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VEGETATIONAL HISTORY DURING BRONZE AND IRON AGES IN PORTALÓN CAVE (SIERRA DE ATAPUERCA, BURGOS, SPAIN)

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ABSTRACT

In this paper we present the obtained results from Portalón of Cueva Mayor (Sierra de Atapuerca, Burgos, Spain) which have allowed to reconstruct the vegetation composition as well as its relation with the climate and the human habitation of the site during 2000 years, from *ca*. 4000 to *ca*. 2000 yr. BP. An open landscape with *Corylus*, *Juglans* and *Betula* was developed at the base of the sequence, from 3910 ± 70 yr. BP to after 3680 ± 40 yr. BP (Pollen Zone I), which reflects humid and temperated climatic conditions. Before 3330 ± 70 yr. BP a mediterranean climate can be inferred by the presence of *Olea* and evergreen *Quercus*, with drier and warmer climatic conditions, leading to the expansion of shrub vegetation. The human activity is clearly detected along Portalón pollen sequence and the evidences of anthropogenic deforestation are shown by the presence of microcharcoal particles.

KEY WORDS

Pollen, Microcharcoal particles, Sierra de Atapuerca, Bronze Age.

INTRODUCTION

Atapuerca is a little mountain located at 15 km east of Burgos (Spain), near of Ibeas de Juarros village and surrounded by the rivers Arlanzón, Pico and Vena. Geographically, this area is in the foothills of Iberian Range, into the sector named Estrecho de Burgos or Corredor de la Bureba, where Iberian Range, Cantabrian Range and the northern Meseta interconnect, being also the water-divide between Ebro and Duero Basins. The location of Sierra de Atapuerca is a biogeographical crossroads with mediterranean, atlantic and continental climatic influences, leading to the coexistence of a great variety of flora and fauna, and so, the existence of an ecosystem with a great biotopes diversity.

The present vegetation around the site is a mosaic as a consequence of the lithological alternation, the slopes orientation and the geographical location. It is made up by a mixed open continental forest of *Quercus ilex* and *Quercus faginea*, and the existence of some elements as *Erica vagans* and *Calluna vulgaris* reflects some atlantic influence. The alkaline soils of this area favours a greater edaphic drought, also conditioning the floristic elements, and the open structure of this forest favours a great presence of herbs, but the taxonomical diversity is not very high. As a general role, *Quercus ilex* is better adapted to mediterranean climate and growths at the insolation slopes with scarcity of water and high temperatures, while *Quercus faginea*, with less resistance to the lack of water, growths at the shady sides. On the terraces of Río Arlanzón, on silicious soils, the presence of *Quercus pyrenaica* is significant.

This sierra is part of a complex and extensive karstic system, into wich the system of Cueva Mayor-

Cueva del Silo outstands (Martín Merino *et al.,* 1981). The caves of Atapuerca have been known since long time ago and the archaeological and palaeontological discoveries have been summarized by different authors (Clark, 1979; Arsuaga *et al.,* 1997; Bermúdez de Castro *et al.,* 1999a, 1999b), and have provided a valuable record since the Lower-Middle Pleistocene.

Cueva Mayor is a large true cave forming one of the entrances to the Atapuerca cave system (Martín Merino *et al.,* 1981) (Fig. 1), and its entrance cave is named Portalón. The first archaeological studies were carried out at Portalón by different authors (Sampayo & Zuarnávar, 1868; Carballo, 1910; Breruil & Obermaier, 1913), and chronologically situated this site in the Upper Paleolithic and the recent Prehistory. Clark (1979) carried out a drilling into Portalón of Cueva Mayor, which revealed a recent Prehistory archaeological site. The analysis of the artifactual material recovered from the cleaning of Cut 1 and the excavation of Trench A provided the following information: Levels 1-3 are assigned to the period of Romanization (1st Century BC); Levels 8-16 are final Bronze Age (III) (*ca.* 750-1000 BC); Levels 17 and 18 are assigned to Bronze Age II (*ca.* 1300 BC); Levels 19 and 20 to the Old Bronze Age (I) (*ca.* 1700 BC) and Levels 21-26 to the later Eneolithic (II) (*ca.* 1900-2100 BC).

Afterwards, Apellániz excavated from 1973 to 1983, identifying the Portalón sector as an habitation site during different phases of Bronze Age and of late Roman period (Apellániz & Domingo, 1987).

The Bronze Age materials from Portalón present a wide chronological frame. The ^{14}C radiometric ages asssigned Level 83 to early Bronze Age, with a ^{14}C age of 1690 ± 50 BC; Level 71 was dated on 1450 ± 50 BC, corresponding to Middle Bronze Age; and Level 30 was assigned to final bronze Age with a ^{14}C age of 1220 ± 130 BC. Finally, Level 10, which is the contact-level with the later Romen habitation, at the top of the sequence of Bronze Age, had a ^{14}C age of 900 ± 50 BC, corresponding with phases of ending final Bronze Age (Apellániz & Domingo, 1987).

The stratigraphical sequence of this excavation presented several difficulties, due to “the excavated materials seem a part of one only level of plastic and grey clays” (Apellániz & Domingo, 1987), and the archaeological studies have allowed to observe foot action and the alteration of materials position (Apellániz & Domingo, 1987). Also in addition the sedimentological analysis indicate that this Portalón sector has been affected by floods, leading to the material movements (Apellániz & Domingo, 1987).

The palaeocarphological studies carried out by Apellániz and Hopf (1979) from Levels 31 and 37 of the Sector II of Apellániz excavation provided burnt grains of three species of wheat, *Triticum aestivum*, *Triticum dicoccum* and *Triticum monococcum*, one grain of barley, *Hordeum vulgare*, and the evidence of lucerne. All these features suggest cultivation of domestic plants. Also a hazelnut and some fragments of sclerotia were recovered (Apellániz & Hopf, 1979).

The faunal analysis from the long Bronze Age sequence (Clark, 1979) indicated the predominance of domestic species, such as ovicaprines (*Capra* sp.) and cattle (*Bos taurus*), over wild species among which the remains of red deer (*Cervus elaphus*) outstand. Clark (1979) interpreted that the predominance of domestic species, represented mainly by juveniles individuals, and the evidence for systematic culling of them suggested that Portalón was used as a stable and very likely a slaughterhouse. Portalón would be related to the open settlement named by Clark (1979) Site 37 (and named as slope-access site by other authors), where the community of Bronze Age responsible for the accumulation of faunal material presumably lived (Clark, 1979). However, Mínguez Álvaro (2001) interpreted that Portalón corresponded to the habitation site of a pastoral population of Bronze Age which choosed Cueva Mayor as a sanctuary and burial site, and Sierra de Atapuerca as geographically strategic settlement.

In respect of palynological analyses, Clark (1979) refered that a total of nine pollen samples were taken: six archaeological pollen samples at Site 36 (Cut 1, Trench A) inside Portalón, and three other surface samples. The archaeological samples gave disappointing results in that 3 were completely sterile, 1 so poor as to be of negligible importance and other was so close to disturbed deposits at the top that must be considered unreilable. That leaft only one sample (nº 3, at –165 cm) which yielded only 66 identifiable spores/pollen grains and showed a higher incidence and a greater variety of arboreal pollens: *Alnus*, *Betula*, *Pinus*, *Quercus* and *Corylus* are all represented. The prevalence of Cyperaceae (35%) was probably owed to the protected sinkhole microenvironment, and the high representation of both types of Compositae (actually named as Asteraceae) that accounted for almost 20% of the spectrum was interpreted as suggesting that a slightly drier climatic episode was represented in this sample. Overall, the archaeological pollen suggested a vegetation configuration markedly different from that of the present day, although more tree cover was probably present during the period of Level 16/17 accumulation, assigned to Bronze Age II period. The absence of significant quantities of pollen from disturbed-ground plants (e.g. Chenopodiaceae, *Plantago*) was interpreted as that perhaps little farming has been done in the inmediate site vicinity. Prime agricultural bottomlands occurred within a kilometer to the south of the site, in the valley of the Río Arlanzón (Clark, 1979).

In 2001, the Palynological Research Team from Universidad de Alcalá began again the palynological research at Portalón, where 15 pollen samples were taken in the South Profile (Fig. 1). In this paper we present the obtained results which have allowed to reconstruct the vegetation composition as well as its relation with the climate and the human habitation of the site during 2000 years, from *ca*. 4000 to *ca*. 2000 yr. BP.

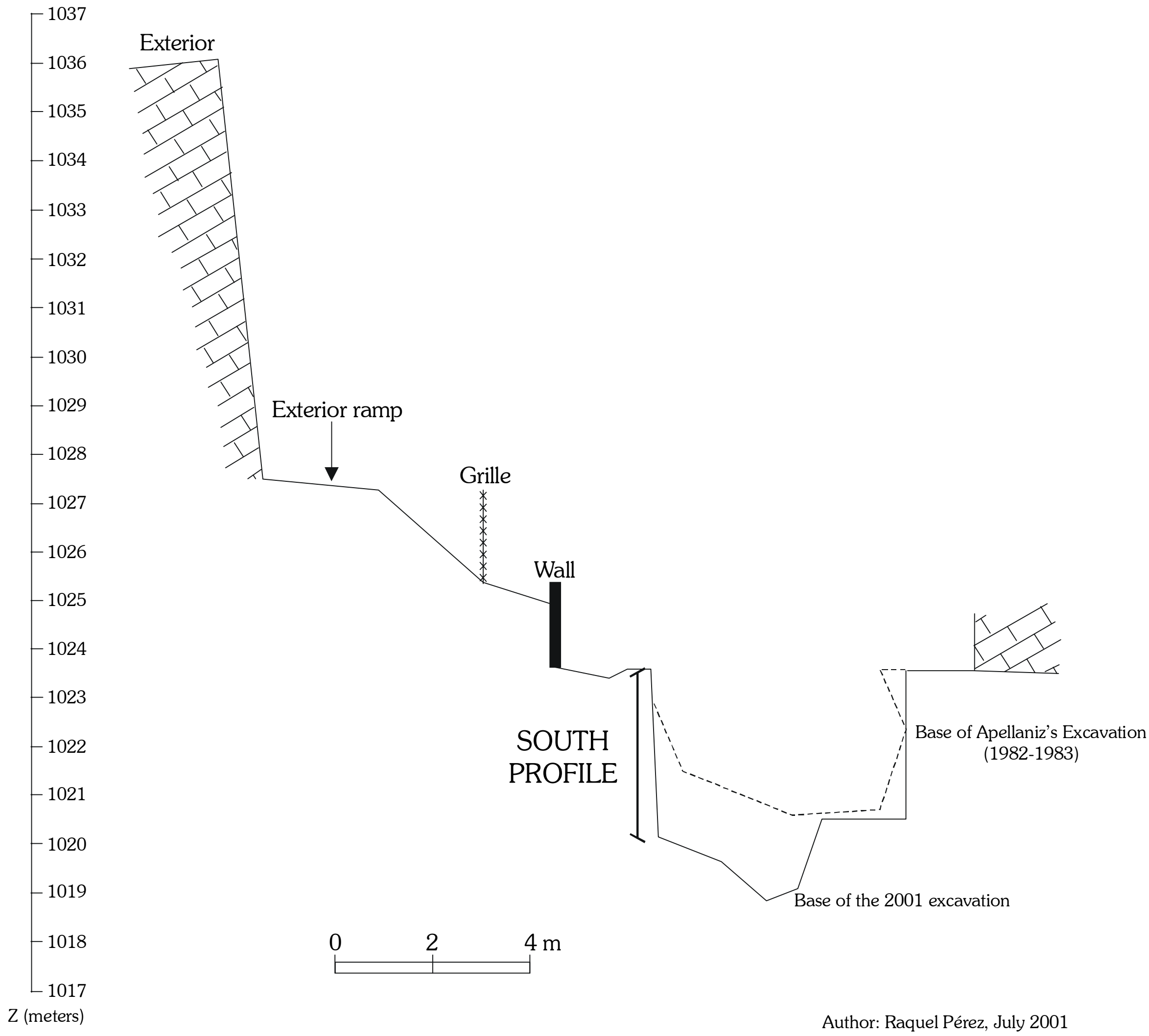

Figure 1.- Excavation profile in 2001 and previous excavations at Portalón of Cueva Mayor (Atapuerca, Burgos, Spain)

METHODS

The samples were hand-taken at Portalón, in the South Profile, a long-profile of 2m. The type section is shown in figure 2 with the location of pollen samples as well as the available radiocarbon ages.

Pollen was extracted from the sediment by flotation on Thoulet's solution (Goeury & Beaulieu, 1979), without acetolysis. Pollen data are presented as the relative pollen frequency of each taxon in a pollen diagram for each core, prepared using the TILIA® and TILIA-GRAPH® (©Eric C. Grimm) computer programs. Pollen percentages for trees, shrubs and herbs were calculated upon a pollen sum, excluding aquatic pollen types, spores and the values of *Pseudoschizaea* and *Lycoperdon.*

The charcoal particles analysis has also been carried out following the methodology proposed by Clark (1982) which allows to calculate charcoal areas in the same pollen preparations. These charcoal areas are represented as mm^2 per gram of analized sample, next to the pollen diagram.

RESULTS

In general, the pollen diagram (Fig. 3) shows that the landscape of this area was dominated by grasses (Asteraceae, Poaceae, Apiaceae, Chenopodiaceae-Amaranthaceae, *Artemisia* and Caryophillaceae). The low representation of shrubby taxa (*Juniperus*, with presences of Ericaceae and Rosaceae), together with the values of *Corylus*, deciduos *Quercus, Betula*, *Juglans*, *Castanea* and *Olea* suggest an open woodland. Also *Alnus*, *Ulmus* and *Salix* are present, representing the riverside vegetation.

The pollen diagram was divided into two pollen zones, showing different palaeoenvironmental characteristics:

Pollen Zone I, developed from 3910 ± 70 yr. BP to after 3680 ± 40 yr. BP. The relatively high pollen percentages of grasses (Asteraceae, Poaceae and steppe taxa such as Chenopodiaceae-Amaranthaceae and *Artemisia*) suggest an open landscape during about 300 years. The arboreal taxa are continually represented by *Corylus*, *Alnus and Salix*, and with less continuity by *Castanea*, deciduous *Quercus*, *Juglans*, *Betula* and *Ulmus*; *Pinus* percentages are low but increase along this pollen zone. The aquatic taxa present the highest representation in the pollen sequence. During this period, significant changes in vegetation can be observed, with different pollen assemblages which allow to divide this pollen zone into three pollen subzones:

Pollen Subzone Ia: with a ^{14}C age of 3910 ± 70 yr. BP at its base, is characterized by a *Pinus* increase parallely to the decrease of other arboreal taxa (*Corylus*, *Betula* and *Alnus*).

Pollen Subzone Ib: the gradual decrease of all arboreal taxa percentages and the occurrence of *Betula*, with low values, can be observed. These features could indicate a reduction of forest cover. At the same time, a increase of grasses occurs, with Asteraceae tubuliflorae as the dominant taxa and Chenopodiaceae-Amaranthaceae, Fabaceae, *Artemisia*, *Urtica*, *Rumex* and Dipsacaceae. In this pollen subzone also the first maximum of microcharcoal particles (>50mm^2 /gr) occurs.

Pollen Subzone Ic: with a ^{14}C age of 3680 ± 40 yr. BP for the sample 4.2.c, *Pinus* increases paralelly to the decrease of *Corylus*, *Juglans* and deciduous *Quercus*. There are very few elements of the arboreal and shrub vegetation. Also important changes on the herbaceous vegetation occurs, with a decrease of steppe taxa and being now Asteraceae liguliflorae the main taxa.

The transition from Pollen Zone I to Pollen Zone II is characterized by the appearance of the second maximum of microcharcoal particles and by the

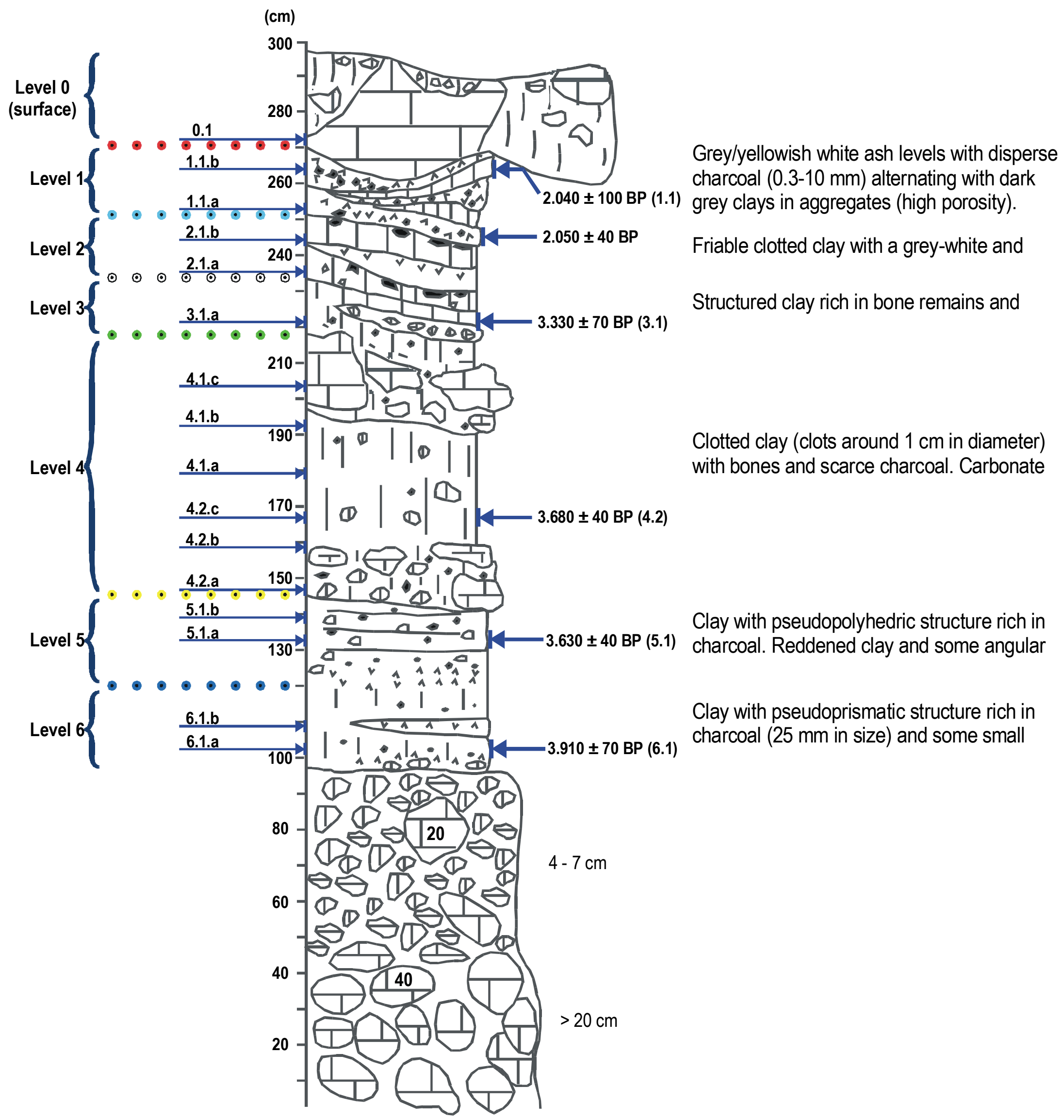

Figure 2.- Type section of South Profile at Portalón of Cueva Mayor showing the location of pollen samples and radiocarbon ages.

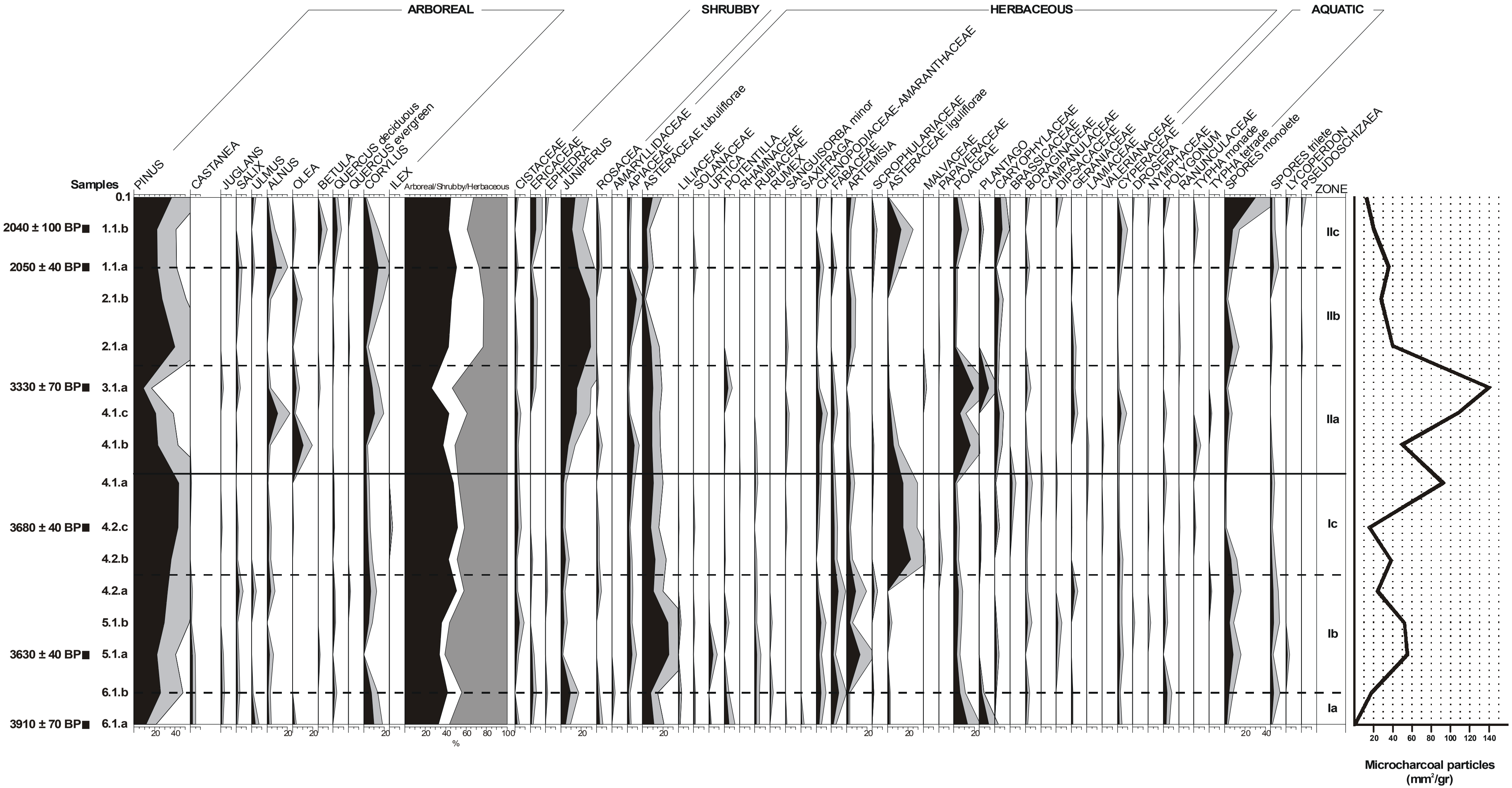

Figure 3.- Pollen diagram and charcoal areas of South profile at Portalón of Cueva Mayor.

changes on vegetation composition and development, with the results observed in Pollen Zone II.

Pollen Zone II: begins before 3330 ± 70 yr. BP and ends after 2040 ± 100 yr. BP and is characterized by a significant herbaceous pollen decrease and the expansion of shrubs pollen, mainly *Juniperus*. The arboreal taxa are represented by relatively high values of *Corylus*, *Olea* and *Alnus*. Also the last and highest maximum of microcharcoal particles occurs in this zone, which has been divided into three pollen subzones.

Pollen Subzone IIa: before 3330 ± 70 yr. BP a progressive decrease of *Pinus* values can be observed parallely to the increase of *Olea* and *Corylus.* Poaceae is the main herbaceous taxa. In the sample 3.1.a, with a ^{14}C age of 3330 ± 70 yr. BP, coincide the lowest *Pinus* percentages of the sequence and the highest maximum of microcharcoal particles.

Pollen Subzone IIb: with a ^{14}C age of 2050 ± 40 yr. BP at the top of this subzone, is characterized by the lowest percentages and a lower taxonomical diversity of the herbaceous taxa, being the main taxa *Artemisia* and Apiaceae. A expansion of shrubby taxa occurs (*Juniperus*, Ericacea and Cistaceae) and also a increase of the arboreal pollen, due mainly to the increases of *Pinus*, *Corylus* and *Olea*. Low values of the aquatic taxa are also observed.

Pollen Subzone IIc: A slight decrease of the arboreal pollen occurs until 2040 ± 100 yr. BP, due mainly to the decline of *Corylus*, *Olea*, *Alnus* and also to the least important decline of *Pinus*. But also occurs a new development of *Betula* and deciduous *Quercus*, and a *Pinus* increase at the top of the sequence. A *Juniperus* decrease parallely to the expansion of Ericaceae, Cistaceae, Rosaceae can be observed together with the presence of *Ephedra*. The microcharcoal parcticles show a gradual decrease along this pollen subzone.

DISCUSSION

The palynological analyses carried out in Portalón of Cueva Mayor (Sierra de Atapuerca, Burgos) provide information to allow a tentative reconstruction of the environmental changes occurred in the surrounding area, since 3910 ± 70 yr. BP until some time after 2040 ± 100 yr. BP.

In our pollen sequence, the deciduous forest is only represented by low percentages of pollen grains of *Corylus*, *Juglans*, *Castanea* and deciduos *Quercus*. The riverside vegetation is represented by *Alnus*, *Salix* and *Ulmus*. The pollen source area was basically local being the regional vegetation represented only by *Pinus.* Pollen assemblages suggest a landscape with a predominance of grasses such as Asteraceae, Poaceae, Apiaceae, Chenopodiaceae-Amaranthaceae, *Artemisia* and Caryophyllaceae, indicating to some extent that deforestation happened at this time.

Some vegetational changes infered by the pollen record can be interpreted as owed to changes on climatic conditions. Under this point of view, the Pollen Zone I is characterized by the presence of deciduous arboreal elements and the highest values of aquatic taxa indicating humid climatic conditions; Pollen Zone II, with the decrease of the herbaceous vegetation and the expansion of the shrub vegetation suggests mediterranean climate, and allowing to infer drier and warmer climatic conditions.

The palynological evidences provided by Clark (1979) based in only one sample and assigned to Bronze Age II could be correlated with the lower part of Pollen Zone II of our pollen sequence.

Pollen data from the mountain ranges near to this area (Peñalba, 1994; Sánchez Goñi & Hannon, 1999; Vegas *et al.*, 2000; Ruiz Zapata *et al.*, 2001) showed a forest expansion, being its components reflecting stability conditions under humid and warm climatic conditions during the time represented in our pollen sequence.

In peats from Neila and Cebollera mountain ranges (Gil *et al.,* 2000a, 2000b) pollen data showed a dense forest cover, developed during Middle Holocene. The forest was dominated by high values of *Pinus* and *Betula*, with a small contribution of both types of *Quercus*. At the beginning of the recent Holocene, the forest cover decreased due to *Betula* decline. After this period, there was an important deforestation, due mainly to the gradual decrease of arboreal taxa (*Pinus*, *Betula*, *Corylus* and both types of *Quercus*), which coincides with a *Juniperus* expansion while the herbaceous vegetation increases.

Afterwards, at *ca.* 3200 yr. BP, a *Corylus* decrease occurred in high mountain areas, but *Fagus* expanded. These features were interpreted by Gil *et al.* (2000a) as a probably altitudinal decrease of the forest. This interpretation could explain the existence of *Corylus* along our pollen sequence.

The human activity is clearly detected along Portalón pollen sequence and the evidences of anthropogenic deforestation are shown by the microcharcoal particles presence parallely to the occurrence and/or expansion of some taxa such as *Olea*, Poaceae, *Plantago*, *Rumex* and *Urtica*.

Also in Pardillas Lake the human activity during this time is detected (Sánchez Goñi & Hannon, 1999), by means of *Cerealia* presence. The use of fire was very usual in the area, as was detected by Stevensson *et al.,* (1991), in the valley located at middle Ebro Basin. In Portalón pollen sequence, three fires are detected, with a gradually increasing intensity.

The first fire (with values of 60 mm^2/gr of microcharcoal particles), is located into the Pollen Subzone Ib. It affected only *Corylus* and deciduous *Quercus,* elements of the local vegetation, while the rest of the arboreal taxa are not affected. *Juglans* and *Castanea* increases could be favoured by human activity, which is clearly evidenced by both the development of the herbaceous vegetation, by means of changes in the main element, and the decrease of the taxonomical diversity of the arboreal vegetation.

The second fire (90 mm^2/gr) is detected in Pollen Subzones Ic and IIa. After the fire, the increases of *Olea*, *Corylus* and Poaceae can be observed, parallely to a shrub expansion in the Pollen Subzone IIa.

Finally, the third fire occurred at the top of Pollen Subzone IIa, leading to changes in the landscape: *Corylus* and *Olea* decrease, while *Urtica*, Poaceae and *Plantago* increase. Just after this fire, a significant decrease and also a lower taxonomical diversity of the herbaceous taxa happened; however, the shrubs (mainly *Juniperus*) and the arboreal vegetation (mainly *Pinus*) increase. At the same time, an arboreal vegetation increase was also detected in high mountain areas (Peñalba, 1994; Sánchez Goñi & Hannon, 1999; Vegas *et al*., 2000; Ruiz Zapata *et al.*, 2001; Gil *et al.,* 2000a, 2000b).

Finally, the increase of the taxonomical diversity of the arboreal taxa at the top of Portalón pollen sequence could be explained as a result of the natural recovering, probably after humans abandoned the site.

CONCLUSIONS

Portalón pollen diagram shows an homogeneous vegetation during 2000 years, from *ca*. 4000 to *ca*. 2000 yr. BP. An open landscape with *Corylus*, *Juglans* and *Betula* was developed at the base of the sequence, from 3910 to after 3680 (Pollen Zone I), which reflects humid and temperated climatic conditions. Before 3330 ± 70 yr. BP a mediterranean climate can be inferred by the presence of *Olea* and evergreen *Quercus*, with drier and warmer climatic conditions, leading to the expansion of shrub vegetation.

On the other hand, the human activity is clearly detected along the pollen sequence. Three fires with a gradually increasing intensity are detected from the microcharcoal particles presence. These fires implied changes on the later vegetation composition, which are detected in the pollen diagram. These changes can only be explained by human activity, but considering that the climate has conditioned this human activity.

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