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Human Ecology and the Southern Iberian Neolithic: An Approach from Archaeobotany and Archaeozoology

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ABSTRACT
Archaeology has long incorporated the methods of the natural sciences and the theoretical principles of the overarching scientific framework. Most archaeologists acknowledge the importance of a systemic perspective in the study of the evolution of human behavior, with emphasis on the contexts in which individuals and populations lived and interacted. This article develops an ecological approach to the subsistence patterns and dynamics of the Neolithic populations in the westernmost regions of the Mediterranean. Methodologically, it implements a systematic quantitative exploration of the structure and evolution of the botanical and zoological taxa documented in a human settlement. Empirically, it begins with one of the most complete and relevant Neolithic archaeological sequences in the region, Dehesilla Cave, which has provided a dataset from high-resolution stratigraphy. The new results are then compared with the available archaeobotanical and archaeozoological records throughout the south of the Iberian Peninsula.

KEYWORDS
subsistence dynamics; high-resolution stratigraphy; farming; livestock; Dehesilla Cave; Iberian Peninsula

Introduction

The study of the Neolithic in the south of the Iberian Peninsula dates back approximately one century (Bosch Gimpera 1920), although it was in the 1960s, and particularly in the ‘70s and ‘80s, that notable progress was made possible by a number of excavation projects aiming to explore the stratigraphic sequences and to establish the chronological and cultural periodization of the Iberian south. Several of these sites remain fundamental references today. Cave sites are clearly preeminent—for instance Nerja (Pellicer 1963; Jordá-Pardo 1986; Pellicer and Acosta 1997), Carigüela (Pellicer 1964), Murciélagos de Zuheros (Vicent and Muñoz 1973), Murciélagos de Albuñol (López-García 1980), and Dehesilla (Acosta and Pellicer 1990)—in comparison to open-air settlements such as Los Castillejos (Arribas and Molina 1979). Other open-air sites on the coast have been located and excavated more recently, for instance El Retamar (Ramos and Lazarich 2002) and Embarcadero del río Palmones (Ramos 2006). The available radiocarbon dates indicate that Neolithic populations arrived in the westernmost regions of the Mediterranean around the mid-6th millennium CAL B.C. (Martín-Socas et al. 2018).

Regarding the specific topic of this paper, there is, at present, a notable amount of archaeological data and knowledge about the Neolithic paleoenvironment and ecology, especially from the last three decades of research (e.g., López-García 1986; Stevenson and Harrison 1992; Rodríguez-Ariza 1996; Riquelme 1998; Bernáldez and Bernáldez 2000; González-Urquijo et al. 2000; García-Rivero 2004; Liesau and Morales 2012; Peña-Chocarro et al. 2013; Rodríguez-Rodríguez et al. 2013; McClure and Welker 2017). Our own work has included new excavations at Dehesilla Cave, one of the key Neolithic sites in the south of the Iberian Peninsula, located in the Sub-Baetic mountain range (Figure 1), with the aim to advance the understanding of the evolution of the ecological patterns and use of natural resources throughout the Iberian Neolithic (García-Rivero et al. 2019).

The main results obtained from the pilot study, based on pollen, carpological, and zoological remains from area C003, indicated a Neolithic environment essentially composed of holm oak and wild olive forests, together with evidence of an oscillating presence over time of agriculture and livestock, especially sheep and goats. The data available for the Early Neolithic B (second half of the 6th millennium B.C.) were suggestive of small human populations with a mixed cereal and livestock-based economy. The Middle Neolithic A (ca. 4800–4500 CAL B.C.) displayed a significant change, resulting in an economy based almost entirely on the monoculture of naked wheat, with a limited presence of naked barley. This new scenario was probably linked to a shift from intensive to extensive agriculture and appears, in fact, to have caused significant pressure on the landscape, leading to a loss of forest cover and the creation of Mediterranean thermophile forests clearly documented from the middle of the 5th millennium B.C. (García-Rivero et al. 2019).

Following this paleoecological line of research, this paper expands the systemic analysis at Dehesilla Cave through the analysis of new data from the archaeological area C006, excavated in 2017. As in our previous work, our aim is to understand and explain the nature and evolution of the diversity and variation of the botanical and zoological populations in relation to a human settlement. For this purpose, we theoretically assume that the different components that make up the natural system (including humans) interact and coexist under common principles of historical change. The methodological design ensures that the analysis of the data belonging to each period provides a detailed synchronic picture, while the comparison between the data from

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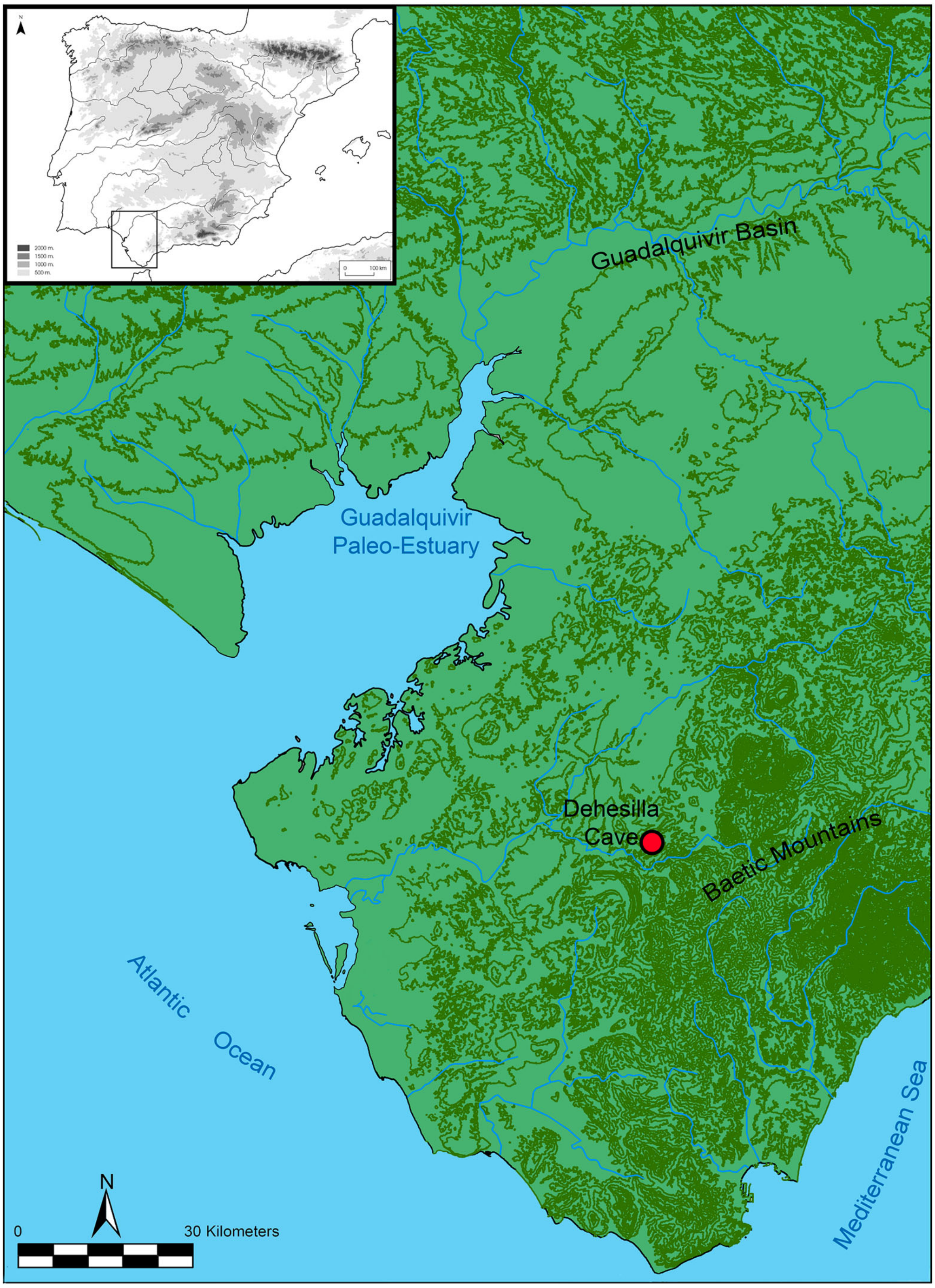

Figure 1. Location of Dehesilla Cave in the southern region of the Iberian Peninsula.

different periods permits a diachronic analysis, in such a way that the structure of the diversity and variation of this archaeological record may be explored in and over time.

The specific objectives of this paper are, first of all, to present the archaeobotanical and archaeozoological data of the Neolithic sequence (from the 6th–4th millennium CAL B.C.) recently documented in a new archaeological area (C006) at Dehesilla Cave. Secondly, and within the framework of a cumulative and progressive perspective of knowledge, a systematic comparison is made between the new results and those previously known from C003, which has an analogous Neolithic sequence. This exercise enables us to explore the implications of the most recent data within the previous observations and working hypotheses and therefore to assess and update the interpretation of the Neolithic record at the site. More specifically, it allows us to compare the empirical patterns of the two excavation areas and to identify where they are convergent and where they are dissimilar. While the former may express consistent empirical patterns linked to the behaviors of individuals and populations over time, the latter may be linked to a range of explanatory scenarios. Among these, significant differences between the data provided by comparable units—archaeological periods—in both areas may indicate empirical bias or instability in the record of a particular area or may be interpreted as evidence of distinct functional patterns in the usage of the different rooms of the cave. Finally, the paper highlights which of the changes and differential replication patterns of the botanical and zoological populations are corroborated and which must be rejected or require additional testing. This, in turn, enables an in-depth revision of the explanatory hypotheses for these differential patterns, which are discussed within the context of the use of plant and animal resources by Neolithic human populations in the south of the Iberian Peninsula.

Data and Methods

Archaeological context and stratigraphy

The data used in this study comes from the recent excavations carried out within the project *Dehesilla Cave: Archaeological and paleoenvironmental study for the knowledge of the prehistoric human occupation of the Sierra de Cádiz* and, specifically, from the excavation during 2017 of a new archaeological area (C006) located in one of the deepest and most inaccessible rooms of the cave (Room 4) (Figure 2). The location and delimitation of the excavation area correspond to an area where the surface sheet of flowstone was broken and absent. This circumstance accounts for the irregular shape of the trench, with an area of approximately 5 m^2, 5 m (north-south) along the western wall of the room × 1 m (east-west). The levels disturbed by contemporary anthropogenic and animal activities are limited to the upper strata, located immediately below the flowstone sheet. The rest of the sequence is intact, reaching a depth of 1.5 m and containing levels formed in several specific Neolithic periods: Early Neolithic B (ENB), Middle Neolithic A (MNA), Middle Neolithic B (MNB), and Late Neolithic (LN) (García-Rivero et al. 2022).

The sedimentological characteristics indicate that several of the strata in C006 were caused by natural phenomena, materializing torrential and depositional episodes in the form of stone blocks and sediments washed down from the adjacent and higher Room 2. Other levels are markedly different in origin, including several clearly anthropic depositional events (García-Rivero et al. 2020, 2021). The analysis of the archaeological materials, especially the pottery, confirms that the assemblages are coherent and synchronic in the ENB and MNA periods, while the MNB and LN levels include occasional residual fragments from earlier periods (García-Rivero et al. 2022). This circumstance highlights a necessary caution in the observations and inferences made from the latter two periods.

The materials considered here are the remains of seeds and fruits, along with fauna. In contrast to the study of area C003 (García-Rivero et al. 2019), suitable pollen data for meaningful comparison were not available for C006 due to its location in one of the deepest rooms of the cave. All of the samples and remains have been recorded in their particular stratigraphic unit of C006, making an allowance only in specific cases in which there was not a complete correspondence to a single unit, in which case they have been labeled and considered accordingly. This procedure makes it possible to assign each element with the greatest possible precision and without compromising the strict rigor of the record.

The comparative study with C003 makes use only of the data ascribed to exclusive (single) stratigraphic units. In addition, it must be noted that the systematic comparison has greater potential for the data sets from the Early Neolithic B, Middle Neolithic A, and Middle Neolithic B periods, which are present in both excavation areas (Table 1). The Early Neolithic A is not documented in area C006, and the Late Neolithic is not clearly defined in area C003 (García-Rivero et al. 2018, 131).

Carpology

20% of the excavated sediment from each stratigraphic unit was set aside for flotation. The rest was screened manually in the field, and all visually identifiable small remains were collected. Thus, the volume of processed sediment is 100%, and the number and density of remains are true to the total contents of each unit throughout the sequence.

Seeds and fruits were recovered through flotation. The flotation system collected the denser materials inside the tank in a 1 mm mesh, while the material that floated was collected in a 0.25 mm mesh on the overflow. Both fractions were dried in the laboratory, where they were processed manually under a 10–15x magnifying glass. The identification of seeds and fruits was carried out at the Institute of History of the CSIC in Madrid. The denomination of wild taxa followed Castroviejo (1986–2012) and that of cultivates followed the binomial classification (Zohary and Weiss 2012). The quantification of the material was problematic due to the small number of samples and remains. However, two fundamental criteria were used, namely the ubiquity of each of the taxa and the number of remains.

Zoology

The zoological remains were recovered directly in the field in the manual screening of sediments and, to a lesser extent, in the heavy fraction of the flotation. The zoological analysis established several quantification criteria, according to the number of identified specimens (NISP), the number of remains—including unidentified remains—(NR), the weight (g), and the minimum number of individuals (MNI). The sedimentological volume of each level was considered in the diachronic analysis, and the variables retained for the comparative quantitative study were the density of specimens (DSP) and individuals (DI). The number of remains did not count fragments resulting from fresh breakage, unfused epiphyses belonging to the same bone, and isolated teeth. Two types of indeterminate bones have been considered: some that cannot be identified at the anatomical level, and therefore not at the species level either (indeterminate), and others which are anatomically recognizable but do not display any characteristic that enables them to be ascribed to a specific species. The latter are included in two groups based on size, following the biostratinomic results of Bernáldez (2009, 2011). Class I includes the skeletal remains of vertebrates with a body mass greater than 250 kg (bovids and equids) and Class II those with a body mass between 18 and 250 kg (sheep, goat, suids, and deer). In addition to the taphonomic analysis of traces of erosion and usage (Lyman 1994; Fernández-Jalvo and Andrews 2016), the state of conservation of the bones has been assessed by the fragmentation index (IF) method described by Bernáldez and Bernáldez (2000), in which $IF = Log (NRT/NISP)$, where NRT is the total number of remains. Since animals with a body mass greater than 18 kg are generally better represented in the record (Bernáldez 2009, 2011), this index has been calculated using only the values obtained for animals belonging to this group. The average weight

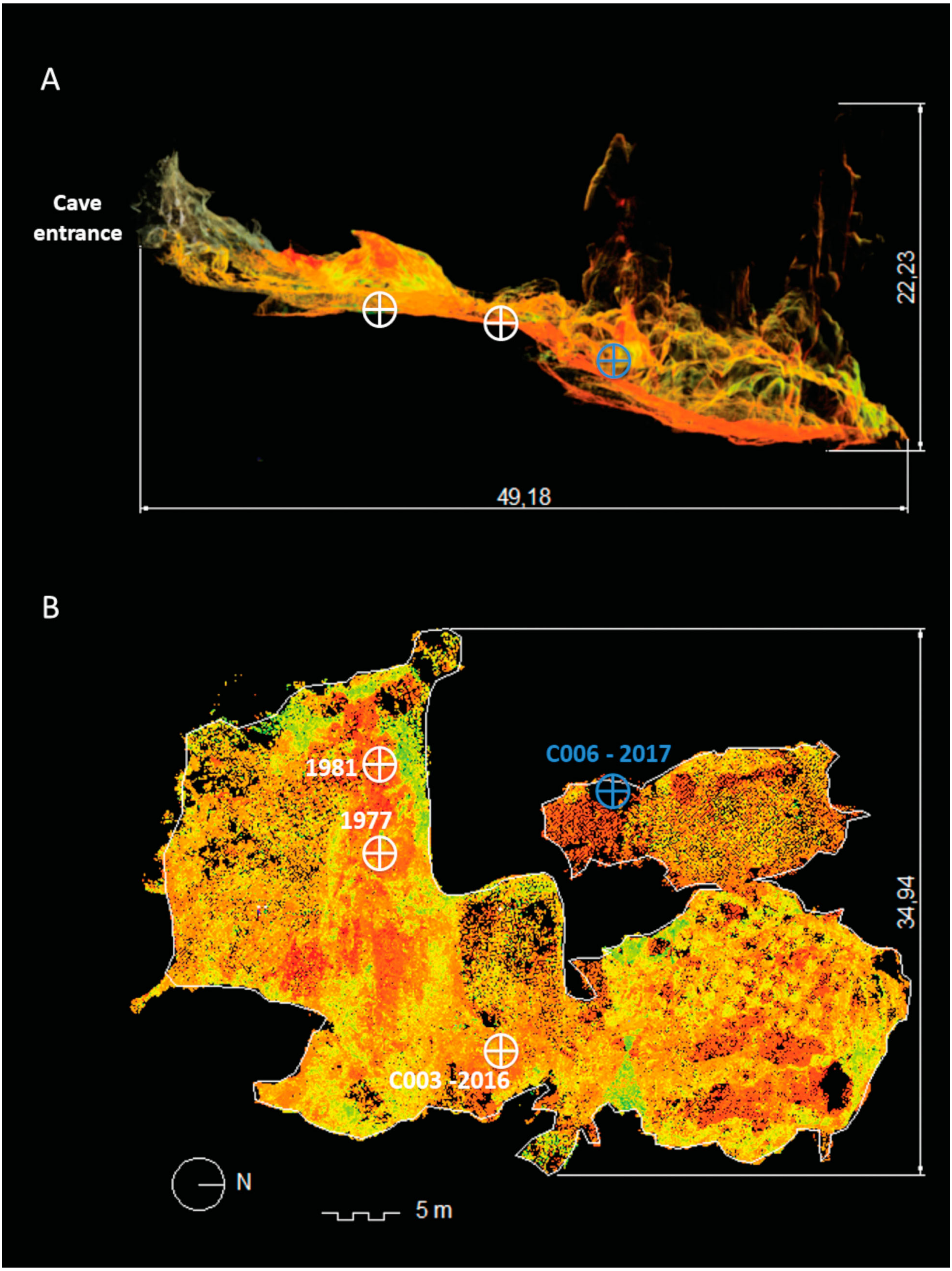

Figure 2. A) Section and B) 3D plan of the cave with the location of all of the archaeological excavation areas.

(Mm) of the elements and the percentage of indeterminacy have been calculated. Finally, the ages of the individuals were estimated following Schmid (1972) and Barone (1999) and grouped as infantile, juvenile, subadult, adult, or senile (Table 2). No complete mandible of adult sheep/goat was recovered in order to apply tooth wear index.

Results

Seeds and fruits

A total of 30 samples from the Neolithic sequence were processed. 29 of these, with a total volume of 254 L of sediment from nine different stratigraphic units, contributed carpological remains preserved by carbonization. A total of 336

Table 1. Correspondence between the stratigraphic phases, units, and chronological periods of the C003 and C006 archaeological areas. The periods represented in both excavation areas and, therefore, used for the explicit quantitative comparison developed in the discussion section are ENB, MNA, and MNB.

Stratigraphic Units—C003	Stratigraphic Units—C006	Chronocultural Periodization
-	4, 1	Late Neolithic (LN)
Unit 11	-	Middle Neolithic B–Late Neolithic (MNB–LN)
Units 13, 12b, 12a, Hearth 1	6b, 6, 5	Middle Neolithic B (MNB)
Unit 14	Locus 2, Structure, 9, 7	Middle Neolithic A (MNA)
Units 15c, 15b, 15a	Units 13, 12, 11, 8, Locus 1	Early Neolithic B (ENB)
Units 16b, 16a	-	Early Neolithic A (ENA)

individuals have been identified, corresponding to nine botanical taxa (Table 3).

The majority of the remains belong to cultivated plants, and, among these, cereal caryopses are by far the most abundant and frequent (Figure 3). Legumes constitute the other group of cultivated plants but are only present in the most recent phase. Wild plants are also present but display a decreasing trend over time.

Five samples (35 L) belong to the ENB phase. The sample from Unit 10-Locus 1 is the only one without cereal remains, which are the most abundant type in the other four samples from this period. The number of remains is always low, although by density two samples (from Units 11 and 8) stand out from the rest (Figure 4). The number of different taxa identified in Unit 13 is also noteworthy. Among the cereal caryopses, wheat is the most common. It has only been possible to confirm the presence of *Triticum aestivum-durum*, to which barley displays a similar ubiquity (Figure 5). As it is poorly preserved, it is not possible to confirm the variety of the latter. The wild plants present are Fabaceae, *Malva* sp., and Poaceae.

Only two samples (19 L) belong to the MNA phase, and their carpological content is extremely limited. A single caryopsis of a naked wheat and a fragment of *Triticum* sp. were identified alongside other fragments of cereals, which were not possible to determine at genus level, and another unidentified fragment.

The largest number of samples, 13, comes from the MNB phase, with a total volume of 119 L of sediment. These samples contained a low number of remains, a limited number of taxa, and an irregular, although also low, density. The remains consist almost exclusively of cereal caryopses, with one legume (*Medicago*/*Melilotus*) and one Poaceae (*Phalaris* sp.) among the wild plants. The dominance of naked wheat is evident, with a much smaller presence of barley, although, again, it is not possible to determine the variety.

There are nine samples (81 L) from the LN phase, with a very high density of remains. Two samples contributed almost all of the material, while the other seven samples are generally remains-poor, with a very limited diversity of taxa and a very low density. The remains belong exclusively to cereal caryopses, with a greater presence of naked wheat than of barley. The two richest samples display different characteristics. The smaller sample from Unit 1 yielded a concentration of wheat, among which only naked wheat is confirmed, although naked barley is also present. The only wild plant is an oat caryopsis (*Avena* sp.). The other sample, belonging to a hearth (Unit 4), has a very high density of remains and the highest diversity of taxa among all of the analyzed samples. The main components are naked barley and, to a lesser extent, naked wheat. Alongside the cereals, there is a broad bean (*Vicia faba*), the only cultivated legume documented in this area of the cave. Wild plants are very scarce and belong to taxa (Chenopodiaceae, Coronilla sp., and Poaceae) that may be identified as weeds associated with cereals or as ruderal plants growing around the cave entrance, which may have been introduced into the cave by human or animal activities.

Table 2: Age group ranges established from the estimated age in months (Riquelme 1998).

	Infantile	Juvenile	Subadult	Adult	Senile
Cattle	0–5/9	5/9–24	24–60	60–180	> 180
Sheep/goat	0–5/9	5/9–24	24–60	60–180	> 180
Suids	0–4/12	4/12–24	24–36	36–150	> 150

Fauna

The total zoological assemblage from area C006, including mollusks and vertebrates over 1 kg in body mass, is composed of 4819 skeletal NISP and 620 malacological NISP. The material securely attributed to single stratigraphic units totals 3719 NISP (77% of the total) and 484 mollusk remains (78% of the total), which are distributed over the four Neolithic periods considered below. The total data is, however, useful in the analysis of the overall Neolithic picture, since the entire sequence belongs to this period.

The number of indeterminate specimens at anatomical and species levels amounts to 43% of the total (4819 NISP). This group is made up of small fragments with an average weight of 0.72 g. The remains of Class I and II vertebrates amount to 54% of the total NISP, although only 46% were assigned at the species level. This assemblage is composed of *Bos taurus*, *Cervus elaphus*, *Sus* sp., *Ovis aries*, and *Capra hircus*. In addition, bones of *Oryctolagus cuniculus*, *Lynx pardinus*, and *Canis* cf. *familiaris* have been identified. They must, however, be set apart from the ungulates because they are still under study and belong to Class III, with a different fossil potential from the above-mentioned Classes I and II (Bernáldez 2009). As is the case at other Neolithic sites, rabbits and ungulates are the most abundant animal remains in area C006. The finding of rabbit remains at cave sites can have several explanations, including human consumption or the use of the cave as habitat or shelter by rabbits or by their predators. The macroscopic analysis has identified localized thermo-alterations in a few of the distal bones that could be the result of human consumption (Lloveras, Moreno-García, and Nadal 2009) or of some other taphonomic process. Indeed, a great number of bones display no clear evidence of human consumption. The analysis of age distribution reveals a large proportion of rabbit bones from infantile individuals. Therefore, the presence of rabbits appears to be linked to natural deposition rather than to human management, as recently indicated for many Neolithic sites throughout southwestern Iberia (Almeida, Saladié, and Cerrillo 2022). The malacological record is dominated

Table 3. Carpological remains recovered from archaeological area C006 of Dehesilla Cave.

	Phase	ENB					MNA		MNB													LN								
	Unit	13	11	11	10—Locus 1	8	7	Locus 2	6-6B	6-6B	6-6B	6-6B	6-6B	6-6B	6	6	6	6	6	6	6	1	1	1	1	1	1	1	1	4
	Volume (L)	9	8	5	3	10	9	10	10	10	10	10	3	10	10	10	10	10	9	9	8	10	10	10	10	10	10	10	10	1
Cereals	*Hordeum vulgare* var.*nudum*																												1	79
	Hordeum vulgare	1		1						2			1								1	1			1				1	44
	Triticum aestivum/durum			2				1	2	3	1		1		2	2	3	3	1			2					1	2	10	57
	Triticum sp.		1			4		3		2						1							1		1				15	47
	Triticum frag.						2			1												2						1	9	11
	Cerealia indet.					1				2		1					1			1				2						11
	Cerealia frag.			6			4	15	1				4	1	1	1	3	3			3					1		2		260
Legumes	*Vicia faba*																													1
Wild plants	*Avena* sp.											1																	1	
	Chenopodiaceae																													1
	Coronilla sp.																													1
	Fabaceae	1				1																	1					1		
	Malva sp.	1																												
	Medicago/Melilotus										1										1									
	Phalaris sp.																	1												
	Poaceae																													2
	Poaceae (frag.)					1																								
	Poaceae (culm node)	1																												
	Indet.				1		1	2								1			1											
	n. remains	3	1	3	0	6	0	4	2	9	2	1	2	0	2	3	4	4	1	1	2	3	2	2	2	0	1	3	27	243
	n. taxa	3	1	2	1	1	1	2	1	2	1	1	2	1	1	2	2	1	1	1	3	1	1	1	2	1	1	1	3	5
	density x 10 L	3.3	1.3	6	0.0	6	0.0	4	2	9	2	1	6.7	0	2	3	4	4	1.1	1.1	2.5	3	2	2	2	0	1	3	27	2430

by terrestrial gastropods, although freshwater gastropods and bivalves and marine bivalves have also been identified. Among the species identified, *Otala lactea* stands out in number, as well as *Glycymeris* cf. *insubrica* and *Ruditapes decussatus* (both found in the MNB levels) because they provide evidence of mobility or contact with the coast.

The results obtained for each period are presented in Table 4. The ENB strata correspond to an excavated volume of 0.84 m^3, the largest volume of those studied in this area. A total of 1548 NISP have been documented, of which 634 are indeterminate fragments, 513 NISP are *Oryctolagus cuniculus*, one is *Canis* cf. *familiaris*, and three are carnivores. Class I and II vertebrates amount to a total of 397 NISP, although only 223 were determined at the species level. Based on this record, at least 24 individuals have been estimated: four *Bos taurus* (two subadults and two juveniles), three *Cervus elaphus* (one male adult, one subadult–adult, and one of indeterminate age), five *Sus* sp. (one adult, one subadult, one juvenile, one infantile, and one of indeterminate age), six *Ovis aries* (two subadults, two juveniles, one infantile–juvenile, and one infantile), three *Capra hircus* (two subadults and one infantile), and three *Ovis aries/Capra* sp. (two infantile and one of indeterminate age). 52% of the domesticated ungulates were juvenile or infantile. The percentage of indeterminate fragments is 41%, a value that increases to just over 61% if the calculation is made using only the data from Class I and II species. The average weight of these indeterminate fragments is 0.62 g, and the fragmentation index is 0.48. In this assemblage, only two bones display bite marks—on the pelvis of a red deer and the pelvis of a sheep/goat. According to Davis and Moreno-García (2007), a deposit with an elevated number of small fragments of bones could be related to human activities. Attending to the taphonomical evidence and the values of IF and the average weight, these deposits may be suggested as being related to human activities rather than to natural processes. The malacological assemblage is composed of 139 fragments from 136 individuals: one Unionidae (four fragments), one freshwater gastropod, 65 *Otala lactea*, two *Rumina decollata*, one *Caracollina lenticula*, one *Cernuella virgata/Xerosecta promissa*, and 64 unidentified pulmonate gastropods.

The MNA levels in C006 belong to a discrete ritual context (García-Rivero et al. 2020) and, therefore, the volume of sediment is small (0.08 m^3). The faunal record totals 168 NISP, of which 77 are indeterminate fragments and 18 belong to *Oryctolagus cuniculus*. The remaining 79 NISP belong to bones of Class I and II vertebrates, although only 57 were determined at the species level. In total, eight individuals have been estimated: three *Cervus elaphus* (two subadults–adults and one of indeterminate age), two *Sus* sp. (one juvenile and one of indeterminate age), one *Ovis aries* (subadult), and two *Ovis/Capra* (one infantile and one of indeterminate age). 40% of the domesticated ungulates were juvenile or infantile. The overall percentage of indeterminacy is 47%, increasing to 49% when limited to Class I and II species. The mean weight of these indeterminate fragments is 0.71 g, and their IF is 0.74. No scavenger marks have been recorded.

The MNB levels total a volume of 0.66 m^3. The faunal assemblage counts 1353 NISP, of which 631 are indeterminate fragments, 306 correspond to *Oryctolagus cuniculus*,

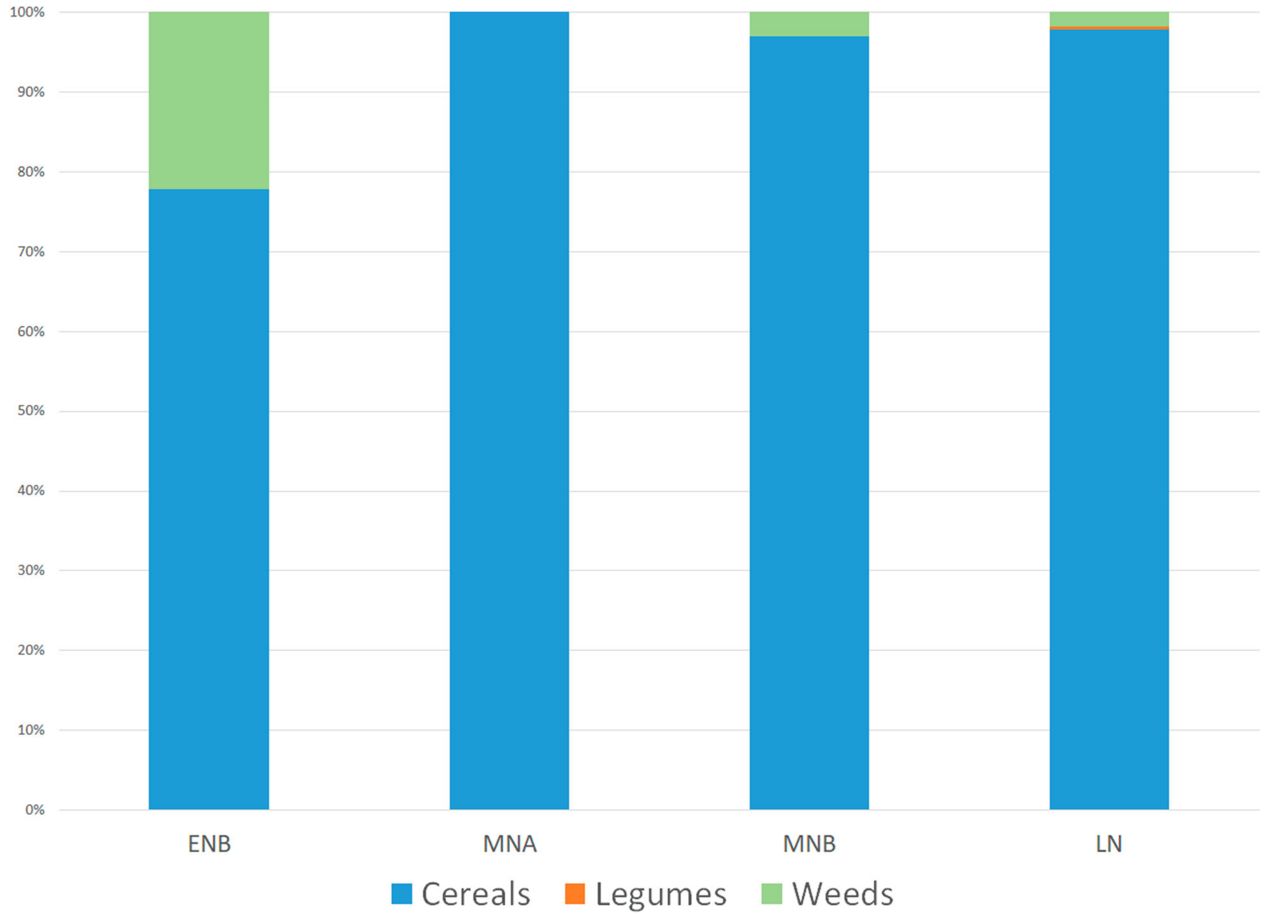

Figure 3. Graph of the relative percentages of cereals, legumes, and wild plants from area C006 per period.

two to *Lynx pardinus*, one to *Canis* cf. *familiaris*, and one to a carnivore. The Class I and II vertebrates total 412 bone elements, 193 of which were determined at the species level. A minimum of 20 individuals has been estimated: three *Bos taurus* (one subadult and two juveniles), three *Cervus elaphus* (two male subadults–adults and one juvenile–subadult), four *Sus* sp. (one subadult–adult, one male juvenile, one female juvenile, and one juvenile), five *Ovis aries* (one adult, two subadults, one juvenile, and one of indeterminate age), three *Capra hircus* (one subadult, one juvenile, and one infantile), and two *Ovis/Capra* (one juvenile and one infantile). 64% of the domesticated ungulates were juvenile or infantile. The overall percentage of indeterminacy is 47%, or 60% if considering only the remains of Class I and II. The fragmentation index is 0.50. The average weight of the indeterminate fragments is slightly heavier but still does not reach 1 g (0.87 g). The malacological assemblage includes 224 fragments of 208 individuals: one *Glycymeris* cf. *insubrica*, one *Ruditapes decussatus*, three *Potomida littoralis*, two specimens of the family Unionidae (18 fragments), one *Melanopsis praemorsa*, 111 *Otala lactea*, two *Rumina decollata*, one *Cochlicella* sp., and 86 unidentified pulmonate gastropods. Scavenger activity is better attested in this period: 12 bones display bite marks, two of them from rodents.

The excavated volume that belongs to the LN is 0.58 m^3. The faunal remains from this period amount to 653 NISP, of which 274 are indeterminate fragments, 213 are *Oryctolagus cuniculus*, and one is *Canis* cf. *familiaris*. Class I and II vertebrates account for 165 NISP, although only 83 were determined at the species level. At least eight individuals have been estimated: one *Bos taurus* (subadult), one *Cervus elaphus* (indeterminate age), two *Sus* sp. (one male adult and one infantile), one *Ovis aries* (juvenile), one *Capra hircus* (infantile–juvenile), and two *Ovis aries*/*Capra* sp. (one infantile and one of indeterminate age). 43% of the domesticated ungulates were juvenile or infantile. The overall percentage of indeterminacy of 42%, and that of Class I and II species 62%, following the same pattern as the previous periods. The fragmentation index is 0.46. The average weight of the indeterminate fragments is 0.62 g. Only two bone fragments display bite marks, one of them probably from a badger. The malacological assemblage is composed of 117 fragments from 102 specimens: two *Potomida littoralis*, two specimens of the family Unionidae (17 fragments), one *Melanopsis cariosa*, 53 *Otala lactea*, one *Cochlicella* sp., and 43 unidentified pulmonate gastropods.

Unfortunately, a complete biometric study is impossible, due to the high number of juvenile and infantile individuals and the high degree of fragmentation of the bone sample. Nevertheless, biometric data have been collected and provide a basis on which to expand with data from futures excavations. Currently, following Davis (2017), the biometric data has been used to certify the presence of *Ovis aries* and *Capra hircus,* and we are presently exploring differences between *Sus scrofa* and *Sus scrofa domesticus*.

Finally, the malacological record is probably related to non-anthropic activities, with the exception of the marine shells from the MNB and probably the *Potomida* shells, which are common in other prehistoric archaeological sites in southwestern Spain (Martínez-Sánchez 2013).

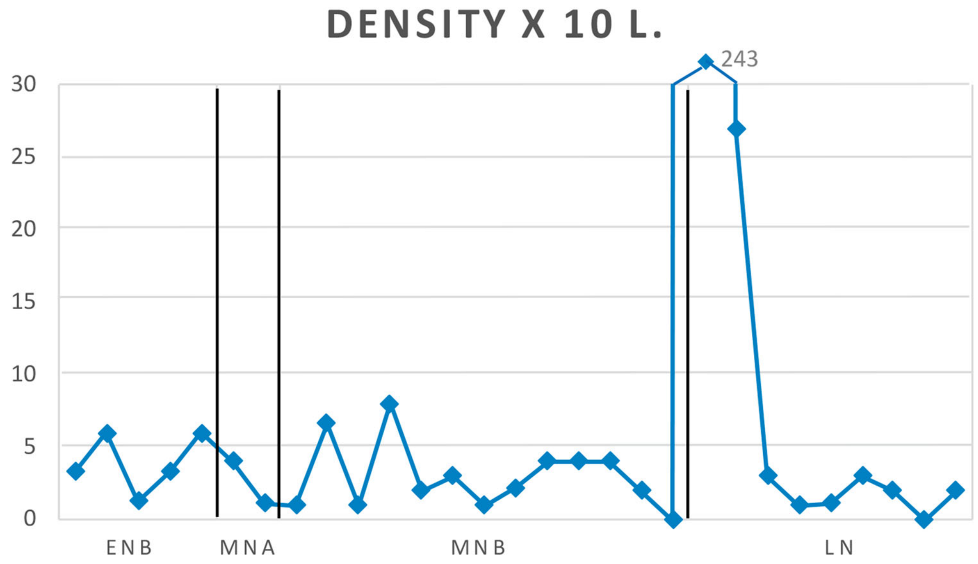

Figure 4. Density chart (per 10 L) of the carpological remains in the samples of each period in area C006. The y-axis indicates number of remains per 10 L.

Discussion

Previously known empirical patterns at Dehesilla Cave in light of the new results

Excavation areas C006 and C003 have different sizes and sedimentological volumes. However, the fragmentation index and the percentage of indeterminacy of Class I and II animal remains from the two zoological assemblages are suitable indicators of similarity between the two areas, thus enabling meaningful comparison. Moreover, comparison is carried out on both the botanical and the zoological assemblages using weighted measures: the density of individuals (DI) and the density of identified specimens (DSP) of the ungulate remains by period and area and the relative proportion of the different species based on the minimum number of individuals (MNI), as well as, in the case of botanical remains, the density of remains by period and area and relative proportions of the different taxa.

The fragmentation index and the percentage of indeterminacy of Class I and II vertebrate remains indicate that the state of preservation of the zoological samples is similar between most of the periods under study. For the most part, the first measure provides an index around 0.5 (Figure 6) and the second a percentage in the region of 60%. The only two exceptions are the levels attributed to the ENA in C003 and those associated with the MNA in C006. The former has not been documented in the subsequent excavation area and is therefore not considered in the comparison below. The dissimilarity of the MNA values in C006 is due to the nature of the formation of these units—as a discrete ritual funerary deposit—in such a

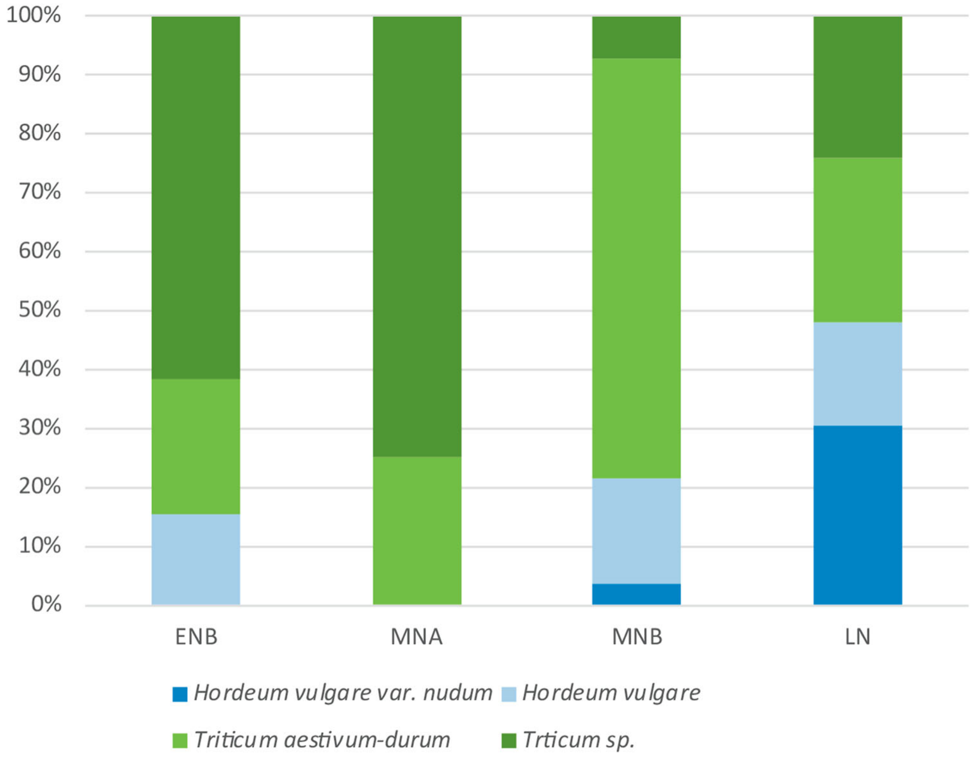

Figure 5. Cumulative bar chart with the relative percentages of each type of cereal from C006 in each period.

Table 4. Anatomical elements described in C006. The NISP of rabbits and NR of indeterminate fragments are cited in the text. NISP of Class I are probably from cattle, while NISP of Class II are probably related to sheep/goat and suids. Class II includes small fragments (see average weight in text) of bones lacking anatomical evidence to establish species. Archaeological periods: 1 = ENB, 2 = MNA, 3 = MNB, and 4 = LN.

	Species	*Bos taurus*				Class I				*Cervus elaphus*				*Sus* sp.				*Ovis aries*				*Capra* sp.				*Ovis/Capra*				*Lynx pardinus*				*Canis* cf. *familiaris*				Carnivore				Class II			
Anatomical part	Archaeological periods	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Maxillary teeth	Incisor															2	1																												
	Canine															1																													
	Premolar	1																								2		1																	
	Molar	1		1																						7		8	5																
Mandibular teeth	Incisor			1						1				2		1	3									5		6	4																
	Canine															2	1																												
	Premolar	5		1										1		6		2			2	1		1		5		3	1							1									
	Molar	2										1		1	1	4	1				1	1				7	1	9	9																
Teeth fragments		1						1						1		1										2		4	2													2		9	2
Axial skeleton	Horn									2		2										2		1		9			2																
	Skull	1				3		1	1	1		2		4	1	7	4	3								4	1	7	3									1				22	3	40	5
	Mandible	2		3								1		1		4	1	1	1	3	1	1				11		5	5													7		13	7
	Hyoid			1																																						1		1	
	Vertebrae					2																																				33	2	18	3
	Atlas									1	2					2										1																			
	Epistropheus													1																															
	Cervical v.															2											1											1				2		2	1
	Thoracic v.	1				1		2																			5															7		6	3
	Lumbar v.																										7																	2	
	Sacrum																																									1			1
	Caudal v.																																									1			
	Rib							4																			13	1														69	5	67	36
	Sternum																										3																		
Apendicular skeleton	Scapula					3		3						2		1	2									2	1	3	3													5	1	6	7
	Humerus	2						1						1								1			1	4	1	3	1													2	1	2	3
	Radius	2												2		1	1	2				1				6	1	9										1						1	4
	Ulna	4		1						1				1			1									3	1	4	2															2	1
	Carpal	1		1																								1														2		1	
	Metacarpal	3		1										1	1					1				1		4	1	6	1																
	Pelvis							1		2						1										3	1	3														1		6	1
	Femur	2		2		1						2														9	3	5	1													5	1	3	2
	Patella					1																				1	1																		1
	Tibia	1		1				5		1				2		4										7	1	5	4													6	2	13	4
	Fibula															2																													
	Talus									1		1			1			3		1								1																	
	Calcaneus	1														1		1		1				1		1		3				1										2			
	Metatarsal			2						1		1	1				1									3	1	6	4								1								
	Metapod			2	1	1						1		1			1									10		6	7			1								1		4	1	3	
	Sesamoid																																												
	Phalanx I	2		2							1	1		2		4	1	3			1	2				3	1	1	2					1								1		6	
	Phalanx II	2														2		5			1	1				1	4	1																	
	Phalanx III	1		2										1		2		1								1	1																		
Total	NISP	35		21	1	12		18	1	11	3	12	1	24	4	50	18	21	1	6	6	10		4	1	111	49	101	56			2		1		1	1	3		1		173	16	201	81
	MNI	4		4	1					3	3	3	1	5	2	4	2	6	1	5	1	3		2	1	3	2	3	2			1		1		1	1	1		1					
	Weight (g)	1301		596	30	124		189	15	326	72	450	2	258.5	11	384.2	103									665	89	538	219			5		2		1	2	8		1		345	71	486	148
	Average weight (g)	37		28	30	10		11	15	30	24	38	2	11	3	8	6									6	2	5	4			3		2		1	2	3		1		2	4	2	2

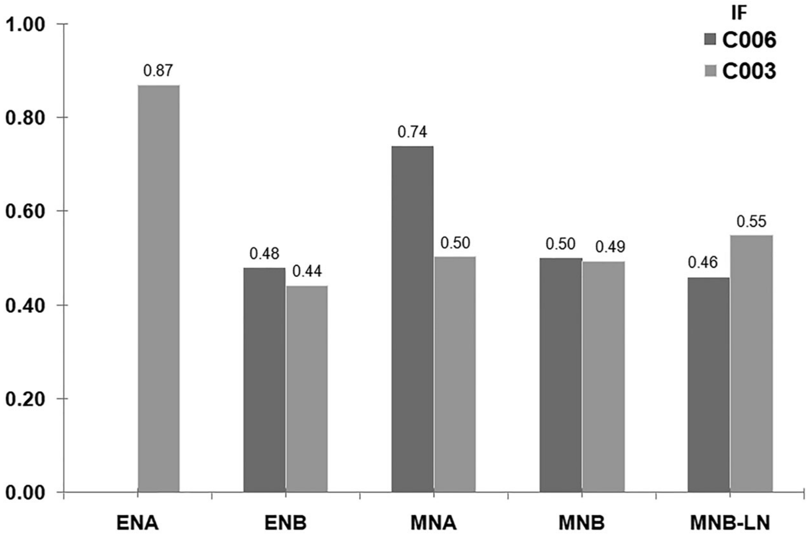

Figure 6. Graph of the Fragmentation Index (IF, indicated on the y-axis) of the zoological remains of areas C003 and C006 by period.

way that caution must be applied in the comparison between the assemblages of this period. Apart from these two specific cases, it can be postulated that the preservation of the taxa is similar in the remaining levels and periods considered and, therefore, that the datasets can be compared with confidence.

The carpological records from areas C003 and C006 display relatively similar characteristics, although there are also some differences. In general, the density of remains is slightly higher in C006, although not necessarily with a higher number of remains. On the other hand, while C003 shows the highest concentration of materials in the MNA, this phase has yielded one of the lowest densities of materials in C006. As mentioned above, this is explained by the funerary and short-lived character of the deposit known as Locus 2 (García-Rivero et al. 2020). In C006, two prominent seed concentrations are observed in two of the LN samples. One of these samples comes from Unit 1, although the remaining seven samples from the same level display average densities, sometimes even lower than those of the rest of the sequence. The other sample, with the highest number of remains of the entire study (243), belongs to a hearth (Unit 4), thus explaining its contrast to the rest of the samples.

Regarding the cereal remains, the C006 record displays some convergent characteristics with those documented previously in C003 (García-Rivero et al. 2019). The predominance of naked wheat and naked barley can be noted, although hulled wheat is not present in C006 (Figure 7). In addition, there are hardly any legumes in C006, and these appear only in the most recent phase (LN)—and only *Vicia faba*—while in C003, they are documented from ENB–MNB. However, the point of greatest difference between the two areas is, perhaps, the absence of wild fruits in C006. In sharp contrast, these were proportionally the most prominent group in the MNB and MNB–LN phases in C003. This may be linked, in all likelihood, to the differential use of the areas near the cave entrance in comparison to the deeper areas of the cavity.

The comparison by period sheds further detail on the results. The data corresponding to the ENB period in both excavation areas converge in the existence, with the same proportion/ubiquity, of *Triticum aestivum-durum* and *Hordeum vulgare*. The presence of hulled wheat is only documented in C003. Wild fruits (wild olive and azofaifo) are also only documented in C003, while in C006 there are very rare remains of wild plants that could be identified as weeds growing among cereal fields.

In the MNA period, there are marked differences between the carpological records of both areas. In C003, in addition to the presence of *Hordeum vulgare*, *Vicia*/*Lathyrus*, and *Pistacia lentiscus*, a clear predominance of *Triticum aestivum-durum* was documented, which supports the hypothesis of a preference for the cultivation of naked wheat. However, in C006, the record is poor. The presence of naked wheat can be confirmed, together with fragments of indeterminate cereals. It must be noted that this contrast between the two areas may be explained by the different characteristics and uses of both spaces during this period. The area near the entrance (C003) may have had a domestic character, while the use of the deep room (C006 in Room 4) was limited to a one-off funerary event (García-Rivero et al. 2020, 2022).

For the MNB, the volume of floated sediment, the number of samples, and the density of remains are higher in C006 than in C003. Regarding cereals, in both cases, there is a dominance of naked wheat, with a much smaller presence of barley, which, in this case, only appears in C006. The fundamental difference lies, again, in the absence of wild fruits in C006, while these were abundant in C003. The geomorphological and sedimentological characteristics of the MNB levels documented in C006 suggest that the deposits may have been washed down from another part of the cavity. In this case, it must be considered that the torrential and depositional episodes would have affected the formation process of the archaeological record, including its botanical remains.

As noted above, no explicit comparison can be made between the records of the two areas for the LN period, given their imprecise material definition in the C003 sequence. However, at least some relevant points are worth mentioning. In the level probably corresponding to this period in C003 (Unit 11), wild fruits are proportionally predominant, and naked wheat and barley are hardly attested, with one identification of each. The majority of samples from C006 show a similar situation in terms of the scarcity and low density of remains, among which naked wheat stands out above naked barley, and the presence of wild fruits is not documented. However, two LN samples from C006,

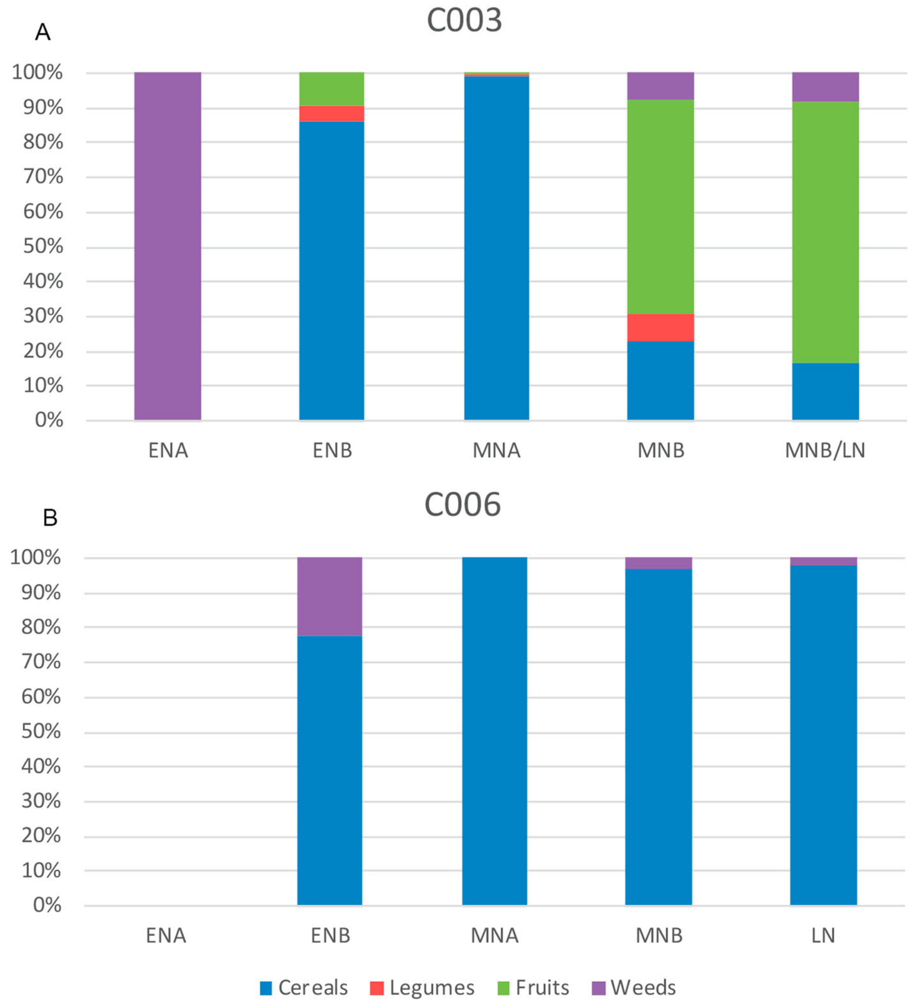

Figure 7. Relative percentages of the seed groups by area and period: A) C003 and B) C006.

and especially that from Unit 4, show a much higher density and number of remains, as well as a greater taxonomic diversity. Naturally, this situation is due to the functional and selective nature of this context: a hearth in which, in addition to some wild plants, there are abundant remains of naked barley and, to a lesser extent, naked wheat. This sample, therefore, must be considered as an accumulation of materials in a functional context that promoted their carbonization and in which, unlike the rest of the samples, there is a predominance of naked barley. This sample has also provided the only cultivated legume, a broad bean, documented in this area of the cavity.

The bone assemblage constitutes the largest part of the faunal record documented in both areas, with over 90% of the remains (the remaining 10% corresponds to malacofauna). As is the case at other Neolithic sites (Morales and Riquelme 2004; Saña 2013; Valente 2016; Bernáldez and García-Viñas in press a), rabbits and ungulates are the most common animals in both sequences. In the bone assemblages of both excavation areas, preliminary taphonomic results help to differentiate between a type of deposit formed by animals with less than 1 kg body mass (rodents, chiroptera, birds, and reptiles), the origin of which cannot be attributed to human action, and another certainly anthropic group composed of ungulates with very scarce evidence of animal scavenging marks (tooth marks or digestion), including deer and domesticated species such as cows, pigs, sheep, and goats. There are no great differences in the distribution of anatomical parts between the taxa throughout the Neolithic periods in C006 (see Table 4). Animals are represented by isolated bones, with the exception of the almost complete skeleton related to a ritual dated to the MNA.

In general terms, the slightly higher number of sheep and goats compared to other ungulates previously observed in C003 is corroborated in C006, in which the former are twice as common as the latter. In C006, with a larger NISP, the number of identified sheep is higher than the number of goats. Both species could have formed mixed herds, as is common in southwestern Spain nowadays and probably in other historical periods (García-Viñas and Bernáldez 2018).

The data on age at death from both excavation areas (Table 5) indicates a high percentage (ca. 50% of the total and ca. 66% of the remains of identified age) of juvenile and infantile individuals among the domestic ungulates (< 2 years) throughout the Neolithic sequence. The data, however, varies between species. Deer—surely a wild species—display the most advanced ages, given that all of the identified individuals are adult or subadult. Cows are the next oldest group, with only subadult or juvenile individuals. In contrast, sheep and goats are characteristically subadult, juvenile, and infantile. Goats, in particular, display younger age ranges, with a greater proportion of infantile individuals. The taxon *Sus* sp., perhaps because it has not yet been possible to discriminate between wild and domesticated animals, displays a wide representation of all age groups, with the exception of senile individuals and a predominance of juveniles.

Table 5. Mortality ages of animal taxa in C003 and C006. Numbers indicate frequency. Decimals express individuals between two adjacent categories. For example, one individual identified as juvenile/subadult accounts for 0.5 in both age groups. When it has not been possible to securely identify *Ovis* or *Capra* and age pertains to two groups, the value per individual (1) is split not only between age group but also between species (0.25).

	Age	ENB	MNA	MNB	LN	Total
Cervus	Infantile					
	Juvenile			0.5		0.5
	Subadult	1	1	1.5		3.5
	Adult	1	1	1		3
	Senile					
Bos taurus	Infantile					
	Juvenile	2		2		4
	Subadult	3		1	1	5
	Adult					
	Senile					
Sus sp.	Infantile	1		1	1	3
	Juvenile	2.5	2	4		8.5
	Subadult	1.5		2	0.5	4
	Adult	1		0.5	1	2.5
	Senile					
Ovis aries	Infantile	3	0.75	0.75	0.75	5.25
	Juvenile	4.5	0.25	2.5	1.5	8.75
	Subadult	2	2	2.5		6.5
	Adult			1		1
	Senile					
Capra hircus	Infantile	2.5	0.75	1.75	1.25	6.25
	Juvenile		0.25	2	0.5	2.75
	Subadult	2		1.5		3.5
	Adult					
	Senile					

The observation of a relatively high peak in the age at death group of individuals under two years in age, and even younger in the case of sheep and, especially, goats, among the herds of Dehesilla Cave, constitutes an interesting empirical pattern. At present, it may be suggested that this pattern corresponds to a livestock system based on the use of meat and dairy products. The ritual use of animals is also known, although perhaps occasional, as is evidenced by the almost complete suckling goat included in the Locus 2 deposition (García-Rivero et al. 2020), but other uses can be dismissed—for instance animal traction by bovids. The aforementioned scenarios, and particularly that of alimentary use, are consistent with the normal (unbiased) representation of the skeletal elements documented in the archaeological record. Livestock may have frequently been in and around the cave.

The densities of NISP and MNI (DSP and DI) by period display a similar structure and diachronic dynamics in both excavation areas, with the exception of the ENA period—not documented in C006—and the MNA—scarcely present in C006 due to the small-scale, punctuated nature of the ritual funerary deposit. The graphical comparison between the different periods based on the DI and DSP of ungulates (Figure 8) shows relatively similar results for

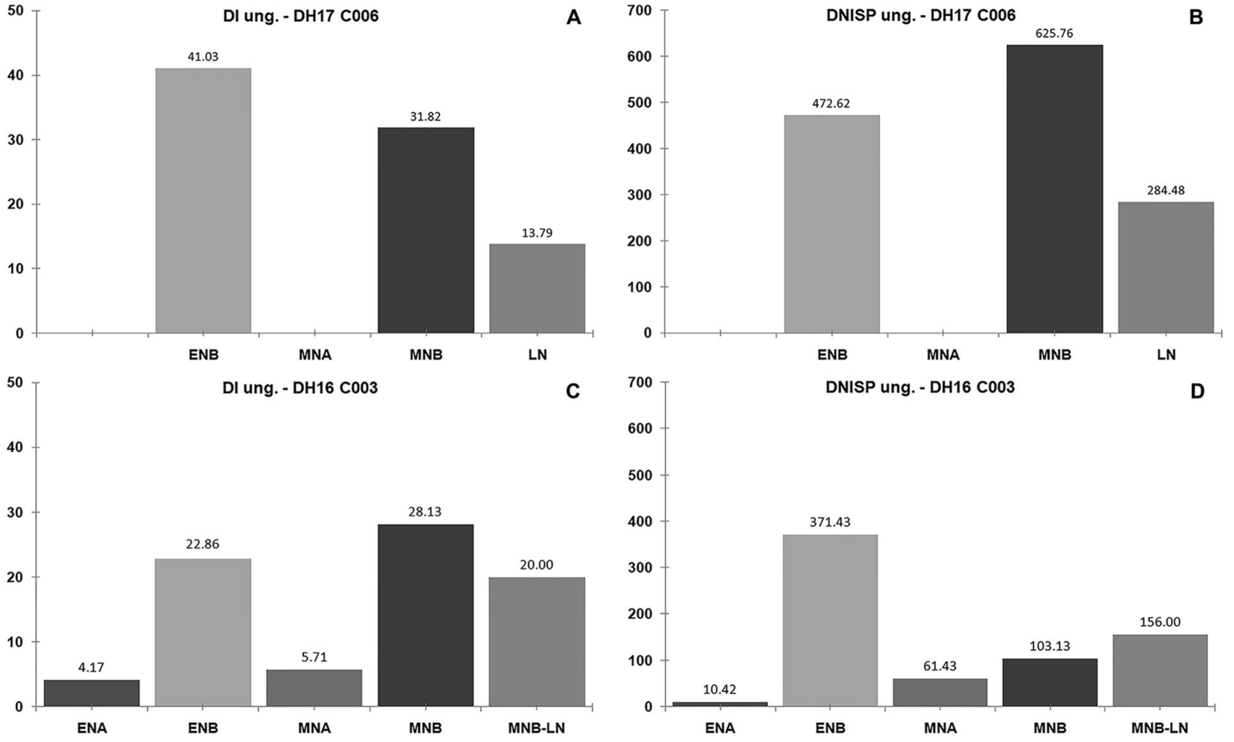

Figure 8. Comparative plots of ungulate densities of individuals (DI) and number of identified specimens (DNISP) by area and period: A–B) C006 and C–D) C003.

both areas, indicating, in addition, that the ENB and MNB periods, followed by the LN, have the highest ungulate DI and DSP. There are, however, slight differences between the two areas, such as the alternating predominant positions between the DIs and DSPs of the ENB and MNB periods. The most notable difference in DSP is observed in the MNB period.

Figure 9 also shows a comparison between periods and areas based on the relative proportions of the MNI of the different ungulate species. In general terms, there is a notable recurrent pattern in which sheep and goats show the highest percentages in all periods of both areas, generally followed by suids and, in smaller proportions, by deer and bovids.

The results obtained for the ENB show some differences between the two areas in terms of the faunal composition, although the densities of NISP and MNI are similar. In C003, suids and sheep/goats have similar percentages of accumulation, while in C006, sheep and goats are more abundant. The results obtained from the second excavation area may be considered more indicative, due to the larger sample size, and they are also in line with what has been described at other Early Neolithic cave sites in the Iberian Peninsula (see below).

The MNA period marks an inflection point in the sequence, with a notable decrease in faunal density. This decrease correlates inversely with the increase in cereal production documented in C003 (García-Rivero et al. 2019), although it has not been possible to corroborate this pattern in C006 due to the specific non-domestic use of this part of the cave. This circumstance also accounts for the differences in both the number of documented remains and the relative proportions of the different species of ungulates (especially bovids and deer).

In the MNB, DI and DSP increase again (only the DSP of C003 does not clearly follow this pattern). This observation may be linked to the increase of coprophilous fungi and plant species indicative of livestock activities recorded in the pollen sequence of C003 (García-Rivero et al. 2019). As for the relative proportions of the different domestic ungulate species, the record from C003—as was the case for the ENB period—shows identical percentages of MNI between suids and sheep/goats. However, the new data from C006 indicate a clear predominance of sheep and goats, especially of the former. We cannot, at present, suggest that the results of one area should be taken as more accurate over those of the other. Although the sedimentological volume, number of remains, and densities of these ungulates are much higher and presumably more reliable for C006, we cannot rule out the possibility of residual bone elements (especially in Units 6b, 6, and 5) from previous periods, as indicated by the pottery record (García-Rivero et al. 2022). This circumstance makes it difficult to accept these results as conclusive and leaves open the assessment of this issue in future excavations.

A similar situation arises from the analysis of the LN period, not only because of the possible presence of residual bone materials in Unit 1 of C006, but also because this period has not been clearly defined in C003. However, most of the values agree in pointing to a slight decrease in faunal density compared with the MNB. The relative proportions of the different livestock herds follow the same trend described above for the ENB and the MNB and are, in turn, consistent with the records from other Andalusian and Iberian sites.

Impact of the results on the paleoecological knowledge of the Iberian Peninsula

Naked wheat and naked barley are the most common taxa at Early Neolithic sites, not only at Dehesilla Cave but also throughout most of the south of the Iberian Peninsula (Pérez-Jordà et al. 2017, 176–ff.). There are several coetaneous archaeobotanical datasets for this period in Andalusia (Rovira I Buendía 2007; Peña-Chocarro et al. 2013; Pérez-Jordà et al. 2017; Peña-Chocarro, Pérez-Jordà, and Morales 2018). The richest come from the hinterland, from the sites of Los Castillejos de Montefrío, Cueva de los Murciélagos de Zuheros, and Cueva de los Mármoles (Figure 10). These assemblages are very similar to that of Dehesilla Cave. This early phase of the Neolithic has provided an archaeological record indicative of small-scale populations with a mixed economy. The poor characteristics of the archaeobotanical record from the ENA of Dehesilla make it impossible to know for the moment if, in the earliest phase of the Neolithic process at this site, there was a predominance or a greater presence of hulled wheat, as is the case at several sites along the Mediterranean coast of the Iberian Peninsula and in the south of France (e.g., De Vareilles et al. 2020).

The most remarkable trend in the different Andalusian sites from the last third of the 6th millennium BC onwards (Figure 11), including Dehesilla Cave, is the dominance of naked wheat and barley, but with a series of secondary cereals such as hulled barley or different hulled wheats (Rovira I Buendía 2007; Peña-Chocarro et al. 2013; Pérez-Jordà et al. 2017; Peña-Chocarro, Pérez-Jordà, and Morales 2018). This pattern coincides with that observed at contemporaneous sites in the Valencian Country and Catalonia (Antolín 2016). However, it is different from the trends observed in other areas, for instance in the interior of the Iberian Peninsula or, even, in the Tingitan peninsula (Morales et al. 2016), where the presence of hulled wheat is more preeminent. Moreover, the botanical record of Dehesilla and the sites of the coast of Málaga is different from that of the sites of the interior of the Guadalquivir Valley. Hulled wheat, flax, and poppy, recurrently present in the inland area, do not appear at any of the sites closer to the coast, neither at this time nor in later periods. Therefore, the current evidence suggests the existence of two distinct agricultural traditions in the interior of the Guadalquivir Valley and the area closest to the coast.

In the 5th millennium B.C., there was a notable reduction in the taxonomic diversity and a consolidation of two main crops, naked wheat and barley. In other Iberian areas, this pattern has been interpreted as a shift from an intensive to an extensive model (Antolín 2016; Pérez-Jordà et al. 2017), in line with what has been suggested for Thessaly or central Europe (Halstead 1996; Bogaard 2004). The current data from Dehesilla, with all of the limitations of its record, coincide in pointing to this same reduction in diversity. At Dehesilla Cave, this transition is detected more clearly, and even somewhat earlier (in the MNA period), than at other Andalusian sites, such as Los Castillejos de Montefrío and Cueva de Murciélagos de Albuñol (Rovira I Buendía 2007).

At the latter, the available data is poorer, at present, but appears to point towards a different agricultural tradition. In the second half of the 5th millennium B.C., the MNB period of Dehesilla Cave may have been part of a more or less generalized pattern in which caves were used in relation to livestock, not only in the south of the Iberian Peninsula

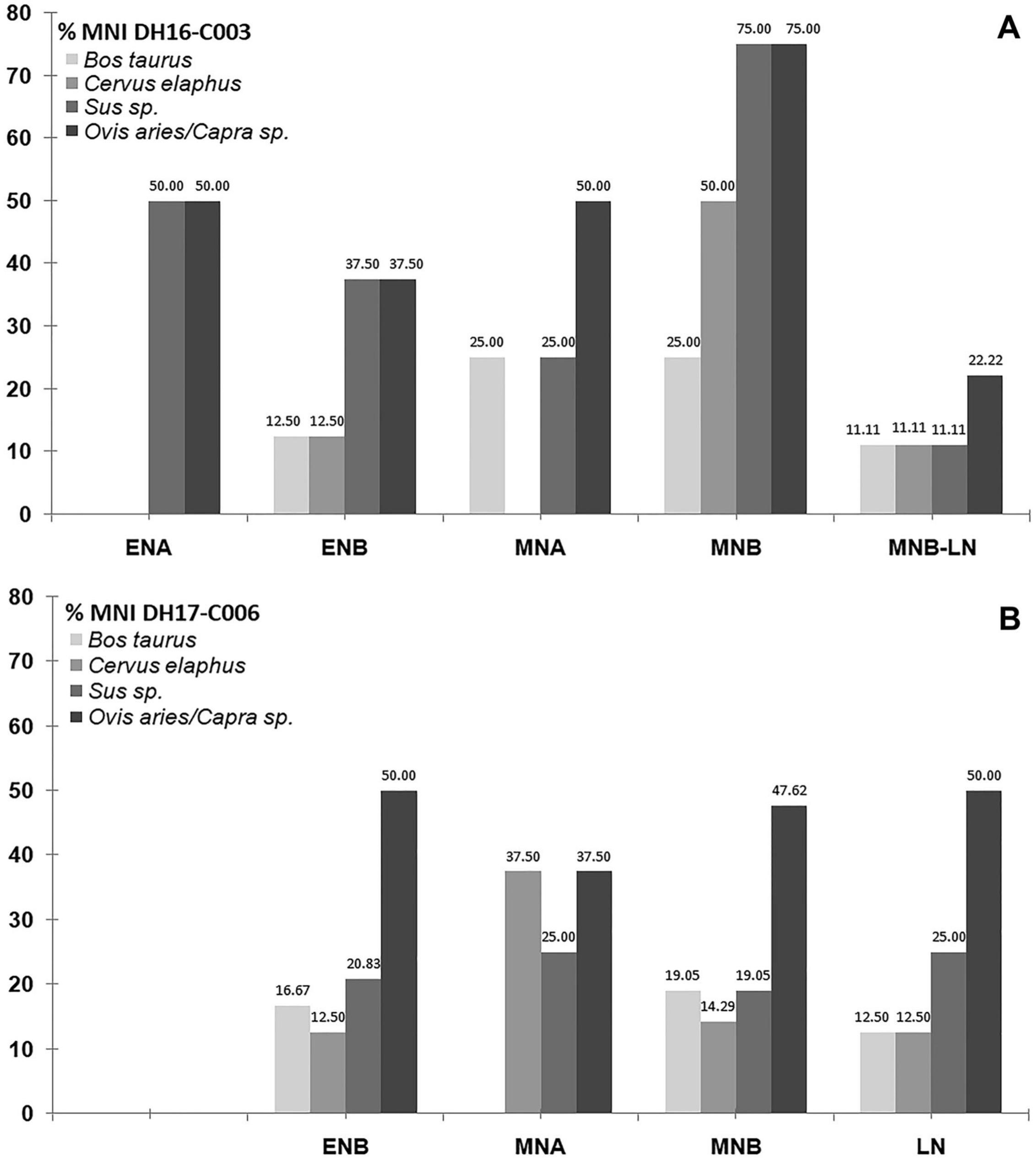

Figure 9. Comparative graphs with the percentages of MNI of the different ungulate species by area and period: A) C003 and B) C006.

but also on the eastern coast, as indicated by the sites of Cova de les Cendres (Bernabeu and Molina 2009), Cova de l'Or (Badal, Martí, and Pérez-Ripoll 2013), Coves de Sta. Maira, and L'Abric de la Falguera (Pérez-Jordà 2013).

More than half of the Neolithic sites in the Iberian Peninsula with faunal studies correspond to caves (cf. Liesau and Morales 2012; Saña 2013). Therefore, caves continue to provide a considerable amount of information for the study of the use of natural resources and this type of agrestic ecosystem. The analysis of the vertebrates from the Neolithic sequences of areas C003 and C006 of Dehesilla Cave contributes new data to the scarce record of archaeozoological studies published for the Andalusian Neolithic (García-Viñas and Bernáldez-Sánchez 2013; García-Viñas et al. 2014).

In general, the animal species best represented at Neolithic sites tend to be the two domesticated species of the Caprinae subfamily (sheep and goats), followed by pigs and cows, to a lesser extent (Bernáldez and Bernáldez 2000; Morales and Riquelme 2004; Altuna and Mariezkurrena 2009; Halstead 2012; Liesau and Morales 2012; Saña 2013; Valente and Carvalho 2014; Valente 2016; Bernáldez and García-Viñas in press a).

This main trend of the predominance of sheep and goat herds over pigs and cattle is observed in many other Neolithic sites in the Iberian Peninsula (Castaños 2004; Saña 2011, 2013; Liesau and Morales 2012; Valente 2016), including those located in the south (Figure 12), as attested by previous work at Dehesilla Cave itself (Boessneck and Von den Driesch 1980, 14–19), as well as the archaeological records from El Parralejo (Morales and Riquelme 2004), Lebrija (Bernáldez and Bernáldez 2000), Cueva Chica de Santiago (Bernáldez and García-Viñas in press b), Nerja (Morales and Martín 1995), Los Castillejos (Riquelme 1998), La Molaina and La Carigüela (Morales and Riquelme 2004), Grañena Baja (Conlin, Martínez, and Morgado 2020), Valdecuevas (Sarrión 1980), and Nacimiento (Alférez et al. 1981; Asquerino 1984).

Among the results on age of death at Dehesilla Cave, the figure around 70% for infantile and juvenile individuals of *Ovis aries* and, especially, *Capra hircus* is clearly noteworthy.

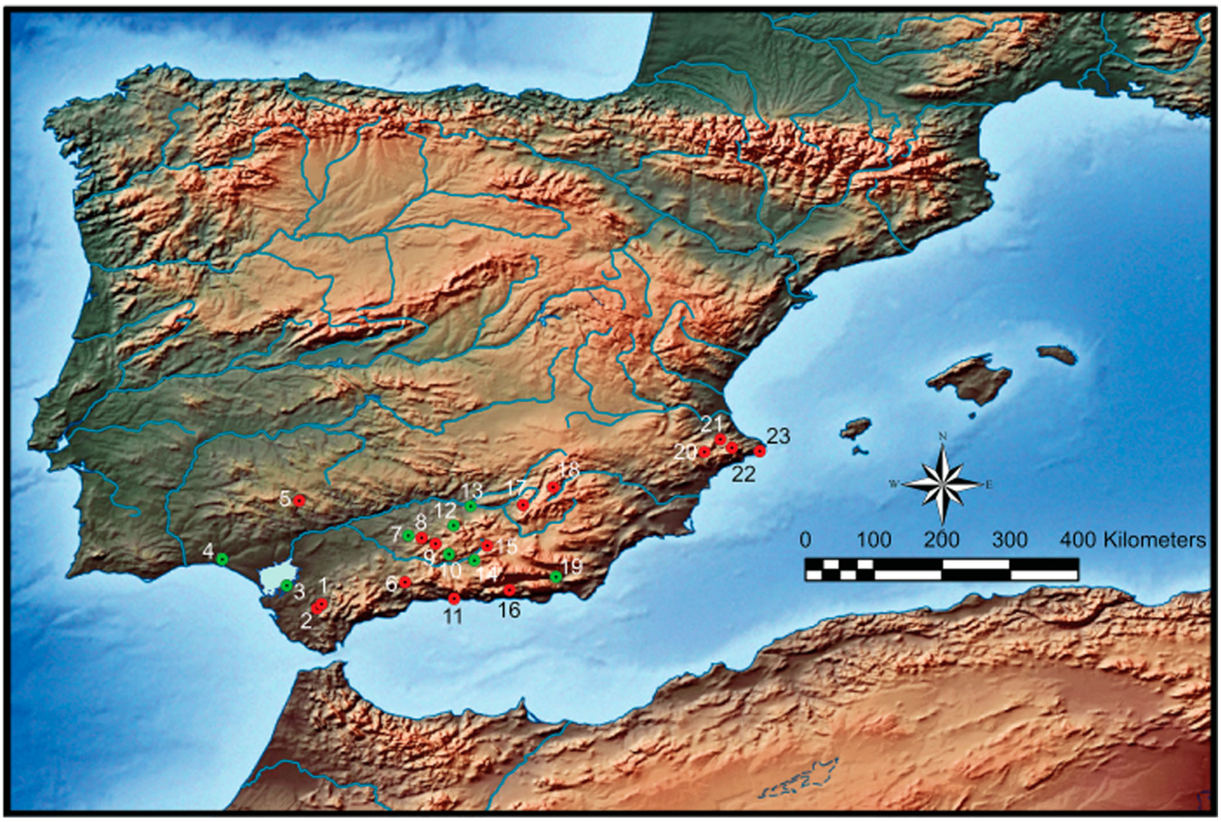

Figure 10. Sites with archaeobotanical and archaeozoological data mentioned in the discussion section (red circles: caves; green circles: open-air sites): 1) Dehesilla, 2) El Parralejo, 3) Lebrija, 4) Papauvas, 5) Chica de Santiago, 6) Toro, 7) Doña Mencía, 8) Murciélagos de Zuheros, 9) Los Mármoles, 10) Los Castillejos, 11) Nerja, 12) Polideportivo de Martos, 13) Grañena Baja, 14) La Molaina, 15) Carigüela, 16) Murciélagos de Albuñol, 17) Valdecuevas, 18) Nacimiento, 19) Cerro de los López, 20) Falguera, 21) L'Or, 22) Sta. Maira, and 23) Cendres.

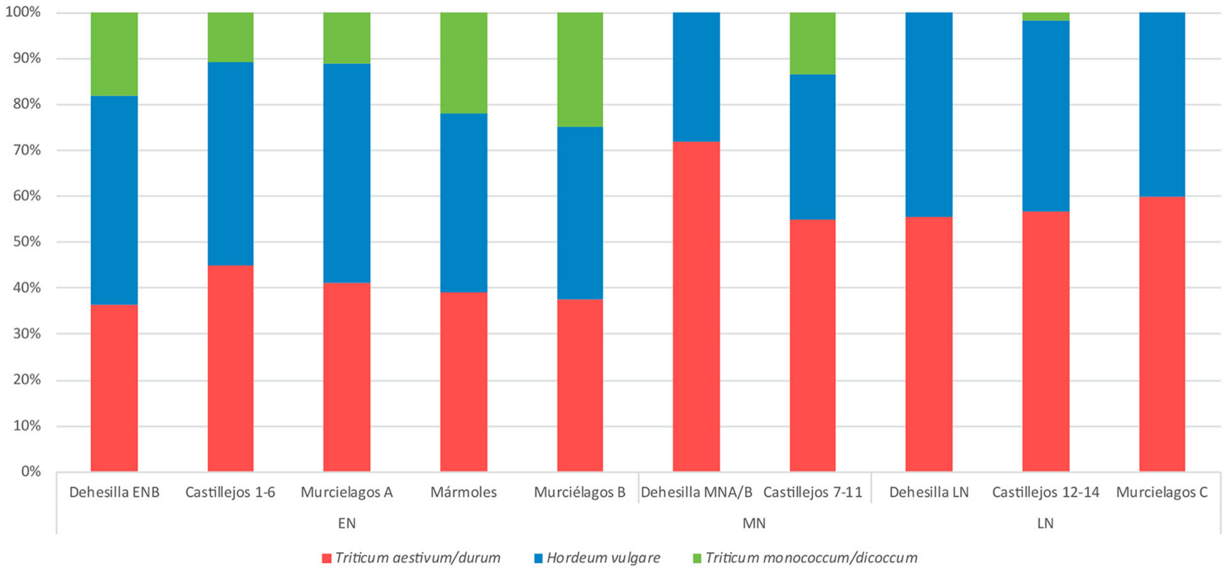

Figure 11. Relative percentages of cereal species in the different Neolithic periods of Dehesilla, Los Castillejos (open-air), Murciélagos de Zuheros (cave), and Mármoles (cave).

A similar pattern is observed at the Andalusian Neolithic sites of Cueva Chica de Santiago (Bernáldez and García-Viñas in press b) and Cueva de Nerja (Morales and Martín 1995), as well as at other Iberian sites, for instance Cueva del Mirador (Martín, Rosell, and Vergès 2009, 85) and Cueva de Chaves (Castaños 2004). It is very possible that the assemblages with high rates of young animals may correspond to herds managed for the consumption of meat (Davis 1989) and production of milk. In any case, this is a fruitful line of research for understanding the subsistence strategies of Neolithic populations.

The balance between wild and domestic species appears, however, to have varied over time. Indeed, Morales and Riquelme (2004) pointed out that the preeminence of domestic animals over wild species at Andalusian sites is less marked in the Early Neolithic than in later periods. Saña (2013) also detected a diachronic decrease in the hunting of ungulates throughout the Neolithic, as well as a shift

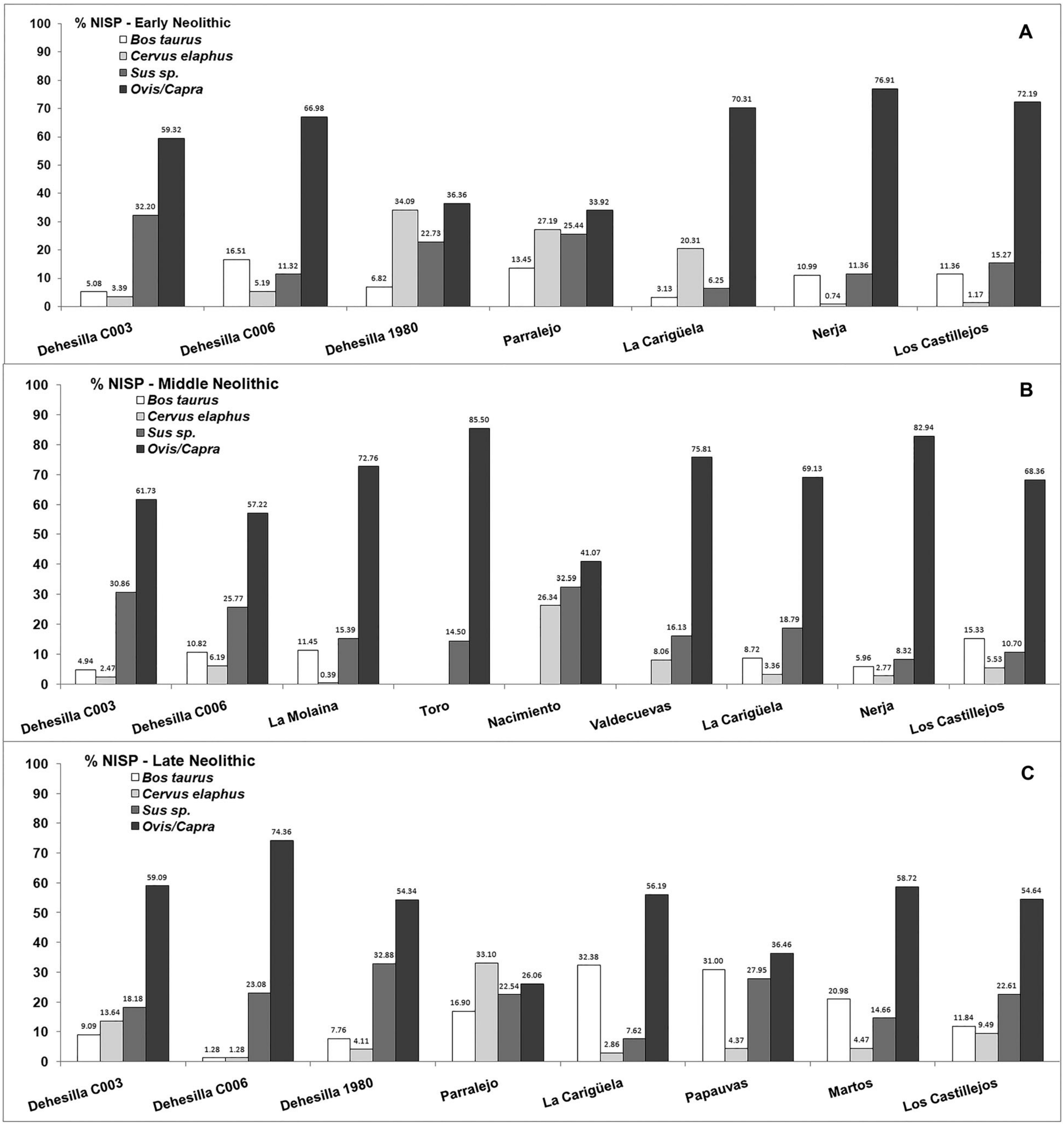

Figure 12. Proportion of NISP of *Bos taurus, Cervus elaphus, Sus srofa/Sus s. domesticus*, and *Ovis aries/Capra hircus* at Neolithic archaeological sites in Andalusia: A) Early Neolithic, B) Middle Neolithic, and C) Late Neolithic.

towards a greater relative importance of pigs and cattle compared to sheep and goats during the period between 4500 and 3300 B.C. These patterns have not been clearly corroborated by the data obtained so far at Dehesilla Cave for the MNB–LN periods (see Figure 9, Table 4), although they have been observed at some sites in the south of the Iberian Peninsula, for example at Papa Uvas (Álvarez and Chaves 1986) and Carigüela (Morales and Riquelme 2004).

The faunal associations between the relative proportions of the different domestic herds documented at Dehesilla Cave for these advanced Neolithic periods is consistent with records from other Andalusian sites such as Papa Uvas (Morales 1985; Álvarez and Chaves 1986), El Parralejo (Morales and Riquelme 2004), Castillo de Doña Mencía (Martínez-Sánchez and Vera 2017), Los Castillejos (Riquelme 1998), La Carigüela (Morales and Riquelme 2004), Martos (Riquelme et al. 2012), and Cerro de Los López (Riquelme 2003), as well as with the generally observed pattern for the Iberian Peninsula (Saña 2013), as is the case for the Early Neolithic data.

Conclusions

The main results previously obtained for area C003 at Dehesilla Cave from pollen, carpological, and zoological analysis suggested a general Neolithic scenario of holm oak and wild olive forests together with oscillating farming and herding practices, with a particular predilection for naked wheat and barley crops and sheep and goat herds. The new data from area C006, with the exception of some specific dissimilarities, broadly agrees with this model. Among the remains of cereals, naked wheat and naked barley are predominant. In the zoological record, both areas show similar patterns in terms of the structure of biodiversity and the diachronic dynamics and are consistent in indicating a higher proportion of sheep and goats over other ungulate species. The data concerning the ENB period at Dehesilla Cave (second half of the 6th millennium B.C.) are indicative of small human populations with a mixed cereal and livestock economy. At the Andalusian sites with good stratigraphic and carpological information—which cluster mainly in the last third of the 6th millennium B.C.—one of the most notable trends observed is the dominance of naked wheat and barley but with a series of secondary cereals such as hulled barley or different hulled wheats.

It may be postulated that the seed record preserved at Dehesilla Cave is more similar to that of the coastal area of Málaga than to that of the Guadalquivir Valley. However, it remains to be clarified whether this presumed pattern can be explained in geographical terms, in the sense of an evolutionary convergence in the face of a similar physiographic context, or whether it is due to some underlying cultural factor. Such a question, in any case, requires future systematic studies of the material and cultural record as a whole. On a larger, let us say, interregional, scale, it seems equally likely that the carpological record of Dehesilla Cave, and by extension that of the southern Iberian Peninsula, shows greater affinity with the Mediterranean regions of Valencia and Catalonia than with the interior regions of the Meseta and even with the Tingitan Peninsula (although, of course, these geographical areas display some degree of internal diversity and differences between their archaeological sites). As far as Iberian geography is concerned, we do not know, at present, if this possible dichotomous pattern may be correlated with two supposed cultural traditions, the Mediterranean and the Inland-Atlantic. In any case, the verification of these hypotheses would require further methodologically systematic and specific analyses.

The clear tendency for sheep and goats to dominate over pigs and cattle during this period, and also during the Neolithic sequence as a whole, is also observed at many other Neolithic sites in the Iberian Peninsula. There is, however, some diversity in the Neolithic record in terms of the patterns of dynamics and relative evolution between domestic herds and wild animal resources, as is suggested by the differences observed between different sites and areas of the Iberian Peninsula.

The MNA period of Dehesilla Cave (ca. 4800–4500 CAL B.C.) is, undoubtedly, a turning point in the Neolithic sequence. There is a notable decrease in zoological remains and, at the same time, a significant change in the botanical record, indicating an economy based mainly on the cultivation of naked wheat and, to a lesser extent, naked barley. This empirical picture could suggest an agricultural scenario similar to monoculture, linked to the shift from intensive to extensive crop systems reported in other Iberian and Mediterranean regions in the 5th millennium B.C. At Dehesilla Cave, this probable extensive agricultural system may have caused pressure on the landscape that would account, from the middle of the 5th millennium B.C. onwards, for the strong decrease of forest cover and the creation of thermophile forests, an ecological system that appears to be observed in other Andalusian sites and may be extendable to other Iberian regions.

The MNB and LN periods (second half of the 5th and 4th millennium B.C., respectively) present some difficulties in the record currently available at Dehesilla Cave. The livestock herds regained greater importance, but the two excavation areas are markedly different in terms of the carpological record. The areas closest to the cave entrance may have been used for livestock, which would explain the predominance of wild fruit remains, as well as the increase in coprophilous fungi, as observed in C003.

At numerous archaeological sites throughout the south of the Iberian Peninsula, the reduction of botanical taxonomic diversity in favor of the differential replication of naked wheat and barley crops is a consolidated model. The faunal association between the relative proportions of the different livestock herds documented at Dehesilla Cave for these advanced Neolithic periods is also consistent with other Andalusian sites of the same period. However, although the record from Dehesilla Cave is not clear in this regard, there may have been a general decline in the hunting and use of wild ungulates (such as deer), as well as a shift towards a greater relative frequency of cattle and pigs and a slight decline in sheep and goats around 4500–3300 B.C.

These patterns are probably related to many of the changes that are visible in the archaeological record from the 4th millennium CAL B.C. onwards. From its onset, and especially by the middle of this millennium, not only in the south but throughout much of the Iberian Peninsula, a demographic increase took place, along with new territorial patterns of human occupation. There was a differential replication of open-air settlements, in valleys and other open fertile areas, where numerous pit structures have been documented, as well as burial sites and megalithic necropoles. The consolidation of these archaeological features would eventually give rise to a new sociocultural era, the Copper Age, across the entire southern Iberian Peninsula at the end of the 4th millennium B.C.

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The authors report here there are no competing interests to declare.

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