8	74,04	0,92	79.000	**Is Cangialis** (comune Nurri). Sediment adhered internal wall from a ceramic fragment. Later Bronze Age
MF5-UE9	90,90	0,83	108.000	**Perda Utzei** (comune Escalaplano). Sediment adhered internal wall from a ceramic fragment. Final Bronze Age
MF6-UE5	88,56	0,79	216.000	**Perda Utzei** (comune Escalaplano). Sediment adhered collected from the surface of a grinding stone. Final Bronze Age
MF8-UE5	90,09	0,95	68.000	Same as before. **Perda Utzei** (comune Escalaplano). Sediment adhered from the surface of a conglomerated grinding stone.
MF7-UE6	94,12	0,98	39.000	**Perda Utzei** (comune Escalaplano). Sediment adhered from the internal part of an *anforetta*. Final Bronze Age
MF7-UE6	92,88	0,85	**278.000**	**CONTROL SAMPLE. Perda Utzei** (comune Escalaplano) collected next to the where the *anforetta* was identified
MF9-UE6	83,31	0,21	189.000	**Martingiana** (comune Orroli). Sediment adhered internal wall of from a ceramic fragment. Later Bronze Age/Final Bronze Age
MF10-UE7	81,11	0,07	242.000	**Martingiana** (comune Orroli). Sediment adhered internal wall from a ceramic fragment. Later Bronze Age
MF13-UE2	86,66	0,81	61.000	**Pranu Illixi** (comune Escalaplano). Sediment adhered collected from the surface of a basalt grinding stone. 1st Iron Age
MF13-UE2	88,80	0,87	**66.000**	**CONTROL SAMPLE**. **Pranu Illixi** (commune Escalaplano). Collected next to the grinding stone of MF13-UE2
MF21,22-UE3	85,49	0,95	83.000	**Pranu Illixi** (comune Escalaplano). Sediment adhered internal part of a vessel. 1st Iron Age

Table 1.- Description of the samples analyzed and main results obtained through the study.

For examination under the optical microscope (Olympus BX 41), slides of the pellets were prepared by weighing around 1 mg of the pellet and placing it on a microscope slide. Three or 4 drops of Entellan New (Merck) were added. The samples were well mixed with the Entellan, and then a cover slide was placed over the suspension. The areal coverage of the sample on the slide was estimated by counting the total number of fields containing sediment grains. Phytoliths in a known number of randomly chosen fields were counted at 400x magnification. If possible a minimum of 200 phytoliths were counted. Albert and Weiner (2001) demonstrated that the counting of 194 phytoliths gives an error margin of 23% whereas for 265 phytoliths the error margin is 12%.

The phytoliths identified in the archaeological samples were compared to a phytolith reference collection of modern plants (Albert *et al*. 2000; Albert and Weiner 2001). The terms used to describe the phytoliths followed wherever possible the anatomical terminology of the cell in which they were formed. When this was not possible, terms describing the geometrical characteristics of the phytoliths were used.

In order to identify other microremains such as starch grains and calcium oxalate crystals, samples were analyzed under the microscope previous to the acid attack. Slides were prepared following the same methods as for the phytolith analyses.

3. Results

The description of the samples and the main results obtained from their study, both from the archaeological samples and the control samples: percentage of AIF, percentage of organic material and total number of phytoliths per gram of AIF are expressed in table 1.

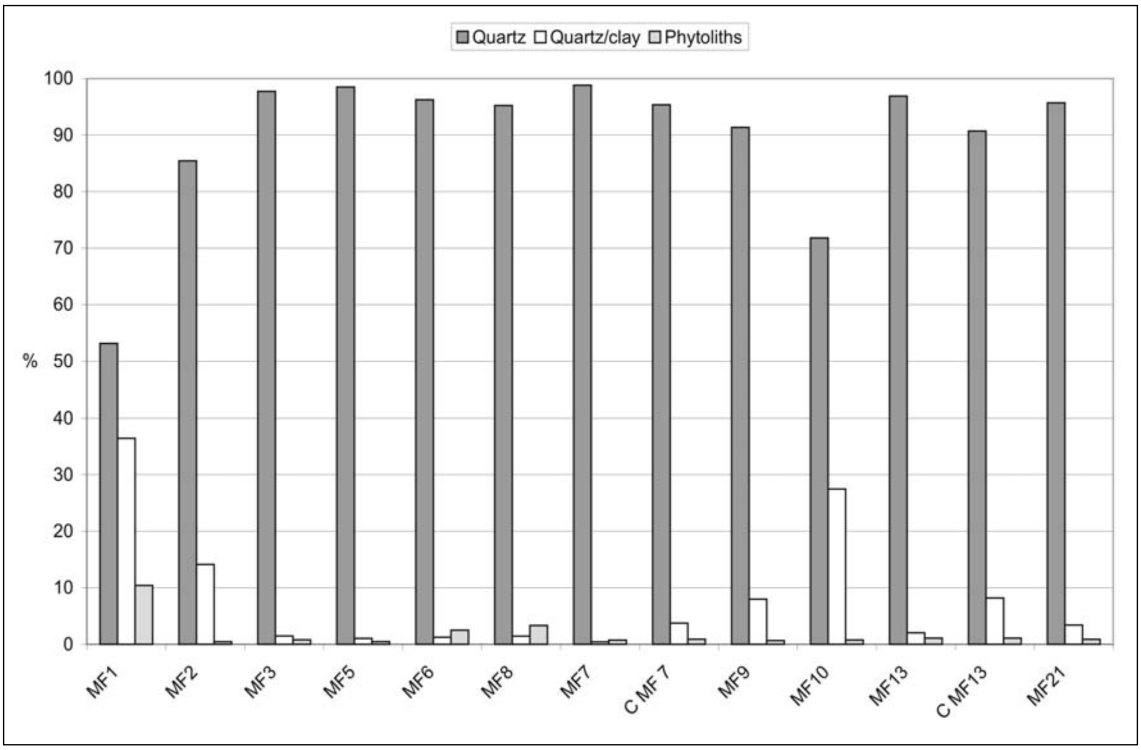

Figure 1.- Histogram showing the AIF mineral distribution in the different samples analyzed.

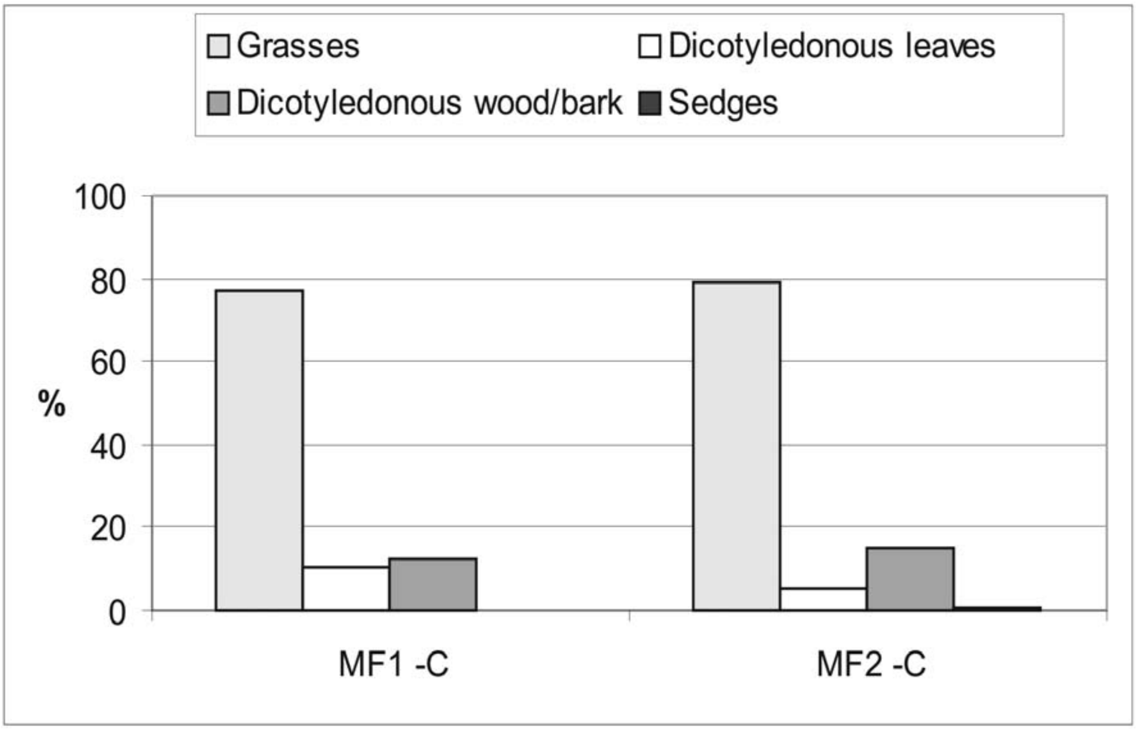

Figure 2.- Histogram showing the phytolith morphological results of the samples analyzed from the site of Gasoru (comune Orroli).

One common trait for all the samples analyzed is the high AIF percentage observed, always above 60% and in most of the case above 80%. This high AIF percentage is accompanied by a low amount of organic material (below 1%) (table 1). According to these results, all the samples analyzed were mineralogically composed of silica minerals, whereas carbonates, phosphates and organics are not representative. The AIF is distributed among quartz; quartz/clay and phytolith fractions (fig. 1). Quartz/clay fraction is more important in Gasoru and Martingiana sites, whereas the rest of the sites are predominated by the presence of quartz, in more than 90%. Phytoliths, although have been identified in enough number for a reliable morphological interpretation do not represent more than 1% of the AIF fraction (table 1). Phytoliths are in general, in good state of conservation and the chemical dissolution percentage does not get, in most of the cases 15% of the total. Mineralogically, control samples did not differ from the archaeological samples, neither in AIF percentage nor in mineral distribution of the AIF. Other microremains such as starch grains and calcium oxalate crystal were not observed in the samples. The results obtained according to the different archaeological sites are as follows.

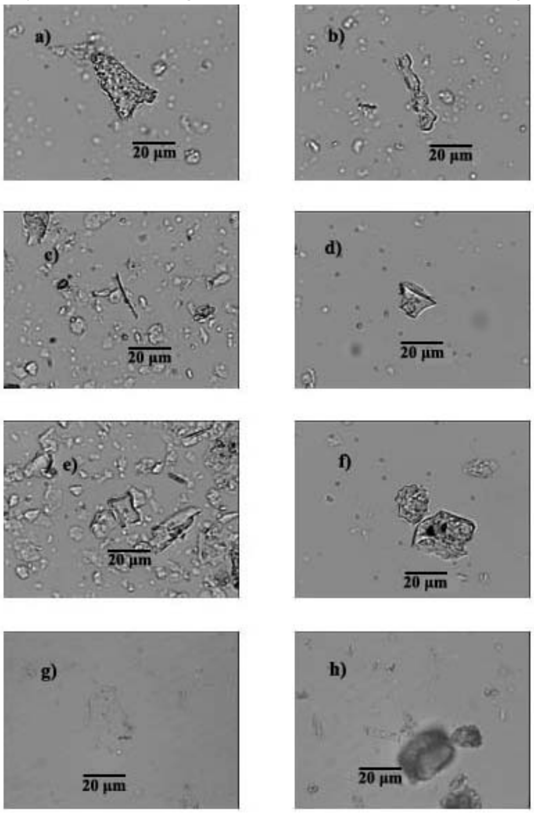

Figure 3.- Photomicrographs of phytoliths. Images taken at 400x. Bar is 20 mµ. a) Epidermal appendage "prickle" from grass identified in sample MF2 from Gasoru; b) Long cell polylobate from grass identified in MF2 (Gasoru); c) Epidermal appendage "hair" from dicotyledonous-leaf observed in MF3 (Is Cangialis); d) Short cell from grass identified in MF7 (Perda Utzei); e) Short cell bilobate from reed identified in MF5 (Perda Utzei); f) Spheroid echinate from palms identified in MF10 (Martingiana); g) Parallelepiped thin psilate from dictolydonous bark identified in F13 (Pranu Illixi); h) long cell echinate from grass inflorescence noted in MF21-22 (Pranu Illixi).

3.1. Gasoru (comune Orroli)

Gasoru is located in the western area of the Pranemuru Plateau. The western area opens to the communication routes and includes dry lands that could have been used for agricultural practices. MF1 and MF2 were selected for study. Both samples corresponded to sediment adhered to the internal wall of ceramic fragments from unit 9. Chronologically the samples were ascribed to the transition between Later Bronze Age /Final Bronze Age (*Bronzo Recente/Bronzo Finale*).

The AIF percentage (quartz, quartz/clays and phytoliths) is lower in MF1 (61%) than in MF2 (74%). The amount of organic material is also higher in the later. In relation to the distribution of mineral components inside AIF (fig. 1) quartz dominated in MF2 (85%) especially in relation to the phytolith presence (0,44%). The presence of quartz/clay fraction is also high in this sample. On the contrary MF1 shows a more even distribution of these mineral components (fig. 1).

The total number of phytoliths estimated per gram of AIF in both samples is relatively low (table 1). MF2 shows a higher number of phytoliths due, most probably to the lesser amount of quartz.

Phytoliths recovered from MF1 were in good state of preservation, whereas phytoliths from MF2 showed evident signs of chemical dissolution. The morphological identification of the phytoliths in both samples (fig. 2) indicated the presence of grasses and dicotyledonous plants. Grasses dominated the phytolith record in both samples and they were represented in all their parts (stem/leaves and inflorescences) (fig. 3a and 3b). Nevertheless the percentage of phytoliths from the inflorescences recovered in the samples in relation to phytoliths from leaves/stems is, in most of the cases, relative-

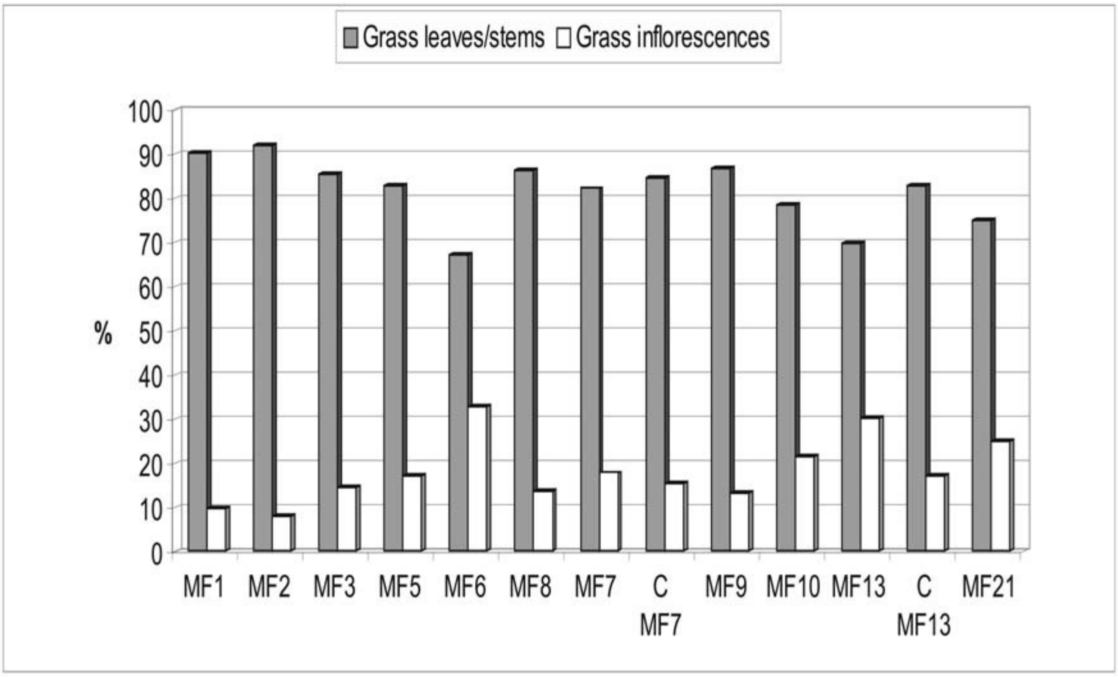

Figure 4.- Histogram showing the percentage between phytoliths from leaf-stem and phytoliths from inflorescences from grasses in the different samples.

ly low (around 8%) (fig. 4). This is especially true if we compare these percentages to other phytolith studies from milling stones and vessels content, where the inflorescences can reach 21% of the total counting (Portillo 2003). Silicified multicellular structures were not noted in these samples. These structures represent parts of the cellular tissue of the plant. A more complete silicification of the cells' plants takes place when it has been an important input of water by the plant (Rosen 1992). The monosilicic acid present in the soil is transported through the aerial parts of the plant together with water. Therefore, the higher the water input, the higher the presence of monosilicic acid in the plant. This mo-

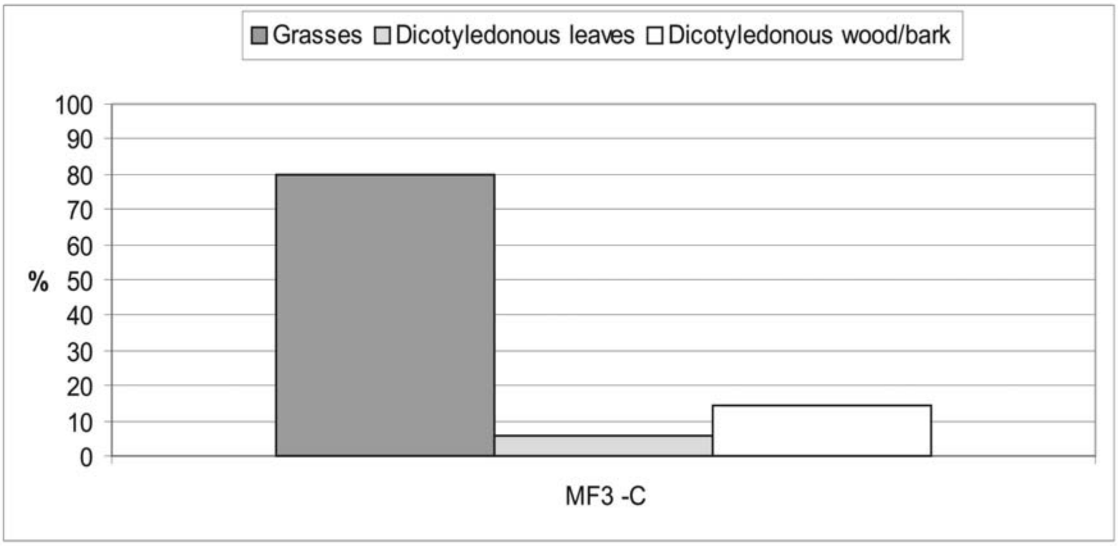

Figure 5.- Histogram showing the phytolith morphological results of the samples analyzed from the site of Is Cangialis (comune Nurri).

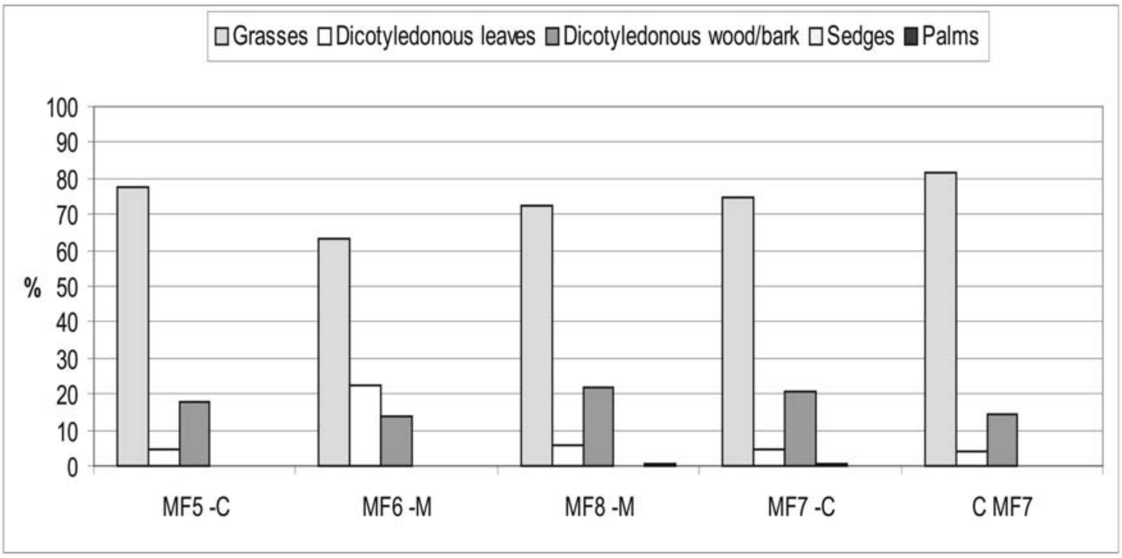

Figure 6.- Histogram showing the phytolith morphological results of the samples analyzed from the site of Perda Utzei (comune Escalaplano).

nosilicic acid will evolve later into hydrated amorphous silica (phytolith) taking the morphological characteristics of the cells' plant. The presence of silicified multicellular structures helps to the recognition of the type of plant and part of the plant present, since it allows a much better identification of the cell structure. Unfortunately the absence of silicified multicellular structures in our samples has not allowed us to identify the genre or even the species of the grasses noted. However, the individual short cells identified indicated that these grasses belonged to the festucoid subfamily group which is the most common in the Mediterranean area and which includes cereals such as wheat and barley.

In relation to dicotyledonous plants, phytoliths from leaves and bark were observed in the samples. Dicotyledonous leaf-phytoliths seem to be more common in MF1 (fig. 2). No multicellular structures from dicotyledonous leaves were identified in the samples either. The fact that most of the phytoliths noted were more characteristic of the bark than from the wood, suggests that, probably, small branches were present in the samples.

3.2. Is Cangialis (comune Nurri)

Is Cangialis has a good visual control of the Flumendosa river. One sample was analyzed from this site (MF3) located in stratigraphic unit 8 dated to the Later Bronze Age period (*Bronzo Recente*). Unit 8 is described as altered pavement by the fallout of materials. The sample corresponded to sediment adhered to the internal wall of a ceramic fragment.

The percentage of AIF in this sample is relatively high (74%) (table1). This AIF is mainly composed of quartz grains, being the phytolith fraction inferior to 1% of the total (fig. 1). The percentage of organic matter is about 1%.

The phytoliths identified were morphologically divided in three groups (fig. 5): grasses, dicotyledonous-leaf phytoliths (fig. 3c) and dicotyledonous bark/wood phytoliths. Phytoliths were in general in good state of preservation, and showed a low dissolution index (ca. 11%). Grasses were represented by all their parts, and as in Gasoru, the percentage of inflorescences presence is relatively low. No multicellular structures were identified in this sample either. The grasses belonged to the festucoid subfamily group. Phytoliths from dicotyledonous plants are represented mostly by forms characteristics from the bark but not from the wood.

3.3. Perda Utzei (comune Escalaplano)

This nuraghe is considerably big. It is located on a valley suitable for agricultural purposes and has a good visibility of the Flumendosa River. Four different samples (MF5, MF6, MF8 and MF7) from different stratigraphic units were analyzed from this site (table 1). MF5 corresponded to sediment adhered

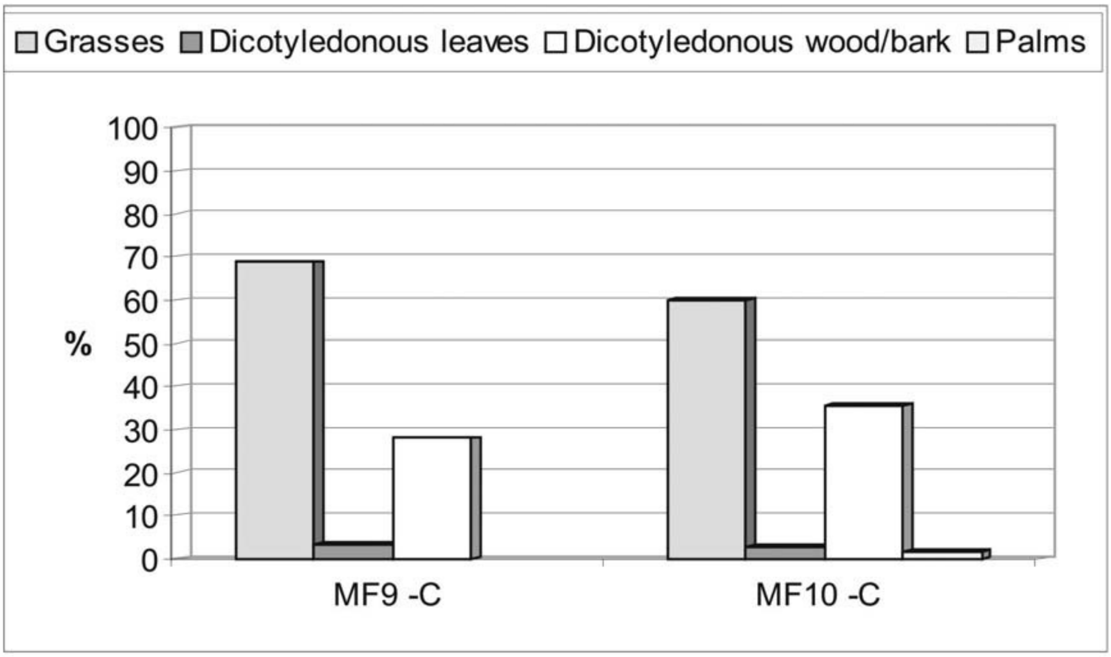

Figure 7.- Histogram showing the phytolith morphological results of the samples analyzed from the site of Martingiana (comune Orroli).

to the internal wall of a ceramic fragment located in unit 9. This unit contained the remains of the fallout of a hut. MF6 and MF8 belonged to the sediment recovered from a grinding stone from unit 5 (fallout of the mud-brick walls of a hut). MF7 was collected from the internal wall of an *anforetta* from the Final Bronze Age from unit 6.

The AIF percentage in these samples is high and it ranges between 88% and 94% (table 1). The percentage of organic matter is in all the cases close to 1% (table 1). Quartz and clay represented about 95% of the total AIF fraction whereas phytoliths represented less than 3% of the total AIF (fig. 1). The number of phytoliths estimated per gram of AIF varies considerably depending on the samples. Control sample from MF7-UE6 showed the highest amount of phytoliths per gram of AIF as well as sample MF6-UE5 corresponding to sediment collected from the surface of a grinding stone. The rest of the samples showed a low number of phytoliths per gram of AIF (table 1).

Grasses (fig. 3d) dominate the phytolith record in all the samples followed by dicotyledonous wood/bark phytoliths ad dicotyledonous leaf-phytoliths (fig. 6). No multicellular structures were identified in these samples either. Grasses were represented in all their parts. The difference of this site in respect to the other nuraghi is the identification in the samples of other plant types such are reeds (fig. 3e), sedges and palms. However these other type of plants were present in low amount.

Phytoliths from bark are also common in these samples although in lower number than in other sites. It is worth noting the differences observed between sample MF6 and sample MF8. Both samples belong, supposedly to the same milling stone. The results indicated that there are important differences between these two samples in relation to the presence of organic matter, the amount of phytoliths per gram of AIF (table 1) as well as in the morphological representation of the phytoliths. MF6 also showed a much higher amount of grass inflorescences.

3.4. Martingiana (comune Orroli)

Martingiana is located close to Gasoru on the western area of the plateau, where it visually dominates the valley between Allocci and Nueddas rivers. This site is characterized by the absence of a defensive wall which is usually present in the other nuraghi. MF9 and MF10 samples, from units 6 and 7 respectively were analyzed from this site. Chronologically these samples belonged to Later Bronze Age (*Bronzo Recente*) and they were collected from the internal wall of ceramic fragments.

The percentage of AIF is high in these samples and it goes from 81% to 83% (table 1). The presence of organic material is low especially in unit 9. The total estimated number of phytoliths per gram of AIF is similar in both samples (table 1). The AIF is dominated by quartz in MF9, whereas in MF10 there is a higher presence of quartz/clay fraction. The phytolith fraction corresponds to less than 1% of the total AIF in both samples (fig. 1).

The morphological analyses of the phytoliths (fig. 7) show that, although grasses dominate the phytolith record, they do it in lower percentage than in the other samples. This is especially evident if we take into account the fact that grasses produce 20 times more phytoliths than bark of dicotyledonous plants. The grasses identified corresponded exclusively to the festucoid subfamily group. The percentage of grass inflorescences is, as in the other samples, low. Dicotyledonous-leaf phytoliths are scarcely represented. Multicellular structures were not present in any of the samples. Palm phytoliths were noted in sample MF10 (fig. 3f).

3.5. Pranu Illixi (comune Escalaplano)

Pranu Illixi, together with Is Cangialis and Perda Utzei, is located in an area that has a good visual control of the river. Pranu Illixi is an interesting case of study because of its chronology which dates to the Iron Age. From this site, two samples were collected for study from units 2 and 3 (MF13 and MF 21-22 respectively) and one control sample from an area next to sample MF13. MF13 corresponded to sediment adhered to a basalt grinding stone, whereas MF21-22 was sediment adhered to a ceramic vase. Stratigraphic unit 3 was associated to burned tools and bones.

In both samples, the AIF percentage is, like in the former sites, high indicating an important amount of silica material. The presence of organic matter is low (about 1%) (especially in MF21-22), whereas the estimated number of phytoliths per gram of AIF is relatively low in both samples (table 1). The AIF fraction is composed, in more than 95%, of quartz whereas the phytolith fraction would be close to 1% of the total AIF.

Grasses dominate the phytolith record (fig. 8) and are represented by all their parts (leaves/stem, inflorescences), followed by phytoliths originated in the bark of dicotyledonous plants (fig. 3g) and in lower number by phytoliths from dicotyledonous leaves. Inflorescences (fig. 3h) are present in these samples, as well as in MF6 from Perda Utzei in higher amounts. Grasses corresponded to the festucoid subfamily group.

4. Discussion

According to the results obtained, there are some common traits that can be applied to all the sites

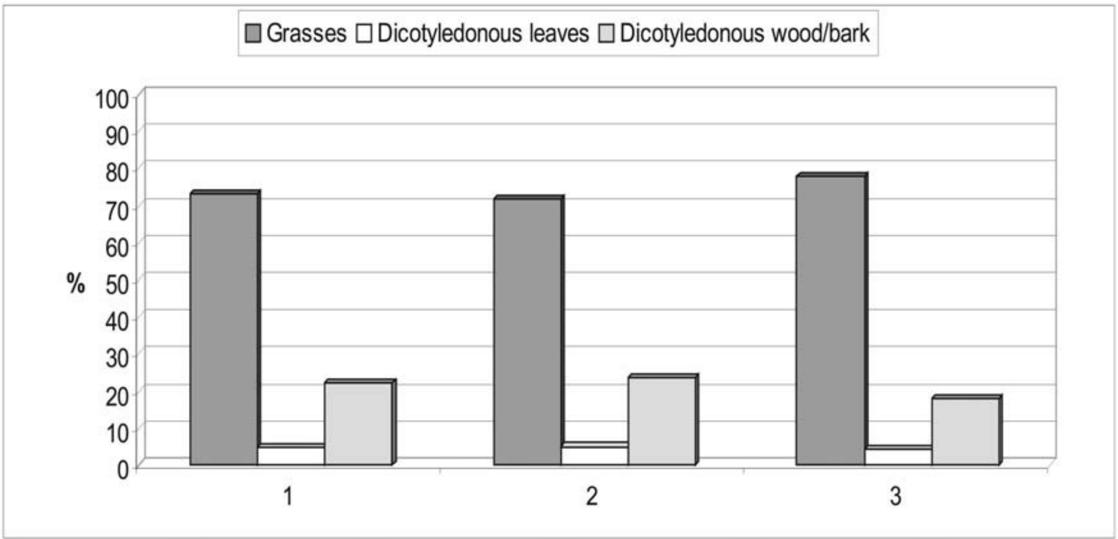

Figure 8.- Histogram showing the phytolith morphological results of the samples analyzed from the site of Pranu Illixi (commune Escalaplano).

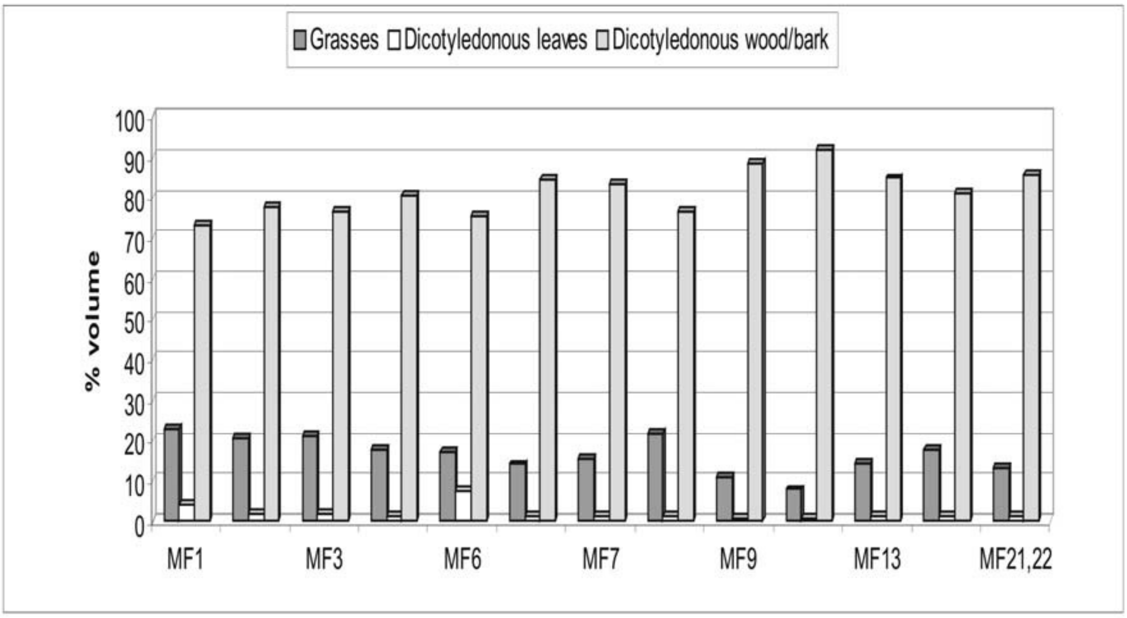

Figure 9.- Histogram showing the converted percentage volume of the phytoliths identified in the different samples.

analyzed. We will comment on them separately. Mineralogically samples are quite similar among them. All the samples from the different nuraghi showed a high AIF percentage. This AIF is dominated by quartz minerals whereas phytoliths are, in general, represented, as an average, in about 2%. Carbonates and phosphates are hardly represented (table 1). This similarity in the mineralogical composition must be related to the mineralogical composition of the sediments in the area. Most of the sites are geographically close (in a radio lesser than 10 km). However, regardless this apparent homogeneity, some minor differences have been noted in relation to the mineralogical composition, which is related to the geographical distribution of the sites in the plateau. Gasoru and Martingiana (comune Orroli) indicated a major presence of clay minerals (fig. 1) and a lower percentage of AIF (especially in Gasoru). Both sites were located in an open area with dry lands, suitable for agricultural practices. Is Cangialis (comune Nurri) also did show a lower AIF percentage than the other sites. Moreover, Perda Utzei and Pranu Illixi (comune Escalaplano) located outside the plateau are dominated, almost exclusively of quartz minerals (fig. 1).

Silica phytoliths were abundantly identified in the samples. On the contrary other microremains such as calcium oxalate crystals or starch granules were not identified in any of the samples. The phytoliths identified were, in general, in good preservation state. Only samples MF2 and MF10 (Gasoru and Martingiana respectively) did show a dissolution percentage around 20%. In any case this higher dissolution index did not interfere in the correct morphological identification of the phytoliths. Dissolution of phytoliths occurs mostly in situations with a high pH, mainly in carbonated areas and with a constant circulation of water (Benayas 1963; Piperno 1988; Albert *et al*. 1997, 2000, 2003). In these situations the dissolution percentage can reach 90% of the phytoliths identified (Albert *et al*. 2000, 2003; Karkanas *et al*. 2002). In our situation, phytoliths are not severely altered due to the mineralogical composition of the sediments, which, as we noted above, are composed mainly of silica minerals.

The phytolith morphological analyses showed that, grasses are represented by a higher number of phytoliths in the samples followed by phytoliths characteristics of wood/bark of dicotyledonous plants and, in lesser amount by dicotyledonous-leaf phytoliths. Other type of plants such as sedges, reeds and palms were also identified but in much lower number. Despite the major percentage of grass phytoliths, it needs to be taken into account that this family produces 20 times more phytoliths than wood and bark of dicotyledonous trees (Wilding and Drees 1971; Kondo 1977; Albert and

Weiner 2001) and 16 times more phytoliths than the leaves of dicotyledonous trees (Albert and Weiner 2001). In order to correct this different production we have converted the phytoliths percentage presence in phytoliths percentage volume (fig. 9). The results show that, by volume, wood/bark of dicotyledonous plants dominated over grasses. Moreover, grasses reach more than 20% volume presence only in Gasoru, Is Cangialis and the control sample from Perda Utzei (fig. 9). No differences are noted in relation to the type of material analyzed (milling stone or vessel). Grasses are represented by all their parts (leaves/stem and inflorescences). However the percentage of grass inflorescences phytoliths is, in general, too low to suggest the exploitation of grasses as a result of agricultural practices. Only samples MF6 (Perda Utzei), MF10 (Martingiana), MF13 and MF21 (Pranu Illixi) did show a higher percentage of grass inflorescences phytoliths (>20%) (fig. 4). These samples were collected from milling stones (MF6 and MF 13) and sediment adhered to a vase from the Iron Age (MF21-22). MF10 corresponded to the sediment adhered to the internal wall of a ceramic fragment. These percentages are similar to the ones obtained from the study of milling stones from the Iron Age in the Northeast of the Iberian Peninsula, where the percentage of grass inflorescences was close to 21%. The milling stones from this area have been interpreted as being used for the transformation and process of cereals (Portillo 2003). Similar percentages of grass inflorescences have been observed also in sediments analyzed in connection to milling stones, querns and handstones from the pre-pottery Neolithic site of Ayn Abû Nukhayla (Wadi Rum, Jordan) (Albert and Henry 2004).

The grass phytoliths identified correspond mainly to the festucoid subfamily group, common in the Mediterranean area and characteristic of a humid and temperate climate. Other grasses such as reeds were noted in Perda Utzei samples (MF5, MF6 and MF7). Sedges were identified in very small number in Gasoru (Sample MF2) and Perda Utzei (sample MF7). Palms were also observed in small amount in sample MF8 from Perda Utzei.

Dicotyledonous leaf-phytoliths are hardly represented in the samples and the few of them identified could not be further interpreted due to their lack of specific morphological characteristics. Wood/bark phytoliths are, opposite to the leaves from the same plants, very common in most of the samples, independently if they come from milling stones or ceramic vessels. They are represented mainly by parallelepipeds forms which mainly found in the bark and they are practically absent from the wood. Moreover, phytoliths from wood (spheroids and ellipsoids forms) have not been identified in the samples. Parallelepiped forms have also been observed, although in not large number in the fruits of some trees (Albert and Weiner 2001). In order to check this possibility we compared our results to the ones obtained from a study of dicotyledonous fruits from Israel (Albert & Weiner 2001) including two different types of oaks, and from acorns collected in the Iberian Peninsula during the summer of 2003. The results showed that, although there are some morphologies present in the archaeological samples that can be also identified in the fruits, not all the morphologies were represented in the samples and some morphologies present in the samples are not common in these fruits. Therefore it was not possible to establish a pattern that could identify the use of these fruits in the archaeological samples. Therefore the most plausible explanation is that the parallelepipeds forms identified would correspond to small branches of dicotyledonous plants, which show a higher presence of parallelepipeds forms in respect to the wood phytoliths.

We can conclude then, that grasses, with all their parts, and small branches would be present on the surface of milling stones and on the content vessels of the different samples analyzed. In relation to this, we need to point out the absence in all the samples of silicified multicellular structures. All of the phytoliths identified were unicellular forms. This absence has been also noted in other studies carried out with milling stones (Portillo 2003) and in sediments connected to milling stones, querns and handstones (Albert & Henry 2004). According to these results, the absence of multicellular structures should be related, not to chemical dissolution, but to a mechanical degradation of the phytoliths. Phytoliths would have been separated as a result of a grounding process. The intercellular spaces of the cells are usually less silicified than the cell itself and therefore they are more easily broken.

The first observation then is that, most of the phytoliths recovered (if not all) independently if they were collected from the surface of milling stones or from sediment adhered to ceramic vessel or as a part of the soil sediment, would have suffered a grounding process and after, in some of the samples, would have been added to the ceramics for a purpose not well understood yet. One possible explanation for this could be that branches were grounded first, and after would have been used as vegetal temper to prepare the ceramics. Grasses could have been present in some of the samples as a result of the same purpose. However in the samples recovered from the milling stones of Perda Utzei and Pranu Illixi the high percentage observed of grass inflorescence could also point to a use of the milling stones for processing cereals. Unfortunately the absence of multicellular structures did not allow us to identify the grasses present in these samples.

4.1. Final remarks

The mineralogical results of the samples analyzed indicated that this area is dominated by silica minerals, and therefore has excellent mineralogical conditions for the preservation of the phytoliths. Some minor mineralogical differences have been observed among samples due to the geographical proximity of some of the sites nuraghi.

The phytolith morphological analyses are characterized by two different results. The absence of multicellular structures, which on one hand, suggests that the plants identified have gone through a grounding process, both the ones recovered from the milling stones and the vessels, and on the other hand this absence did not allow us to identify the type of grass represented in the phytolith record. The second important result obtained is the dominance in the samples, of phytoliths formed in the bark of dicotyledonous plants (probably small branches). According to these results, the plants identified could have been used as vegetal temper to prepare the ceramics.