The Early Pleistocene paleontological site in the Sierra del Chaparral (Villaluenga del Rosario, Cádiz, Southwestern Spain)

Francisco Giles Pacheco a,*, Antonio Santiago b, José María Gutiérrez c, Juan Manuel López-García d, Hugues-Alexandre Blain d, Gloria Cuenca-Bescós e, Jan van der Made f, Isabel Cáceres d, Nuria García g,h

a Gibraltar Caves Project, C/Elbrillo 43, 11500 Puerto de Santa María, Cádiz, España
b Gibraltar Caves Project, Archivo Histórico Municipal, Plaza Craf, Primo de Rivera nº 7 y 8, 11402 Jerez de la Frontera, Cádiz, España
c Museo Municipal de Villamartín, Avenida de la Feria, s/n. 11050 Villamartín, Cádiz, Spain
d Instituto de Paleontología Humana e Evolución Social, Área de Prehistoria, de la Universitat Rovira i Virgili de Tarragona, Plaça Imperial Tarraco, nº 1, E-4005 Tarragona, Spain
e Departamento de Paleontología, Facultad de Ciencias Geológicas, de la Universidad Rovira i Virgili de Tarragona, C/Polígrafo Lluch nº 12, E-50009 Zaragoza, Spain
f Museo Nacional de Ciencias Naturales, CSIC, C/ José Gutiérrez Abascal nº 2, 28006 Madrid, Spain
g Centro de Evolución y Comportamiento Humanos (UCM-ISCHII), Avda. Monforte de Lemos 5, Pabellón 14, 28029 Madrid, Spain
h Departamento de Paleontología, Universidad Complutense de Madrid, Facultad de Ciencias Geológicas, Ciudad Universitaria s/n, 28040 Madrid, Spain

Abstract
This article outlines the results obtained during the first study of the Chaparral site (Villaluenga del Rosario, Cádiz, Spain) situated in the karst area of the Sierra de Grazalema. The varied macro- and microvertebrate fauna include carnivores, herbivores and rodents, as well as reptiles and amphibians, suggesting an Early Pleistocene age. The taphonomic study of the fauna discovered on the site is underway.

Once the state of conservation of the osseous remains and of the brecciated deposit containing terra-rossa was evaluated, it was agreed that the site would be excavated during 2009 with a budget subsidized by the Dirección General de Bienes Culturales, the Office for Cultural Assets of the Junta de Andalucía, Andalusian Regional Government. The conditions in which the site was found, exposed to being destroyed or pillaged, with a track for all terrain vehicles having been created less than 2 m from its location as well as the erosive factors accelerated by the pressure caused by tourism in this sector of the Sierra de Grazalema favored the decision that the archaeological intervention was of an “urgent” character, to avoid the partial or total destruction of the site.

The site is located in the Western Sector of the Betic Cordilleras Mountain Range, in an area known as Manga de Villaluenga del Rosario (Cádiz), forming part of the Grazalema Natural Park. It is a deposit of endokarst origin located between 1000 and 1080 m above sea level, which forms part of the Jurassic limestone pavement of the Sierra del Chaparral (UTM coordinates X-286547, Y-4062771; Fig. 1). The paleontological findings are welded together by heavily crystallized calcite flow formations to large blocks of highly altered limestone rock, typical of Jurassic formations, which are now exposed due to loss through erosion of the red clays of karst origin which fill the dissolution fissures and holes of the endokarst and which mainly form part of a terra-rossa deposit which fills the fracture. The morphology of the terrain appears to correspond, in genesis, to a karst fracture. The fossils are covered by...
a dense impregnation of manganese as a result of having been in a very humid environment during their long period of fossilization.

The excavation area, limited by the internal surface area of the fracture (25 m²), is bordered by the north-south oriented natural walls of fossiliferous deposits which have remained in situ and which fell into the cavern due to gravity (Fig. 2). The osseous remains display a high level of old breakage due to pressure exerted by the deposits themselves and new breakages due to the current fragmentation of the edaphic level, bioturbation, passing over by livestock, and temperature changes. In both the conglomerate deposits and the red clays (terra-rossa), it was ascertained that anatomical connections are present. Therefore, the fossils have remained in situ without suffering significant displacement.

2. Geological setting

The Penibetic and Subbetic ranges are found in the western sector of the Betic Cordillera Mountain Range. The Penibetic, which rises in the Sierra de Endrinal, in Ubrique and Líbar, in the Serranía de Grazalema, is characterized by a completely carbonate Jurassic and Cretaceous layer (Moreno Serrano, 1990), between 400 and 600 m in thickness. Superimposed on this are clays and silty marls, typically reddish, from the Cretaceous to the Oligocene (red layers). In tectonic contact with and covering these materials is a flysch layer which alternates between sandstones and shales, of Aquitanian-Burdigalian age (Sierra Peralto, Las Cumbres, Alcornocales).

To the south of the Boyar Tectonic Corridor, the penibetic domain consists of wide fan folds (Sierra de Líbar, and Sierra de Ubrique) and dilated anticlines (Sierra del Endrinal), affected by fracturing and folding. The general direction of these folds is NNE-SSW to NE-SW, with inclination towards the south, therefore conditioning the general orientation of the mountainous regions, the fluvial valleys and the drainage direction.

The structural layout plays an important part in the karstification and in the organization of the underground drainage (Delannoy, 1999). The alternation between deep fan folds and syncline furrows in the penibetic domain offers characteristics favorable to underground drainage, that is, infiltration of water in...
anticline areas and concentration of the underground flow towards the syncline valleys, where the collecting infrastructure is to be found. It is also in the nucleus of these same synclines, in which the impermeable Cretaceous covering still remains, that the hydrographic network has developed (Gaduares, los Álamos stream, Villaluenga stream, Líbar stream), which is then immersed in the interior of the karst (Hundidero-Gato, Simas del Republicano, Villaluenga, Líbar, systems etc.).

The climate is typically humid Mediterranean, with dry summers and intense seasonal precipitation, with an average annual precipitation of 1500 mm for the whole of the Sierra de Grazalema, although there are areas with almost double the precipitation. These geological and climatic factors together result in karst formation in certain carbonate strata (Rodríguez Vidal et al., 1999, 2000a, 2000b), although the general line of evolution has been influenced by the exokarst fluvial network and its temporary base level changes. This means that the underground networks all trend towards the principal fluvial valleys such as the Guadiaro and the Guadalete, and they are spaced and evolve according to the engagement speed of the rivers. Therefore, a coordinated evolution of the fluvial networks and the endokarst networks does exist, with simultaneous engagement phases (canyons, abysses and wells) or horizontal stability (horizontal terraces and cavities).

La Manga de Villaluenga, situated between the towns of Benaojác and Grazalema, to the south-west of the Sierra de Grazalema Nature Park, is a site of scenic interest made up of a long and narrow depression of abrupt walls and a flat base, through which no fluvial course of any importance flows, except some torrents which drain towards the Abyss of Villaluenga due to the high degree of surface infiltration produced by the karstification of the Jurassic limestone (Santiago and Pedroche, 2000). The valley is positioned on a fan syncline, in the nucleus of which are situated the silty marl of the upper Cretaceous (red layers). The sides (Sierra del Caillo-Sierra del Chaparral) are made up of Jurassic limestone and dolomite with almost vertical inclination. The direction of the valley coincides with that of the syncline axis, having been excavated by erosion to the core, in favour of the softer Cretaceous materials which are now only present in small amounts at the lowest points of the sides and base of the valley (Gutiérrez et al., 1991).

The karst system plays an important part in the area as a whole, offering abundant examples of nivokarst, exokarst and endokarst forms (Delannoy and Díaz del Olmo, 1986; Delannoy, 1987; Pedroche and Mendoza, 1992; Santiago and Pedroche, 2000). The Quaternary deposits in this sector are made up of calcium deficient red clays (terra-rossa), on which temporary streams flow and which, upon reaching the limestone substrate, go underground through abysses and fractures, getting lost in the interior of the massif. The depression’s ponor is situated near the town of Villaluenga del Rosario, producing the well-known Abyss or Sima de Villaluenga (Santiago and Pederoche, 2000), which develops normal to the axis of the valley and acts as an outlet for various streams which drain towards it. Erosion is noted on the chalky materials of the bed which begins its initial stretch in a narrow canyon with “giant kettles” until losing itself inside the massif, where it continues its underground course until surfacing in the springs in Ubrique. No other significant fluvial course flows along the flat bottom of the depression.

These deposits are notably developed on the slopes of the Sierras de Cadiz, characterized by slopes, erosions, slides and solifluction flowstones, as well as thermoclastic scree situated on the
cliff face of Jurassic limestone, due to the fracturing of rock in which the caving in and sliding of the substrate in the higher areas and the solifluction phenomena in the depressed areas and softer ground, such as Cretaceous silt and silty marl which form part of the filling of “La Manga” have an effect.

The deposit is situated in the western sector of the Betic Cordilleras, in Manga de Vilalluenga del Rosario (Cádiz). It is a deposit of endokarst origin found between 950 and 1080 m asl in the Jurassic massif Sierra del Chaparral. It is a karst fracture, an abyss tilted with calcium deficient terra-rossa, limestone blocks normal in Jurassic formations highly affected by the action of clays and speleothems (calcites) from the walls of the fracture.

The paleontological deposit is found in the interior of the fracture and is partially brecciated (conglomerate of fauna, highly altered limestone blocks, speleothems (calcites) covered in the matrix clay of terra-rossa) in some cases and in others there are only non-brecciated remains in the same clays. All seems to correspond to the same unit of red clays (terra-rossa).

3. Methodology and excavation process

The archaeological study was in line with the habitual methodology used in excavations controlled by Cartesian coordinates and three-dimensional planimetric leveling on X-Y-Z axes of the site. The axes are established as reference points to outline the grid squares of 1 m². The hypothetical north is traced with a deviation of 4° relative to geographical North. The paleontological remains were extracted and their spatial position located within each grid square in relation to the sedimentary deposit within which they were contained.

Given the sedimentological characteristics of the site, the prime aim was fixed as evaluation of the site’s paleontological potential and calculation of the density of the fossil findings, as well as establishment of the age of the deposits and the analysis of the fossilized taxa in stratigraphical context. A series of grid squares which limited the areas with higher percentages of osseous remains and the peripheral areas in contact with the rocks which limit the area of the former cavity were excavated separately from the fossil remains of the breccia deposit which were extracted in individual blocks, and treated and excavated in the laboratory of the Museo Histórico de Villamartín due to their intense state of consolidation. Stratigraphic test drilling was done in grid squares J-15 and M-16. Square J-15 was divided into two sectors. The space which is in contact with the north-easterly side of the gridded zone was excavated. This sampling provided abundant fossil remains (macrofauna and microfauna). Some of the pieces were in anatomical position and located vertically in the terra-rossa deposits, maintaining their original position, confirming their displacement due to gravity.

Various parts of square J-18 were also excavated in order to determine the concentration of fossiliferous remains and their position in the deposits of terra-rossa and the breccia. The highest concentration of osseous remains was detected in sector W which, in theory, corresponds to the interior of the cavity, the exterior area of the cave being separated by the vertical speleothems which limit the wall of this fracture and are void of paleontological findings (Fig. 3).

Squares K-16, K-17 and K-18, occupy the central part of the site around the ossified breccias. It is in this space where the highest number of fossils per m², both in horizontal surfaces as well as at depth has been detected. As regards the fossiliferous remains, the most representative parts correspond with fragments of diaphysis and epiphysis of extremities and a high number of pieces corresponding to parts of the post-cranial skeleton. The parts corresponding to the skull are represented by dental pieces, mainly fragments of jawbone of herbivorous, horns of caprini and jawbones of carnivores.

4. Description of the stratigraphic layers

The stratigraphy is based on the sedimentary units which mainly form the deposits called C1 and C2. Level C1, reaching 10–15 cm, is composed of an edaphic sublevel of terra-rossa integrated with sediments of red clays with organic elements and a high rate of bioturbation, mainly by vegetation. It contains macro and microfauna with some taxa associated with the Pleistocene (rodents from the Cricetidae family).

Level C2, reaching from 50 to 60 cm, is made up of an extremely homogeneous multi-coloured compact terra-rossa. It does not show signs of significant bioturbation. The coarser elements of the deposit are predominantly limestone rock, completely smoothed on the surface by the slow erosive action of the terra-rossa and of angular calcite fragments. They contain the highest concentration of macro and microfauna (Fig. 4).
A third level (C3) is considered not to be correlative with those previously described. The brecciated deposit is formed by accumulations of speleothems and calcite crystals, fragments of altered limestone, compacted clays and fossils. Three processes of dissolution are observed: a) central nucleus of the breccia; b) dissolved sector of the breccia; and c) nuclei of speleothems in stratigraphic connection and paleontological remains firmly welded together. This deposit formed from the clayey sediments of terra-rossa and appears to be unrelated to the clayey accumulations of layers C1 and C2.

Chronologically, these formations may have begun to originate prior to those of terra-rossa. Confirmation will have to wait for future chronosedimentary analysis of the deposits. The volume of the osseous conglomerates exhumed is ~1 m³ (Fig. 5).

5. Paleontology

5.1. Carnivores

The carnivore fossil record from El Chaparral (Cádiz, Spain) site is mainly constituted by remains recovered during the 2009 field season from levels C1, C2 and C6. The fossil collection is limited in the number of specimens, restricting the taxonomic analyses. However, some of the elements are, at this preliminary level of study, of diagnostic relevance. A first paleontological approach to the study of the carnivore association from El Chaparral includes Puma pardoides ssp., Lynx sp., Canis cf. mosbachensis, Vulpes praeglacialis, and a mustelid of the size of a Polecat, which is assigned to Mustela sp. until further study is completed. This assemblage is characteristic of the late Early Pleistocene, with presence of the European Puma, a rare element that inhabited Europe from before 2.4 Ma to the Early Middle Pleistocene.

5.1.1. Puma pardoides ssp. (=Panthera schaubi = Viretalturus schaubi)

Several mandible and dental remains (n = 7) with the morphology and dimensions of a puma-like cat have been identified and likely belong to the same young individual. Left and right hemi-mandibles come from units C1 and C2 respectively; although the fossils come from two different levels, considering dimensions, morphology, ontogeny and wear stage criteria, it is considered that all remains belong to the same individual. The dimensions of the mandible and dentition fall within the Puma pardoides values from Untermassfeld (Mei.18376; Hemmer, 2001), Cueva Victoria and Vallparadís (Madurell-Malapiera et al., 2010). The morphology and metrics are almost identical to the specimen from Untermassfeld.

5.1.2. Vulpes cf. praeglacialis Kormos, 1932

An upper and a lower carnassial of a small fox have been recovered from levels C2 and C6 at El Chaparral. A small fox was first described at the Villány-Kalkberg (Hungary) Plio-Pleistocene site, and since then a number of Early and early Middle Pleistocene sites have also yielded remains of this species. The morphology and dimensions of the two dental elements recovered from El Chaparral are very similar to the specimens attributed by Kormos (1932) to Vulpes (Alopex) praeglacialis.

5.1.3. Canis cf. mosbachensis Soergel, 1925

One upper third premolar was recovered from level C2 at El Chaparral. The dimensions fall within the range of the Untermassfeld site collection analyzed by Sotnikova (2001). This P3 is posteriorly elongated with two posterior cusplets, a morphology also described for the Untermassfeld canid. However, the upper teeth morphology is similar to Canis arnensis, and only cranial features can help to distinguish both canid species (Sotnikova, 2001). Therefore, definite attribution to Canis mosbachensis cannot be yet established.

5.1.4. Carnivore biochronology

The carnivore assemblage from El Chaparral includes Canis cf. mosbachensis, Puma pardoides ssp. Vulpes cf. praeglacialis, Lynx sp., and a polecat-like mustelid, and is characteristic of the late Early Pleistocene. The first record of Puma pardoides is documented at Kavbebi (Georgia) dated to before 2.4 Ma, together with an associated mixed mammalian fauna from a region connecting Africa, Asia and Europe (Hemmer et al., 2004), Varshets (Bulgary) (MN 17zone; Spassov, 1997, 2003) and the Middle Villafranchian site of Saint-Vallier (France) are European sites with Puma pardoides (=Panthera schaubi = Viretalturus schaubi) placed between approximately 2.3 and 2.2 Ma. The Iberian fossil record of puma-like cats covers the whole known chronological distribution in Europe, from the Late Pliocene to the Early Pleistocene. Remains from Puebla de Valverde, Cueva Victoria and Vallparadís ranging from between 2.6 and 2.0 Ma (MNQ16-17) are referred by Madurell-Malapiera et al. (2010) to this felid. The Epivillafranchian record is covered by Untermassfeld (Germany) and Le Vallonnet (France), both placed within the Jaramillo subchron between 107 and 0.99 Ma., at an early part of the MNQ 20 (MIS 31-30).The youngest Eurasian puma record currently known is that from the Early Middle Pleistocene.
Stránská Skála (Moravia, Czech Republic; identified as a puma by Hemmer, 2001: 728).

If the occurrence of *C. mosbachensis* is confirmed, then a first appearance of this canid at Untermassfeld (Jaramillo Subchron between 1.07 and 0.99 Ma) (Kahlke, 1997; Sotnikova, 2001) would mark an older age limit. The age of Villány 3 (Villány-Kalkberg-Nord), where *V. praeglacialis* first occurs, marks an early time limit for this species, ranging from 2.0 to 1.5 Ma (Jánossy, 1986). Probably the fossil-bearing strata correspond to a rather long period of time with more than one faunal association (Spassov, 2000). It is broadly accepted that the Villány 3 long period of time with more than one faunal association (1986). Probably the fossil-bearing strata correspond to a rather long period of time with more than one faunal association (Spassov, 2000). It is broadly accepted that the Villány 3 assemblage matches with the Saint-Vallier Unit (MN 17 (Spassov, 2000). It is broadly accepted that the Villány 3 assemblage matches with the Saint-Vallier Unit (MN 17–18). *Vulpes cf. assemblage matches with the Saint-Vallier Unit (MN 17–18). Vulpes cf. praeglacialis* is coincident at two Sierra de Atapuerca sites of late Early Pleistocene age: Trinchera Elefante lower levels (TE7-14) (Carbonell et al., 2009) and Trinchera Dolina, (TD4, TD5, TD6) (García, 2003). Also, the Iberian Early Pleistocene record has yielded *V. praeglacialis* at Quibas and Venta Micena (Calero et al., 2006). Directly above the Matuyama-Bruhnes boundary, it is present in Stránska Skála (MIS 16–18), and at La Caune de L’Aragó (France) (Crégut Bonnoure, 1979), a Middle Pleistocene site of uncertain age, which might represent the last occurrence of this small-sized fox.

The last occurrences of *Puma pardoides* and *V. praeglacialis* at Stránská Skála (MIS 16–18, shortly after Brunhes–Matuyama transition at 0.78 Ma) bracket the likely age of El Chaparral. The evolutionary stage of the *Puma* remains from Chaparral is almost undistinguishable from the Untermassfeld specimen described by Hemmer (2001), suggesting a date for El Chaparral layers around 1 Ma, within the Jaramillo subchron. Pumas are nowadays well adapted to a variety of landscapes in the American continent, although they prefer mountainous or rocky environments. In view of its somewhat shorter hind limbs (Hemmer, 2001) *Puma pardoides* was possibly more restricted to the forest, woodland and bush.

### 5.2. Ungulates from El Chaparral

#### 5.2.1. Equus cf. suessenbornensis

Some remains from unit C2 include a proximal metacarpal and a first phalanx, but no teeth. The first phalanx is large and robust (Fig. 6). Different authors have different opinions on the classification, evolution and stratigraphic distribution of the European *Equus* (Azzaroli, 1990; Alberdi et al., 1998; Eisenmann, 1991; Forstén, 1998; Musil, 2001, etc.) and the scheme given in Fig. 6 can at most be considered to be an attempt to represent the major features. A group or lineage of gracile and mostly small forms is that of *Equus altidens, E. wuesti* and *E. hyduntinus*. *Equus stenonis* and related forms tend to be more robust and larger. Still larger robust forms include the “stenonid” (with v-shaped lingual fold in the lower cheek teeth) *Equus livenzovensis, E. major, E. bressanus* and *E. suessenbornensis* and the caballoid (with different lingual folds) *Equus ferus* (as well as its domestic descendant *E. caballus*). The proportions of the specimen from El Chaparral best fit the latter group. Material attributed to *Equus suessenbornensis* dates from the late Early Pleistocene to the earlier part of the Middle Pleistocene (about 600 ka), a temporal range which probably encompasses El Chaparral, while remains attributed to *E. ferus* (or other caballoid species or subspecies, such as *Equus mosbachensis* or *E. ferus mosbachensis*) date from about 500 ka onward. The preferred habitat of all these large robust forms is probably an open landscape.

#### 5.2.2. Stephanorhinus etruscus

Some remains of rhinoceros from units C1 and C2 include a first abaxial phalanx (from toe II or IV) (Fig. 7) and fragments of a calcaneum, fibula, femur and a metapodial, probably a third metatarsal. The first phalanx is very small for a rhinoceros. Apart from the very rare and gigantic *Elasmotherium*, the temporal distributions of the European rhinoceroses are indicated in Fig. 7, but it should be noted that Coelodonta arrived considerably later in Spain (around 100 or 200 ka), while Stephanorhinus kirchbergensis even may not have reached Spain (van der Made, 2010; van der Made and Gruber, 2010). The latter species is very large (Fig. 7), while the former was large or robust in most cases. *Stephanorhinus etruscus*, *Stephanorhinus hundsheimensis*, and *S. hemitoechus* have dentitions of more or less similar size (e.g. M3 size in Fig. 7).

Fortelius et al. (1993) recognized a small late Early Pleistocene form, which they considered similar or closely related to *S. hundsheimensis*, but which Lacombe (2006) believed to be more closely related to the late Early Pleistocene *S. jeanvireti*. Material from Atapuerca TD4 and TD7 shows that this form is dentally similar to *S. etruscus*, but the post-cranial skeleton appears to be smaller than either *S. hundsheimensis* or the typical *S. etruscus* as from Valdarno and Olivola (Fig. 7, phalanx 1). The material from El Chaparral belongs to this form, first documented from Pietrafitta (Mazza and Sala Fortelius, 1993; about 1.4 Ma) and last from Atapuerca TD8 (slightly younger than 0.78 Ma).

#### 5.2.3. Bison sp.

Some remains of a large bovid have been recovered from units C1 and C2. An upper molar has well marked buccal ribs and styles and a well-developed interlobular column, typical of most Bovini.
The temporal distribution of the European Bovini is indicated in Fig. 8. The small *Bubalus murrensis* is known from stage 5 and 9 localities in Germany and is assumed to have dispersed twice during an interglacial from China to Western Europe (von Koenigswald, 1986). Material from Megalopolis that has been assigned to *Bubalus* (Sickenberg, 1976) might be even slightly older. No post-cranial or dental material is known. Older material from southern Spain was assigned to *Bubalus* (Martínez-Navarro, 1992), but the dental and post-cranial morphology published (Moyà Solà, 1987) is very similar to that of *Leptobos*. This limits the comparison of the material from El Chaparral to *Leptobos*, *Bison* and *Bos*.

Though the molar from El Chaparral is worn, its crown seems to have been higher than in *Leptobos*. The P4 has a metaconid that is placed far behind the protoconid, but is better developed than in most *Leptobos*. The bones and teeth have sizes in the upper ranges of that genus, well below those of *Bos primigenius*, and are comparable to those of the smaller species of *Bison*, such as *Bison voigtstedtensis* and the earlier forms of *Bison schoetensacki*.

5.2.4. *Cf. Hemitragus bonali*

Some bones from unit C-4 have the morphology of the Caprinae: the medial side of the distal articulation of the humerus has a small radius of curvature, the metacarpal is robust and the articulations with the phalanges have the abaxial portion with an extensive dorsal surface and a very small radius of curvature, and the first phalanx is dorso-plantarly compressed (Fig. 9). The size of the specimens is inferior to that of *Soergelia*, *Praeovibos*, *Ovibos* (*Ovibovini*), but superior to that of *Rupicapra*. No (or little) post-cranial material is known from the Early Pleistocene Caprini. The robusticity of the metacarpal from El Chaparral cannot be calculated, but seems to be much more than in *Ovis*. The sizes of the metacarpal and phalanx are roughly in the upper ranges of *Hemitragus*, *Capra ibex* and *Capra caucasica*. The first phalanx of *Hemitragus* seems to have a wider range of robusticity than in *Capra* (at least in the specimens studied), which probably means that the anterior phalanges are clearly more robust than the posterior ones. The specimen from El Chaparral is also relatively robust as may occur in *H. bonali*.
Crégut-Bonnoure (2006) was of the opinion that *Capra dalii* from Dmanisi and *H. bonali* from Vallonnet might belong to *Hemitragus orientalis*. However, the material from Vallonnet (Jaramillo Subchron) is very similar to the accepted *H. bonali* from Hundsheim, and here it is taken as the first record of that species.

The Caprini are well adapted to mountainous or rocky environments. As was the case with other mountainous species, their distribution may have been wider during interglacial periods.

5.2.5. *Capreolus* sp.

A small unciform (width 11.7 mm and height 9.6 mm; Fig. 10) belongs to a ruminant of the size of *Capreolus*. The next largest deer are the *Dama*-like deer, which are clearly larger. The temporal distribution of *Capreolus* in Europe is indicated in Fig. 10, while *Procapreolus cusanus* is omitted (2 Ma).

The number of species recognized differs from author to author, but is irrelevant here, since a sole unciform does not allow for a more precise assignation.

5.2.6. *Dama cf. vallonnetensis*

A deer of approximately the size of the extant fallow deer is by far the most abundant large mammal. The surface texture of the antler and the pearling of the burr (Fig. 10) are similar to that of *Dama* and different of that of *Cervus* (Lister, 1996). There are widely different opinions on the late Early Pleistocene European *Dama*-like deer: they are considered to belong to *Euraxis*, *Axis*, *Rusa*, *Dama* or *Pseudodama*, and in particular to *Cervus* (s.l.) *nestii* *vallonnetensis*, *Dama* "*nestii" *vallonetensis* or simply *Dama vallonnetensis* (e.g. Croitor, 2006; Kahlke, 1997; van der Made, 1999, 2005). There is a size increase in the *Dama*-like deer from about 1.4–0.4 Ma, and the position of the first bifurcation in the antler becomes lower from the earliest Pleistocene to recent (van der Made, 1999, Fig. 11, 12). The small size and the position of the bifurcation of the antler (100 Hext/DAPb = 83) are compatible with *Dama vallonnetensis*, which is known between about 1.2 and 1.4 and 0.6 Ma and especially with the earlier samples.

5.2.7. Biochronology-ungulates

The first occurrence of *H. bonali* (at Vallonnet, Jaramillo Subchron, between 1.07 and 0.99 Ma) and *Capreolus* (at Untermassfeld, Jaramillo Subchron) and the last occurrences of *S. etruscus* (at Atapuerca TD8, shortly after the Brunhes–Matuyama transition at 0.78 Ma) bracket the likely age of El Chaparral.

5.3. Small mammals: materials, methods, biochronological and environmental data

The small-vertebrate fossil remains used for this study consist of disarticulated bone fragments collected by water-screening during the 2008 and 2009 excavation campaigns at El Chaparral. All the sediment (approximately 2000 kg) was water screened using superimposed 5 and 0.5 mm mesh screens, and bagged by layer.

The preliminary paleontological study of the small mammal of El Chaparral comprises at least 13 species (Fig. 11): 5 insectivores (*Erinaceus* sp., *Talpa* sp., *Crocidura* sp., *Sorex* sp., *Asoriculus*...
gibberodon), 1 bat (Rhinolophus ferrumequinum) and 7 rodents (Sciurus sp., Hystrix sp., Apodemus sp., Allophaiomys lavocati, Allophaiomys chalinei, Iberomys huescarensis and Pliomys episcopalis). As a whole, this small mammal assemblage is indicative of wet and open Mediterranean woodland areas, with the presence of Apodemus sp., Sciurus sp., Hystrix sp., Rhinolophus ferrumequinum, Erinaceus sp., Talpa sp. and Sorex sp. Crocidura sp. is indicative of dry areas and A. gibberodon of aquatic environments. The species A. gibberodon, A. lavocati, A. chalini, I. huescarensis and P. episcopalis became extinct before the end of the Early Pleistocene, and therefore these are the most characteristic elements in biochronological terms. The association of A. lavocati and A. gibberodon appears in other Iberian Early Pleistocene sites such as Trinchera Elefante 7-14 (TE7-14) in the Sierra de Atapuerca (Cuenca-Bescós et al., 2010; Rofes and Cuenca-Bescós, 2006; Rofes, 2009) and Barraco León D (BL-D) and Fuente Nueva 3 (FN3) in Orce (Agustí et al. in press, 2009; Furió, 2003; Furió, 2007). These localities are situated in a pre-Jaramillo chronology between ~1.1–1.5 Ma in the Allophaiomys lavocati biozone which may be included in the early Biharian of the mammal ages of the European biozonation (Cuenca-Bescós et al., 2001, 2010). The A. chalini, I. huescarensis and P. episcopalis association is present in the Early Pleistocene layers of the Gran Dolina (TD3-4 -14) in the Sierra de Atapuerca. These layers are situated in a Jaramillo-Matuyama-Brhunes chronology between ~0.9–0.78 Ma in the A. chalini biozone (Cuenca-Bescós et al., 2010), which may be included in the late Biharian mammal age, correlated with the Galerian. The absence in the small mammal assemblage of El Chaparral of advanced microtine species such as Stenocranius galgooides and Terricola arvalidens, together the nonappearance of ancient rodents forms such as Allophaiomys nutiensis and Castillomys rivas, also differentiates El Chaparral from TD3-4, TE7-14, BL-D and FN3. This association therefore suggests that the El Chaparral is older than TD3-4 and younger than TE7-14, BL-D and FN3, making it more similar to Cueva Victoria in Murcia (Gilbert et al., 2006; Blain et al., 2008; Agustí et al., 2009) and Huescar-1 in Granada (Mazo et al., 1985; Agustí et. al., in press), suggesting a date for El Chaparral layers around 1 Ma, in the Jaramillo subchron (Table 1).

5.4. Fossil amphibians and squamate reptiles: taxonomic classification; palaeobiogeographical and palaeoecological implications

To date, the palaeontological locality of El Chaparral has revealed a few fossil remains of amphibians and squamate reptiles. This association of herpetofauna is constituted of the fire salamander (Salamandra salamandra), a painted frog (Discoglossus sp.), a parsley frog (Pelodytes sp.), the common toad (Bufo bufo), the natterjack toad (Bufo calamita), the worm lizard (Blanus cinereus), some indeterminate lacertids (Lacertidae indet.), the southern
smooth snake (Coronella girondica), the Montpellier snake (M. monspessulanus) and Lataste’s viper (Vipera latasti). Noticeable is the abundance of a large size Salamandra salamandra in El Chaparral.

Today, the fire salamander populations of the Cádiz and Málaga Provinces (Sierra de Grazalema and Sierra de Ronda) correspond to a subspecies S. salamandra longirostris that is geographically isolated from the other Iberian salamanders. According to García-París et al. (1998), the Guadalquivir valley may serve as a geographical barrier between S. s. longirostris and the morenica-crespoi group, and divergence between these two clades may have be due to the formation of the Guadalquivir valley, during the Pliocene. For the other Iberian subspecies, the sub-speciation may have occurred in Pleistocene times (Joger and Steinfartz, 1994; Montori and Herrero, 2004).

From a palaeoenvironmental point of view, the large abundance of S. salamandra as well as of V. latasti may be indicative of a landscape mainly composed by a lateral variation of rocky areas (favorable to V. latasti, C. girondica, Pelodytes, B. calamita) and moist (mean annual precipitation higher to 800 mm) woody areas (deciduous trees) (favorable to S. salamandra, B. bufo, and in a minor way to B. cinereus). The occurrence of Discoglossus suggests the presence of still-water environment with good insolation.

Such an association of amphibians and squamate reptiles suggests a warm and humid climate, similar to the current one in Western Andalusia and to that in other Spanish Early Pleistocene localities such as the Sima del Elefante of Atapuerca, Burgos (Agustí et al., 2009; Cuenca-Bescós et al., 2010; Rodríguez et al., 2010), Barranco León D and Fuente Nueva 3, Granada (Agustí et al., 2009, in press; Blain et al. in press) and Quibas in Murcia (Montoya et al., 2001; Manchello et al., 2009).

To conclude, the locality of el Chaparral in the future will contribute some knowledge on the amphibians and squamates from the Early Pleistocene of the province of Cádiz and may furnish the first palaeontological data on the speciation phenomena that took place after the formation of the Guadalquivir valley at the end of the Pliocene and during the beginning of the Early Pleistocene in genus Salamandra, Discoglossus, Alytes, Pleurodeles, Lacerta lepida and Psammodromus (Carranza and Amat, 2005).

6. Taphonomic approach

The fossil association of El Chaparral is under study, and more than 500 fossils have been analyzed. Though a preliminary macroscopic observation was done, all surfaces were analyzed using stereomicroscope (Olympus EUROPE SZ11 ×110 magnification) and, when necessary, an ESEM (FEI-QUANTA 600).
Table 1  
Biochronological proposed location of the Sierra del Chaparal.

<table>
<thead>
<tr>
<th>Chronology</th>
<th>MA</th>
<th>Biozones</th>
<th>Archeo-Paleontological sites</th>
<th>Mammalian Chronology M&amp;S07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Pleistocene</td>
<td>Jaramillo</td>
<td>1.3</td>
<td>TD3-TD4,Cuerva Victoria, El Chaparral, Huescar-1</td>
<td>Small Mammal Galerian</td>
</tr>
<tr>
<td></td>
<td>Pre-Jaramillo</td>
<td>1.1</td>
<td>Quibas, TE7-14, BL-D, FN3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Allophaiomys lavacoti</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correlation of the European Chronology (Gibbard and Kolfschoten, 2004; Gibbard and Marakova, 2007; Maul et al., 2007) with the principal Early Pleistocene archeo-paleontological sites in the Iberian Peninsula (TD3-TD4: Cuenca-Bescós et al., 1995; 2001; 2010; Cal Guardiola: Berastegui et al., 2000; Agustí et al., 2009; Amenara Casa-blanca 3: Agustí and Galobart, 1986; Agustí et al., 2009; Cueva Victoria: Gibert et al., 2006; Blain et al., 2008; Agustí et al., 2009; El Chaparral: from this work, Huescar-1: Mazo et al., 1985; Agustí et al., in press; Quibas: Montoya et al., 2001; Agustí et al., 2009, TE7-TE14: Cuenca-Bescós and García, 2007; Cuenca-Bescós et al., 2010; BL-D and FN3: Agustí et al., 2009; in press), the biozones established by Cuenca-Bescós et al. (2010) and the mammalian chronology (last synthesized by Masini and Sala, 2007).

7. The Chaparral in the context of biological refuge in the south of the Iberian Peninsula in the Early Pleistocene

The well-known Milankovich cycles have had important effects on the distribution of flora, fauna and early humans (Menocal, 1995; Shackleton, 1995; van der Made, 2010). Between 1.2 and 0.9 Ma the eccentricity cycle became more important in global climate, causing glacial cycles of approximately 100 ky duration. This changed the North Eurasian and North American biogeography in a fundamental way: during the cold periods the taiga disappeared and the tundra and steppe fused into a habitat called the "mammoth steppe", which extended from France to Alaska (Guthrie, 1990), and which was inhabited by the "glacial fauna" consisting of mammoths, musk oxen, reindeer, woolly rhinoceroses, lemmings, etc.. During warm periods, these animals survived in a variety of habitats, including tundra, steppe and mountainous habitats, while the "interglacial fauna", including fallow deer, boars (Sus scrofa), and straight-tusked elephants (Elephas antiquus), spread from their refugia into extensive areas of mid-latitude Eurasia. A number of "interglacial" species are known from western but not from eastern Eurasia (like Dama), which proves that their refugia were in western Eurasia. The Iberian Peninsula, Italy and the Balkans were such refugia.

This change from a more stable biogeography to an alternation of cold and temperate environments with their respective faunas is related to a major faunal turnover with dispersals of new taxa during each cycle, and often twice per cycle. The dispersal of Homo antecessor into Western Europe seems to have coincided with the onset of this series of dispersals (van der Made, 2011). There has been discussion on whether human presence in Europe may have been continuous during the late Early and early Middle Pleistocene (e.g. Dennell and Roberts, 1996), and it has been suggested that if Spain was a refugium for interglacial mammals, it also may have been a refugium for early humans (van der Made, 1999).

The data which allows establishment of an approximate age of the karst filling of the Chaparral paleontological site proceeds mainly from the study of the association between micro mammalian and amphibian fossils, typified in the Early Pleistocene of the Iberian Peninsula and their relation to the rest of the macrafauna. This provides parallel ages for the different macrofauna taxa (Agustí et al., 2009; Furió, 2003, 2007, Gibert et al., 2006; Rofes and Cuenca-Bescós, 2006; Blain et al., 2008; Cuenca-Bescós et al., 2009; Furió, 2007; Rofes, 2009; Agustí et al. in press; Montoya et al. 2001). The chronology of these species, confirmed by the vertebrate microfauna, in the context of the Early Pleistocene corroborates the biographical and bioclimatic role that the south of the Iberian Peninsula — particularly the basins of the hydrographical network of the Guadalquivir, Guadalete and the “Arch of Gibraltar”, played as a biological refuge when faced with the climatic cooling in the
Iberian Peninsula from the Early Pliocene to the Holocene (Giles and Finlayson, 2000; Finlayson et al., 2007).

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