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A new Ruscinian site in Europe: Baza-1 (Baza basin, Andalusia, Spain)

Un nouveau gisement ruscinien en Europe : Baza-1 (bassin de Baza, Andalousie, Espagne)

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ABSTRACT

The Guadix–Baza depression (southeastern Spain) preserves one of the best continental Plio-Pleistocene records of the European continent. The new site, Baza-1, is the first Ruscinian locality with fauna of large vertebrates known in the basin. During the summer seasons of 2001, 2002, 2015 and 2016, systematic excavations were undertaken in the site over an area of 25 m^2, which provided > 400 fossil remains of Ruscinian mammals. The faunal assemblage is diverse, comprising 17 genera. Rodentia are represented by *Ruscinomys* sp., *Apocricetus barrierei*, *Debruijnimys julii*, *Apodemus gorafensis*, *Castillomys gracilis*, *Occitanomys* cf. *brailloni*, *Paraethomys meini*, *Paraethomys* aff. *abaigari*, *Stephanomys cordii*, *Trilophomys* cf. *castroi* and *Eliomys* aff. *intermedius*. Large mammals are represented by two proboscideans, *Anancus arvernensis* and *Mammut borsoni*, the rhino *Stephanorhinus* sp. cf. *S. jeanvireti*, the equid cf. *Hipparion* sp., two bovids, a large sized *Alephis* sp. and a small-to-middle sized Bovidae indet. (cf. *Antilope* sp.), and a middle sized deer, Cervinae indet. This record is completed by the presence of a chelonid, Testudinae indet. Biostratigraphic data from micro and macromammals suggest an age for the assemblage between 4 and 4.5 Ma.

Mots clés :
Dépression de Cadix–Baza
Pliocène
Mammut borsoni
Anancus arvernensis

RÉSUMÉ

La dépression de Cadix–Baza (Sud-Est de l'Espagne) préserve l'un des meilleurs registres continentaux du Plio-Pléistocène pour le continent Européen. Le nouveau gisement de Baza-1 est la première localité ruscinienne à faune de grands vertébrés, reconnue dans ce bassin. Durant les étés de 2001, 2002, 2015 et 2016, des fouilles systématiques ont été

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menées dans le site de Baza-1 sur une surface de 25 m^2, et ont fourni plus de 400 restes fossiles de mammifères d'âge ruscinien. L'association faunique est diversifiée, comprenant 17 genres. Les rongeurs sont représentés par *Ruscinomys* sp., *Apocricetus barrierei*, *Debruijnimys julii*, *Apodemus gorafensis*, *Castillomys gracilis*, *Occitanomys* cf. *brailloni*, *Paraethomys meini*, *Paraethomys* aff. *abaigari*, *Stephanomys cordii*, *Trilophomys* cf. *castroi* et *Eliomys* aff. *intermedius*. Les grands mammifères sont représentés par deux proboscidiens, *Anancus arvernensis* et *Mammut borsoni*, le rhinocéros *Stephanorhinus* sp. cf. *S. jeanvireti*, l'équidé cf. *Hipparion* sp., deux bovidés, un de grande taille, *Alephis* sp., et un de taille petite à moyenne Bovidae indet. (cf. *Antilope* sp.), et un cervidé de taille moyenne, Cervinae indet. Ce registre est complété par la présence d'un chélonien, Testudinae indet. Les données biostratigraphiques des micro- et macromammifères suggèrent un âge compris entre 4 et 4,5 Ma pour cet assemblage.

1. Introduction

The early Pliocene continental site of Baza-1 is located in the Guadix–Baza depression (Betic Cordillera, Andalusia, SE Spain) near the town of Baza, in the ravine of "Seguidillas–Cuesta del Francés", which is placed in an area locally known as "Las Arrodeas" (Fig. 1). The site was discovered in 1996 by one of the authors of this paper (BMN). Up to this year, five paleontological field studies have been carried out at the site, including a geological and paleontological survey in 1999, two small excavations of 3×3 m during the years 2000 and 2001, and two systematic excavations in 2015 and 2016. By the moment, ~ 25 m^2 have been excavated and ~ 400 vertebrate fossil remains have been unearthed.

The continental sedimentary record of the Baza basin shows six sedimentary units of lacustrine origin deposited from the latest Miocene to the middle Pleistocene (García-Aguilar and Martín, 2000; García-Aguilar and Palmqvist, 2011). Depending on the interval considered, these deposits are mainly composed of marls, carbonates or gypsiferous evaporites, showing lithological, mineralogical and geochemical features that evidence intense, tectonically induced hydrothermal activity. The supply of hot waters was particularly intense during the early Pleistocene, as indicated by the high concentrations of strontium and sulphur as well as the abundance of travertines and magnesium clays. This evidences the presence of warm conditions throughout the year and a high level of organic productivity, which allowed the development of a rich and well diversified mammalian community in the Baza basin (García-Aguilar et al., 2014, 2015).

The Guadix–Baza depression preserves the most complete mammalian record of the circum-Mediterranean area, ranging in age from the latest Miocene until the latest middle Pleistocene. The best-studied deposits correspond to the middle and late Villafranchian. These are especially well represented in the Orce area, with sites such as Venta Micena, which has a chronology of ~ 1.6 Ma and has provided a record of > 17,000 fossils of large mammals unearthed from a surface of ~ 370 m^2. However, it should be noted that this site has a potential of more than a million of fossiliferous square meters to be excavated (Espigares, 2010; Martínez-Navarro, 1991). In addition, there are a couple of sites in the vicinity of Orce, Barranco León and Fuente Nueva 3, which are both somewhat younger (~ 1.4 Ma) than Venta Micena and preserve the oldest evidence of human presence in western Europe, including huge tool assemblages of Oldowan tradition, abundant cut marks on large mammal bones and a human deciduous tooth in the case of Barranco León (see reviews in Espigares et al., 2013; Toro-Moyano et al., 2013). In spite of its exceptional Pleistocene record, no Ruscinian locality with large mammals was known in the Baza basin until the discovery of Baza-1. This situation is normal in Europe, where early Pliocene large mammals sites in the time interval comprised between 5.3 and 3.4 Ma (Ruscinian) are rather scarce.

The best known localities are Çalta (in the Asian part of Turkey, close to Ankara), with an age close to 4 Ma (MN15) (Sen et al., 1998), Megalo Emvolon in Greece (Arambourg and Piveteau, 1929; Koufos and Kostopoulos, 1997), Malusteni (MN15a), Capeni and Varghis (MN15b) in Romania (Radulescu et al., 2003), Ivanovce and Hajnacka I (MN16a) in Slovakia (Fejfar et al., 2012), several localities in the area of Roussillon in France, Val de Pugna in Tuscany, Italy with a chronology of MN15-MN16 (Bianucci et al., 2001), several sites with MN14 and MN15 chronologies in Russia (Pevzner et al., 1996), Dorkovo in Bulgaria with an age close to 4.5 Ma (Metz-Muller, 2000; Radulescu and Crégut-Bonnoure, 1997; Spassov, 2005; Thomas et al., 1986) and Vialette in the French Massif, with a younger chronology (3.2 Ma) and a very interesting faunal association (Lacombat et al., 2008).

In the Iberian Peninsula, Ruscinian deposits are present in Alcoy, Alicante (MN14) (Montoya et al., 2006), La Calera, in the Calatayud–Teruel basin, and Layna, in Soria (Alberdi and Alcalá, 1989–1990; Alcalá et al., 1989–1990; Azanza and Menéndez, 1989–1990). Another interesting Pliocene site in Spain is Camp dels Ninots, in the maar of Caldes de Malavella (Girona), with a chronology of ~ 3.2 Ma (early Villafranchian), in which skeletal remains in anatomical connection of several individuals from different species have been recovered (Campeny Vall-Llosera and Gómez, 2010; Gómez De Soler et al., 2012).

Other deposits close to Baza-1 with a similar age include Barranco de las Quebradas and Huéscar 3, both in Huéscar (Martínez-Navarro et al., 2006; Mazo et al., 1985), and Zújar (Agustí and Oms, 1998), although the large mammal record recovered from these sites is less abundant than in Baza-1.

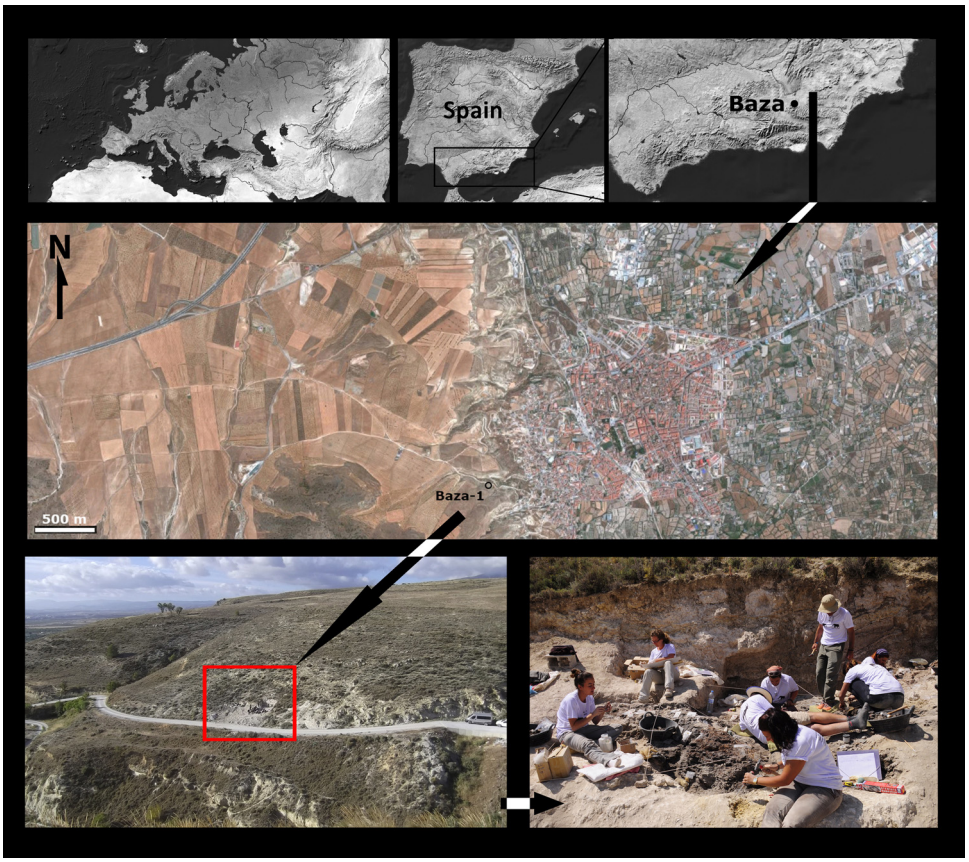

Fig. 1. Geographic localization of Baza-1 site.
Fig. 1. Localisation géographique du gisement de Baza-1.

Finally, there are some localities of the Guadix–Baza basin that only preserve microfaunal remains (Guerra-Merchán et al., 1991, 2013; Minwer-Barakat et al., 2012).

2. Geology

Two major lithological sets can be differentiated in the Baza sector (Fig. 2). The oldest set is characterized by the presence of Triassic carbonate rocks (limestones, dolomite, limestone-marls and marls), phyllites, quartzites and calc-schists. These rocks outcrop in the Sierra de Baza and belong to the Alpujárride Complex of the Internals Zones of the Betic Cordillera (Delgado, 1978). They represent the basement of the post-orogenic infillings of the Guadix–Baza depression, which was formed at the beginning of the late Miocene. Late Miocene-Quaternary post-orogenic deposits characterize the youngest lithological set in this sector and are discordantly deposited over the basement. Within this set, two major Stratigraphical Units have been differentiated, the Tortonian marine deposits at the base, which were deposited in fan deltas, shores and shallow shelf environments (Fernández and Guerra-Merchán, 1996; Guerra-Merchán, 1993; Guerra-Merchán et al., 1988), and the uppermost Miocene–middle Pleistocene continental sediments, which are discordantly deposited above the previous unit and the basement of the basin.

In the Baza area, the continental deposits belong to the two characteristic formations: the Guadix Formation of alluvial and fluvial origin, and the Baza Formation of lacustrine origin (García-Aguilar, 1997; Vera, 1969, 1970a, 1970b; Viseras, 1991). These two formations are related by lateral and vertical changes of facies (Fig. 2). A third lithological unit, consisting of alluvial conglomerates, is discordantly placed above the two previous units and represents the last deposits of the basin. A glacis surface appears above this unit, with an average altitude of 1000 m.

In the studied area, Guerra-Merchán (1993) distinguished two lithological members within the Baza Formation, separated by the Baza Fault, which shows a predominantly NNW–SSE orientation and a normal component (Alfaro et al., 2008). The limestone–marly member outcrops in the raised tectonic block, located to the west of the fault, while the marly–silty member outcrops in the sunken block, located to the east (Fig. 2). The limestone–marly member has been dated to the latest Miocene – earliest Pliocene based on nine micromammal sites (Guerra-Merchán and Ruiz Bustos, 1991; Guerra-Merchán et al., 1991), and includes the top of the MN13 biounit, the complete MN14 and the lower part of the MN15 biounits (the latter two belong to the Ruscinian). The other member is located in the Areba site (Guerra-Merchán and

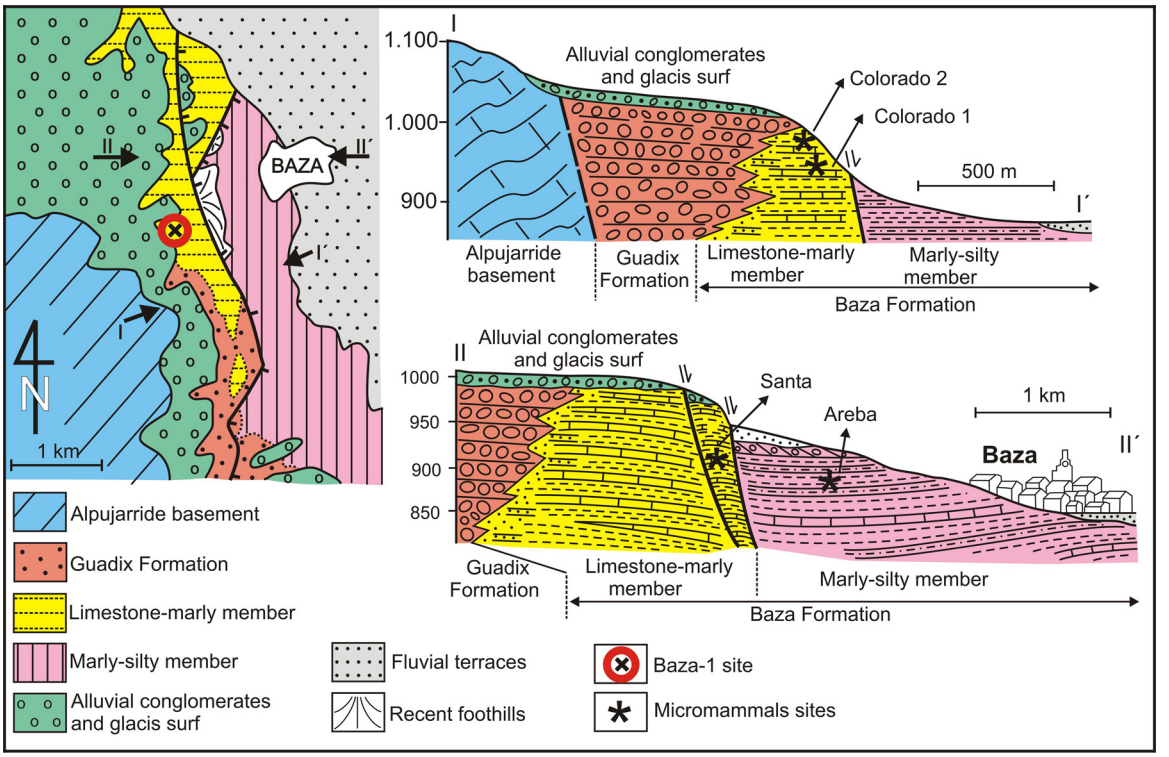

Fig. 2. Geologic map and sections of the Baza area.
Fig. 2. Carte géologique et sections de la zone de Baza.

Ruiz Bustos, 1991) and its age corresponds to the late Villafranchian (MN17 biounit).

The Baza-1 site is located in the limestone-marly member, which is ≥ 80 m thick in the studied sector (Fig. 3). The first 25 m are composed of massive marlstones interspersed with levels of marly limestones, limestones and dark levels. Part of this section is covered by hillside debris. The following 10 m are composed of nine lacustrine shallowing-upward cycles, consisting of marls at the bottom and limestone-marls or limestones at the top. The next interval (15 m thick) is composed of seven shallowing-upward cycles and is very similar to the previous section, although in this case there are some fine detrital facies intercalated (brown or grey laminate clays and marly-silts). The upper interval, where the site is located, shows four dark levels with abundant remains, which are not reactive to hydrochloric acid, and several brown laminated clay levels. The lower dark level, 50 cm thick, corresponds to the Baza-1 site.

The lithological sections of the site and of the overlying levels represent also several shallowing-upward cycles, which are affected by slumping and both syn-sedimentary and post-sedimentary deformations. Warped surfaces originated from slipping are frequent. These phenomena are recognizable in the stratigraphic column between 48 and 68 m, approximately, and show a lateral extension of 400-500 m in north–south direction and 100 m in east–west direction. At some points of this section, the slipped materials are covered by younger red deposits, which are composed of 5-m-thick conglomerates with a clayey matrix that show a chaotic appearance.

The last 12 m are composed of six cycles of calcilutites and silts at the bottom and compact stratified limestones at the top. The stratigraphic series ends with a glacis surface, which implies that the highest part of this unit was eroded.

The sedimentary context of the early Pliocene deposits, in which the Baza-1 site is located, corresponds to alluvial fans (Guadix Formation) originated at the base of the high reliefs of Sierra de Baza mountains. Towards the east, these deposits are distally connected with a lacustrine environment where the limestone-marly member of the Baza Formation was deposited. The shallowing-upward cycles are conditioned by periodic changes in the water table of the lake.

The presence of red and grey conglomeratic deposits situated at the lake edge corresponds to the minimum extension of the lake environment, thus evidencing the changes in the water table through the stratigraphic column. Shallowing-upward cycles are related with allocyclic factors (i.e. Milankovitch climatic cycles), as suggested by García-Aguilar et al. (2013) for similar deposits of the same age in other sectors of the basin (e.g., Gorafe, Fonelas or Huéscar). During moments of low depth and little or no detrital input, marshy environments were occasionally developed. In this environment, dark clay levels with plant remains were deposited and use to preserve vertebrate fossils, as in the case of Baza-1.

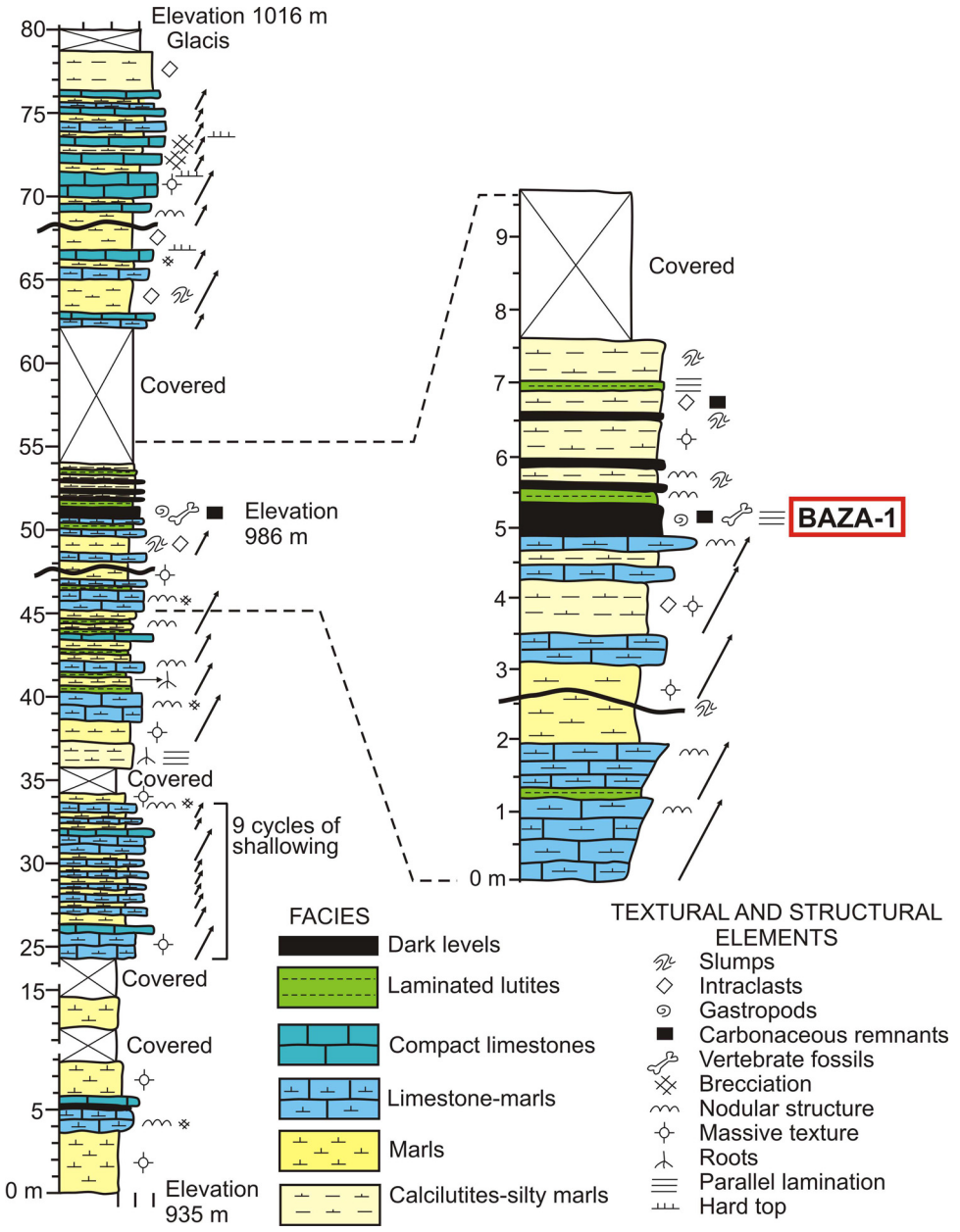

Fig. 3. Stratigraphical column of Baza-1 site.
Fig. 3. Colonne stratigraphique du gisement de Baza-1.

3. Fauna

Faunal remains come from a one-meter thick black and grey level. The density of fossils by square meter is high, since bones cover up to 50% of the total excavated surface. Their preservation is not good, as the bones are fractured and crushed by tectonic and diagenetic processes related with the slumping of the original deposit. In addition, most of the excavated area is very close to the current topographical surface and fossils are affected by atmospheric agents and plant roots.

The faunal list is composed of the following taxa (Martínez-Navarro et al., 2015; Piñero et al., 2016; Ros-Montoya, 2010): *Ruscinomys* sp., *Apocricetus barrierei*, *Debruijnimys julii*, *Apodemus gorafensis*, *Castillomys gracilis*, *Occitanomys* cf. *brailloni*, *P. meini*, *Paraethomys* aff. *abaigari*, *S. cordii*, *Trilophomys* cf. *castroi*, *Eliomys* aff. *intermedius*, *Mammut borsoni*, *Anancus arvernensis*, *Stephanorhinus* sp. cf. *S. jeanvireti* cf. *Hipparion* sp., *Alephis* sp., Bovidae indet. small-middle size (cf. *Antilope* sp.), Cervinae indet., and Testudinae indet. This faunal association indicates that Baza-1 is located on the boundary between the MN-14 and MN-15

biounits, with an age of 4–4.5 Ma (Ruscinian). Remains of insectivores and lagomorphs are under study. No carnivore remains have been documented at the site by the moment.

4. Rodent fauna

The preliminary study of the micromammal remains (Piñero et al., 2016; Piñero et al., submitted) evidences the presence of a huge rodent assemblage, including 405 identified teeth that represent a minimum of eleven taxa: *Ruscinomys* sp., *A. barrierei*, *D. julii*, *A. gorafensis*, *C. gracilis*, *Occitanomys* cf. *brailloni*, *P. meini*, *Paraethomys* aff. *abaigari*, *S. cordii*, *Trilophomys* cf. *castroi* and *Eliomys* aff. *intermedius*.

The coexistence of a large-sized *Paraethomys* (*P.* aff. *abaigari*) with a small-sized form of this genus (*P. meini*) has been cited in other Ruscinian localities, including Sête type (Michaux, 1969) and other sites of the Teruel and Granada basins (Adrover, 1986; García-Alix et al., 2008). In addition, the presence of *A. barrierei* indicates an early Ruscinian age. As far as other localities of the Guadix–Baza depression are concerned, the assemblages from Gorafe 2, 3, 5 with the presence of an arvicolid identified as *Dolomys occitanus*, and Galera-C and Tollo de Chiclana-1 with *Dolomys adroveri* indicate a younger age than Baza-1 for these sites (MN15 biounit) (Agustí and Martín-Suárez, 1984; Agustí et al., 1997; Minwer-Barakat, 2005). In contrast, the presence of *Apodemus gudrunae* and *Apocricetus alberti* in Botardo-C, as well as the presence of *Debruijnimys almenarensis* and *Myocricetodon jaegeri* in Negratín-1, indicate an older age for these sites (late Miocene, MN 13 biounit) (Freudenthal et al., 1998; Martín-Suárez, 1988; Martín-Suárez and Mein, 1998; Minwer-Bararat et al., 2009 and references there in).

The assemblage of Baza-1 is very similar to those of Gorafe A, Gorafe-1, Gorafe-4 and Yeguas from the Guadix basin, all of them placed within the *Trilophomys* biozone (Minwer-Barakat et al., 2012). Baza-1 can be assigned to the MN14 biounit and is characterized by the presence of *A. barrierei*, *S. cordii*, *C. gracilis*, *A. gorafensis*, *P. meini* and *Trilophomys*. However, the coexistence of two *Paraethomys* species in Baza-1 is a remarkable difference with these sites. This can be used for correlating Baza-1 to the *Paraethomys* + *Promimomys* biozone from the Teruel Basin (Mein et al., 1990), which is placed immediately below the *Trilophomys* biozone from the Guadix basin, although it should be remembered that there may be differences in the composition of the faunal assemblages between inland and coastal basins. For this reason, Baza-1 can be tentatively considered as the first locality of this age in the Guadix–Baza depression.

5. Materials and methods

In this paper, we will focus on the dental remains of large mammals from the site of Baza-1, which are the most abundantly preserved and are key for taxonomic identification. In addition, postcranial remains of a genus of which no dental remains have been yet recovered is also described. As noted before, the bones are not well preserved in the site due to taphonomic reasons and most of them do not have good anatomic resolution. The fossils are housed in the "Museo Arqueológico de Granada".

Most of the described materials were recovered during the dig seasons of 2015 and 2016; part of the fossils is being restored and has not been analysed. The materials from the 2000 and 2001 dig seasons are badly preserved and only some dental remains are identifiable.

Metric data were collected with digital callipers and the measurements are given in mm.

Abbreviations: BA-1: Baza-1 site; MDD: tooth mesio-distal diameter; BLDa: average bucco-lingual diameter; Hc: crown height; Ha: average height; E: average enamel width; TM: mesial talonid; ML1L2, L3, L4, L5: number of lophids; TD: distal talonid; BLD: bucco-lingual diameter; HL: lophid height; R1R2, R3: number of ridges; MLD: middle-lateral diameter; APD: antero-posterior diameter; L diastema: length of diastema; L: length; W: weight; T: thickness; HDL: distal lobe height; HML: mesial lobe height; LT: total length; H p3: mandible height in p3; H m1: mandible height in m1; H m2: mandible height in m2; L p2-m3: mandible length between p2-m3; L p2-p4: mandible length between p2-p4; L m1-m3: mandible length between m1-m3; L diastem: length of diastem.

Order Proboscidea Illiger, 1811
Family Gomphotheriidae Hay, 1922
Genus ***Anancus*** Aymard, 1855
Species *Anancus arvernensis* (Croizet and Jobert, 1828)

Material: Maxilla with left M2-M3 and right M3 (BA-1 2000 sn2).

The maxilla (BA-1 2000 sn2) is composed of the second left molar and both third molars; the latter teeth are well preserved, but the second molar is broken and only preserves the posterior root. This palate corresponds to an adult individual (Ros-Montoya, 2010).

Left M2: an incomplete and badly preserved tooth that only preserves two lophids and the distal talonid. It shows an advanced degree of wear, mainly in the anterior zone. According to the morphometric characters, this molar was formed by four lophids. The enamel layer is thick and cement is absent. In occlusal view, the semilophids alternate in position, exhibiting a clear anancoidy. The talonid consists of five cuspids (Fig. 4, Table 1).

Right and left M3: these molars are complete and well preserved; they are composed of five lophids together with the mesial and distal talonids. Both molars show an early wear stage, which is only evident in the anterior zone. This implies that the maxilla belongs to an adult individual. Each semilophid is formed by the main conid and some small conelets. The enamel is thick and there is no cement. In occlusal view, the semilophids alternate in position, exhibiting a clear anancoidy. The mesial talonid consists of four aligned cuspids, and the distal one shows four disorganized cuspids (Fig. 4, Table 1).

During the last dig season, a molar fragment of this species identified as a talonid of a second or third lower molar was unearthed.

Fig. 4. *Anancus arvernensis* molars. Left M/2. A. BA-1 2000 sn2A; left M/3. B. BA-1 2000 sn2B. C. Right M/3 BA-1 2000 sn2C. 1: occlusal view, 2: lingual view; 3: buccal view. The scale bar represents 10 cm.
Fig. 4. Molaires d'*Anancus arvernensis*. M/2 gauche. A. BA-1 2000 sn2A. M/3 gauche. B. BA-1 2000 sn2B. C. M/3 droite BA-1 2000 sn2C. 1 : vue occlusale, 2 : vue linguale ; 3 : vue buccale. L'échelle représente 10 cm.

Table 1
General measurements of tooth remains of *Anancus arvernensis*.
Tableau 1
Mesures générales des restes dentaires d'*Anancus arvernensis*.

M2

			T_M	L_1	L_2	L_3	L_4	T_D
BA-1 2000 sn2A	Side	Left						
	MDD	138.7				32.48	20.9	16.03
	BLD	83.27				79.6	81.7	63.92
	H_L					37.6	40.95	47.83
	H_T	109.45						
	e	6.49				6.58	7	5.88

M3

			T_M	L_1	L_2	L_3	L_4	L_5	T_D
BA-1 2000 sn2B									
	Side	Left							
	MDD	198.09	14.57	30.28	35	39	34.74	29.27	24.31
	BLD	88.62	74.2	86.46	85.33	87.63	83.74	75.51	58.16
	H_L	–	22.66	42.13	40.34	43.35	44.76	35.87	18.82
	H_T	72.38							
	e	6.74	7.07	7.9	5.25				
BA-1 2000 sn2C	Side	Right							
	MDD	198.46	13.6	33.38	32.92	34.49	34.48	30.85	23
	BLD	92.42	66.65	83.71	87.24	84.28	81.18	74.48	58.08
	H_L	–	24.29	44.83	51.63	48.54	41.49	30.95	25.62
	H_T	71.69							
	e	6.2	7.27	6.09	5.22				

A. arvernensis is a species frequently preserved in the European record, with a wide stratigraphic range in the Pliocene and the early early Pleistocene. *Anancus* is typical of wooded environments (close habitat) and has been interpreted as a browser with a diet composed of bark, twigs, seeds and fruits (Athanassios, 2016; Rivals et al., 2015), which provides palaeoecological information on the Baza-1 site during the Ruscinian.

Family Mammutidae, Hay 1922
Genus ***Mammut*** Blumenbach, 1799
Species *Mammut borsoni* (Hays, 1834)

Material: two left and right m1 (BA-1 2000 O11 No. 4A, and BA-1 2000 O11 No. 4B), two left m2 (BA-1 2000 Ñ11 No. 12 and BA-1 2000 Ñ12 No. 1A) and one left M3 (BA-1 2000 Ñ12 No. 1B).

Five molars of *M. borsoni* were recovered during 2000 and 2001 (Fig. 5), (Ros-Montoya, 2010). In addition, a complete mandible was unearthed during the dig season of 2015 (Fig. 6). The right and left M/1 (BA-1 2000 O11 No. 4A and BA-1 2000 O11 No. 4B) are complete and not well preserved. The left molar preserves the roots. Both molars belong to the same subadult individual (Table 2). The teeth show a wide crown, where three transversal lophs can be clearly distinguished; the enamel is thick. The anterior cingulum is clear and crushed. The molars show a non-accentuated wearing stage, which is only visible in the first and second ridges. The median sulcus is present around all transversal lophs. The syncline between the second and third ridges is V-shaped and the one between the first and second is curved towards the anterior side. The zygodont crest is not visible in the two molars. The second ridge is wider than the first and third ones.

The left and right m2 (BA-1 2000 Ñ11 No. 12 and BA-1 2000 Ñ12 No. 1, respectively) probably represent a subadult individual (Table 2). The left m2 is well preserved, showing a wide crown and is composed of three transversal lophs, which are more or less perpendicular to the sagital axis of the tooth. The anterior cingulum is marked. Wear is incipient and only visible in the mesial ridge. The median sulcus is present on all transversal lophs. The synclines between the first and second ridges and between the second and third ridges are both V-shaped. The zygodont crest is hardly visible in the tooth. The second ridge is slightly wider than the first and third ones. The tooth is typically trilophodont.

The right m2 is badly preserved, showing a wide crown and only one transverse loph, the first ridge and a fragment of the second. Wear is minimal. The syncline between the first and second ridges is V-shaped. This tooth fragment shows the same degree of wear and dimensions than the previous one (BA-1 2000 Ñ11 No. 12). Therefore, both molars probably belong to the same subadult individual.

The left M3 (BA-1 2000 Ñ12 No. 1B): It is a badly preserved molar fragment, with a wide crown composed of one transverse loph and a half of the second. Wear is minimal. The syncline between the first and second ridges is V-shaped. It probably belonged to an adult individual. The second ridge is wider than the first (Table 2).

M. borsoni belongs to the proboscidean Family *Mammutidae*, which comprises three genera, *Eozygodon* (early Miocene), *Zygolophodon* (early-middle Miocene) and *Mammut* (late Miocene-early Pleistocene) (Tsouskala, 2000). The genus *Mammut* is poorly represented in the European sites and is interpreted as an open habitat dweller with a browsing diet. There are other sites, for example Norwich Cage, in which *A. arvernensis* coexisted with another proboscidean, *Mammuthus meridionalis* (Saarinen and Lister, 2016). In this site, *M. meridionalis* had a mixed diet that included some browse and huge amounts of grass, which probably happened also in the case of Baza-1. These data, together with the dental features previously described of *A. arvernensis*, indicate different dietary niches for both megafaunal species, which allowed them to avoid ecological displacement.

During the 2015 dig season, a mandible of this species was unearthed. However, this element is pending of restoration and was excluded from the study (Fig. 6). Finally, several remains of the Order Proboscidea were found in the last two excavation seasons. These materials, together with the mandible of *M. borsoni*, are pending of restoration and have not been included in the present study.

Order Perissodactyla Owen, 1848
Family Rhinocerotidae Owen, 1845
Genus ***Stephanorhinus*** Kretzoi, 1942
Species *Stephanorhinus* sp. cf. *S. jeanvireti* Guérin, 1972

Material: right m2 (BA-1 2001 O10 No. 8); right m3 (BA-1 2015 N9 No. 35) and Mtt. II (BA-1 2000 sn1).

The family Rhinocerotidae is represented in the Baza-1 site by few remains, two molars and one metatarsal fragment (Fig. 7, Table 3). During the last dig season (2016), three new fossils of this species were recovered, including a phalanx, a tooth fragment and a complete M3. However, these remains are currently under restoration and are not included in this study. The molars do not preserve the roots, wear is minimum in the m2 and more advanced in the m3. The m2 preserves the mesial and distal lobules as well as both valleys; the metaconid and hypoconid are still isolated. The anterior valley is V-shaped and the posterior one is U-shaped. The difference in crown height between the bottoms of the two valleys is clearly visible in both molars. According to the wear stage, these teeth belong to two different individuals.

In this time frame, the European record shows the presence of only one species of Rhinocerotidae (Lacombat, 2007), *Stephanorhinus jeanvireti*. The few remains of this lineage found in Baza-1 fall, from a morphological point of view, within the variability of this species and have been classified as *Stephanorhinus* sp. cf. *S. jeanvireti*. Given that these remains are currently under restoration, they have not been metrically analysed by the moment.

Family Equidae Gray, 1821
Species cf. *Hipparion* sp.

Material: one lunar (BA-1 2015 O12 No. 5B). The measurements of this bone are 28.9 mm (H), 28.4 mm (MLD) and 16.8 mm (APD_{MAX}).

The only remain that could be ascribed to the family Equidae is a fragment of a left lunar. Although the morphology of this lunar is typical of the equids, such element is not diagnostic and allows a taxonomic approximation only at the genus level. It has been tentatively classified as cf. *Hipparion* sp., the equid genus present in Europe during the Ruscinian.

Table 2
General measurements of dental remains of *Mammut borsoni.*
Tableau 2
Mesures générales des restes dentaires de *Mammut borsoni*.

m1

				R_1	R_2	R_3
BA-1 2000 O11 No. 4B	Side	Right				
	MDD	97.04				
	BLD	79.04	MDD	31.61	32.66	30.58
	H	130.02	BLD	66.52	70.24	66.51
	H_c	39.18	*H*	21.28	25.32	27.7
	e	3.34	*e*	3.6	2.91	–
BA-1 2000 O11 No. 4A	Side	Left				
	MDD	97.63				
	BLD	78.86	MDD	29.63	30.55	25.87
	H	70.28	BLD	68.2	72.01	69.4
	H_c	41.45	*H*	19.11	25.5	28.02
	e	3.25	*e*	3.69	3.46	2.87

m2

				R_1	R_2	R_3
BA-1 2000 Ñ11 No. 12						
	Side	Left	MDD	40.85	38.12	40.41
	MDD	120.34	BLD	77.57	79.78	76.11
	BLD	88.09	H	30.58	36.98	29.48
	H	66.01	*e*			
BA-1 2000 Ñ12 No. 1A	Side	Right	MDD	39.54	34.44	
	MDD	76.89?	BLD	79.29	77.72?	
	BLD	86.67	*H*	31.44	33.07	
	H	49.18	*e*			

m3

				R_1	R_2
BA-1 2000 Ñ12 No. 1B					
	Side	Left	MDD	43.64	40.35
	MDD	89.55?	BLD	88.04	93.11
	BLD	95.93?	*H*	36.76	42.02
	H	52.98	*e*	–	–

Table 3
Dental remains measurements of *Stephanorhinus* sp. cf. *S. jeanvireti*.
Tableau 3
Mesures des restes dentaires de *Stephanorhinus* sp. cf. *S. jeanvireti*.

	Side	m2					m3				
		MDD	BLD	H_C	H_{DL}	H_{ML}	MDD	BLD	H_C	H_{DL}	H_{ML}
BA-1 2015 N9 No. 35	Right	–	–	–	–	–	30.8?	28.2?	38.7	32.4	38.7
BA-1 2001 O10 No. 8	Right	45.6	29.1	43.8	32.5	43.8	–	–	–	–	–

Table 4
Measurements of the upper and lower teeth of *Alephis* sp. and mandible measurements of *Alephis* sp.
Tableau 4
Mesures des dents supérieures et inférieures d'*Alephis* sp. et mesures de la mandibule d'*Alephis* sp.

	Side	P3		p4		m1		m2		m3		Mandible			
		DMD	DBL	DMD	DBL	DMD	DBL	DMD	DBL	DMD	DBL	L_T	*L* distem	*H* m1	*H* m2
BA-1 2015 O11 No. 22	Left	19.4	20.2												
BA-1 2015 N9 No. 13	Left			18.7	6.5	25.9	14.3	29.6	15.7	37.2	15.8	25.3	71.6	42.4	45.1
BA-1 2001 O10 No. 7	Left			22.8	12.9	24.8	15.7	30.6	18.6	40.1	17.9				

Fig. 5. *Mammut borsoni* molars. A. Left M/1 BA-1 2000 O11 No. 4A. B. Right M/1 BA-1 2000 O11 No. 4B. C. Left M/2 BA-1 2000 Ñ11 No. 12. D. Right M/2 BA-1 2000 Ñ12 No. 1A. E. Left M3/BA-1 2000 Ñ12 No. 1B. 1: occlusal view; 2: lingual view; 3: labial view. The scale bar represents 5 cm.
Fig. 5. Molaires de *Mammut borsoni*. A. M/1 gauche BA-1 2000 O11 Nº 4A. B. M/1 droite BA-1 2000 O11 Nº 4B. C. M/2 gauche BA-1 2000 Ñ11 Nº 12. D. M/2 droite BA-1 2000 Ñ12 Nº 1A. E. M3/gauche BA-1 2000 Ñ12 Nº 1B. 1 : vue occlusale ; 2 : vue linguale ; 3 : vue labiale. L'échelle représente 5 cm.

Fig. 6. Mandible of *Mammut borsoni* found in 2015.
Fig. 6. Mandibule de *Mammut borsoni* trouvé en 2015.

Order Artiodactila Owen, 1898
Family Bovidae Gray, 1821
Tribu Bovini Simpson, 1945
Genus ***Alephis*** Gromolard, 1980
Species *Alephis* sp. Gromolard, 1980

Material: Skull with both horn cores (BA-1 2015 N9 No. 15); left P3 (BA-1 2015 O11 No. 22); two mandibles (BA-1 2001 O10 No. 7 and BA-1 2015 N9 No. 13); two right and one left pyramidals (BA-1 2015 N9 No. 23, BA-1 2015 N14 No. 1 and BA-1 2015 O12 No. 41); right pisiform (BA-1 2015 N9 No. 5); left scaphoid (BA-1 2015 O12 No. 6); two right unciforms (BA-1 2015 O12 No. 9 y BA-1 2015 P11 No. 1); sesamoid (BA-1 2015 O11 No. 27); right astragalus (BA-1 2015 O11 No. 27); metapodial fragment (BA-1 2015 O11 No. 20); and one first phalanx (BA-1 2015 O11 No. 14).

Left P3: BA-1 2015 O11 No. 22: left upper premolar with one lobe, preserving a parastyle and a well-marked

Fig. 7. *Stephanorhinus* sp. cf. *S. jeanvireti* molars. A. Right M/2 BA-1 2001 O10 No. 8. B. Right M/3 BA-1 2015 N9 No. 35. 1: occlusal view; 2: labial view. The scale bar represents 5 cm.
Fig. 7. Molaires de *Stephanorhinus* sp. cf. *S. jeanvireti*. A. M/2 droite BA-1 2001 O10 N° 8. B. M/3 droite BA-1 2015 N9 N° 35. 1 : vue occlusale ; 2 : vue labiale. L'échelle représente 5 cm.

metastyle, with the bucco-lingual diameter slightly greater in the base than in the crown apex (Fig. 8, Table 4).

Mandibles: BA-1 2001 O10 No. 7 is a left dental series with p4, m1, m2 and m3, all of them well preserved. The p4 shows a joined paraconid and metaconid. A low entostylid is present in all molars (Fig. 8, Table 4). The m2 and m3 have Caprini folds, the parastylid is more marked than the metastylid, and the mesostylid is present only in the apical region. The m3 shows small metastylid. BA-1 2015 N9 No. 13 is a left mandible with m1-m3. The horizontal branch is incomplete, showing the mentonian foramen and a short diastema. The m1 and m2 are similar to those of BA-1 2001 O10 no. 7 (Fig. 8, Table 4).

Four different species of large sized bovids have been described in the European Ruscinian, including *Alephis boobon* (Montoya et al., 2006), *A. tignerensis* (Micheaux et al., 1991), *A. liryx* (Micheaux et al., 1991) and *Parabos cordieri* (Gremolard and Guérin, 1980). These species have been defined according to the morphology of the horn cores (Gremolard, 1980). In Baza-1, a skull with the horn cores was unearthed during the dig season of 2015, but it is badly preserved for supporting a specific attribution. However, according to its dental features (Fig. 6) it probably belongs to the genus *Alephis*. At the specific level, *A. boodon* or *A. lyrix* are the main candidates, because the index BLD/MDD in Baza dental specimens is very similar to those for these species. In spite of this, preliminarily and waiting for new and better diagnostic fossil remains, these materials are classified as *Alephis* sp.

Tribe Antilopini Gray, 1821
Genus ***Antilope*** Pallas, 1766
Species cf. *Antilope* sp. Pallas, 1766

Material: two left m1 (BA-1 2015 O12 No. 50 and BA-1 2015 N9 No. 24A); right m2 (BA-1 2015 N9 No. 24B); right p2-m3 and left p2-p4, m2-m3 (BA-1 2015 O12 No. 42); right p3-p4 and right m3 (BA-1 2015 N9 No. 6B); left scaphoid (BA-1 2015 O12 No. 46); right astragalus (BA-1 2015 N9 No. 11); right calcaneus (BA-1 2015 N9 No. 4); metapodial fragment (BA-1 2015 N9 No. 2); two proximal phalanges (BA-1 2015 N9 No. 12 and BA-1 2015 N9 No. 1); and two middle phalanges (BA-1 2015 N9 No. 28 and BA-1 2015 N9 No. 3).

Until the 2015 excavation season, only one bovid species was documented at Baza-1, but 13 fossils belonging to a small-to-middle-sized Bovidae were found that year. Among these elements, two semicomplete mandibles from the same individual (Fig. 9) stand out. Several isolated teeth and additional postcranial remains were also found.

Mandibles (BA-1 2015 O12 No. 50 and BA-1 2015 N9 No. 24A): Both hemimandibles preserve mesodont to brachydont teeth and show a similar degree of wear. The

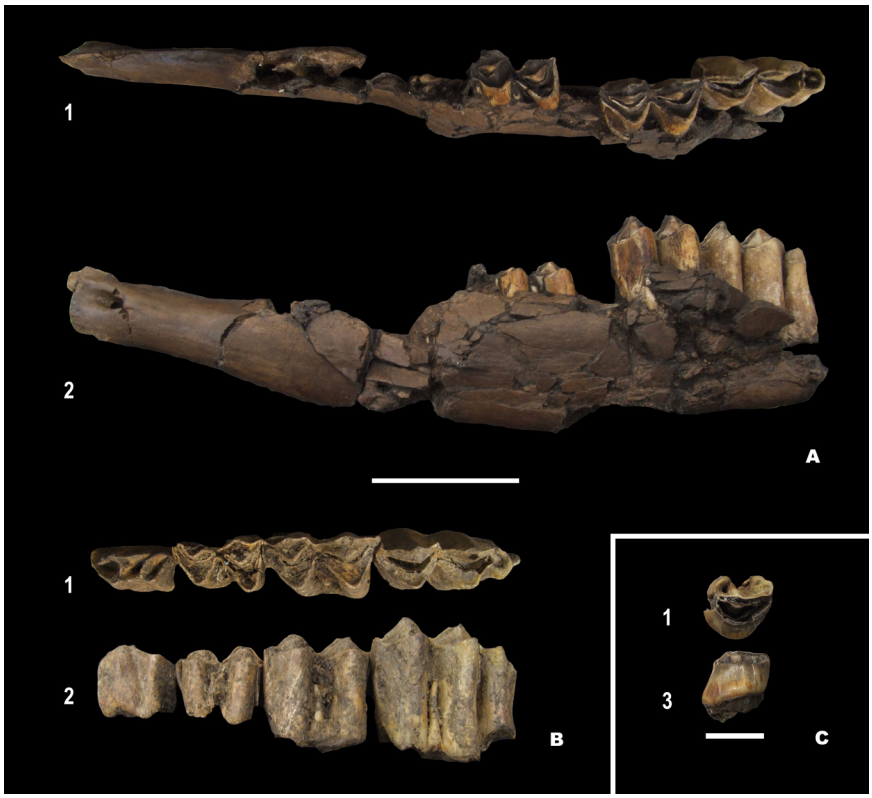

Fig. 8. *Alephis* sp. remains. A. Left mandible BA-1 2015 N9 No. 13. B. Left mandible BA-1 2001 O10 No. 7. C. Left P3/BA-1 2015 O11 No. 22. 1: occlusal view, 2: labial view; 3: lingual view. Scale bars represent 5 cm (A and B) and 2 cm (C).
Fig. 8. Fossiles d'*Alephis* sp. A. Mandibule gauche BA-1 2015 N9 Nº 13. B. Mandibule gauche BA-1 2001 O10 Nº 7. C. P3/gauche BA-1 2015 O11 Nº 22. 1 : vue occlusale ; 2 : vue labiale ; 3 : vue linguale. Les échelles représentent 5 cm (A et B) et 2 cm (C).

Fig. 9. cf. *Antilope* sp. dentals remains of Baza-1 site. A. Right mandible. B. Left mandible BA-1 2015 O12 No. 42. C. Left M/1 BA-1 2015 O12 No. 50. D. Right M/3 BA-1 2015 N9 No. 6B. E. Right M/2 BA-1 2015 N9 No. 24B. F. Left M/1 BA-1 2015 N9 No. 24A. 1: occlusal view; 2: buccal view. Scale bars represent 5 cm (A and B) and 2 cm (C–F).
Fig. 9. Restes dentaires de cf. *Antilope* sp. du gisement de Baza-1. A. Mandibule droite. B. Mandibule gauche BA-1 2015 O12 Nº 42. C. M/1 gauche BA-1 2015 O12 Nº 50. D. M/3 droite BA-1 2015 N9 Nº 6B. E. M/2 droite BA-1 2015 N9 Nº 24B. F. M/1 gauche BA-1 2015 N9 Nº 24A. 1 : vue occlusale ; 2 : vue buccale. Les échelles représentent 5 cm (A et B) et 2 cm (C–F).

Fig. 10. Dental remains of Cervinae indet. from Baza-1. A. Left P/2 (BA-1 2015 N9 No. 18). B. Right P/3 (BA-1 2015 P11 No. 4). C. Left P/2-P/3 (BA-1 2015 N9 No. 6A). 1: occlusal view; 2: buccal view. Scale bar represents 2 cm.
Fig. 10. Restes dentaires de Cervinae indet. de Baza-1. A. P/2 gauche (BA-1 2015 N9 Nº 18). B. P/3 droite (BA-1 2015 P11 Nº 4). C. P/2-P/3 gauche (BA-1 2015 N9 Nº 6A). 1 : vue occlusale ; 2 : vue buccale. L'échelle représente 2 cm.

right mandible preserves p2–m3, the horizontal ramus is almost complete and the base of the coronoid process is preserved. The left hemimandible preserves p3–p4 and m2–m3, together with part of the horizontal ramus with a complete diastema. Both p4 are molariform and very worn, their paraconid and parastylid are not visible, a wide valley is present between the metaconid and entoconid, and the hypoconid is well marked. The molar crowns are narrow. The entostylid is very marked and the caprini fold is not well developed. The m3 has a well-marked hypoconulid. The m1 shows a small ectostylid (Fig. 9, Table 5).

Two left m1 (BA-1 2015 O12 No. 50 and BA-1 2015 N9 No. 24A) and one right m2 (BA-1 2015 N9 No. 24B): the left molars are heavily worn and have narrow crowns. They do not have the Caprini fold and show small ectostilids (Fig. 9, Table 5). A right m3 (BA-1 2015 N9 No. 6B): It is worn, showing a Caprini fold and a slightly pronounced metastylid (Fig. 9, Table 5).

All dentals remains have been morphometrically compared with different species of bovids, and they lie within the size range of *Antilope* and *Gazella*. The comparative study with antelope species from Pakistan (Khan & Akhtar, 2012) included *Antolipe subtorta*, *Antilope cervicapra* and another intermediate form, as well as two different forms of *Gazella* (Alcala and Morales, 2006; Bouvrain, 1998), *Hispanodorcas heintzi* and *Gazella emilii*. The comparison showed that the fossils of Baza-1 are similar to the *Antilope* species, particularly *A. subtorta*, and different from *Gazella*. All these species have been defined by their horn cores. However, horn cores are absent by the moment from the Baza-1 record. For this reason, the remains of a small-to-middle sized bovidae unearthed from the site have been preliminarily assigned to cf. *Antilope* sp.

Family Cervidae Gray, 1821
Subfamily Cervinae Baird, 1961

Cervinae indet.

Material: left p2 (BA-1 2015 N9 No. 18), right p3 (BA-1 2015 P11 No. 4), left p2–p3 (BA-1 2015 N9 No. 6A) and tooth fragment (BA-1 2015 O11 No. 25).

Only five dentals remains of deer have been recovered in the Baza-1, including two second premolars, two third premolars (Fig. 10, Table 6) and one indeterminate tooth fragment. The scarcity of this record does not allow to attribute this material to a given genus or species. For this reason, they have been classified as Cervinae indet.

Order Testudines Batsch, 1788

Testudinae indet.

Forty-eight fragment plates (BA-1 2015 N12 No. 2, BA-1 2015 O10 No. 12, BA-1 2015 O11 No. 8, BA-1 2015 O12 No. 2, BA-1 2015 O12 No. 13, BA-1 2015 O12 No. 14, BA-1 2015 O12 No. 15, BA-1 2015 O12 No. 16, BA-1 2015 O12 No. 17, BA-1 2015 O12 No. 18, BA-1 2015 O12 No. 19, BA-1 2015 O12 No. 21, BA-1 2015 O12 No. 22A, BA-1 2015 O12 No. 23, BA-1 2015 O12 No. 25, BA-1 2015 O12 No. 27, BA-1 2015 O12 No. 28, BA-1 2015 O12 No. 29, BA-1 2015 O12 No. 30, BA-1 2015 O12 No. 32, BA-1 2015 O12 No. 35, BA-1 2015 O12 No. 43, BA-1 2015 O10 No. 25, BA-1 2015 O12 No. 45, BA-1 2015 O12 No. 47, BA-1 2015 O12 No. 49, BA-1 2015 O12 No. 52, BA-1 2015 O11 No. 26, BA-1 2015 N9 No. 30, BA-1 2015 N9 No. 31, BA-1 2015 N9 No. 32, BA-1 2015 N9 No. 33, BA-1 2015 O12 No. 54, BA-1 2015 M12 No. 2, BA-1 2015 O12 No. 57, BA-1 2015 O11 No. 29, BA-1 2015 O11 No. 30, BA-1 2015 N10 No. 3, BA-1 2016 N10 No. 3, BA-1 2016 N10 No. 8, BA-1 2016 N10 No. 3, BA-1 2016 N12 No. 4, BA-1 2016 N13 No. 2, BA-1 2016 O10 No. 6, BA-1 2016 O12 No. 1, BA-1 2016 O12 No. 3, BA-1 2016 O12 No. 5 and BA-1 2016 O12 No. 10).

Thirty-eight carapace fragments of chelonians were unearthed in 2015 and ten in 2016. Most of the fragments have small dimensions. The taxonomical study of these fragments is not finished and they have been preliminarily attributed to Testudinae indet.

Table 5
Dental remains measurements and mandible measurements of cf. *Antilope* sp.
Tableau 5
Mesures des restes dentaires et des mandibules de cf. *Antilope* sp.

	Side	p2			p3			p4			m1			m2			m3			Mandible						
		MDD	BLD	*H*	MDD	BLD	*H*	MDD	BLD	*H*	MDD	BLD	*H*	MDD	BLD	*H*	MDD	BLD	*H*	*L*	*L* diastem	*H* p3	*H* m2	*L* p2–m3	*L* p2–p4	L m1–m3
BA-1 2015 O12 No. 50	Left	–	–	–	–	–	–	–	–	–	13.6	9.7	10.9	–	–	–	–	–	–							
BA-1 2015 N9 No. 24 (A)	Left	–	–	–	–	–	–	–	–	–	14.4	9.9	8.3	–	–	–	–	–	–							
BA-1 2015 N9 No. 24 (B)	Right	–	–	–	–	–	–	–	–	–	–	–	–	16.9	11.5	11.8	–	–	–							
BA-1 2015 O12 No. 42	Right	8.4	5.4	7.3	11.7	7	11.1	11.3	7.5	11.9	14.2	9.8	9.8	16.6	10.4	18.4	25.6	10.2	27.7	168.06	–	27.1	29.2	87.3	30.7	56.8
	Left	8.6	5.9	7.7	12	6.9	10.2	12.1	7.6	12.3	–	–	–	17.4	10.5	20.4	26.4	10.2	28.4	121.3	51.5	26.3	–	–	32.6	-
BA-1 2015 N9 No. 6B	Right	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	26.5	11.3	16.1							

Table 6
Measurements taken in the dental remains of Cervinae indet. from Baza-1.
Tableau 6
Mesures prises sur les restes dentaires de Cervinae indet. de Baza-1.

	Side	p2			p3		
		MDD	BLD	*H*	MDD	BLD	*H*
BA-1 2015 P11 No. 4	Right	–	–	–	16.8	9.1	13.1
BA-1 2015 N9 No. 18	Left	13.7	7.9	10.9	–	–	–
BA-1 2015 N9 No. 6A	Left	11.9	–	8.7	12.8	7.5	9.3

6. Conclusions

The European continental Pliocene record is scarce. The new site of Baza-1 in the Guadix–Baza depression (southern Spain) provides important information for this chronology in the continent. The preliminary study of micromammals evidences the presence of eleven rodent species, including *Ruscinomys* sp., *Apocricetus barriere*, *D. julii*, *A. gorafensis*, *C. gracilis*, *Occitanomys* cf. *brailloni*, *P. meini*, *Paraethomys* aff. *abaigari*, *S. cordii*, *Trilophomys* cf. *castroi* and *Eliomys* aff. *intermedius.* Macromammals are represented by seven taxa, including *A. arvernensis*, *M. borsoni*, *Stephanorhinus* sp. cf. *jeanvireti*, cf. *Hipparion* sp., *Alephis* sp., cf. *Antilope* sp. Cervinae indet. The presence of Testudinae indet. completes the faunal record from this site. Biochronological data from micro and macromammals indicate an age range comprised between 4 and 4.5 Ma.

The coexistence of two mastodons, *A. arvernensis* and *M. borsoni*. Baza-1 is by the moment the only site in the Iberian Peninsula where these two species appear together, an association that is not frequent in the European record. By the moment, no carnivore remains have been documented in Baza-1. From the point of view of the palaeoenvironmental reconstruction, the ungulate association identified in the site is indicative of a mixture of different landscapes in the region. As a final remark, we can affirm that Baza-1 is a very important site for the study of continental ecosystems during Ruscinian times in Europe due to the scarcity of the large mammal record for this time frame. The high density of fossils present in the locality will allow us to get further insights on the knowledge of the fauna from an epoch that is not well known in the European continent.

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