LANDSCAPE AND FIREWOOD AT ESPANTALOBOS MESOLITHIC SITE (HUESCA, SPAIN). FIRST RESULTS.

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Wood charcoal analysis carried out at Espantalobos (Quicena, Huesca) provides key data on the research of past vegetation and woodland exploitation by late Mesolithic groups in the Middle Ebro Valley. Radiocarbon dates place the occupations between 8975-8547 cal BP and 8321-8046 cal BP, the last one related to the well-known 8.2 cal BP event. Its location, outside the mountainous ranges of the Ebro basin where a large network of Mesolithic seasonal rockshelters are known, helps to improve our understanding on the prehistoric occupation of plains. This research provides also palaeoecological information about the natural environmental conditions of a poorly documented bioclimatic belt in which present-day vegetation has been heavily modified by human activity (intensive agriculture practices and deforestation). Anthracological study has focused on the main vegetation changes along the two described archaeological levels and the taxa distribution across their surfaces. A total of 1,711 charcoal remains have been studied: 1120 are scattered fragments (560 from each of the two archaeological layers) and the rest belong to three different hearths. A high taxonomic diversity is observed in the assemblage. Juniper wood is the main taxon used as fuel. Mediterranean trees and shrubs, both xerophytic and thermophilous, are abundantly documented, in contrast with the presence of mesophilous and deciduous taxa, mainly maples, which nevertheless are also well represented. According to wood charcoal analysis, the collection of firewood was carried out following opportunistic strategies, in a regime of recurrent and seasonal short-term visits to a settlement whose surroundings were characterized by an open landscape.

1. INTRODUCTION

Charred wood and seeds from archaeological contexts provide valuable palaeoclimatic and palaeoeconomic data (Antolín et al., 2016; Picornell et al., i.p), especially in a period of environmental and cultural change like the Early Holocene. In the last years, many archaeobotanical studies based on charred plant macroremains performed in western Mediterranean, including Iberian Peninsula, stress this idea (Zapata et al., 2002; Aura et al., 2005; Théry-Parisot et al. (eds.), 2009; Henry et al., 2012; Monteiro et al., i.p.). This paper presents new data concerning plant use at the Mesolithic site of Espantalobos (Quicena, Huesca, in NE Iberia).

The onset of the Holocene was a period marked by climatic instability, with a series of cool and dry episodes (Bond et al., 1997) influencing vegetation dynamics and human populations. The central Pyrenean Ranges and the central Ebro Depression constitute well-documented areas in terms of palaeoecology (Valero-Garcés et al., 2004; González-Sampériz et al., 2006, 2008, 2010; Morellón et al., 2009; Pérez-Sanz et al., 2013; Vegas-Vilarúbia et al., 2013; Gil-Romera et al., 2014; Pérez-Sanz, 2014; i. a.). The Ebro Basin seems to be particularly sensitive to extreme environmental conditions because of its location in a semi-arid Mediterranean climatic region. For some of its areas a clear impact of the 8.2 event (Alley and Agustdottir, 2005; Rolling and Pälike, 2005) has been proposed (González-Sampériz et al., 2009), although in other parts of the Basin its influence is far less evident (Montes et al., 2015b: 142; García-Ruiz et al., 2015)

The Mesolithic (10.5-7.5 cal BP) is a cultural period that has been extensively studied in the Ebro Basin (Alday (ed.), 2006; Utrilla and Montes (eds.), 2009; Soto et al., 2015). The best-known archaeological records show seasonal short-term occupations in rockshelters where recurrent human presences result in a succession of overlapped hearths, many of them already dismantled in prehistoric times. The abundance of charred plant material in these sites has produced many archaeobotanical studies in recent years (Zapata, 1999; Allué, 2002; Badal, 2004, 2013; Zapata and Peña-Chocarro, 2005; Allué et al., 2012, 2013; García-Martínez de Lagrán et al., 2015; Ruiz-Alonso and Zapata, 2015; Alcolea, 2014, 2016a, 2016b, i.p.; Montes et al., 2015b; Utrilla et al., 2016). Although wood charcoals do not accumulate randomly, a synthesis effect of the surroundings vegetation can be recognized as a consequence of the Mesolithic populations fuel collecting activities. These deposits with domestic fuel accumulations, where no specialized uses can be identified, seem to constitute a reliable source for local vegetation reconstruction. They are considered valuable synthetic type deposits with a statistical consistency (Chabal et al., 1999).

In the Ebro Basin, most of the quoted archaeological sites from this period are located in mid-mountain areas (ca. 700 m asl); on the contrary, the prehistoric occupations of the Central Basin are still poorly known due to the almost complete lack of records, dismantled and/or covered by huge-scale erosive processes during Holocene times (Peña et al., 2014). Espantalobos (500 m asl) is located in the boundary between the mid-mountain region of the Pre-Pyrenean foothills and the plains of the Central Basin. There, nine samples for palynological analysis taken during the 2013 field season were sterile –a common situation in similar archaeological sequences- (Montes el al., 2015a), being anthracology the only information source about the vegetation of its surroundings. The aim of this paper is the reconstruction of the vegetal landscape and the woodland exploitation practices carried out in this Mesolithic site.

2. REGIONAL SETTING

2.1. Geographical context and local present-day vegetation.

The Ebro Valley is located in northeastern Spain (Figure 1). It is a huge territory (80,000 sq km) surrounded by three high mountain ranges: the Pyrenees to the north, the Iberian Ranges to the south, and the Catalan Coastal Ranges to the east. Its central depression has an average elevation of 200 m asl and constitutes a large semiarid plain crossed by one of the largest rivers in the Iberian Peninsula, the Ebro, that flows to the Mediterranean Sea. From North to South and West to East, the Basin is characterized by a juxtaposition of very different environments, from the cold and wet Pyrenean peaks to the hot and dry plains of the lowlands. This high variability of ecosystems (from Euro-Siberian to Mediterranean) is the result of strong topographic, climatic, and geographic gradients, which interact on a mosaic of different lithological units (mainly composed of sandstone, limestone, marl, and gypsum). The current vegetation cover is also conditioned by this variability (Blanco et al., 1997; Pérez-Bujarrabal, 2009).

The site of Espantalobos profited a nowadays-dismantled sandstone rockshelter that opens on the margins of a small modern ravine (Figure 2), not far from the town of

Huesca (500 m asl.). Present-day climate can be defined as Mediterranean continental, characterized by cold and dry winters, very hot summers, low and irregular rainfalls and high insolation and evapotranspiration. Current vegetation is dominated by patches of thermophilous holm oak woodland (*Quercus ilex* spp. *rotundifolia*), but the natural cover has been heavily modified by human activities, namely intensive agriculture practices and deforestation. The lowlands are dominated by agricultural fields and steppes, while vegetation covers less than 50% of this territory; the aforementioned holm oak appears next to other species such as Aleppo pine (*Pinus halepensis*), Kermes oak (*Quercus coccifera*) and Spanish juniper (*Juniperus thurifera*), ocasionally accompanied by Corsican juniper (*Juniperus phoenicea*) and Cade (*Juniperus oxycedrus*), as well as shrub formations with species such as mastic (*Pistacia lentiscus*), wild olive (*Olea europaea* var. *sylvestris*) and rosemary (*Rosmarinus officinalis*) (Braun-Blanquet and Bolòs, 1987).

2.2. Archaeological background and site description.

The Mesolithic in the Ebro Valley is a well-documented period that spans from the second half of the 11th to the first half of the 8th millennia cal BP. This is the last stage of the Palaeolithic-tradition economy based on hunting and gathering. A large network of rockshelters has been documented, most of them seasonally occupied by human groups that focused in the gathering of varied resources (animals, plants, lithic raw materials…) where overlapped hearths are frequent (Alday, 2006; 2009; Montes el al., 2006; Utrilla et al., 2009). Most of them are located in middle mountain environments, where they profit rocky outcrops as rockshelters. The fertile central plains of the Ebro Basin should have been frequented by those prehistoric groups, but up to the discovery of Espantalobos, which in any case is located in the margins of that plains, we barely knew the open-air site of Cabezo de la Cruz (Rodanés and Picazo, 2013). Our site contributes to fill this gap and helps to improve our knowledge on the prehistoric occupation of lowlands in the central Ebro Basin (Montes et al., 2015a).

From top (the current surface) to the bottom (Eocene marls and clays from level f), the Espantalobos archaeological deposit comprises only three sandy-silt layers, the central one (level d) being sterile. The two anthropic layers (c – e) have been dated by two radiocarbon dates (Figure 2) (Table 1). The oldest occupation, level e (8975-8547 cal BP), can be ascribed to the transition from the Denticulate to the Geometric Mesolithic.

Level c contains the most recent occupation, which belongs to an ancient moment of the Geometric Mesolithic (Trapeze Phase) and was radiocarbon dated in 8321-8046 cal BP.

Lithic industry, a laminar ensemble composed mainly by elongated trapezes and microburins, is scarce in both units. In the expectancy of a forthcoming functional analysis, we propose that the frequent presence of non-siliceous denticulate pieces, choppers and rabots implies that diverse activities (such as the work on wood and vegetables) took place at the site. Due to the variety of lithic tools and to the scarcity of faunal remains, an exclusive characterization of the site as hunting camp is discarded: a poor sample of animal bones, many of them cremated on purpose, reveals the hunting of scarce ungulates, mainly ibex and red deer (*Capra pyrenaica* and *Cervus elaphus*). As usual in many similar sites, rabbit (*Oryctolagus cuniculus*) dominate the faunal ensemble. Both levels show some identifiable hearths and combustion areas (three of them exceptionally conserved) and a high density of charred wood remains. (Montes et al., 2015a). Two of the hearths belong to level c (squares 20C and 14D), while the third, the best-preserved one, was found in level e (square 22D) (Figure 3).

3. METHODS AND MATERIALS.

This paper concerns the wood charcoal remains recovered at Espantalobos during the 2013 and 2014 field seasons; there, systematic sampling strategies have been applied and all the sediment has been processed in order to ensure an optimal collection of plant macroremains. Up to day a surface of 25 m^2 has been affected by the archaeological works, although given the topography of the shelter, the two occupational levels have not appeared all over the area excavated until 2014. The 1 meter-side squares were subdivided into smaller units (33x33x5 cm), excavated independently: the scattered charcoals from each of these units were recovered in individual containers. These scattered charcoal and the concentrated samples from particular burning structures were collected and processed separately. Especially large charcoal fragments were manually recovered and coordinated during the fieldwork. In addition, the sediment from each minimum unit was processed by manual flotation and sieving in the field using 2 mm meshes sizes, with the exception of the concentrated charcoal related to the combustion structures, which was individualized in the laboratory.

According to several authors (Chabal, 1990; 1992; Badal and Heinz, 1991; Badal, 1992) scattered charcoal is the final result of the disassembling / cleaning of consecutive combustion events and, as a whole, is a good indicator of the surrounding vegetation. However, charcoal remains that appear inside well-preserved combustion structures represent their last use, that is, a moment of temporary or definitive abandonment of the site, and their palaeoecological significance is different. As mentioned, both archaeological levels comprised well-conserved hearths, dismantled structures and a high density of scattered charred wood remains. The hearths distribution across the site could be interpreted as a sign of recurrent visits along time. Some of them would have been simple circular structures, currently ill-conserved, bounded by clasts of sandstone or pebbles of limestone that were brought purposely to the site, from adjacent plateaus like the *Saso de Montearagón* or from the neighboring Flumen riverbed. Sometimes, burnt sediment, wood charcoals and ashes fill shallow hearth-pits, being the only evidence of the ancient existence of partially dismantled hearths or perhaps simple combustion structures. Three of them (14C and 20C in level c and 22D in level e) contained a noteworthy number of wood charcoals and are worthy a singular treatment in this work.

The wood charcoal analysis follows the standardized anthracological methodology (Chabal et al., 1999). Each fragment was manually broken and the anatomical patterns of each wood species were observed along three sections (transverse, tangential, and radial). We have used a metallographic microscope that spans from 40X to 600X magnifications. Botanical identification was possible by referencing wood anatomy atlases for both non-charred (Schweingruber, 1990; García Esteban et al., 2003) and charred wood (Vernet et al., 2001), as well as a reference experimental collection of carbonized woods. Photography and detailed observation of anatomical elements were carried out using Scanning Electron Microscopy (SEM). The nomenclature employed was that of Flora Europaea (Tutin et al., 1980).

4. RESULTS

This paper analyses a sample of 1,120 scattered wood charcoal fragments (560 from each level) and the whole ensemble from the three aforementioned combustion structures: 57 from hearth 14D and 132 from hearth 20C, both in level c, and 402 from hearth 22D in level e. In summary, 1,711 charcoal fragments have been processed and classified (Table 2).

4.1. Scattered charcoal

The 1,120 scattered wood charcoal fragments recovered in the two archaeological layers (Table 2) allow the identification of a total of 14 different taxa (Figure 4 shows anatomical features of selected taxa): in level c we have recognized 11 different taxa, while in level e the variety of taxa reaches 12. Their distribution can be seen in the anthracological diagram (Figure 5).

- Conifers are the most important component in the disseminated assemblage of Espantalobos. Junipers (*Juniperus* sp.) are the best-represented taxon at both levels (44% in level e, and 36% in level c). Different species of this genus cannot be distinguished from each other based on wood anatomy (Schweingruber, 1990). Currently, the most common species in the central Ebro basin are Corsican juniper (*Juniperus phoenicea*) and Spanish juniper (*Juniperus thurifera*) and Cade (*Juniperus oxycedrus*). Junipers are a heliophilous and xerophilous genre. It grows in forest boundaries or forms secondary colonizing formations where climate and soil conditions do not allow the development of other plants.
- The presence of Aleppo pine (*Pinus halepensis*) is relevant in both levels, although in different proportions: while it remains in the 16% in the oldest, it reaches similar values to junipers (36%) in the most recent one. Aleppo pine is a thermophilous and xerophilous taxon that currently grows widely in central Ebro Basin. The presence of cold and mountainous pines (*Pinus* type *sylvestris*) is only attested by 2 fragments identified in the earliest level and cannot offer any paleoecological inferences.
- Broadleaved elements are also well represented in the dispersed assemblage. Maples (*Acer* sp.) are the most abundant, with almost a 24% in the oldest level, well above the Aleppo pines. *Prunus* sp. is represented in both levels although with very low percentages (<1%). Riparian vegetation, represented by Ash (*Fraxinus* sp.) in level c and Poplar/Willow (*Populus/Salix*) in level e, is very scarce (<1%) and do not appear at all in the hearths ensembles.
- Evergreen oak (Evergreen *Quercus*), that constitutes the main element in current formations according to the bioclimatic belt, is represented only by 2 fragments in the assemblage of the most recent level.
- Other identified taxa among the charred dispersed wood are Mediterranean trees and shrubs such as box (*Buxus sempervirens*), mastic/terebinth (*Pistacia* sp.),

mock privet/buckthorn (*Phillyrea/Rhamnus*), rosemary (*Rosmarinus officinalis*), Fabaceae, and Monocotiledoneae in the family rank.

4.2. Concentrated wood charcoal.

The contents of the three hearths were analysed individually (Figure 6), being the amount of wood charcoal contained in each one variable: 402 fragments in hearth 22D (level e), 57 in hearth 14D and 132 in hearth 20C (level c). The taxonomic richness of the three structures is lower than in the scattered assemblage. Among 591 fragments only 8 taxa have been identified. In all cases *Juniperus* sp. is the dominant taxon: in hearths 20C (level c) and 22D (level e) junipers exceed 90% of the fragments. In the hearth 14D (level c), the variety of documented taxa is greater, with a significant presence of maples (*Acer* sp.).

5. DISCUSSION

5.1 Wood charcoal assemblage formation.

As mentioned, scattered charcoal appearing dispersed in the sediment of archaeological sites is considered the result of consecutive combustion events that through cleaning and conditioning of the space eventually integrated into the archaeological sediments. Taxonomic richness of scattered charcoal is due to the accumulation of successive combustion events (Chabal, 1997). In general terms, the distribution of woody taxa along the surface of the archaeological deposits is not uniform. Spatial analysis of woody taxa distribution at Espantalobos allows discussing this issue. Regardless of the studied level, the most frequent taxa (junipers, Aleppo pines and, to a lesser extent, maples) are found in all -or almost all- sampled squares (Figure 7), although in very different percentages. On the contrary, infrequent taxa (box, mastic/terebinth, buck privet/buckthorn, rosemary…) barely appear in one or few squares. Although the fieldworks are still unfinished and new areas will be added to this panorama, the results here presented must be seen as archaeologically significant if we consider the exhaustive methodology applied.

In this sense, it should be noted that, at the first stages of the scrutinizing, percentages of infrequent species remain quite stable while the values of the frequent species are very variable. At Espantalobos frequencies stabilize when reaching 450 fragments (Figure 8). This number of studied fragments guarantees that future variations should be minimal

(≤ 3%): the analysis of a large amount of wood charcoal samples, like the one described here, ensures accurate and representative conclusions.

Hearths are a possible distortion factor in this dispersion scheme. The residues of the last hearths appear less affected by natural post-depositional processes or later human activities such as trampling, reworking, sweeping or cleaning (Théry-Parisot et al., 2010), preventing their mixture with the residues of precedent combustions. The presence of overlapped hearths is interpreted like the consequence of recurrent and short visits by prehistoric groups (Montes et al., 2015 a and b) that once and again reconditioned the living space and, thus, influenced the wood charcoal assemblage formation processes. Three of these are well-preserved hearths and have been studied in this work. Their good conservation can be explained in different terms: in level e, the combustion structure appears directly under a big sandstone block that helped to its conservation; in level c, the two hearths could be somewhat contemporary, because they are more than three meters apart and their depths are very similar (less than 10 cm of difference). In this last case, perhaps a more prolonged time lap between visits allowed these structures to be naturally covered by sediments and made unnecessary their cleaning and dismantling when the group settled at the site some time later.

But we cannot exclude the existence of other hearths or combustion structures that could have been dismantled and, as a consequence, not preserved. The frequent apparition of partially burnt sandstone clasts and limestone cobbles all over the stratigraphy, which might have bounded those structures, as well as the rubefacted surfaces of some areas of the sandstone rockshelter blocks, points to this possibility. In the three preserved hearths, junipers are the dominant taxon with percentages between 64% and 96%. According to the spatial distribution of frequent taxa (Figure 9) in the scattered assemblage, junipers have also a greater representation around those hearths: partial cleanings of these structures cause a distorted image of their immediate surroundings as areas where less mixture occurs, when it is a mere overrepresentation of burnt remains from them.

5.2. Vegetation dynamics.

Archaeobotanical data from Espantalobos reveals an open landscape. In both phases the charcoal assemblage is dominated by colonizing and heliophilous elements, such as Aleppo pines (*Pinus halepensis*), maples (*Acer* sp.) junipers (*Juniperus* sp.), and other

Mediterranean shrubs. Conifers have traditionally played a significant role in the characterization of the open vegetation that defines the early phase of colonization in the Holocene, in accordance with the palaeoecological information available for the Mediterranean area (Vegas-Vilarrúbia et al., 2013; Aranbarri et al., 2014). The trend towards the establishment of Mediterranean conditions is documented in regional Early Holocene palaeoenvironmental sequences (Montes et al., 2015b and references therein). At the central Ebro depression the saline lake pollen records show a semiarid vegetation cover, similar to current formations where *Pinus* is the main arboreal component, followed by *Juniperus* and evergreen *Quercus* (González-Sampériz et al., 2008). These Mediterranean elements, also registered at Espantalobos wood charcoal record, are characterized by high resistance to aridity, which is a major limiting factor in this regional vegetation.

The presence of Mediterranean taxa accompanying Aleppo pine suggests a low rainfall regime in the central Ebro basin. Concerning other archaeological records from Iberia, Aleppo pine is present in low percentages in southern and eastern coastal and inland sites (also with similar Mediterranean climatic regimes). In Falguera (8385-8299 cal BP) (Alcoy, Alicante) it barely reaches a 5%, while the assemblage is dominated by oak, holm oak and ash (Carrión, 2002; García-Puchol et al., 2006). At Espantalobos values even exceed 30% in level c (8321-8046 cal BP). Similar values have been documented in the anthracological record of La Cativera (8951-8718 cal BP) (El Catllar, Tarragona) (Allué, 2002). In both wood charcoal assemblages, as in Cabezo de la Cruz (8095-7826 cal BP) (La Muela, Zaragoza) (Badal, 2013) or Los Baños (8873-8545 cal BP) (Ariño, Teruel) (Badal, 2004) the most moisture-demanding plants are barely represented. Contemporary anthracological sequences in PrePyrenaean mountainous areas (500-800 m a.s.l.) reflect different plant formations clearly dominated by cold pines (*Pinus* type *sylvestris*), with values close to 90%; the presence of oaks is consequently minimal (Zapata, 1999; Allué, 2002; Zapata and Peña-Chocarro, 2005; Alcolea, 2014, 2016a, 2016b, i.p.; Montes et al., 2015b; Ruiz-Alonso and Zapata; 2015; Utrilla et al., 2016).

During the Holocene Climatic Optimum, Pyrenaean and Pre-Pyrenaean pollen sequences show the warmest and moistest conditions of the whole phase, which allows an expansion of woody and mesophilous taxa (*Betula*, *Corylus* and *Quercus*) in a landscape until then strongly conditioned by seasonality and aridity (Pérez-Sanz et al., 2013; Montes et al., 2015b and references therein). Sedimentology records show an increase of river flow associated with the deglaciation of the Pyrenees. Greater precipitations and water level rise caused large spread of deciduous taxa (Morellón et al., 2009), which in the lowlands could be related to riparian formations, favored by the abovementioned greater river flows and growing winter temperatures in mid-mountain areas (Pérez Sanz, 2014). The abundant presence of maples in Espantalobos wood charcoal assemblage, accompanied by other riparian elements, can be explained by its location not far from the Flumen River. Also, the supposedly ancient presence of a currently active water spring related to the *Saso de Montearagón* phreatic level in the neighborhood of the site couldn't be discarded.

Although Pre-Pyreneaen foothills are still a poorly documented area, a relevant shift in the vegetation landscape composition is reflected in Estanya pollen sequence after 8.2 cal BP, with a large spread of the semi-deciduous and evergreen *Quercus* replacing broad-leaf taxa (mainly *Corylus*), suggesting a relevant increase in winter temperatures (Pérez-Sanz, 2014). The most recent occupation level of Espantalobos coincides with the well-known 8.2 cal BP event (Montes et al., 2015a), which seems to have had a great impact in human occupation patterns in certain areas of the Ebro basin (González-Sampériz et al., 2006; 2009; López de Pablo and Jochim, 2010), but not in others such as the Pyrenean Ranges (Pérez-Sanz et al., 2013; Montes et al., 2015b; García-Martínez de Lagrán et al., 2015). At a first glimpse, the changes in the vegetation cover shown by the Espantalobos anthracological diagram, with the decrease in broadleaved elements, could be related to the first signs of aridity, a situation that did not had an immediate impact in the human occupation of our site. Both levels seem to be quite similar in terms of documented species. This first survey suggests that cold taxa such as *Pinus* type *sylvestris* disappear in level c while warm taxa such as evergreen *Quercus* appear, but we have to bear in mind that their actual figures are minimal. A future increase in the sampling will confirm or discard this preliminary idea. Without disdaining broad-scale climatic impacts, growing Aleppo pine (*Pinus halepensis*) frequencies in level c might be due to a local expansion of pine leading to a more forested ground cover. In any case, we must recall that those differences could be provoked by particular firewood gathering strategies related to short-term occupations and/or taphonomic factors linked to wood charcoal assemblage formation and conservation processes.

5.3. Firewood gathering and uses.

Besides palaeoenvironmental information, the aim of this work is to understand how firewood was gathered and used. The three combustion structures show a clear dominance of junipers, with percentages of 64%, 94% and 96% (Table 2 and Figure 6). Usually, charcoal assemblages in individualized combustion structures are taxonomically poor or monospecific, due to the punctual character of these accumulations, which reflects a last and unique collection of firewood. However, it is interesting to point out the recurrent choice of the same taxon in the three structures. This recurrent collection of junipers was probably related to two main factors: first, their abundance in the surrounding vegetal landscape of the campsite and, second, their frequent production of dry branches. Short-term visits did not allow gathering green wood and waiting for them to get dry in order to obtain proper firewood, so the prehistoric groups had to choose already dead branches to light their fires.

Aleppo pine and maples were also frequently used: their charred macrorremains, currently scattered, would have composed other combustion structures not preserved in the archaeological record. Pollen sequences from the central Ebro depression (Valero-Garcés et al., 2004; González-Sampériz et al., 2008) and the Pre-Pyrenean Ranges (Morellón et al., 2009; Vegas-Vilarrubia et al., 2013; Pérez-Sanz, 2014) show the same Mediterranean trees and shrubs profited in Espantalobos: juniper, pine, rosemary… As commented, river moisture favors the presence of riparian vegetation (maples) in the neighborhood of the archaeological site, as the current vegetation also reflects. Data from Espantalobos do not allow suggesting a specialized use of wood related to specific activities or combustion structures like hide or meat smoking (Alday, 2005: 590).

At Espantalobos, the almost complete absence of evergreen oaks (Evergreen *Quercus*), documented by only two fragments in level c, is very remarkable. Evergreen oak constitutes the dominant present-day vegetation in its bioclimatic belt (Braun-Blanquet and Bolòs, 1987) and is common in natural pollen records from the IX millennium cal BP in the Ebro Basin (González-Sampériz et al., 2008; Pérez-Sanz, 2014). Nevertheless, it always shows a punctual presence in Mesolithic wood charcoal records from this region (Zapata and Peña-Chocarro, 2005; Badal, 2004, 2013; García-Martínez de Lagrán et al., 2015; Alcolea, i.p.), in contrast with its greater occurrence in other Mediterranean areas of Iberia (Allué, 2002; Carrión, 2002; García-Puchol et al., 2006; Uzquiano et al., 2015; Berihuete et al., i.p.). It seems that although those species were available for exploitation, the human populations of Espantalobos only sporadically used them as fuel: more common species in the neighborhood of the site, such as conifers and maples, were preferentially exploited. We cannot discard that, as suggested before, prehistoric groups preferred these last for their greater production of dry firewood, more suited to an immediate consumption during short-term occupations. Prehistoric firewood gathering seems to answer to a taxonomic choice, collecting specific taxa instead of exploiting a broader spectrum from their environment (Henry et al., 2009; Allué et al., 2013; Monteiro et al., i.p.). We can conclude that in the Ebro Basin evergreen *Quercus* was not very abundant before the Neolithic and that, in any case, Mesolithic human groups were not particularly fond of it.

6. CONCLUSIONS

Systematic recovery techniques and sampling strategies have allowed the recovery of a large amount of charcoal remains at Espantalobos Mesolithic site. Charcoal analysis has helped us to reconstruct its surrounding vegetation and has provided valuable palaeoecological information, specially in the context of a bioclimatic belt where data are still scarce. But we cannot forget that archaeobotanical deposits are conditioned by human tasks, so they also report the economic activities of the prehistoric groups that produced them.

Despite its Holocene chronology, Espantalobos charcoal analysis reveals a poorly forested open landscape dominated by conifers and pioneer species, supposedly more frequent in Lateglacial forests. The relative importance of mesophytes in this record, mainly maples, is probably related to its location near to a watercourse. The noteworthy presence of xerophytes confirms that arid conditions had already established in this region, as revealed by other palaeoclimatic records.

Juniper wood constitutes the main fuel at Espantalobos, a fact that might be related to its abundant presence in the immediate area and its suitability for their needs. Espantalobos inhabitants also consumed abundantly Aleppo pine and maples. The diversity of taxa documented in the record suggests that prehistoric groups developed local opportunistic firewood collection strategies, in a regime of recurrent and seasonal occupations. The character of our site, as it happens in most Mesolithic settlements, suggests that human impact in the environment was scarce.

In any case, further anthracological analyses are needed to complement the present results, in order to better understand the formation processes of the charcoal record in the site and to reveal the firewood gathering and use strategies of the Mesolithic groups.

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FUGURE CAPTIONS

Table 1. Radiocarbon (AMS) absolute and calibrated dates (IntCal13; OXCAL v4.2.4) obtained for Espantalobos (Montes et al., 2015a).

Table 2. Absolute and relative frequencies of identified taxa in the anthracological study. Percentages of hearth 14D are included only in order to offer homogeneous data.

Figure 1. Location map, a) The site of Espantalobos and its surroundings (image: F. Navajas), b) The location of Espantalobos and other contemporary sites with anthracological studies.

Figure 2. Topography and aerial view of the site and the ravine of Espantalobos (in grey, excavated surface). Top left, a site profile after the 2013 fieldworks (the black line marks its location).

Figure 3. Hearth 22D during the fieldwork: note the rubefacted basis of the block that covered it.

Figure 4. SEM images of selected identified taxa: A) *Pinus halepensis*. Transverse section, B) *Pinus halepensis*. Tangencial section, C) *Acer* sp. Transverse section, D)

Acer sp. Radial section, E) *Buxus sempervirens*. Transverse section, F) *Buxus sempervirens*. Tangential section.

Figure 5. Anthracological diagram of the scattered charcoals from Espantalobos (Quicena, Huesca).

Figure 6. Circle diagrams showing relative frequencies of identified taxa in studied hearths. Percentages of hearth 14D are included only in order to offer homogeneous data.

Figure 7. Spatial record of scattered wood charcoals in the archaeological levels. Histograms shows frequency with intervals of confidence.

Figure 8. Diagram showing relation between the progression in the number of analysed fragments and the obtained frequencies from representative taxa documented in Espantalobos wood charcoal record.

Figure 9. Spatial distribution maps of main woody taxa. The scale bar gives the percentage of concentration of the taxon from 0% to 100%. H symbol shows the location of the hearths.

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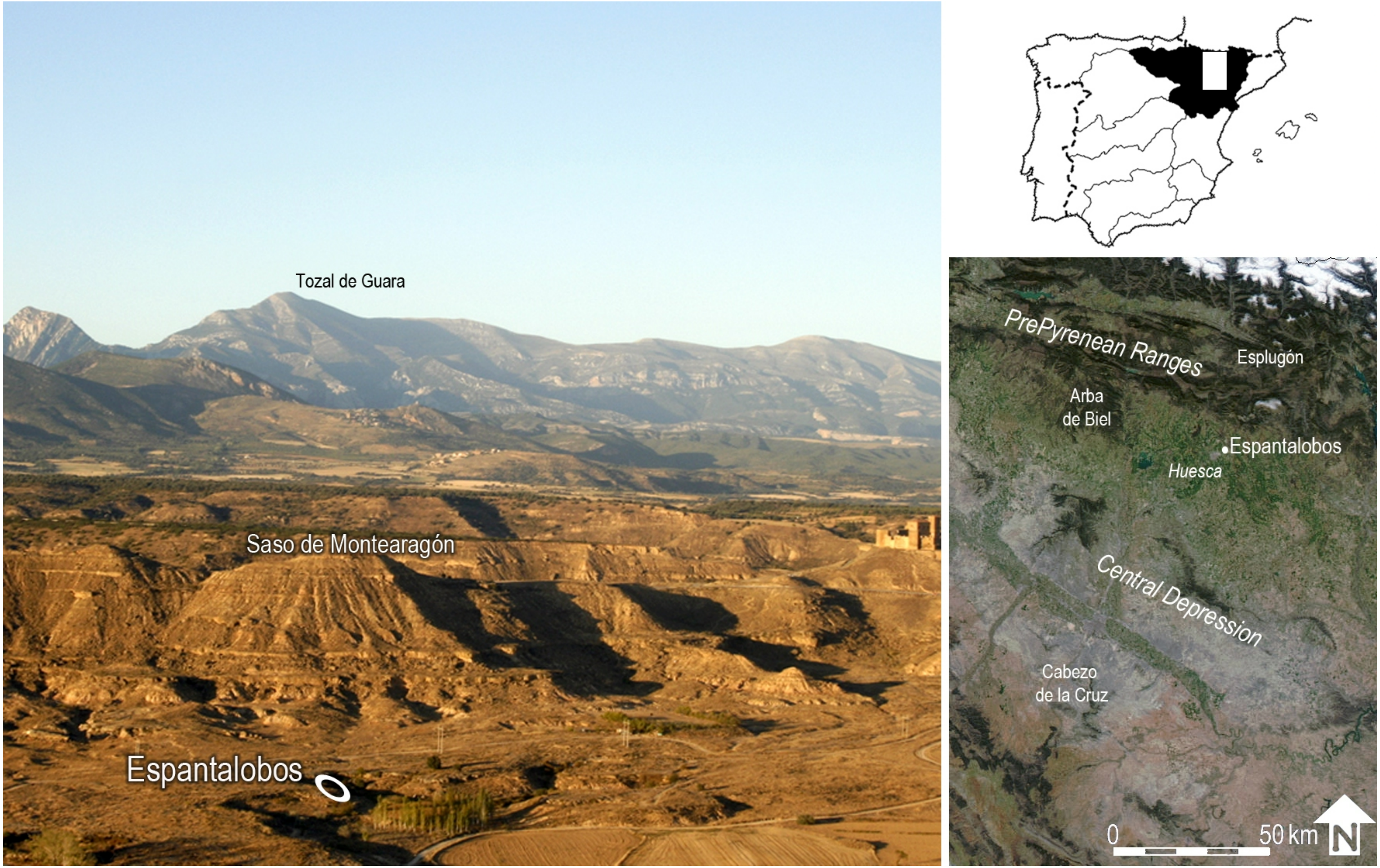

Tozal de Guara
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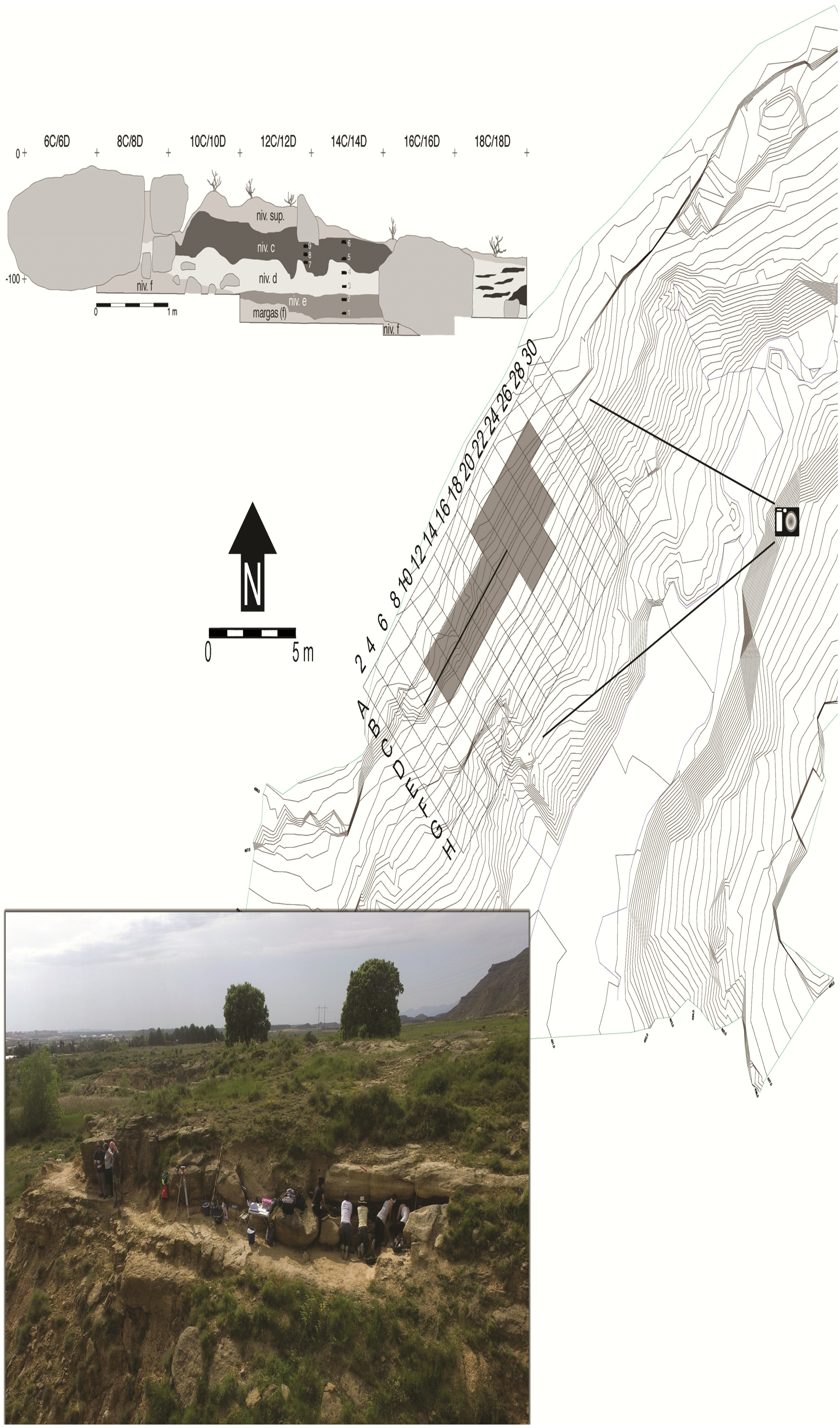
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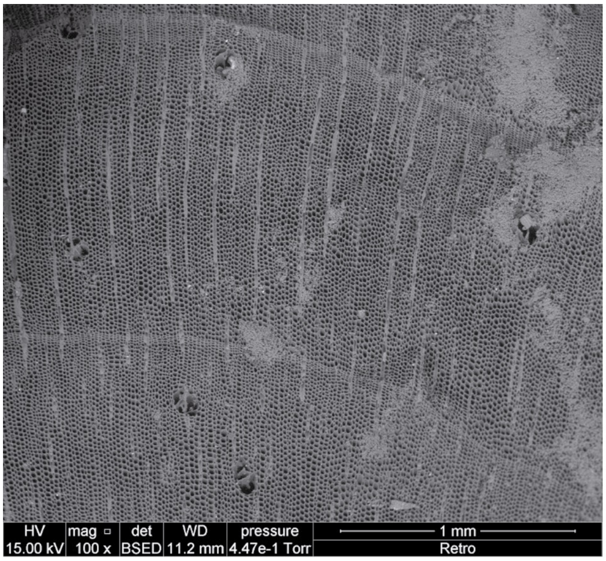
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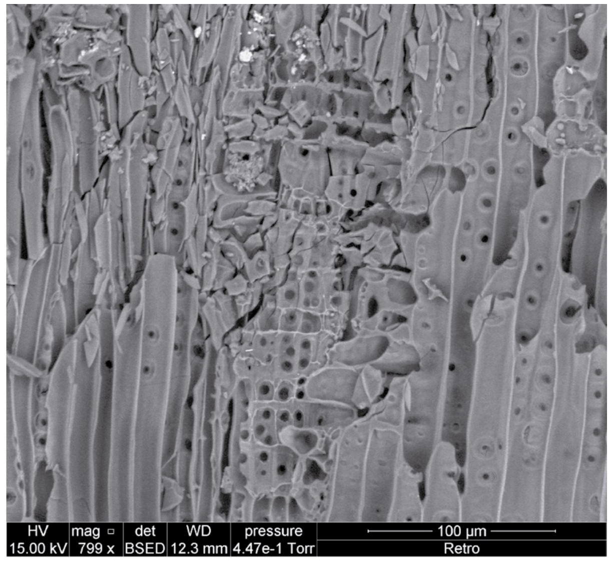
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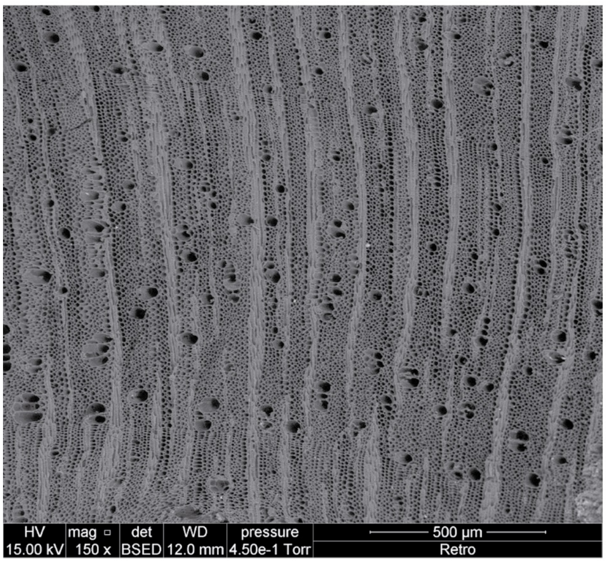
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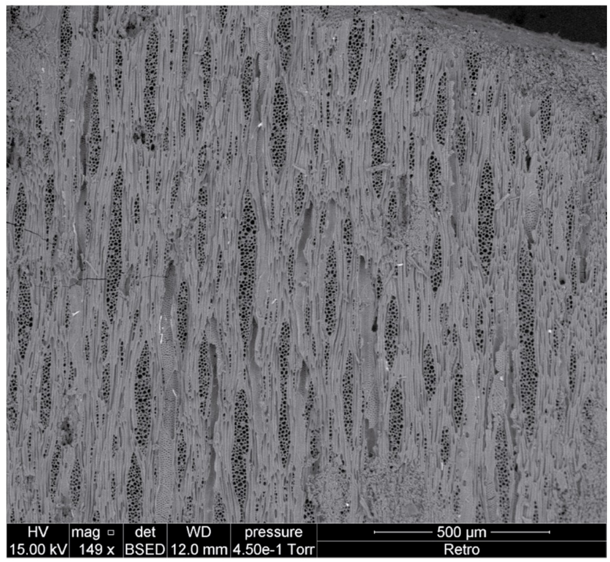
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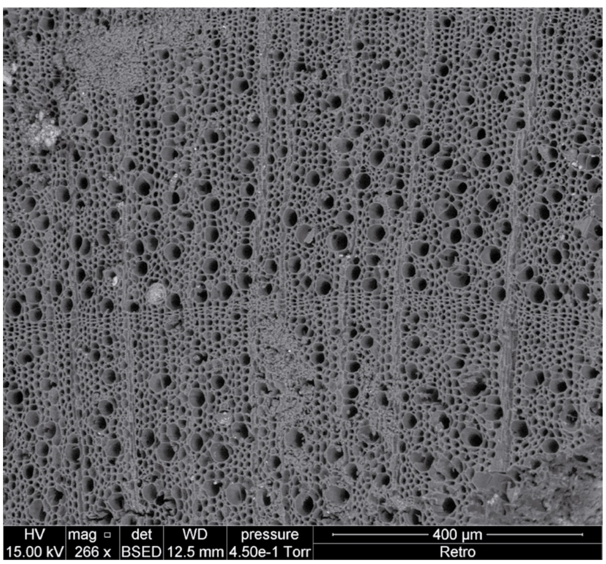
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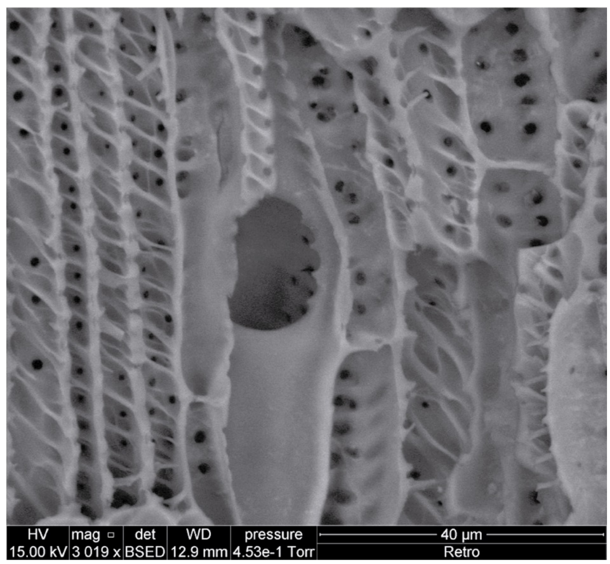
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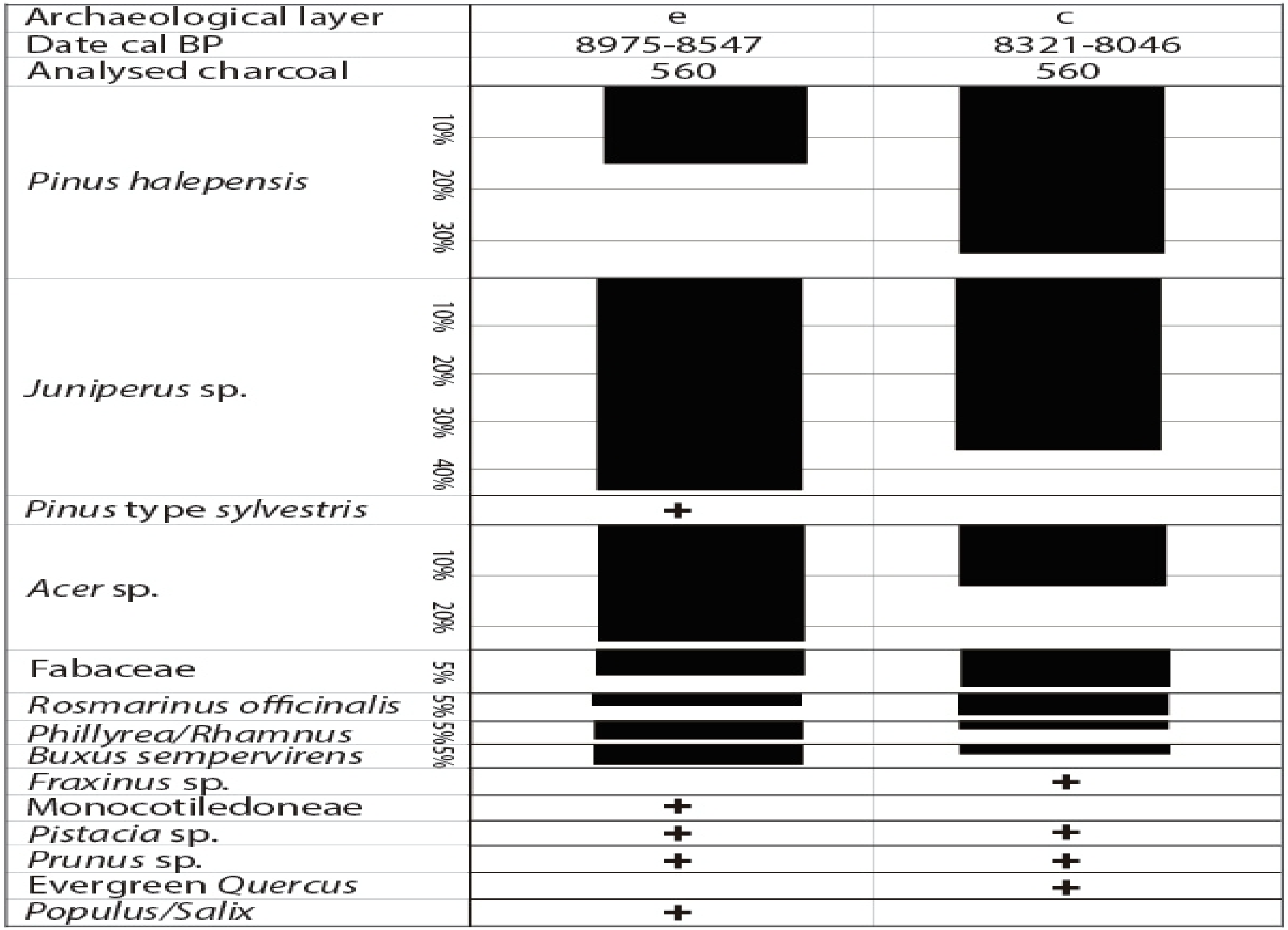
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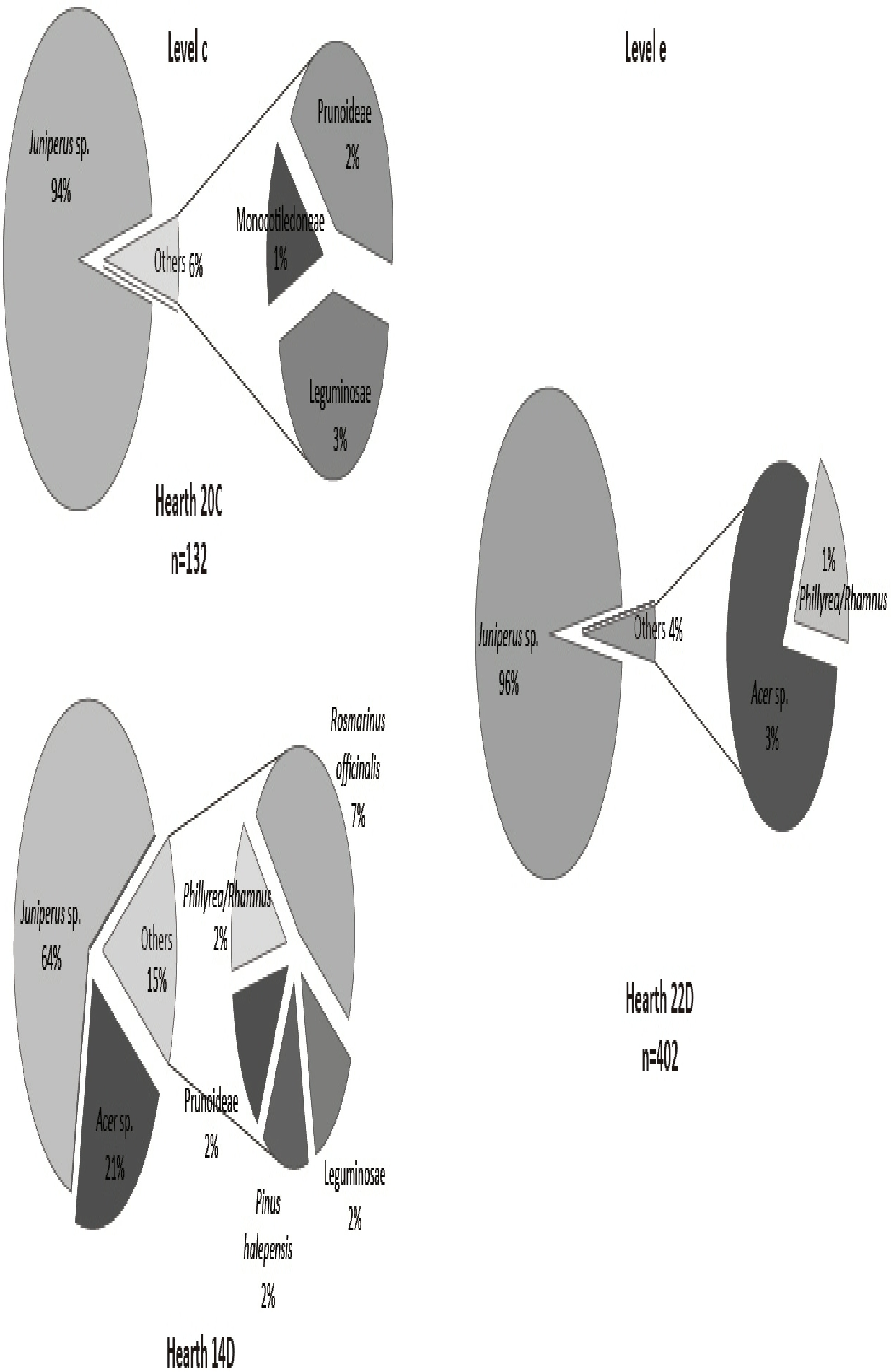
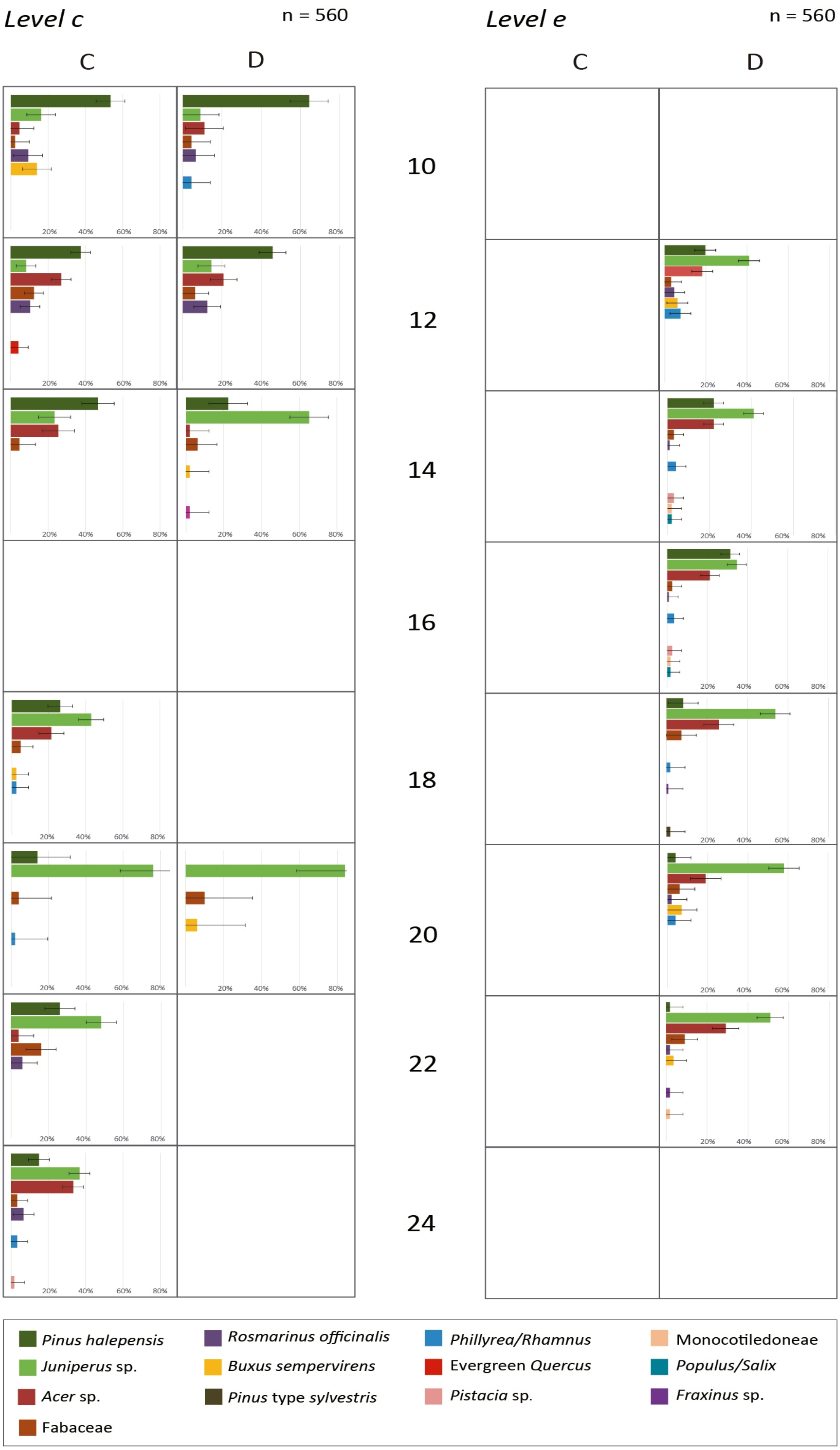
560
560
Pinus halepensis
10%
20%
30%
Juniperus sp.
10%
20%
30%
40%
Pinus type sylvestris
Acer sp.
10%
20%
Fabaceae
5%
Rosmarinus officinalis
5%
Phillyrea/Rhamnus
5%
Buxus sempervirens
5%
Fraxinus sp.
Monocotiledoneae
Pistacia sp.
Prunus sp.
Evergreen Quercus
Populus/Salix



Level c
Juniperus sp. 94%
Others 6%
Prunoideae 2%
Monocotiledoneae 1%
Leguminosae 3%
Hearth 20C
n=132
Level e
Juniperus sp. 96%
Others 4%
1% Phillyrea/Rhamnus
Acer sp. 3%
Hearth 22D
n=402
Juniperus sp. 64%
Others 15%
Rosmarinus officinalis 7%
Phillyrea/Rhamnus 2%
Acer sp. 21%
Prunoideae 2%
Pinus halepensis 2%
Leguminosae 2%
Hearth 14D
n=57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Pinus halepensis
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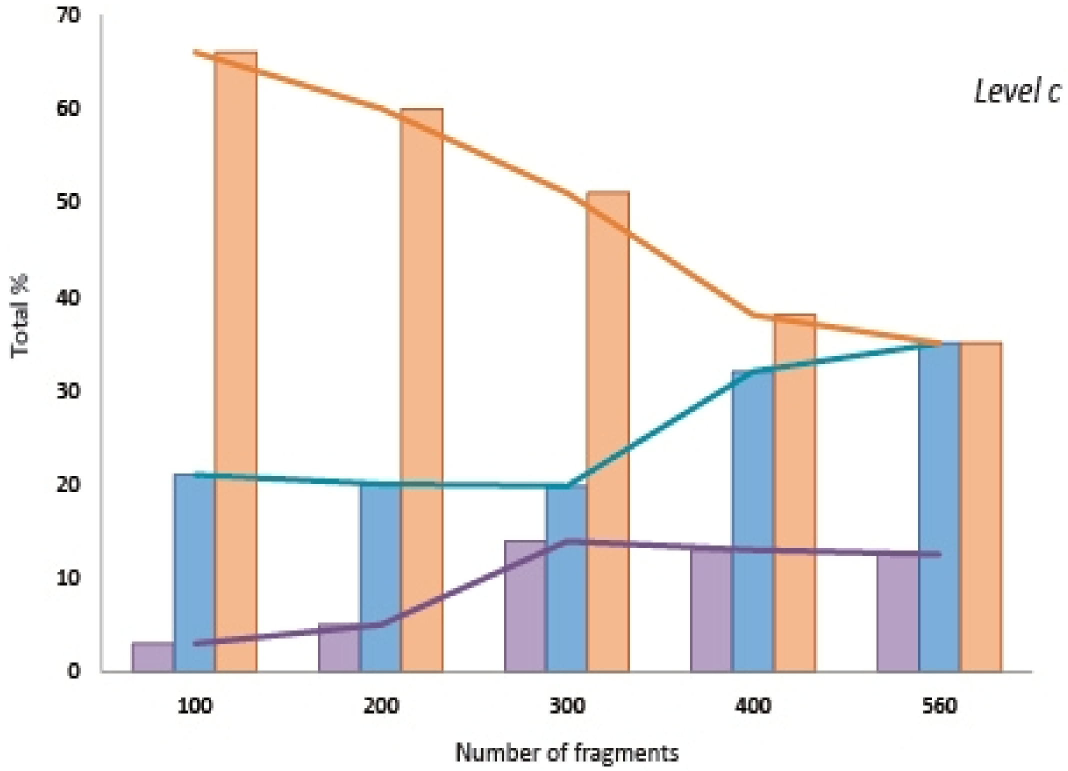
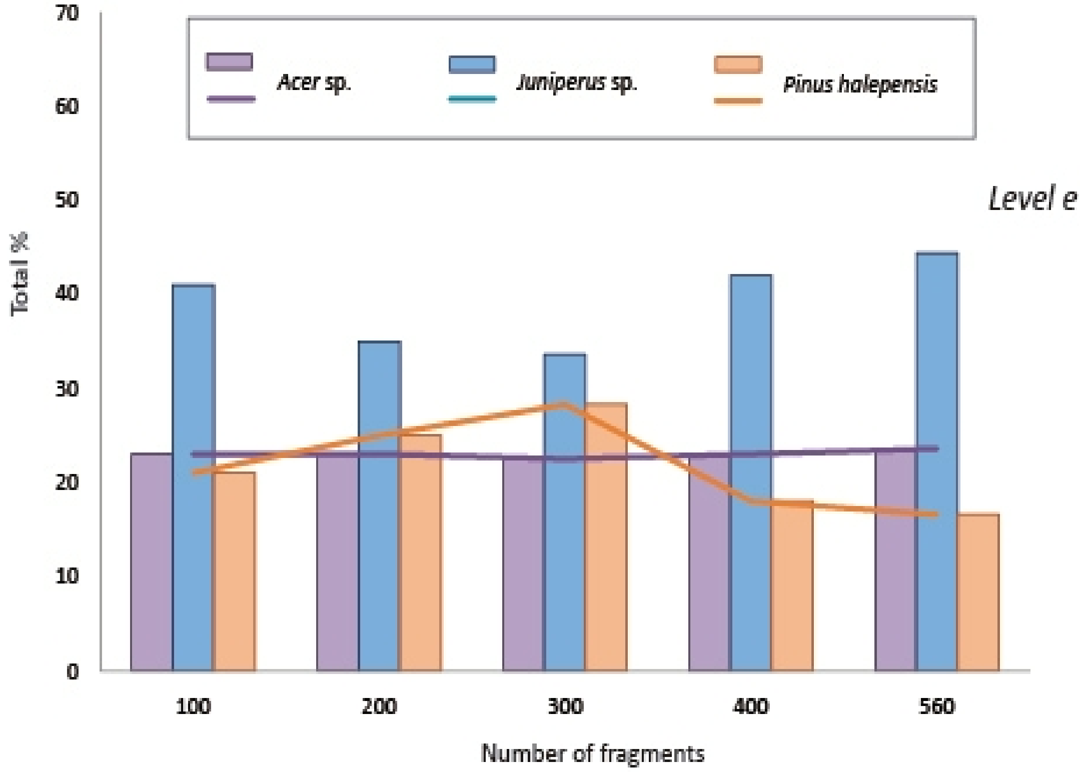
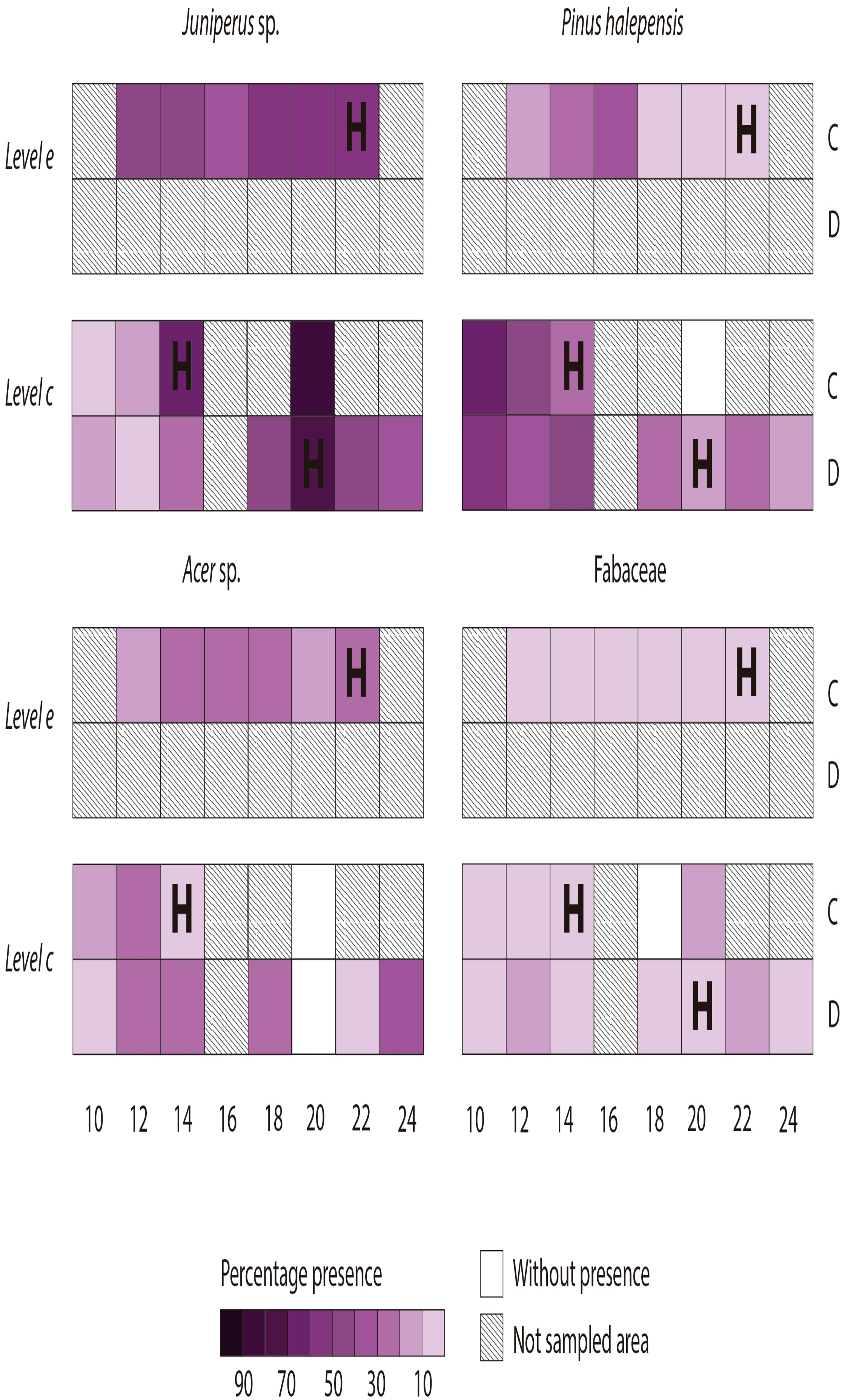
Acer sp.
Fabaceae
Rosmarinus officinalis
Buxus sempervirens
Pinus type sylvestris
Phillyrea/Rhamnus
Evergreen Quercus
Pistacia sp.
Monocotiledoneae
Populus/Salix
Fraxinus sp.


70
60
50
40
30
20
10
0
Total %
Level c
100
200
300
400
560
Number of fragments


70
60
50
40
30
20
10
0
Total %
Acer sp.
Juniperus sp.
Pinus halepensis
Level e
100
200
300
400
560
Number of fragments



Juniperus sp.
Pinus halepensis
Level e
Level c
C
D
H
Acer sp.
Fabaceae
10 12 14 16 18 20 22 24
Percentage presence
90 70 50 30 10
Without presence
Not sampled area

	Z	SAMPLE	LABORATORY CODE	DATE BP	DATE CAL BP (2σ)
LEVEL c	-95 cm	Charcoal *Juniperus* sp.	Beta-361624	7390±40	8321-8046
LEVEL e	-130 cm	Charcoal *Juniperus* sp.	Beta-361625	7900±50	8975-8547

	LEVEL e 8975-8547 cal BP				LEVEL c 8321-8046 cal BP					
CHARCOAL FRAGMENTS	962				749					
FRAGMENTS by CONTEXT	**Scattered**		**Hearth 22D**		**Scattered**		**Hearth 14D**		**Hearth 20C**	
	560		**402**		**560**		**57**		**132**	
TAXA (14 determinable)	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Acer sp.	121	*23.6*	8	*3.0*	65	*12.5*	9	*20.9*		
Buxus sempervirens	16	*3.1*			12	*2.3*				
Evergreen *Quercus*					2	*0.4*				
Fabaceae	25	*4.9*			37	*7.1*	1	*2.3*	3	*2.4*
Fraxinus sp.					1	*0.2*				
Juniperus sp.	228	*44.4*	260	*96.3*	187	*36.0*	27	*62.8*	119	*93.7*
Monocotolidoneae	3	*0.6*							1	*0.8*
Pinus halepensis	85	*16.6*			186	*35.8*	1	*2.3*		
Pinus type *sylvestris*	2	*0.4*								
Pistacia sp.	3	*0.6*			1	*0.2*				
Prunus sp.	2	*0.4*			1	*0.2*	1	*2.3*	3	*2.4*
Phillyrea/Rhamnus	13	*2.5*	2	*0.7*	6	*1.2*	1	*2.3*		
Rosmarinus officinalis	12	*2.3*			21	*4.0*	3	*7.0*		
Populus/Salix	3	*0.6*								
Indeterminate									1	*0.8*
Total determinable	**513**	*91.6*	**270**	*67.2*	**519**	*92.7*	**43**	*75.4*	**127**	*96.2*
Indeterminable	47	*8.3*	130	*32.3*	41	*7.3*	14	*24.6*		
Pine bract									2	
Parenchyme			2						3	
TOTAL TAXA by CONTEXT	**12**		**3**		**11**		**7**		**6**	