PALAEOENVIRONMENTAL AND PALAEOECONOMIC APPROACH TO THE EARLY MIDDLE AGE RECORD FROM THE VILLAGE OF *GASTEIZ* (BASQUE COUNTRY, NORTHERN IBERIAN PENINSULA)

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Abstract

An integrated archaeobotanical study carried out in the medieval village of Gasteiz (Basque Country, Northern Iberian Peninsula) was able to establish a diachronic view of the evolution of the vegetal landscape, the plant economy and the forest management in this rural community between the 8th and 12th centuries AD, through the study of seeds, fruits, firewood, pollens, spores and non-pollen palynomorphs. The main results show the presence of an anthropogenic vegetal landscape, shaped by the economic activities of the inhabitants of the village, based on cereal crops, legumes and animal husbandry. Also new data are provided about forest management related to metallurgical activities.

Key words

Vegetation dynamics, Agriculture, Plant economy, Woodland exploitation, Early Middle Age, Northen Iberian Peninsula.

INTRODUCTION

The conceptual and methodological bases of modern archaeology demand collaboration between different disciplines to achieve the same objective: to explain adequately the mechanisms of change and evolution in past cultures. In this multidisciplinary context, the study of botanical remains recovered from different archaeological sites helps to characterize past societies, from the standpoint of social and economic development. This is the starting point of the Master Plan for the Restoration of Santa María Cathedral in Vitoria-Gasteiz (Basque Country, Northern Iberian Peninsula) (Azkarate et al. 2001).

The results presented here are the fruit of such interdisciplinary work, mainly from the cross-checking of data obtained from the stratigraphic analysis of the site and archaeobotanical research (palynological, carpological and anthracological studies). Archaeobotanical studies have a long tradition in prehistoric research projects in the Iberian Peninsula (see Burjachs et al. 2005; Peña-Chocarro et al. 2005; Iriarte et al. 2008; Miras et al. 2010; Allue et al. 2012; Uzquiano et al. 2012, among others). However, in recent decades, interest in studies of historical chronologies has grown, due to the great potential of such studies (see Zapata 1997; Pèlachs et al. 2009; Ruiz-Alonso and Zapata 2009; López Merino et al. 2010; Pérez-Díaz and López-Sáez 2012; López-Sáez et al. 2013, Ntinou et al. 2013, Hernández-Beloqui et al. 2014, among others). Given that written records for the Early Middle Ages are limited and that the number of records available for some periods and areas is unlikely to increase, archaeology, and in particular archaeobotany, is a suitable tool for approaching the agrarian and environmental history of medieval societies (Bosi et al. 2001; Zapata and Ruiz-Alonso 2013; Mercury et al. 2014).

This text aims to be a good example of this, by showing that when different disciplines collaborate correctly, and systematic and exhaustive sampling strategies are implemented, there is great potential for generating historical knowledge. The objectives of this study are (1) to provide a synthesised overview of the plant landscape in the primitive village of Gasteiz (now known as Vitoria-Gasteiz) between the 8th and 12th Centuries, (2) to analyse its socioeconomic foundations and determine how important the different types of crops were, and finally, (3) to assess how forest resources were selected and exploited by the inhabitants of Gasteiz and connect these choices and trends to possible forest management practices.

Study area

The archaeological site is located in the South-Western Europe, in the north of the Iberian Peninsula, where the Alava plain and the town of Vitoria-Gasteiz are situated (Fig. 1). This area is strategically located and acts as a crossroads between the plateau, the Ebro Valley, the Western Pyrenees and the Atlantic Valleys.

Although it is part of the Mediterranean biogeographical region, the current climatic conditions in the area fall between the Atlantic conditions, which are typical of the northern coastal regions, and the Mediterranean climate of the southern regions of Spain. Therefore, a Subatlantic climate prevails in this area. It has an annual precipitation of about 600-700mm and a mean annual temperature of 12ºC. The city's location in an extremely urban area is the reason for the lack of natural vegetation, which is limited to some farmland and small deciduous woods in the local area. Those woods are oak woods of *Quercus robur* L. (Pendunculate oak), *Quercus pyrenaica* Willd. (Pyrenean oak) and small stands of *Quercus faginea* Lam. (Portuguese oak), together with areas of *Quercus ilex* L. (holm oak) and *Pinus sylvestris* L. (Scots pine) (Aseginolaza et al. 1996). In the nearby hills they are located calcicolous *Fagus sylvatica* L. (Beech) woods.

Archaeological background of the site

Archaeological research carried out in the surroundings of Santa María Cathedral over the last fifteen years has made it possible to trace Vitoria-Gasteiz's origin to the Bronze Age. From this moment only have been documented few and dispersed archaeological remains. However, it is about 700 AD when we have identified a stable settlement here, that has lasted up until the present day. This was the old village of Gasteiz, the origin of the present day city of Vitoria-Gasteiz. The history and evolution of this settlement can be divided into four main phases (Azkarate and Solaun 2009, 2013) (Fig. 2), whose chronology has been deduced from the intersection of the results provided by the stratigraphic analysis and other indicators such as ceramic studies and radiocarbon dates (Rubinos 2013) (Table 1).

- Phase 1 (8th century-first half of the 10th century). The archaeological research provides evidence that a household unit existed at the time that the land was first occupied in the far north of the settlement. We have documented also other domestic units in the area, forming the primitive village of Gasteiz. This household unit comprised several perishable structures, mainly made from wood and clay, which were organized in two well-separated areas. The first of these consisted of a large residential building (*longhouse*), an area for agricultural activity, a water supply area and a storage area, all of which were arranged around a multi-use open space. The distinctive features of the second area, which was located immediately to the north of the first, suggest that it was used for metallurgical activities.

- Phase 2 (second half of the 10th century). The mid-10th century brought huge changes to the primitive household unit and construction techniques. The domestic and craft areas were joined together in a single space (the old domestic area) with a patio area in the centre, around which two large buildings were built, one a residential building and the other to be used for metallurgical activities. In the western part of the unit, the storage area and the water supply present in the previous phase were preserved. Moreover, the use of stone was introduced into the main constructions, mainly in the foundations of their enclosure walls.

- Phase 3 (11th century). At the start of the new millennium, an urban section arranged in three parallel streets was added to Gasteiz, radically changing the appearance of the old village. The old cluster layout disappeared and a new one consisting of residential buildings arranged in lines along the streets was introduced, although the buildings did not yet form blocks of compact houses. The household unit retained the old residential building's design and location, although it was divided up into several independent and uniform rooms. During the archaeological work it was only possible to exhume three of these: a forge, a dwelling and another storage area.

- Phase 4 (12th century). The significant changes that were made to the features of the village during the 11th century continued into the 12th century, when a strong stone wall was built and, some time later, when a church was erected inside the village walls themselves. This construction work continued to respect the primitive dwelling, to which another storey was added, although some of the old floors and hearths were re-used.

MATERIALS AND METHODS

The plant remains in association with archaeological contexts are a very delicate part of the record, so they have to be treated in a specific way. The pollen grains frequently have an adequate preservation in sediments, where they are sampled and analyzed. The macroremains, usually charcoal, seeds and fruits are often preserved by charring. The materials that have been burned, either accidentally or intentionally, are not destroyed by the action of bacteria, fungi or other agents. In practice, this creates a bias towards preferential preservation of plants that are manipulated in contact with fire, versus those foods consumed green. These factors must be taken into account when developing an archaeobotanical research as presented here.

From the beginning of the archaeological project in the surroundings of Santa Maria Cathedral, was considered essential to address appropriate sampling strategies for archaeobotanical studies. To do this, intensive work was carried out with the aim of documenting all phases of occupation of the site. In every one of these phases, and archaeological levels, was developed, in parallel sediment sampling for the palynological, anthracological and carpological study. This event favours the comparison and interrelation of the results obtained, allowing adequate comprehensive interpretations of the whole archaeobotanical record. Below, we detailed the sampling strategies employed for palynological study and the plant macroremains

Pollen, spores and Non-Pollen Palynomorphs

The archaeopalynological study was performed on 8 sediment samples from sediments dating between the 8th and 12th century (Figure 3). With the aim of covering most of the chronological periods recorded in the site, the samples were collected using two different strategies due to the presence of multiple stratigraphic levels. In order to do so, both stratigraphic profiles and some isolated samples were taken (Burjachs et al. 2003).

All the palynological samples were chemically treated following the method that Girard and Renault-Miskovsky (1969) proposed for extracting sporopollinic remains and non-pollen palynomorphs, with the samples being concentrated in a high-density Thoulet solution (Goeury and de Beaulieu 1979). The microscopic identification of pollen morphotypes was conducted in accordance with Moore et al. (1991) and Reille (1992, 1995), with the support of the Archaeobiology Research Group's pollen reference collection (CCHS-CSIC, Madrid). In each sample were counted a minimum of 200 pollen grains, excluding hydro-hygrophilous, Cichorioideae, *Aster* and Cardueae, due to their anthropogenic origin and theoretical overrepresentation (Bottema 1975; Carrión 1992; Burjachs et al. 2003; López Sáez et al. 2003), and non-pollen palynomorphs. In addition, a minimum number of twenty species was counted per sample. Non-pollen palynomorphs were appointed as HdV, followed by the number of the type. These refer to taxa defined and published at the Hugo de Vries Laboratory (HdV), University of Amsterdam (see overview publication by Miola, 2012). The palynological diagram (Fig. 4) was produced using the Tilia 2.0 and TGView programs (Grimm 1992, 2004).

Plant macroremains (charcoal, seeds and fruits)

A total of 47 stratigraphical levels were sampled for the anthracological and carpological analysis, with an average of 1-81 l of sediment per sample (Table 2). The criteria used to select the contexts mainly took into account chronology and typology. In terms of the chronological approach, an initial selection was made of macroremains that would be sure to provide dates between the 8th and 12th centuries, with precise and clear-cut chronological ranges. The layers that were selected according to typology were chosen depending on their formation process, and priority was given to contexts with lower amounts of residue, which would, therefore, guarantee that the botanical remains were located in their original context (Fig. 3). Processing samples from contexts with a significant volume of sediment was also of particular interest.

Retrieving plant macroremains requires systematic sampling strategies, planned in advance and while the field work. In this case, the systematic sampling of macroremains took place during the excavation process, in order to examine stratigraphic units which had different origins, namely metallurgical and domestic ones (Table 2). The excavated sediment was processed with a Siraf-type flotation tank as described de Moulins (1996). The floating fraction was collected in a sieve with a mesh size of 250 μm. The sunken residue was collected in a 1 mm mesh and was also examined. The samples were sorted under a low-power stereoscopic microscope. Only wood, seeds and fruits have been identified between the macroremains.

Anthracological remains were identified using epi-illuminated light microscopy and carbonised wood reference collections of modern woods from Western Europe of the CCHS-CSIC (Madrid), and wood anatomy atlases by Schweingruber (1978, 1990), Hather (2000) and Vernet et al. (2001). At least one hundred fragments were identified in each chronological context, whenever possible. Fragments bigger than 4 mm have been identified and the samples include both, the flot and the charcoal collected from the residue.

Carpological remains were identified using several types of microscope equipment. The samples were examined in four parts: 1) ≥ 2 mm 2) ≥ 1-2 mm 3) ≥ 0.5-1 mm 4) ≥ 0.25-0.5 mm, and the archaeobotanical material was compared with specialised atlases and a collection of modern reference material of the University of the Basque Country (Vitoria). We follow the taxonomy and nomenclature from Jacomet (2006) and Zohary et al. (2012) for the cereals.

RESULTS

Pollen and non-pollen palynomorphs

All the samples provided a sufficient number of pollen remains, except those which correspond to the period from the second half of the 12th century to the first half of the 13th century. The palynological diagram (Fig. 4) shows that from the beginning of the sequence, between the 8th and 10th centuries (Phase 1), trees in the area were scarce (26.9%); those which have been documented include *Betula* (birch, 9.6%), deciduous *Quercus* (8.2%) and *Alnus* (alder, 5%). The remaining tree species are *Pinus sylvestris* (Scots pine), *Acer* (maple), *Corylus* (hazel), *Fraxinus* (ash), *Salix* (willow) and *Ulmus* (elm), amounted to less than 2%. Herbs constituted the largest group (71.2%), and Poaceae (33.3%) were the most prevalent, along with some indicators of anthropic and ruderal environments, such as Cichorioideae (35%), Chenopodiaceae (6.8%), *Aster* type (4.5%), Scrophulariaceae (2.3%) and Cardueae (1.5%). There was also a significant proportion of Fabaceae (9.6%) and *Cerealia*-type pollen (5.9%). Finally, non-pollen palynomorphs were underrepresented, as only the following were recorded: *Glomus* cf. *fasciculatum* (HdV-207, 3.2%), *Podospora* sp. (HdV-368, 1.1%), *Pseudoschizea circula* (0.6%) and HdV-181 (0.6%).

A small percentage of trees (25.8%) was again recorded in the first half of the 10th century, with *Betula* (9.1%), deciduous *Quercus* (8.6%) and *Alnus* (4.3%) as the most commonly occurring taxa. Open spaces still dominated the landscape (71.5%), and high values of Fabaceae (7%) and *Cerealia*-type pollen (5.9%) were again recorded. *Glomus* cf. *fasciculatum* (HdV-207) was one of the most common non-pollen palynomorphs with an occurrence level of 3%. Others included *Podospora* sp. (HdV-368, 0.7%), *Pseudoschizea circula* (0.5%) and type HdV-181.

Forest areas still remained sparse during the second half of the 10th century (Phase 2), reaching 33-35%. Particularly, deciduous *Quercus* grows from 8.2% to 9.1%. The increase in pine forests (*Pinus sylvestris*) at this time was also significant (5.5-6%), in contrast with the decrease in other deciduous tree taxa (*Betula*, *Alnus* and *Corylus*). It is also important to emphasize the presence of herbaceous taxa, especially Poaceae, and cereal pollen (2.3%), and the disappearance of Fabaceae. *Pseudoschizaea circula* and *Glomus* cf. *fasciculatum* were the only non-pollen palynomorphs to be recorded.

The samples corresponding to the first half of the 11th century (Phase 3) show the same previously described trend, namely low values of tree pollen (22.9%) with deciduous taxa, especially deciduous *Quercus*, being the most dominant, in an open space in which Poaceae formed the most widespread plant community. The values of cereal pollen which were recorded were very low (< 1%).

In the second half of the 11th century and the first half of the 12th century (Phases 3-4), the same trends (a limited presence of deciduous forests in an area that was dominated by open spaces) continued. At this time there was a significant increase in the amount of cereal pollen (6.6%), including the appearance of *Secale*, one of the few gramineae that can be identified at species level. Nothing can be said about the period from the second half of the 12th century to the first half of the 13th century. The samples were sterile from the palynological point of view, because did not contain pollen grains.

Charcoal

The number of remains which were analysed was higher for the earlier time ranges (8th-10th century), since there were more samples from these periods (Ruiz-Alonso et al. 2012). In contrast, fewer samples and carbon remains were available for the more recent periods (Table 2). Despite the limitations resulting from this low number, a decision was made to include them, due to the coherence of the results with the rest of the sequence. This paper presents the samples which were taken from the following: 1) the wood charcoal scattered across the general site, which is probably a by-product of domestic fuel (Fig. 5), and 2) charcoal in the stratigraphic units identified as places where metallurgical work was performed (8th-9th centuries, Fig. 6).

As mentioned above, the charcoal remains came from two different sources. A total of 1493 fragments over 4mm in size were identified in general contexts. The period from the 8th century to the first half of the 10th century (Phase 1) is the best documented in terms of the amount of charcoal samples which were analysed (n=721). In this context the largest group are deciduous and marcescent deciduous oaks (58%). *Fagus sylvatica* (beech) woods were recorded, although in relatively low proportions (9%). Rosaceae reached values of 30%, including almost equal proportions of *Prunus* and Pomoideae (Fig. 5).

Deciduous *Quercus* is still the main taxon during the second half of the 10th century (Phase 2), but now accounts for less than half of the total of the identified types of wood (45%). Rosaceae continued to be very significant and its values from earlier periods (30%) remained the same. The increase in *Fagus* wood was significant (23%). Other taxa were present, such as *Acer*, *Corylus*, *Fraxinus* and *Rhamnus*, but with percentages below 1%.

During the first half of the 11th century (Phase 3), the relatively high proportion of deciduous *Quercus* and *Fagus* wood continued to be similar to the values for the previous period (43% and 21%, respectively). The decrease in Rosaceae wood to 18% and the presence of *Fraxinus* (10%) were significant. The remaining taxa (*Acer*, *Cornus*, *Corylus*) are represented by 4 fragments each (2.3% of the total in each case).

In the second half of the 11th century, two main taxa are documented, deciduous *Quercus* and *Fagus*. The amount of oak did not vary significantly (it increased from 43% to 47%), but beech wood did increase significantly. *Prunus* and *Acer* only amounted to 3% of the sample, while *Cornus*, *Corylus*, *Fraxinus*, Pomoideae and thorns (*Prunus spinosa*) were no longer recorded. Although this may be partly due to the fact that the number of identified fragments was lower and that minor taxa have less chance of being represented, it seems likely that the ways in which forest resources were used and exploited in the area were changing.

Although the anthracological data documented for the 12th century (Phase 4) should be approached with some caution because of the lower number of identified fragments for this period (n=45), the results do reflect the previously mentioned trend of a significant increase in *Fagus sylvatica* wood (58%) at the expense of deciduous *Quercus* (24%). Other taxa which were present were *Corylus* (9%), Rosaceae (7%) and *Acer* (2%, with only a single fragment).

In the contexts associated with metallurgical activities, dated to the 8th-9th century, the high level of Rosaceae is very significant (close to 70%), followed by deciduous *Quercus* (18%) and *Fagus sylvatica* (8%). Other types of fuel which were recorded include *Acer*, *Cornus*, *Corylus*, *Fraxinus*, *Salix* and *Ulmus*, each with percentages fewer than 2% (Fig. 6).

Seeds and fruits

The number of carpological remains which were retrieved and identified varied greatly depending on the period analysed; those with the largest amount were from the oldest samples and the 12th century. The most consistent results therefore come from the earliest period, which had a greater number of samples and remains (Table 2, Fig. 7). Although the amount of remains recovered from the 12th century was high, it should be borne in mind that these all came from a single sample, that is, a single chronological context.

The information retrieved for the period from the 8th century until the first half of the 10th century (Phase 1), shows that three main types of crop were present: *Hordeum vulgare vulgare* (covered barley, 26%), *Triticum aestivum*/*durum* (naked wheat, 24%) and the foxtail and proso millet group (*Panicum/Setaria*) (26%). In addition, among the crops grown probably for nutrition purposes, a level of 6% of legumes was identified, which included *Lens culinaris* (lentils), maybe peas (cf. *Pisum*) and bitter vetch or chickling vetch (*Vicia/Lathyrus*). Remains of fruit that was grown and/or gathered are scarce; those identified include *Pyrus communis* (pear), *Prunus* sp., *Crataegus monogyna* (hawthorn) and *Rubus fruticosus* (blackberry). *Linum usitatissimum* (flax) was also present, and in the samples it amounts to 18% of the annual crops (Fig. 6).

In the second half of the 10th century (Phase 2) the main groups of seeds were still cereals. *Hordeum vulgare vulgare* was the most common (30%), followed by *Triticum aestivum*/*durum* (24%) and *Panicum/Setaria* (19%). A possible naked barley caryopsis (*Hordeum vulgare* cf. *nudum*) was also identified, which was the only one in all the samples analysed from the whole settlement. *Secale cereale* was recorded for the first time in the site from a single seed. Legumes made up 13% of the crops, and those which were identified include *Lens culinaris*, bitter vetch (*Vicia ervilia*), broad bean (*Vicia faba*) and the pea (*Pisum sativum*). *Linum usitatissimum* was also recorded from only two seeds which were recovered in one of the samples. The gathered fruits which were identified include sloes (*Prunus spinosa*) and blackberries (*Rubus fruticosus*), and the fruit trees which were grown include the pear tree (*Pyrus communis*).

The samples which were analysed from the 11th century (Phase 3) indicate that naked wheat (*Triticum aestivum*/*durum*) became the main cereal in Gasteiz (38% of the total crops). Foxtail and proso millets (*Panicum/Setaria*) accounted for 19% and barley (*Hordeum vulgare vulgare*) for 17% of the crops. Among the cereals, rye (*Secale cereale*) became more important (7%). Legumes amounted for 19% of crops and the lentil (*Lens culinaris*), broad bean (*Vicia faba*) and some other species from the pea/bitter vetch/chickling vetch group were present. Flax was not recorded. Fruit trees were extremely scarce once again, and only the remains of a walnut (*Juglans regia*) shell and of a plum (*Prunus domestica*) were identified. Two identified blackberry (*Rubus fruticosus*) seeds could indicate that this wild fruit was picked, although it cannot be excluded that its presence in the site was adventitious, given that this bush is usually found in anthropised places.

Finally, carpological data for the 12th century (Phase 4) come taken from a single archaeobotanical sample, which was recovered from a spot which had suffered a fire. Among the different crops which were identified, the trend for naked wheat (*Triticum aestivum*/*durum*) as the main cereal was confirmed (46%) and it was followed by *Panicum/Setaria* (29%). The amount of barley (*Hordeum vulgare vulgare*) continued to drop and it only accounted for 14% of the crops, while the presence of rye was recorded (9%). Legumes represented only 2% of the sample, but did include the lentil (*Lens culinaris*), bitter vetch (*Vicia ervilia*), broad bean (*Vicia faba*) and the chickling vetch (*Lathyrus* tp *sativus*). Flax was not recorded in this period either.

DISCUSSION AND INTERPRETATION

The confluence of different archaeobotanical records makes it possible to approach several historical issues related to medieval chronology, and enables a better understanding of such issues as the composition and evolution of the landscape, the plant economy, diet and forest resource management. Furthermore, the archaeobotanical data have been compared and cross-checked with other textual, architectural, faunal and metallurgical data, demonstrating a prominent cross-disciplinary vision.

Vegetation

The palynological and anthracological study carried out in the village of Gasteiz identified a landscape in the central part of the Basque Country (northern Iberian Peninsula) greatly affected by human activity between the 8th and 12th centuries, as reflected by a forest cover which had reduced in size due to productive economic activities (Fig. 4). This intense deforestation in the vicinity of the human settlements is a phenomenon documented in this region from at least the end of the Bronze Age and during the Iron Age, as the palynological studies of other nearby deposits demonstrate (Pérez-Díaz et al. 2014). Therefore, it cannot be attributed to the inhabitants of the medieval village, because the landscape had already been affected in that way before the Middle Ages.

The vegetation community that seems to have been most significant throughout the period, at least on a local scale, is deciduous forest. Both the pollen and anthracological records indicate the significant presence of deciduous oak (Table 3), possibly Pedunculate oak, which could be found in this area due to the high water availability in valley bottoms on the Álava plain (Aseguinolaza et al. 1996). It was undoubtedly used in the first buildings constructed in Gasteiz, given that the charred remains of thick pillars made using this wood were found *in situ* (archaeological level 18644, Table 2).

Other deciduous trees which were recorded include maple (*Acer*), birch (*Betula*), hazel (*Corylus*), ash (*Fraxinus*) and holly (*Ilex aquifolium*), which could either have accompanied the deciduous oak woods or have grown on the floodplains of rivers in the surrounding area. There must have been a watercourse of considerable size in the vicinity, judging from the identification of arboreal flora typical of riparian environments, such as alder (*Alnus*), willows (*Salix*) and perhaps elms (*Ulmus*) (Aseguinolaza et al. 1996). A scarce presence of scots pine woods has been recorded, which seems to suggest that they were located on a regional scale.

It is interesting to highlight the case of the beech. Although it seems to have been a very commonly used wood (Fig. 5), it scarcely features in the palynological records. Considering its ecological characteristics, such as its requirement for high humidity, it is unlikely that it was found in the bottoms of the nearby valleys, where oak seems better adapted to the drop in humidity in summer. It may therefore have grown in the nearby mountain areas above an altitude of 650 m. asl, with higher winter precipitation and heavy mist in summer, providing a significant amount of moisture throughout the year. In fact, some paleoenvironmental records for these mountain areas indicate that there was a significant presence of beech trees from at least the 3rd century cal AD (Pérez-Díaz et al, 2009; Pérez-Díaz and López Sáez, 2012, 2014a, 2014b).

Particular attention should be paid to the significant percentage of wood of Rosaceae taxa from the 8th to the 10th century (Phases 1 and 2), which is unusual (Fig. 5 and Fig. 6). Their occurrence could indicate the existence of a significant strip of thorny trees (*Prunus* sp., Pomoideae), extensive cultivation of fruit trees or even a combination of both. However, the scarcity of fruit seeds in the carpological studies seems to support the first hypothesis, even more so when Rosaceae is recorded on a massive scale in the contexts relating to the foundry in the household unit.

Despite the general reduction in forests in the area, reforestation was noted during the second half of the 10th century (Phase 2), as indicated particularly by the expansion of oak woods (Fig. 4, Table 3). The same trend was seen in the evolution of pine forests. However, despite the fact that these percentages double, they are not high enough to indicate a significant local presence, and their most likely location is the Álava plain, where their natural character seems to have been proven (Aseguinolaza et al. 1996). Moreover, other tree taxa are much more plentiful on a qualitative and quantitative level, namely the maple, hazel, ash, holly, pine, willow and elm, with the beech appearing for the first time. A decline is only seen in alder and birch, which could be the consequence of a period when the edaphic moisture level was low or of anthropic pressure on the formation of riparian forests. Recovery of the forest cover is related to a drop in the level of human impact on the landscape, which is also reflected by the decrease in pollen anthropisation indicators, such as Cichorioideae, *Aster*, Cardueae and Scrophulariaceae. This lesser anthropic pressure is equally shown by a reduction in pastoral pressure on the landscape, given that *Plantago lanceolata* and *Podospora* are now absent. Indicators of arable land also decline.

There do not seem to have been any major changes in the landscape during the 11th century (Phase 3). Tree cover continued to be quite sparse; while it has been confirmed that oak woods experienced a significant decline during the first half of the 11th century, this was followed by a period of recovery in the second half of the century. The other forest communities shown in the diagram (riparian and pine forests) did not undergo changes during this time when compared with the previous period (Fig. 4). It is significant that in the second half of the 11th century and the first half of the 12th century the original forest did recover somewhat in size, especially the oak woods, and there was a significant increase in the presence of beech trees. Anthracological data also reflect the dominance of oak and beech formations, contrasting with the disappearance of such relevant taxa as Rosaceae, which as stated above had been present in large proportions in the Early Middle Ages.

To conclude, despite some forests existing in the vicinity of Gasteiz, most of the area in which the site is located consisted of open spaces with no tree cover during the period from the 8th to the 12th century. Herbaceous taxa were a dominant feature of the landscapes, especially grasslands created by humans, which were typical of anthropised and ruderal environments (Behre 1981; López Sáez et al. 2003). Anthropic and nitrophilous (*Centaurea nigra, Dipsacus fullonum, Aster,* Cardueae, Cichorioideae, Scrophulariaceae) and anthropogenic (Chenopodiaceae, *Plantago lanceolata, Urtica dioica*) vegetation communities were the most prominent features of the landscape.

Plant economy

The principal causes of this deforested landscape were the productive economic activities carried out by the inhabitants of Gasteiz. Agriculture, livestock farming and metallurgy have all been documented in all phases. All these activities led to the area becoming highly anthropised. In terms of archaeobotany, farm crops, the harvesting of wild products and livestock development have all been identified, which suggests that there was a varied and complex plant economy throughout the 8th-12th centuries.

Wheat, barley and foxtail/proso millet

Cereal crops have been clearly recognised both in palynological and carpological records. Cereal pollen (*Cerealia* type) has been recorded in all periods, although with varying values (Table 3). Unfortunately, information on cereal pollen morphology is not always sufficient to discriminate types or species (except in the case of maize and rye). Cereal pollen values in the 8th-10th centuries (Phase 1) are significant and reached 5.9%, showing that cereals were cultivated in fields located close to the household units forming the village of Gasteiz (López-Sáez and López Merino 2005).

During the second half of the 10th century (Phase 2) the agricultural landscape would experience significant changes, which were undoubtedly prompted by successive changes made to farming and livestock techniques in the village. The most significant changes that occurred in this period were moving most of the arable land away from the immediate vicinity of the village, and the decline in the area of wet pastures.

Although in the palynological record cereals are present, their values, below 3%, suggest most cereals were not grown near the settlement. They are thought to have been grown some distance away, very possibly on the flat lands in the surrounding area and occupying land previously used as pasture.

Although pollen is able to record the presence, level of intensity and impact of agricultural activity on the landscape, it is difficult to identify specific crops or farming practices (Zapata 2008). The carpological studies show that agriculture across the entire studied period was based on a combination of naked wheat, barley and the foxtail and proso millets group, crops which always accounted for over 75% of the carpological remains from harvested plants.

From the beginning of the period, wheat emerges as one of the pillars of the Gasteiz economy. The particular type of wheat was naked wheat (*Triticum aestivum/T. durum*) and, as is clear from Fig. 7, the gradual increase in its abundance is notable, while barley (*Hordeum vulgare vulgare*) decreased. The purpose of this agrarian strategy would be to ensure human and animal consumption; the types of animals would essentially be cattle, as identified in the fauna studies (Castaños 2013), since the livestock system was mainly focused on raising large livestock, in order to provide dairy products and as working animals (milk cows and oxen). In fact, along with agricultural practices, the palynological record shows that throughout the period in question there were open spaces which had been colonised by anthropogenic plant communities (Chenopodiaceae, *Plantago lanceolata*, *Urtica dioica*), which could have formed part of pastures clearly used for livestock (Fig. 4). Furthermore, although identified in low values, *Podospora* sp. (HdV-368) coprophilous fungal ascospores are another indicator in this respect. These are fungi which develop in animal excrement and are therefore clear evidence of domestic animals *in situ* (van Geel et al. 1981, López Sáez et al. 2000; López Sáez and López Merino, 2007). In short, the productive system achieved a balance between agriculture and animal husbandry to optimise their synergies, in which cereals allowed the villagers to maintain their animals, which worked the fields, periodically re-initiating the farming cycle.

Cereal cultivation seems to have reached its peak in the 12th century (Phase 4), as reflected in palynological data (Fig. 4), showing the highest percentage of cereal in the entire period studied (*Cerealia* type, 6.1%). The rise in agricultural activities focused on cereal seem to coincide with a significant increase in the cultivated area around the settlement, as reflected in several written documents from that time, which mentioned that wide areas of land in the fields surrounding Gasteiz were ploughed (Azkarate and Solaun 2009). Cereal crops at this time seem to have covered larger and more distant areas, in particular meadows, hillside areas and, perhaps, some wetlands close to water channels. In fact, given the lack of Cyperaceae it can be inferred that these significant developments in cereal-growing occurred during a particularly dry period, which would have helped to dry out peat bogs and wetlands.

The carpological studies also offer extremely other interesting data (Fig. 7). For example, it may be concluded that the increase in the amount of arable land was closely linked to changes in agricultural strategies, which were then focused on reducing barley crops (14%) and gradually increasing the amount of wheat. Wheat values higher than 45% indicate specialisation in wheat from the 12th century onwards. This had immediate consequences for the livestock, as indicated by a new livestock strategy mainly concentrated on raising sheep, after four centuries during which heavy livestock dominated.

The presence of short-cycle cereals (foxtail millet and proso millet) remained stable throughout the studied period. Considering only the caryopses which were identified as belonging to a particular species, foxtail millet (*Setaria italica*) was most abundant, but gradually declined as the amount of proso millet rose (*Panicum miliaceum*). It is interesting that these supposedly minor cereals were identified. Foxtail and proso millets, which are very significant in the samples from Gasteiz, tend to be invisible products in written documentation, which usually detail payments and leases for wheat and barley. Archaeobotanical data are, therefore, especially useful for revealing the history behind these crops, which were used for human or animal food (Bornstein-Johanssen 1975; Zohary et al. 2012).

Other harvested plants

Rye is recorded in Gasteiz from the second half of the 10th century. In the north of the Peninsula, based on currently available data, it seems to have been a minor cereal during the Early Middle Ages, in contrast to other areas of Europe (Comet 2004). It is usually considered a rustic plant, which can grow in cold climates and is resistant to drought and not very demanding in terms of soil quality. It is therefore able to grow well in areas where wheat could not. It is sometimes used as a cover crop, to protect species such as wheat from cold temperatures or to support legumes such as vetches or peas. It is also one of the few cereals which can be identified from a palynological perspective. In this case, it has been recorded during the period between the second half of the 11th century and the first half of the 12th century.

Avena grains are also present in the archaeobotanical samples from Gasteiz. However, the grain's morphology does not make it possible to identify whether it is a cultivated oat (*Avena sativa*) or another species such as *Avena fatua*, the wild oat, which is an adventitious plant. Its widespread presence in storage contexts can indicate that it is actually a cultivated plant, but this was not observed in the samples that we studied. In any case, *Avena* would have been a minor crop in Gasteiz.

Cultivated legumes have been an extremely important aspect of agriculture in southern Europe since the Neolithic Period (Buxó 1997; Zapata et al. 2004) and they have also been present in Gasteiz (Fig. 7). It is difficult to recognise cultivated species in many cases, since their distinctive characteristics usually disappear when carbonisation occurs. For this reason it is not possible to estimate the relative proportions of legumes consumed in Gasteiz. Nevertheless, by accurately identifying some examples it is possible to confirm that the following were cultivated: the lentil (*Lens culinaris*), bean (*Vicia faba*), pea (*Pisum sativum*), bitter vetch (*Vicia ervilia*), chickling vetch and red pea (*Lathyrus sativus* and/or *L. cicera*). Legumes were also identified in the pollen record, but unfortunately those palynomorphs could not be identified generally or more specifically from their pollen morphology, and it is not therefore possible to discern whether they represented groups of wild legume species or, on the other hand, if they were crops. Nevertheless, their high percentage (over 5% in some contexts) could indicate that these plants were a type of crop, as confirmed by the carpological analysis.

Another cultivated species recorded in the Vitoria-Gasteiz cathedral deposits is flax (*Linum usitatissimum*). The presence of flax is usually connected to textile production, although it must not be forgotten that it may be used to obtain oil for cooking purposes. The appearance of flax seeds would indicate that it was used for culinary purposes, since stalks are harvested before the seed ripens if they are to be used for textiles. This suggests that flax production for textiles or culinary uses (at least on a domestic level) took place and remained stable until the first half of the 10th century, when it disappears from the archaeological record, perhaps to the advantage of other fats and fabrics such as wool.

In addition to crops, other resources have been recorded in Gasteiz, such as the remains of cultivated fruit trees, although scarce in number, such as plums, walnuts and pears, and isolated remains of gathered fruits, such as sloes, hawthorns and blackberries. On the basis of available archaeobotanical data, these all seem to have been food stuffs which did not play an important part in the diet of the inhabitants of Gasteiz. It must be recalled that taphonomic processes also affect different types of food (processing, cooking methods, consumption and waste disposal methods), preventing their archaeological conservation. Some wild plants which had been gathered and showed up in the samples (such as the elderberry, *Sambucus nigra*, which was preserved without undergoing carbonisation, or verbena, *Verbena officinalis*) could have been used in human and animal food.

Woodland exploitation

One of the most interesting aspects of the integration of different archaeobotanical records is that they are able to provide information about specific economic activities. In this case, by combining the palynological and anthracological record, it was possible to identify some patterns in the exploitation of the forest in the surroundings of Gasteiz village.

As mentioned, one of the most significant aspects of the archaeological record was the finding of an iron foundry dated between the 8th and 10th centuries. Anthracological data from this identified an abundance of Rosaceae wood (*Prunus* and Pomoideae), which reached 70% of the total (Fig. 6). The presence of this wood in anthracological records from the north of the Peninsula is not unusual, although it usually occurs in lower percentages. It is therefore clear that this wood was selected as the main fuel for metallurgical activities. Furthermore, these types of shrub are very common in the present day, both in the strip of shrubs found around several types of deciduous forests and in the inner shrub stratum (Aseguinolza et al. 1996). Rosaceae may have been chosen because form a group of dense wood with a high calorific value. The use of thin or small types of wood, such as most rosaceae, is very common for lighting fires in combustion structures (bread ovens, ceramic kilns, etc.). In ovens used in Roman and Medieval times, in particular, it was common to use fallen branches or waste collected when pruning fruit trees, as for example in the Roman settlement of Aloria and in a Medieval ceramic oven in the Antigua Audiencia (Euba 2005). Olive wood was the main fuel used in the El Moro thermal baths. According to suggestions by the authors of a study (Euba and Allue 2003), the wood may have come from leftovers collected while pruning trees. It was also recorded that fig tree prunings were used in the Riff region of Morocco for firing ceramics in open ovens (Zapata et al. 2003). These types of small materials would have been used to achieve high temperatures in a short space of time, given that the calibre of the firewood and its water content, rather than the species, are the main factors which determine the calorific power and performance of firewood (Chabal 1997).

Excluding samples from metallurgical contexts, it is evident that the principal fuels used for domestic purposes in Gasteiz were deciduous *Quercus* and beech (Fig. 5, Table 3). There was also a dynamic phase of decline in the abundance of oak and a gradual increase in beech wood. The presence of oak in the settlement area is clearly documented in the palynological diagram, and oak wood could possibly have been the most important on a local scale (Fig. 4). However, in the present day, oak groves have been disappearing due to human demand for charcoal or the gradual expansion in crops (Aseguinolaza et al. 1996). In addition, it should be borne in mind that deciduous *Quercus* supply wood of excellent quality for use as fuel, for making craft or industrial objects or for construction purposes, owing to its high resistance to moisture (for use in beams, supports, struts, etc.).

The exploitation of Penduncculate (*Quercus robur* L.) and Portuguese oak (*Quercus faginea* Lam.) woods continued to be relatively constant throughout the time sequence studied, although it clearly declined in the 12th century (Phase 4), while beech wood, another excellent fuel, increased (Zapata and Ruiz-Alonso 2013). At this moment we have to keep in mind the small numbers of studies charcoals (n=45). Beech woods are leafy and have large trees with an almost invisible shrub stratum and a very sparse grass layer and they can become single-species groups. Beech seems to have expanded in the nearby mountains, where in the present day cover significant stretches of land. The oak groves were located in the immediate vicinity of the settlement, which would have made it easier to collect the wood without having to transport it across long distances.

As started above, the usage of beech wood in Gasteiz experienced a continuous period of growth and became the main wood identified from the second half of the 11th century onwards (50% of the analysed fragments). However, its presence in the settlement's immediate surroundings was always very scarce, according to palynological data.

It would appear that increasing human impact on the oak communities in the Gasteiz area would cause a significant decrease in the numbers of oak trees as a consequence of over-exploitation of the wood. However, both the palynological results in the Gasteiz record and other regional palynological sequences suggest that oak groves were a more or less stable feature throughout the Early Middle Ages, and in already highly anthropised landscapes (Pérez-Díaz et al. 2014). Similarly, it may be thought that the expansion of beech forests and the resulting increase in available wood could have promoted a significant increase in its use as fuel. However, the regional palynological sequences do not show that beech forests in the regional area expanded significantly. Explanations for the opposition of oak groves and beech woods seem to be related more to regulated and carefully managed strategies for forest exploitation. We cannot ignore the changes that occurred to cultural preferences and the perception of using fuels and raw materials. In any case, the dominant presence of *Quercus* wood in the oldest samples suggests that groups of trees in the immediate vicinity of the village were exploited, whereas the systematic usage of *Fagus* from the second half of the 11th century indicates that areas a little further away from the village, on the hillsides of nearby mountains, were exploited.

CONCLUSIONS

Multidisciplinary studies, such as this one, demonstrate that appropriate collaboration between different specialists is crucial when approaching historical issues, in general, and in particular, those addressing historical chronology. Moreover, when systematic and exhaustive sampling strategies are implemented their potential for generating historical knowledge is very high.

The plant landscape in the surrounding area of the Gasteiz settlement during the 8th-12th centuries is characterised by intense anthropisation and significant deforestation. The only forests were made up of deciduous trees, such as *Quercus* (probably Pendunculate oak), hazel, birch and riparian vegetation (alder, ash and elm). The low values that were recorded for pine reflect a regional trend, which is the same for beech. The landscape would have been dominated by grasslands, namely open areas shaped by the economic productive activities in which the village inhabitants engaged.

Agricultural practices involving cereals were recorded and were complemented by cultivating legumes and an apparently low contribution of fruit trees. Between the 8th and 11th century, the arable crops were highly diversified (barley, wheat and short-cycle cereals such as foxtail and proso millets), which would reduce the risk of a particular crop failing. In the 12th century a significant change in the agricultural strategy was noted, as seen by an increase in the size of fields and the decline in barley cultivation in favour of wheat. It is possible that cereal-based foods were made in Gasteiz using different blends, taking into account that wheat would have been the most valuable cereal. The other cereals which were identified - barley, rye, foxtail and proso millets - can be used for making bread or be mixed with wheat, but they are generally regarded as less valuable for human food. It is likely that a significant part of the agricultural production, particularly barley and some legumes such as bitter vetch, were intended for use as animal feed. The presence of flax in the earlier periods indicates that it was used as an important source of oil and/or fibre.

Regarding forest usage, the records suggest that the wood available in the area was exploited in a diversified and even opportunist manner from the 8th century until the second half of the 11th century. At that time, the general trend moved towards exploiting almost exclusively oak and beech trees. These results suggest that the use of oak and beech forests was regulated and carefully managed from the 11th century and throughout the 12th century. The charter granted to the village of Gasteiz in 1181 supports this conclusion, as it decries the partially restricted access to the forest, as there were areas from which wood could not be taken to build houses or for use as firewood. Finally, the choice of Rosaceae as fuel in metallurgical activities could be the result of either its good fuel properties or its availability near the settlement.

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TABLE AND FIGURE CAPTIONS

Fig. 1. Geographycal context of the study area. **a**, location of the Basque Country and the Province of Alava, **b**, location of the town of Vitoria-Gasteiz, **c**, aerial view of the old town of Vitoria-Gasteiz, where the excavation area is placed, **d**, image of the archaeological works (Image GPAC).

Fig. 2. Recreations of the evolution of Gasteiz, based on the archaeological record (pictures Dbolit).

Fig.3. Map of the excavation area showing the sampling sites in Gasteiz village. **a,** Stratigraphic plant showing the contexts in which the plant macro-remains were recovered (dark gray), and **b**, stratigraphic column profile, in which the pollen samples were collected (dark gray).

Fig. 4. Palynological diagram of the village of Gasteiz.

Fig. 5. Wood charcoal histogram from general domestic medieval contexts (not linked to metallurgy) from Gasteiz village (n=1493; indet not included).

Fig. 6. Summary of charcoal results from wood coming from contexts where primary reduction of iron ore has been attested (8th and 9th centuries; n=357).

Fig. 7. Summary of anual crops of Gasteiz village.

Table 1. Radiocarbon dates from Gasteiz village calibrated with OxCal 3.10 program using the Intcal09 Curve.

Table 2. Origin of macrorremain samples. * Samples with a representative number of identified wood fragments.

Table 3. Summary of the main features related to palinology, anthracology and carpology of the village of Gasteiz.

Figure1
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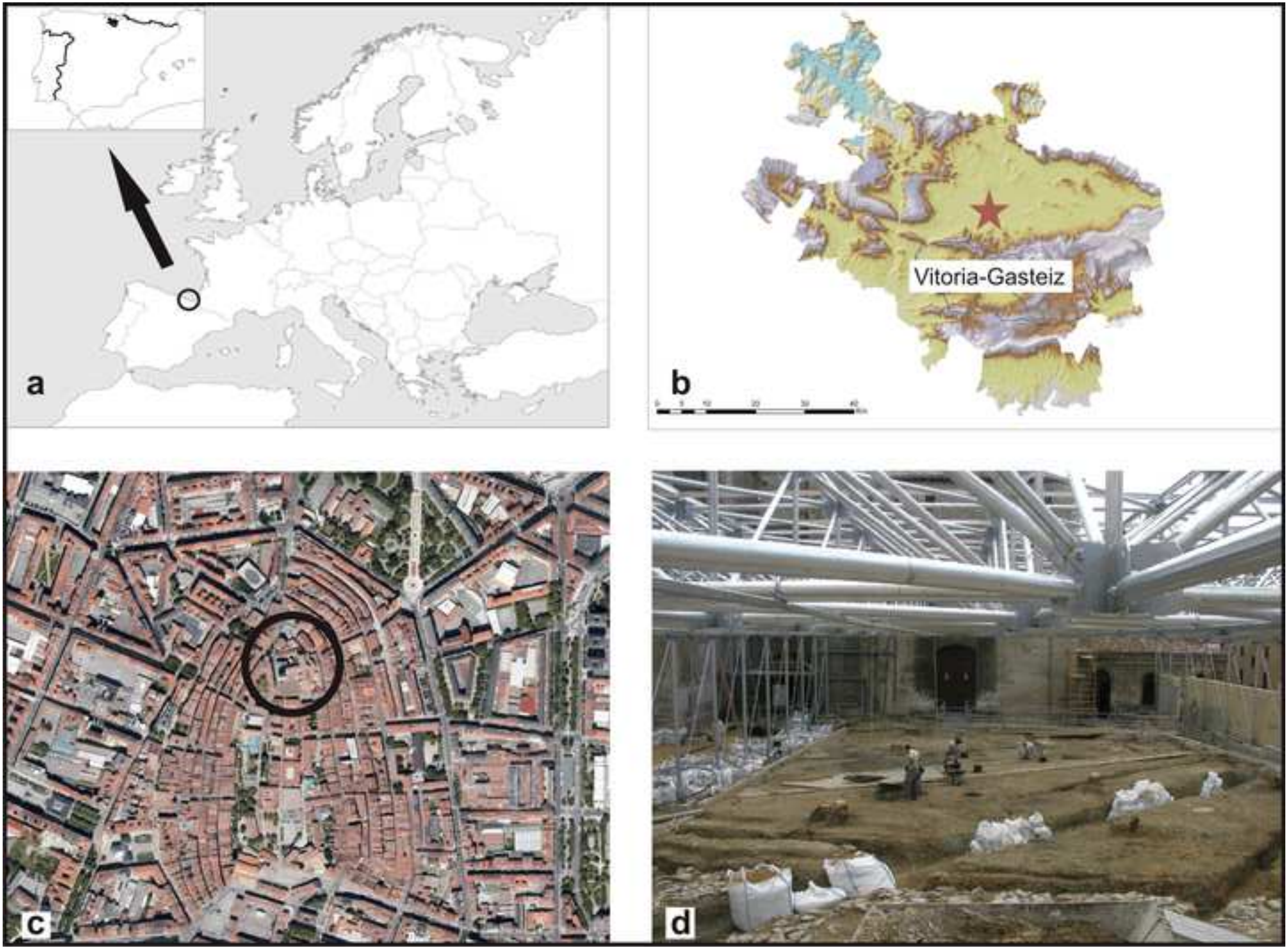

Figure2

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PHASE 1 (8th-first half 10th c. A.D.)

PHASE 2 (second half 10th c. A.D.)

PHASE 3 (11th c. A.D.)

PHASE 4 (12th c. A.D.)

Figure3

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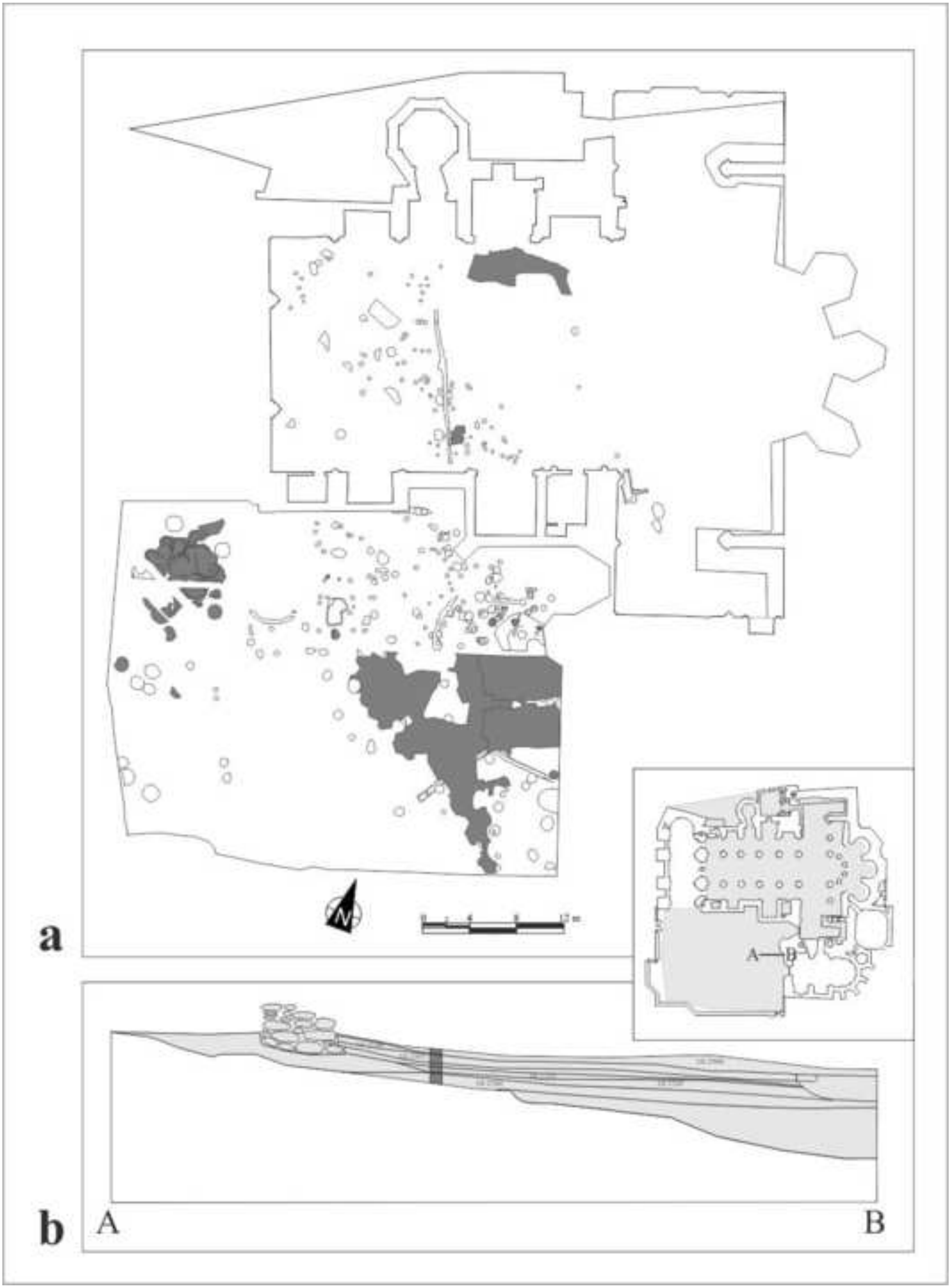

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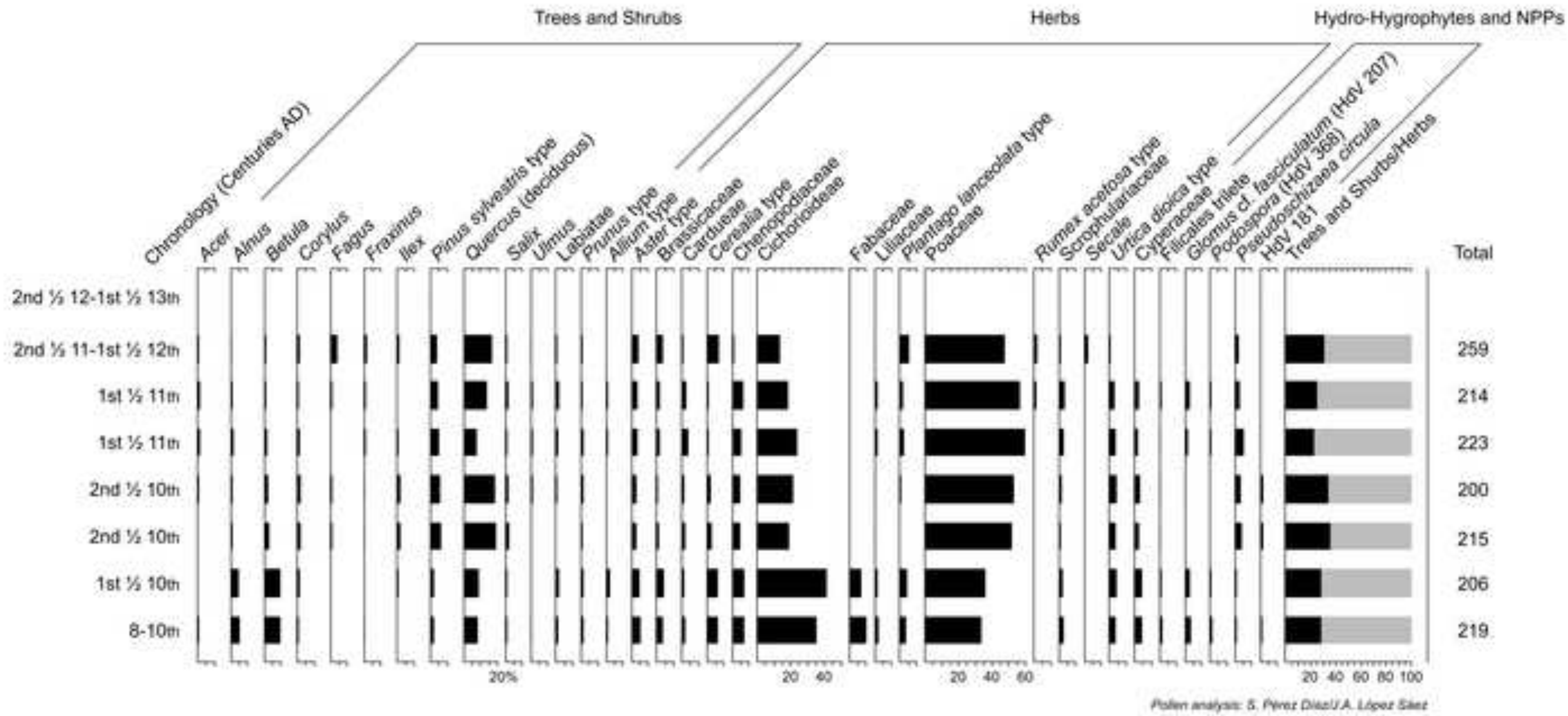

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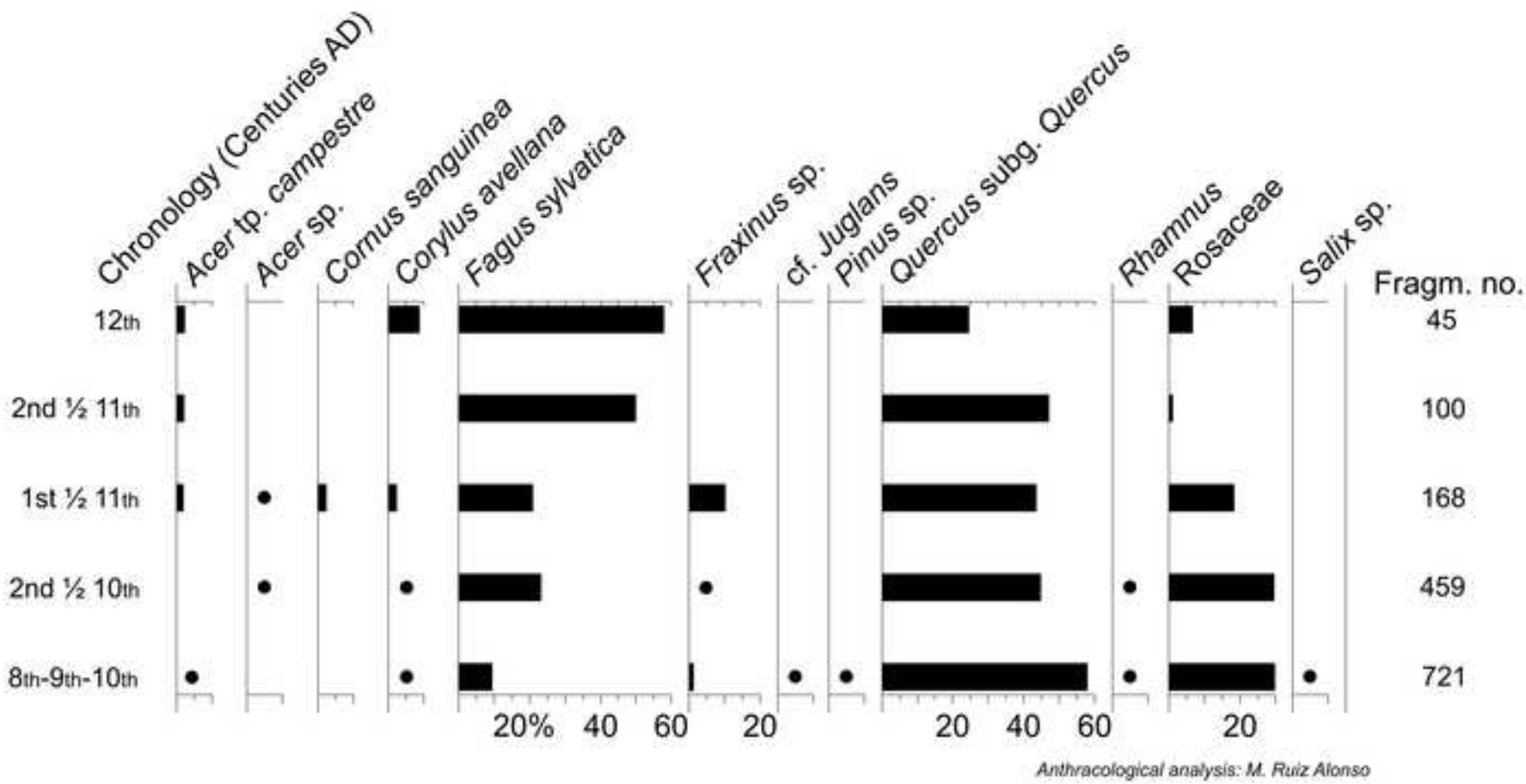

Figure6

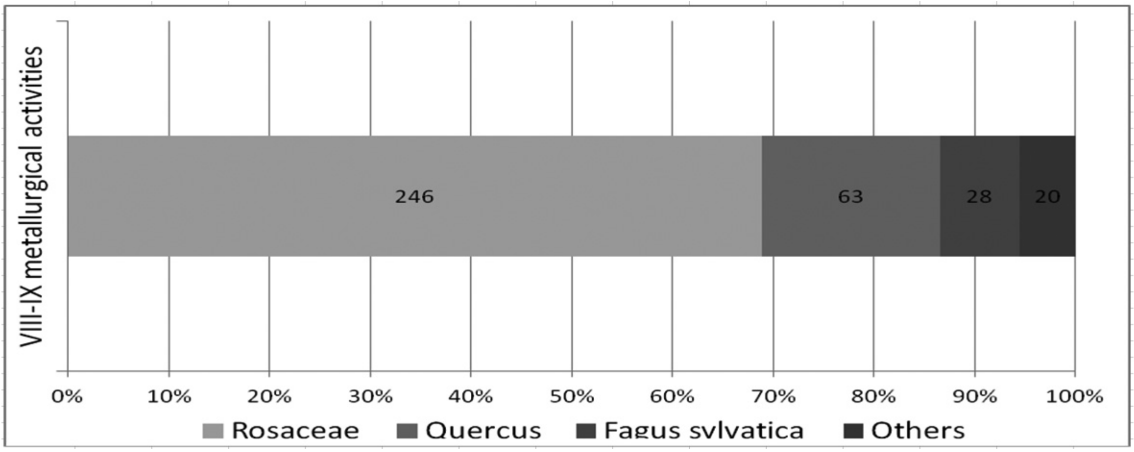
VIII-IX metallurgical activities
246
63
28
20
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Rosaceae
Quercus
Fagus sylvatica
Others

Figure7

Click here to download high resolution image

	S. VIII-1ª 1/2 X	2ª 1/2 X	S. XI	S. XII
Linum usitatissimum	94	2		
Legumes	32	16	14	40
Secale cereale		1	5	149
Panicum/Setaria	143	23	14	478
Hordeum/Triticum		13		
Hordeum vulgare vulgare	140	36	13	232
T. aestivum/durum	126	28	29	775

Carpological analysis: L. Zapata

Table1

Click here to download Table: Table 1.doc

PHASE	AGE	CONTEXT	CODE	RADIOCARBON DATE (age BP)	CALIBRATED DATE (cal AD)
I	8th Century-first half 10th Century	24116	Ua-22281	1200 ± 40	680 - 900 (91,1%) 910 - 950 (4,3%)
		18950	Ua-22995	1190 ± 50	680 - 970 (95,4%)
		18293	Ua-18814	1155 ± 35	770 - 980 (95,4%)
II	2nd half of the 10th Century	18445	CSIC-1731	1093 ± 29	890 - 1020 (95,4%)
		18581	CSIC-1723	1084 ± 36	890 - 1020 (95,4%)
		18549	CSIC-1730	1082 ± 36	890 - 1020 (95,4%)
		27358	CSIC-2119	1076 ± 49	820 - 850 (1,4%) 860 - 1040 (94,0%)
		18587	CSIC-1724	1061 ± 36	890 - 1030 (95,4%)
		23930	CSIC-1903	1002 ± 34	970 - 1060 (67,3%) 1070 - 1160 (28,1%)
III	11th Century	23821	CSIC-1922	971 ± 30	1010 - 1160 (95,4%)
IV	12th Century	23649	Ua-21486	945 ± 40	1010 - 1190 (95,4%)

Table2
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Chronology (Phase)	Level	Type of context	Processed Volume (l.)	Vol. Residue (l.)	Vol. Flot (cc)	Total seeds and fruits	% Analyzed	Total wood	% Analyzed
	27185	Domestic	27	6	110	255	100%	50	*
	27222	Domestic	15	0.8	70	14	100%	50	*
	27370	Domestic	54	7	2	6	100%	29	100%
	18923	Domestic	18	1.4	13	122	100%	-	-
	18911	Domestic	25	2	75	170	100%	50	*
	18913	Domestic	9	0.6	20	53	100%	50	*
	18909	Domestic	5	0.3	20	25	100%	49	*
	18950	Domestic	2.6	0.3	50	24	100%	49	*
	26111	Domestic	14	1.2	50	207	100%	50	*
	26260	Domestic	54	5.2	90	49	100%	49	*
	26123	Domestic	52	6.5	10	91	100%	49	*
	26097	Domestic	54	4	170	54	100%	64	100%
	26113	Domestic	1.7	0.8	1	0	100%	6	100%
	18828	Domestic	1	0.01	2	1	100%	10	100%
	27195	Domestic	54	3.5	70	43	100%	48	*
	26090	Domestic	54	1.5	14	9	100%	50	*
VIIIth-First half Xth C. (Phase 1)	18948	Domestic	2.3	0.3	2	0	100%	18	100%
	27273	Domestic	54	1.9	80	216	100%	50	*
	18654	Domestic	0.5	0.05	5	3	100%	-	-
	24094	Domestic	2.6	0.05	0.5	2	100%	-	-
	24108	Domestic	1.1	0.1	1	2	100%	-	-
	18830	Domestic	1.8	0.05	8	2	100%	-	-
	23956	Domestic	3.2	0.1	6	25	100%	-	-
	24088	Domestic	0.4	0.05	3	1	100%	-	-
	24089	Domestic	9.8	0.6	1	3	100%	-	-
	24092	Domestic	2	0.03	0.2	0	100%	-	-
	24096	Domestic	1	0.05	0.5	1	100%	-	-
	24102	Domestic	6.5	1.4	0.5	4	100%	-	-
	24104	Domestic	7.3	0.6	4	9	100%	-	-
	24106	Domestic	5	1.1	0.2	2	100%	-	-
	24110	Domestic	5.4	0.1	13	13	100%	-	-
	24111	Domestic	7.7	0.8	2	3	100%	-	-
	24116	Metallurgical	81	27.7	4	21	100%	66	100%
	24117	Metallurgical	81	25.1	6	43	100%	43	100%
	24118	Metallurgical	81	23.3	8	33	100%	62	100%
	23953	Metallurgical	9	0.6	275	316	100%	100	*
	24115	Metallurgical	36	4.2	250	161	50%	100	*
	27358	Domestic	54	3.9	220	161	100%	100	*
	27269	Domestic	72	6.9	80	212	100%	100	*
Second half Xth C. (Phase 2)	27270	Domestic	36	6	600	15	100%	100	*
	18594	Domestic	12	0.6	8	21	100%	100	*
	18644	Domestic (Pole)	-	-	3	-	100%	34	100%
	27349	Domestic	54	23	125	149	100%	25	100%
	23866	Domestic	19.6	1.3	68	148	100%	68	100%
XIth C. (Phase 3)	27136	Domestic	54	3	240	195	100%	100	*
	2081	Farming	15	1.2	65	119	100%	100	*
XIIth C. (Phase 4)	27050	Domestic	144	62	100	2639	5%	45	100%

Table3

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Phase	Age (Centuries AD)	Palynology	Anthracology	Carpology
4	12th	Dominance of open areas	Dominance of beech	Wheat as main harvested plant
		Increase of beech and deciduous oak forests.	Significant decrease of oaks	Increase of foxtail millet/proso millet
		Presence of other deciduous trees (maple, hazel,ash, holly, pine, willow and elm)	Reduced presence of Rosaceae, hazel and maple	Barley decrease
		Highest values of Ceralia pollen		Increase of rye
3	11th	Dominance of open areas	Dominance of deciduous oaks	Wheat as main harvested plant
		Presence of deciduous forests (oak, maple, hazel,ash, holly, pine, willow and elm)	Increase of beech (dominant on the second half)	Presence of foxtail millet/proso millet and legumes
		Increase of beech forests.	Significant decrease of Rosaceae	Barley and legumes decrease
		Increased human pressure (agriculture and livestock practices)	Reduced presence of cornel, hazel, maple and ash	Increase of rye
2	Second half 10th	Dominance of open areas. Some reforestationis detected (expansion of oaks and pines)	Dominance of deciduous oaks, but with lower values	Barley is the main harvested plants
		Presence of deciduous trees (maple, hazel, ash,holly, pine, willow and elm)	Great importance of Rosaceae	High presence of wheat
		First appearence of beech.	Increase of beech	Presence of foxtail millet/proso millet and legumes
		Drop in the level of human impact on the landscape(decrease in pollen anthropisation indicators)	Reduced presence of hazel, maple, ash and Rhamnus	Flax decrease. First appearence of rye
1	8th- first half 10th	Dominance of open areas	Dominance of deciduous oaks	Barley and foxtail millet/proso millet are the main harvested plants
		Presence of deciduous forests with oak, maple, birch, hazel, ash, lime and holly	Great importance of Rosaceae	High presence of wheat
		Riparian forest with alder, willows and elms	Low presence of beech	Lower presence of flax and legumes
		Highest human pressure (agriculture and livestock practices)	Reduced presence of hazel, maple, ash, walnut, pine, willow and Rhamnus	