New stratigraphically constrained palaeoenvironmental reconstructions for the first human settlement in Western Europe : The Early Pleistocene herpetofaunal assemblages from Barranco Leon and Fuente Nueva 3 (Granada, SE Spain)

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New stratigraphically constrained palaeoenvironmental reconstructions for the first human settlement in Western Europe: the Early Pleistocene herpetofaunal assemblages from Barranco León and Fuente Nueva 3 (Granada, SE Spain)

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Abstract:	The Early Pleistocene sites of Barranco León and Fuente Nueva 3 (Guadix-Baza Basin, SE Spain) have yielded abundant Oldowan lithic artifacts and one hominin tooth (*Homo* sp. in level D1 or D2 of Barranco León), today considered to be among the earliest evidence for a hominin presence in Western Europe, at *ca* . 1.4-1.2 Ma. Here, for the first time, the stratigraphic succession of these two sites are studied more precisely from a palaeoenvironmental point of view, taking into account the different levels of the depositional sequences to analyze the successive fossil assemblages of amphibians and reptiles. Palaeoenvironmental reconstructions are carried out by applying the “habitat weighting” method, which uses the modern distribution by habitat of amphibian and reptile species in order to interpret past landscapes. The successive herpetofaunal assemblages from Barranco León show a certain tendency towards more arid conditions from level D1 to level E, whereas in Fuente Nueva 3 environmental reconstructions reveal oscillating conditions, with a tendency towards more arid conditions in the basal part of the sequence, up to level 5, where the tendency shifts back to more humid conditions. Our results show that the layers included in this study with the highest density of anthropic evidence (such as levels 5 in FN 3 and levels D1 and D2 in BL) are situated within the late Early Pleistocene climatic and environmental cyclicity, yielding different environmental conditions: a humid, wooded biotope for BL, and a more open and drier biotope in FN 3. This suggests that the hominins of the late Early Pleistocene, although conditioned to some extent by climatic factors, were able to cope with changing environmental conditions, both “interglacial” and “glacial”, in the southwestern extremity of the European continent.

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Response to Reviewers:	

Dear Editor Danielle Schreve,

We are resubmitting here our contribution entitled "New stratigraphically constrained paleoenvironmental reconstructions for the first human settlement in Western Europe: the Early Pleistocene herpetofaunal assemblages from Barranco León and Fuente Nueva 3 (Granada, SE Spain)".

Most of the changes asked by the reviewers have been done, as commented in the detailed response. Adequation between the text and stratigraphic figures has been discussed again between the different co-authors. A double check of the language editing has been done by our co-author Deborah Barsky.

Some of the suggestions have not been followed, as we think that it is too early or too simplistic to present yet southern Spain as a glacial refugia during the Early Pleistocene, as we have no equivalent section anywhere in Europe.

Conflict of interest were mentioned during the first submission but they reflect more problems with another research group that did not have had any influence on the results we present in this manuscript. As one of this people (the former director of the project) is from our own institute (and acknowledged in the paper), we would like in the final version of the paper that such a petition does not appears as a conflict. We hope this is not a problem at this stage?

Hope you will consider our work for publication.

Sincerely Yours,
Hugues-Alexandre Blain

Editor and Reviewer comments:

Reviewer #1: In this paper, the authors present a detailed environmental study of some of the most important hominin fossil sites in the Iberian Peninsula. By studying the herpetofauna of each stratigraphic level, they are able reconstruct the changes in landscape and environment during the formation of these sites. Together with the lithic industry record, this allows them to draw very interesting conclusions regarding human occupation of the area of Orce in the context of a cyclic climate. I believe the methods employed in the study are very useful and successfully depict environmentally changes which are in agreement with the stratigraphic succession of the studied sites. The results allows the authors to suggests that hominins could have occupied the area of Orce even during the arid and cold glacial periods. This is a remarkable conclusion, as the influence of the climate in the expansion of early humans in Europe is still an open question, with different authors supporting multiple competing hypotheses on the topic.
Regarding the suitability of the paper in JQSR, the material presented is novel and interesting, certainly suitable for the journal. Additionally, the authors make a good review of what is known from the paleoenvironments of the sites of Barranco León and Fuente Nueva 3. However, I would suggest the authors to undertake a last dive into the available bibliography to make sure that they do not miss any previous works dealing with the environment of the sites. For example, I found no reference to Anadón and Gabàs (2009) which study environmental changes in Barranco Leon. I understand Anadón et al. (2015) covers similar material, but all previous works in the specific topic should be included. Adding the few missing studies will complete the "review" aspect of their paper and make it, in my opinion, perfectly fitting into JQSR.

Additionally, I have a few comments and suggestions which would improve the paper:

1- The geological description of the sites and figure 1c

There is sometimes discrepancy between the description of the stratigraphic levels in the text and their description in figure 1c. Also, the lithological legend is a bit confusing.

ANSWER: Figure 1C has been updated.

-Mudstone is described in the legend of figure 1c as the bodies with dark coloration, while limestone is described as bodies with white coloration. No patterns are indicated. But in the stratigraphic column, the colors seem to indicate the actual color of the level, not the lithology? This is confusing. I would suggest to either have the colors represent different lithologies or to add patterns to differentiate between limestone and mudstone.

-Some levels are often described in the text as sands but in the figure they appear as mudstone (for example, levels F2, E of Barranco León, in lines 189-191). Please be consistent with the denominations. If these are indeed sands then depict them in the figure with a dotted symbology (sands) instead of plain (mudstone).

ANSWER: Adequation and correspondence between Figure 1C and text has been checked in the geological description.

-The text describes the levels of Barranco León from oldest to youngest (line 188) starting from level G to level A. However the figure shows level A being the oldest and level G the youngest. Please change the order to the correct one.

ANSWER: Done

-The description of Fuente Nueva in the text says that lithic industry is found in layers 2, 3 and 5 (lines 262-264). However, figure 1c indicates that lithics are found in levels 1, 2 and 5. Which one is correct? Also, some levels are described to contain invertebrate fossils in the text, but in the column there is no symbols for them (for example, level 3 of Fuente Nueva).

ANSWER: Lithics were founded in levels 2 and 5. What was previously attributed to level 3 may in fact proceed from the boundary between levels 2 and 3. Information regarding fauna has been enlarged such as small vertebrates not previously included, but in the case of the herpetological sample from the level 3 of Fuente Nueva (as explained in text), as our sedimentologist thinks that it is impossible that these remains comes from level 3, we renamed this sample as 2sup, maybe located at the 2-3 boundary. A new point as been added to the conclusion concerning this issue: to verify again in the future the base of FN3 stratigraphy in order to understand which of the levels are sterile and which ones are not. We hope that, even raising some doubt about the contextualization of our results, readers will understand the problem raised by many year of ongoing excavation (and subsequent changes in stratigraphical nomenclature) and the honesty of the presentation of our work.

-Also, in Figure 1c the icon for lithic tools is not in the legend.

ANSWER: Added

-In the description of the site of Barranco León there is not a clear explanation of the distribution of the lithic material nor the hominin molar (quite important), this is also not clear in the figure 1c, since it shows level D2 containing no lithics or hominin remains. Please clarify. I understood from the abstract and the caption of figure 6 that the molar cannot be placed either in D1 or D2, but this should be explained in the description of the site.

ANSWER: Added

2- Previous analyses of the material

It is noted in line 323 that "Part of the material used in this study has already been studied and published in Agustí e al. (2015a)". However, it is not clear what are the differences between the material in that study and this one. I went to check and it seems that in this work the authors present a list with much more material and a slightly different taxonomical list for the herpetofauna for Barranco León. Agustí et al., 2015a report for the levels D1 and D2 the presence of cf. Dopasia (instead of Ophisaurus) and assign a species to Coronella. These are not found in the list by Sánchez-Bandera et al. which includes many new taxa not reported by Agustí et al., 2015a. I am assuming that this is due to an updated classification of the old material and the addition of newer fossils? If so, perhaps all these differences should be briefly explained in the text. Similarly to how the differences with the studies of Blain, 2005, 2009 and Blain et al., 2011, 2016a are explained.

ANSWER: OK, main changes are linked with adapting former faunal list to recent taxonomical nomenclature. Unless for Coronella snake, where more material raised some doubt about the secure attribution to this taxa. We now comment all these differences in the manuscript.

3- I think it would be nice to see the % of the variance represented by each axis in the correspondence analysis in Figure 2.

ANSWER: Thanks for your observation, we completed the correspondence analyses' figures by adding the % of the variance represented by each axis.

4- Figures 3-4

Already contain the same values as those presented in figure 5. I think with figure 5 the authors want to represent the data in a more stratigraphical sense. But as it is now figure 5 seems to be mostly repetition of the previous figures. I would suggest the authors to increase the stratigraphical sense in figure 5 by adding simplified versions of the stratigraphical columns and simple explanations of the environmental changes. Perhaps highlighting sequences of aridification and tentatively identifying the possible glacial maximum or periods of transition.

ANSWER: New figure contains a simplified version of the lithological section, and values are thus referred to a true space dimension (vertical scale).

5- Glacial maximum hypothesis

In line 713 the authors suggest that level 6 could represent a glacial maximum. And yet level 6 is barely discussed in the text due the low amount of material recovered from it. I get the feeling that the argument is that the low amount of herpetofaunal remains could be caused by the existence of a more extreme environment such as a glacial maximum. If the authors want to raise this possibility then the reasoning for it should be explained. Right now the text is not clear on how they arrive at such idea.

Additionally, since there seems to be not enough evidence supporting the glacial maximum hypothesis, I would advise the authors to clarify in the text that this is a hypothesis they raise which should be tested in future studies in order to confirm it.

ANSWER: Thank for your comment. In fact glacial maximum is proposed for level 5. We corrected it rephrasing the sentences in order to improve the clarity.

6- Hominin survival

The discussion ends raising the idea that early hominins in Orce were capable of coping with and adapting to conditions that were both "interglacial" (levels D1 and D2) and "glacial" (levels 3 and 5). This is a remarkable conclusion and I would encourage the authors to expand it a little bit. Does this mean that Orce could have been a glacial refugia for european hominins? Does this fit with the climate reconstructions? How does this fit with the current models for the colonization of Africa.

I understand that the authors will probably tackle these questions in a future papers, as this is a very exciting conclusion. I am just suggesting expanding it a bit here, but I leave it to the discretion of the authors.

ANSWER: Yes, indeed this idea that early hominins were able to cope with Early Pleistocene glacial periods is very interesting (even if not so impressive from a southern point of view). In our opinion, to be able to speak about a glacial refugee, we must have a whole overview of the fossil record at a continental scale (like for Neanderthals), and for the moment Barranco León has no analogue. We feel that it is too early for been able to speak about a glacial refuge for FN3. Also, the faunal list for each stratigraphical levels (especially in FN3) is not rich enough (low number of taxa and/or taxa represented in the whole Iberian Peninsula) to perform a robust climate reconstruction. We hope that future excavation campaigns will bring more material for each of the lower level.

7- Figure 6

Figure 6 is a bit confusing. The CA diagram is the same shown in figure 2, but the authors indicate the presence (and abundance) of lithic and hominin fossil material. This is very good and it is discussed in the text. But then, they also add animal silhouettes, which represent the main taxonomical category of large and very large mammals butchered in each level. However, I think the text does not address this point of the discussion. The macrofauna of the sites is discussed in the paragraph in line 616 and 639, but there is no reference to the figure nor mention of which animals were most commonly butchered.

I would suggest the authors to explain the significance of the relationship between butchered animals and the environment. Otherwise, I see no point to including the animal silhouettes in figure 6.

ANSWER: We corrected that point: we were not referring to butchered animals only but to the most commonly found by the archaeologist (even if still not formally quantified by level yet).

8- I have made numerous minor remarks in the pdf of the manuscript.

ANSWER: We added in the new version of the manuscript all the minor remarks suggested in the pdf.

In conclusion, I believe the present manuscript should be published in JQSR after some corrections and clarifications have been made to the text.

Reviewer #2: This is an interesting manuscript bringing new methods and perspectives into the discussion of earliest human presence in Europe. I have a couple of minor points, which I think are easy to correct/improve.

Line 145
"movable ground" - what do you mean here? Be more precise.

ANSWER: We means ground made of loose material (sand and mud) where some of our taxa (mainly toads) can burrow. We finally decide to remove this information.

Line 152

ANSWER: changed

Line 163

"chronology of this formation runs": formation is a (litho-)stratigraphic term, so I suggest to use words like this: 'the chronostratigraphy of the Baza Formation is ….'

ANSWER: done

Line 165

"major geological members": again a member is a lithostratigraphic term, hence 'lithostratigraphic members' (without "major").

ANSWER: changed

Line 171, 187, etc.

"lutite" is (in my view) not a precise sedimentological term. It would be better to use 'siltstone' and/or 'mudstone' (also to be consistent with later terminology, e.g. line 259).

ANSWER: changed

Line 193/194

"calcites": what you mean here, limestones? Calcite is a mineralogical term, not a sedimentological one.

ANSWER: changed

Line 196/197

Which "environmental features ….indicate a freshwater marginal area of the more saline main lake"? In the previous lines you mention petrological and sedimentological features, which have to be translated into "environmental features". What indicates "freshwater" and especially what indicates a "more saline main lake"? Be here more precise and consult Anadón et al. 2015.

ANSWER: Answered in the manuscript

Lines 260/261

"These deposits are situated": I would suggest 'be correlated' (biostratigraphy is a correlation tool). Further, Agusti et al. (2010) mention the presence of Allophaiomys aff. lavocati (maybe cite here also Agusti & Madurell 2003, which seems to be the primary reference for FN3, but also Agusti et al. 2015 as reference for biozone A. aff. lavocati).

ANSWER: Done

Lines 333-335

My concerns relates to the estimation of MNI for snakes based on vertebra size. I actually have some doubts that this is possible and, if this is indeed possible, I miss a reference and/or technical details (e.g. which measurements, how to measure, statistics, etc.). My concern relates to intra-column variability of centrum-size (did anybody publish research on it?) and how this variability (if present) relates to infra-specific variability. In my opinion, the only way for MNI estimates for snakes are cranial or cervical elements.

ANSWER: Yes, it can be true for Miocene taxa or tropical area species, but not really in Europe where the snake fauna does not present a big intracolumnar variation between vertebra size. It is to add here that we not only rely on centrum length (that is somewhat variable in a same snake) but on the overall estimation of the vertebral size in a same sample. We understand the doubt of the reviewer, as it is not a formal methodology but more an intuitive approach when studying the material.

Line 355
What you mean with "synchronic and diachronic" studies? At contemporary and non-contemporary sites?

ANSWER: We delete the sentence.

Line 387
Is Bufonidae indet. confidently different from Epidalea calamita and Bufotes viridis s.l.? If not, I would count six amphibian species for BL.

ANSWER: Bufonidae indet. does not represent any different taxonomical category from the already identified taxa. It just indicates that we were not able to securely attribute such remains neither to Bufo, nor to Epidalea or Bufotes. It has therefore not to be taken into account in the count for the number of species.

Lines 410/411
I would write '… including aquatic taxa in the analyses and secondly excluding them (without aquatic taxa)…'. State here which taxa you exclude (you bring this quite late in line 444).

ANSWER: We added the aquatic taxa list in that part of the text, thank you for the observation.

Further, you use five different terms for water dependence: "fully aquatic" (line 408), "semiaquatic" (line 429), "water taxa" (line 411), "water edge" (Fig. 5, Tab. 2), "water" (Fig. 3 and 4, Tab. 5), without defining them (be consistent in using one term for same meaning). See also below.

ANSWER: We have simplified it, using 'aquatic' for speaking about the water dependence of the species, and using 'water and water-edge when we speak about the environment (that's last according with the habitat categories we have followed in the present study).

Lines 413/414
"in which the hominins would have moved": maybe better 'which hominins occupied'.

ANSWER: Thank you for your comment, we rewrote this sentence following your suggestion.

Lines 429+443

You introduce Natrix maura as "semi-aquatic" (line 429) and call it later "full aquatic" (line 443).

ANSWER: Thank you for the observation, we have corrected it. *Natrix maura* can be described as fully aquatic in comparison with her congeneric species Natrix natrix/astreptophora.

Chapter 4.3 (Tab. 5)

You present your "environmental values" (habitat weighting) with two decimal places (e.g. 8.89%). Is this justified from the statistics? Why not give one (or maybe better) no decimals (e.g. 8.9% or 9%)?

ANSWER: We have simplified values by giving only one decimal in the text in order to facilitate the reading, but we keep the values with two decimals in the tables and figures because we consider that for some of these values it can be important.

Line 488

"little tall vegetation": I assume you mean 'few/scarce arboreal vegetation'?
“In short, this level is characterized by an open landscape, with scarce humid areas and little tall vegetation.”

ANSWER: Thank you for your comment, we have rewrote this sentence.

Line 736

"an additional indication": what are/is the other indication? Please explain. (see also below).

ANSWER: Done

Line 779-781 (Conclusion)

"further evidence" (see above).

ANSWER: Done

"nor probably chronological period": can you explain here (or before in Discussion) why both 'glacials' in BL and FN3 could not be contemporary?

ANSWER: We have added an explanation in both parts of the text (lines 736 and lines 779-781). Such no-contemporality between the two studied sites is an issue of the new excavations, based on the Mimomys evolutionary degree, on numeric dating (even if this last one is not so clear) and on some differences observed by the new studies of the lithics.

HIGHLIGHTS

- Amphibians and reptiles are good proxies for the environmental reconstructions.
- Paleoenvironmental conditions are reconstructed by stratigraphic levels.
- The first hominins in Western Europe coped with changing environmental conditions.
- The paleoenvironmental changes are in agreement with the climate oscillations.

New stratigraphically constrained ~~paleo~~palaeoenvironmental reconstructions for the first human settlement in Western Europe: the Early Pleistocene herpetofaunal assemblages from Barranco León and Fuente Nueva 3 (Granada, SE Spain)

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Abstract

The Early Pleistocene sites of Barranco León and Fuente Nueva 3 (Guadix-Baza Basin, SE Spain) have yielded abundant Oldowan lithic artifacts and one hominin tooth (*Homo* sp. in level~~ayer~~ D1 or D2 of Barranco León), today considered to be among the earliest evidence for a hominin presence in Western Europe, at *ca*. 1.4-1.2 Ma. Here, for the first time, the stratigraphic ~~sequences~~ succession of these two sites are studied more precisely from a palaeoenvironmental point of view, taking into account the different levels~~ayers~~ of the depositional sequences to analyze the successive fossil assemblages of amphibians and reptiles. Palaeoenvironmental reconstructions are carried out by applying the "habitat weighting" method, which uses the modern distribution by habitat of amphibian and reptile species in order to interpret past landscapes. The successive herpetofaunal assemblages from Barranco León show a certain tendency towards more arid conditions from level~~ayer~~ D1 to level~~ayer~~ E, whereas in Fuente Nueva 3 environmental reconstructions reveal oscillating conditions, with a tendency towards more arid conditions in the basal part of the sequence, up to level 5~~ayer 7~~, where the tendency shifts back to more humid conditions. Our results show that the layers included in this study with the highest density of anthropic evidence (such as levels ~~ayers 3 and~~ 5 in FN 3 and

levels~~ayers~~ D1 and D2 in BL) are situated within the late Early Pleistocene climatic and environmental cyclicity, yielding different environmental conditions: a humid, wooded biotope for BL, and a more open and drier biotope in FN 3. This suggests that the hominins of the late Early Pleistocene, although conditioned to some extent by climatic factors, were able to cope with changing environmental conditions, both “interglacial” and “glacial”, in the southwestern extremity of the European continent.

Key words: First Human Settlement in Europe; Early Pleistocene; Amphibia; Squamata; Habitat Weighting; Iberian Peninsula

1. Introduction

The Barranco León (BL) and Fuente Nueva 3 (FN 3) sites are among the oldest and most significant Oldowan occurrences so far discovered outside Africa (Martínez-Navarro et al., 1997; Oms et al., 2000a). Moreover, an infant molar attributed to *Homo* sp. from Barranco León ~~may represent~~is one of the oldest hominin remains~~nant~~ ever found so far in Western Europe (Toro-Moyano et al., 2013). In addition to their exceptionally rich large- and small-mammal record, these two sites have yielded very rich and well-documented stone tool assemblages (Barsky et al., 2013, 2015a, 2015b, 2018; Titton et al., 2018, 2020; Toro-Moyano et al., 2010, 2011), now consisting of around 45~~0~~00 pieces. These assemblages present remarkable features, including an impressive macro-toolkit made from locally available Jurassic limestone and small-sized flakes and cores knapped from flint nodules collected in detrital position near or in the sites. Ongoing research on the lithics from these two sites now distinguishes subtle similarities and differences between them, highlighting how early hominin behaviors could have been influenced by the availability and formal features of the lithic raw materials they used, as well as by environmental and chronological differences now recognized between the two site contexts (Barsky et al., 2015a; Titton et al., 2020).

Previous works have carried out ~~paleo~~palaeoenvironmental and ~~paleo~~palaeoclimatic reconstructions of both sites on the basis of studies of their amphibian and squamate reptile assemblages (Blain et al., 2011, 2016a), but without making distinctions by level. The faunal list resulting from these studies was composed of a total of 16 species at BL and 12 at FN 3 (Blain, 2005, 2009; Blain and Bailon, 2010; Blain et al., 2011, 2016a): in total seven anurans (*Discoglossus* cf. *jeanneae*, *Pelobates cultripes*, *Bufo bufo* s.l., *Epidalea calamita*, *Bufotes* sp. (*viridis* group), *Hyla* sp., *Pelophylax* cf. *perezi*), four lizards (*Chalcides* cf. *bedriagai*, *Timon* cf. *lepidus*, small indeterminate lizards and *Ophisaurus* sp.), and five snakes (*Coronella girondica*, *Natrix maura*, *Natrix natrix* s.l., *Zamenis scalaris* and *Malpolon monspessulanus*). On the basis of these assemblages, the climate was characterized as warm for both sites, with hot summers and mild winters, and with low precipitation (albeit more abundant than at present) of irregular distribution, concentrated in winter and to a lesser extent in spring, and with a four-month drought period in the summer and at the beginning of autumn. From a ~~paleo~~palaeoenvironmental point of view, both sites were characterized by a terrestrial landscape composed of open environments (mainly dry meadows, rocky-stony areas and Mediterranean scrubland), although there were some wet wooded areas. Water-linked amphibians and reptiles suggest the existence of a sunny, permanently aquatic environment ~~with banks made up of movable ground~~ (Blain et al., 2011).

The aim of the present work is to produce some stratigraphically more detailed ~~paleo~~palaeoenvironmental reconstructions for each site on the basis of their amphibian and squamate reptile assemblages, using the remains gathered during the most recent field campaigns, undertaken from 2015 to 2017 at FN 3 and from 2015 to 2018 at BL.~~ These allow this more detailed stratigraphic approach.~~

2. Stratigraphic setting and chronology

The Guadix-Baza Basin is located in the southeast of the Iberian Peninsula (Fig. 1A), within the Betic Range. This basin was gradually uplifted due to the action of plate tectonics during part of the Miocene (some 8 Ma), disconnecting from the sea and becoming continental.~~–~~ The basin became a catchment area of the present-day Guadalquivir river slightly before 205 ka (Díaz-Hernández and Julià, 2006). ~~The basin~~It was subsequently infilled by the alluvial Guadix Formation, composed of conglomerates (Viseras, 1991), and ~~of~~ by the lacustrine and palustrine Baza Formation, covering the central area (Anadón et al., 1987; Vera et al., 1985). The sites analyzed in the present work are located in the Baza Formation (Fig. 1~~A,~~B). The chronostratigraphy of the Baza Formation is~~logy of this formation runs from the end of the~~ Early Pliocene (Agustí, 1986; Garcés et al., 1996) to ~~the~~ Middle Pleistocene (Agustí et al., 1987), and is composed of three ~~major geological~~ lithostratigraphic M~~m~~embers (Vera et al., 1985; Oms et al., 1998, 2000b): a L~~l~~ower M~~m~~ember (calcareous surface deposits of a lacustrine and palustrine origin); an I~~i~~ntermediate M~~m~~ember (fluvial mudstones and sandstones); and an U~~u~~pper M~~m~~ember (lacustrine and palustrine deposits resulting from an accumulation of silty calcareous deposits as well as coarser fractions). ~~The archaeo-paleontological sites of~~ BL and FN 3 are included in the U~~u~~pper M~~m~~ember. ~~The lithological diversity of this section includes limestones, lutites, sandstones, conglomerates and breccias (Oms et al., 2011).~~

The archaeo-~~paleo~~palaeontological sites of BL and FN 3, ~~which are~~ separated by a distance of 4.1 km, are located 124 km north of the city of Granada (SE Spain), at approximately 950 meters above sea level, in the northeastern part of the Guadix-Baza Basin. In general (see Fig. 1C), the succession containing the archaeo-~~paleo~~palaeontological sites at F~~uente~~ N~~ueva~~ 3 is dominantly palustrine, while ~~in~~ B~~arranco~~ L~~eón~~ is more lacustrine (Oms et al. 2011~~0~~). In both cases (see Fig. 1C), ~~paleo~~palaeohydrological conditions were ~~not~~ unstable throughout the sections in terms of water salinity and ~~level~~depth. A general overview of the sedimentary conditions is ~~here~~ summarized here in order to better control any bias of ~~paleo~~palaeoenvironmental data.

2.1 Barranco León

This site is located ~~roughly~~ around 3 km from the village of Orce, which lies on the left bank of a ravine linked to the Sierra de la Umbría, one of the mountain ranges that delimits the northeastern part of the Guadix-Baza Basin. The site is located to the south of the Cañada de Vélez~~,~~ valley, in a tributary gorge ~~which~~ that presents a ~~geological sequence~~succession consisting of mudstones, grey to yellow sands, ~~lutites,~~ gravels and limestones. ~~Its~~ The stratigraphy bounding the site is divided into nine levels. From oldest to youngest these are ~~as follows~~ (Anadón et al., 2003; Anadón and Gabàs, 2009; Oms et al., 2011; Fig. 1C): level A, beige calcsiltites to calcarenites; level B, black and dark green feldspar quartz muddy sands~~level G corresponds to beige-colored sands~~; level C, beige calcsiltites to calcarenites; level D1, greyish gravels with a sandy matrix; level D2, greyish quartz-bioclastic sands, ending in whitish limestones; level E, fine-to-medium-grained quartz and feldspar sands, with reddish, brown and greenish colorations; level F1, black sandy lutitesmudstones-; level F2, bioclastic sands of greyish quartz with small chalk nodules in the upper part; level F1, black sandy lutites; level E, fine-to-medium-grained quartz and feldspar sands, with reddish, brown and greenish colorations; level D2, greyish quartz-bioclastic sands, ending in whitish limestones; level D1, greyish quartz with a sandy matrix; level C, beige calcites to calcarenites; level B, black and dark green feldspar quartz sands; and finally, level G corresponds to beige-colored sands. level A, beige calcarenites to calcites.

In Barranco León, the main environmental features from levels D1, D2 and E indicate a marginal freshwater marginal area of the more saline main lake. Theeis freshwater was sourced from the adjacent highlands and got mixed with surface waters and hydrothermal ones (Anadón et al., 2015). This freshwaterIts presence must have attracted humanss activities during the relatively lower phasesing of the lake waters. This is consistent with micromorphologic data by (Rodriguez-Rivas, (20019). The faunal content of D1 level have an obvious component of reworking (parautochtonusautochthonous), while D2 is far more autoctonousautochthonous and E is fully autochtonousautochthonous.

In archaeo-paleopalaeontological terms, the most important and interesting significant levels are D2 and D1. Level D1 ranges from 65 to 0 cm in thickness and gravels consist mainly of angular pebbles, varying from small quartz clasts to palustrine limestone boulders (Anadón and Julià, 2010). The formation of level D1 is associated with a sudden event whereby high-energy water currents brought gravels together with most of palaeontological and archaeological remains (Oms et al., 2011). Nevertheless, at least a small fraction of the archaeological remains could be *in situ* as shown by the presence of a re-assembled flint core (Gibert et al., 1998). It is the only event of this nature that has been documented so far in the BL sequence and its sudden character is also supported by the absence of lateral accretion surfaces or sedimentary features indicating some type of recurrence (Oms et al., 2011). Level D2 is roughly 20 cm thick and records background sedimentation. Both the sands and the microfaunal remains in D2 are reasonably similar to those found in level D1, apart from the fact that they appear to be *in situ* (Oms et al., 2011).

As regards its chronology, the stratigraphic sequence of B~~arranco ~~L~~eón~~ has been dated by a variety of techniques, using large-vertebrate and small-mammal assemblages, ~~paleo~~palaeomagnetic studies and electron spin resonance (ESR). The ESR dating was applied to optically bleached quartz grains, giving the sequence an age of between 1.2 ± 0.09 Ma in the upper part, and 1.88 ± 0.19 Ma at the base. The datings of levels D1 and D2 yielded an age of 1.46 ± 0.17 Ma (Toro-Moyano et al., 2013). In general, ~~T~~the estimations of the ESR range are ~~in general ~~consistent with the stratigraphy, showing an overall increase in age with depth, and ascribing the deposits an Early Pleistocene age. The ~~paleo~~palaeomagnetic study shows reverse polarity throughout the BL stratigraphic section (Oms et al., 2000a, 2003) belonging to the upper Matuyama chron.~~. In conjunction with the ESR results, this indicates that the sequence of Barranco León was deposited during the Matuyama Chron (0.78 – 2.58 Ma) (Oms et al., 2003).~~

The~~se~~ numerical dates~~ings~~ are supported by the biochronological data. Without taking the levels into account, the faunal list for large vertebrates consists of *Ursus* sp., *Canis mosbachensis*, *Lycaon* cf. *lycaonoides*, *Vulpes* cf. *praeglacialis*, *Meles* sp., *Pannonictis* cf. *nestii*, *Pachycrocuta brevirostris*, *Homotherium* sp., *Stephanorhinus* cf. *hundsheimensis*, *Equus altidens granatensis*, *Equus sussenbornensis*, *Hippopotamus antiquus*, *Bison* sp., *Hemitragus* cf. *albus*, *Praemegaceros* cf. *verticornis* and *Metacervocerus rhenanus* (Martínez-Navarro et al., 2010). This large-mammal association is characteristic of the Late Villafranchian period (Rook and Martínez-Navarro, 2010) and is fairly similar to that from the nearby ~~paleo~~palaeontological site of Venta Micena, dated to ~~roughly~~ around 1.4-1.6 Ma (Duval et al., 2010), despite the presence of *Equus sussenbornensis*, which suggests a slightly more recent age for BL. The faunal list for small mammals is composed of *Mimomys savini* (showing a representativity of 80% in relation to the total rodents), *Allophaiomys* aff. *lavocati*, *Oryctolagus* cf. *lacosti*, Erinaceinae indet., *Crocidura* sp., *Sorex minutus*, *Sorex* sp., *Galemys* sp., *Asoriculus gibberodon*, *Apodemus* aff. *flavicollis*, and *Hystrix* sp. (Agustí and Madurell, 2003; Agustí et al., 2010, 2015a). This assemblage places BL in the regional *Allophaiomys lavocati* biozone (Agustí and Madurell, 2003; Agustí et al., 2010, 2015b), where level TE9c of the ~~site of~~ Sima del Elefante site (Atapuerca) is also ~~located~~situated, biochronologically dated to between 1.5 and 1 Ma (Cuenca-Bescós et al., 2010, 2013). The evolutionary differences between the *M. savini* populations of BL and FN 3 have ~~permitted~~ allowed to suggest that BL is older than FN 3 (Lozano-Fernández et al., ~~2014~~ 2015). Finally, combining ~~the~~ data from the numerical datings with the biochronological and ~~paleo~~palaeoclimatic data, Blain et al. (2016a) propose~~d~~ that BL and FN 3 had been formed during particularly hot climatic periods around 1.4 Ma, suggesting a correlation with Marine Isotope Stages 43-49 (i.e. between 1.47 and 1.35 Ma~~1.35 and 1.47 Ma~~).

2.2 Fuente Nueva 3

The FN 3 site is located to the east of the town of Orce (Granada), on one of thea slopes north of the Cañada de Vélez river valley (Fig. 1B), in the village of Fuente Nueva. The site is some 2 km to the north of the large Sierra Umbría mesozoic reliefs and 900 m to the west of the smaller -Cerro de la Venta hill (see Fig 1B b). It is made up of mudstones, limestones, silts and sands, containing some freshwater mollusk shells. These deposits are situated in thea biozone in which the presence of *Allophaiomys lavocati* is recorded (Agustí et al., 2010). The general section displays up to Within these deposits, 12 levels have been distinguished (Oms et al., 2011, see also Anadón et al., 2003), of which levels 2 and 3 5 are particularly noteworthy presenting abundant remains of lithic industry (although some 3 bones may, in fact be at the 2/3 boundary). Lithic industries are also found in levels 1 and 5, where In level 5, furthermore, a specimen of *Mammuthus meridionalis* in anatomical connection was found, associated with hyena coprolites (*Pachycrocuta brevirostris*) and with remains of lithic industry (Espigares et al., 2013; Toro-Moyano et al., 2010; Martínez-Navarro et al., 1997). Industry-rich levels are also rich in fauna, except for level 3 (that has no industry), that in fact are likely to belong to the 2/3 boundary.

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The geological composition of each level (from younger to older) was established by Anadón et al. (2003) and Oms et al. (2011) (Fig. 1C): level 1, the oUnits (levels)ldest level 1,, 4, 11 and 12 are whitish limestones of mudstone lumpy texture, common calcrete nodules, and post-depositional hydroplastic depositional structures (these last in levels 1 and 4). Level 2 is a green to greenish clays that towards the southern part of the excavation gets more carbonatic and whitish. Level 3 is a brown whitish clay with nodular limestonescarbonate nodules, the top of which is transitional to level 4. Level 5 is a greenish fine-grained sand that has strong irregularities in thickness and induration. Thickness variations are due to the compensation of the irregularities of the top of underlying 4 level, while hardening variations are due to differential cementation, which is common at the base of ~~-~~level 5. The top of level 5 becomes brownish and has plenty of lacustrine invertebrates and locally small (1 cm in diameter) edaphic nodules ~~of around 1 cm in diameter~~are found. Level 6 are soft dark brown clays in fresh outcrop, that get whitish when drying. Levels 7 and 9 are greenish-brown dark marly mudstones and levels 8 and 10 are pale-brown greenish ~~-~~marly mudstones.~~ comprising limestones made up of nodular lithofacies. This last level is affected by large, post depositional hydroplastic deformation structures. levels 11 and 12 comprise whitish limestones; levels 8 and 10 consist of pale, greenish-brown-colored marly lutites; levels 7 and 9, dark, greenish-brown-colored marly lutites; level 6, dark, brown clays; level 5, fine-grained, greenish sands and marly lutites; level 4, limestones strongly affected by hydroplastic deformations; levels 2 and 3, calcareous lutites containing invertebrate remains, mainly ostracods, mollusk shells and opercula; and finally level 1, the oldest level, comprising limestones made up of nodular lithofacies. This last level is affected by large, post-depositional hydroplastic deformation structures.~~

The stratigraphic ~~sequence~~ succession at~~of~~ FN 3 has been dated by ~~means of~~ the large-~~vertebrate~~ and small-mammal assemblages, ~~paleo~~palaeomagnetic studies and ESR. The data obtained by ESR place the site within a chronological range from 1.67 to 1.34 ~~1.34 to 1.67~~ Ma (Duval, 2008; Duval et al., 2012). ~~These results are in broad agreement with the stratigraphy, showing a general increase in age with depth and assigning the deposits an Early Pleistocene age.~~ The ~~paleo~~palaeomagnetic analyses reveal reverse polarity (Oms et al., 2000a),~~,~~ which, in conjunction with the ESR data, ~~gives~~ attributes the site an age prior to the Jaramillo subchron (1.07-0.99 Ma) (Oms et al., ~~2000, ~~2003, Alvarez et al., 2015).~~.~~ The taxonomic list of large mammals published by Martínez-Navarro et al. (2010), ~~leaving the different levels out of account~~for all levels combined, is composed of *Ursus* sp., *Canis mosbachensis*, *Lycaon* cf. *lycaonoides*, *Vulpes* cf. *praeglacialis*, *Meles* sp., *Pannonictis* cf. *nestii*, *Mustelidae* indet. (small-sized), *Pachycrocuta brevirostris*, *Lynx* sp., *Felidae* indet., *Mammuthus meridionalis*, *Stephanorhinus* cf. *hundsheimensis*, *Equus altidens granatensis*, *Hippopotamus antiquus*, *Bison* sp., *Ammotragus europaeus*, *Hemitragus* cf. *albus*, *Praemegaceros* cf. *verticornis* and *Metacervocerus rhenanus.* Notable by comparison with BL is the abundance of *M. meridionalis* remains. This large-vertebrate assemblage is also characteristic of the Late Villafranchian period (Rook and Martínez-Navarro, 2010) and reasonably similar to that present at the nearby ~~paleo~~palaeontological site of Venta Micena, despite the presence of *Ammotragus europaeus*, which suggests a more recent age for the site of FN 3, as likewise suggested for BL. The taxonomic list of rodents is composed of *Hystrix major*, *Allophaiomys* aff. *lavocati*, *Mimomys savini* and *Mimomys* sp. (Agustí and Madurell, 2003; Agustí et al., 2010, 2015b, 2019). This rodent assemblage fits within the *Allophaiomys lavocati* biozone (Agustí and Madurell, 2003; Agustí et al., 2010), the same biozone as BL. As commented above, the evolutionary stages of *Mimomys savini* suggest that FN 3 is more recent than BL (Lozano-Fernández et al., ~~2014~~ 2015).

3. Material and Methods

3.1 Fieldwork

The amphibian and squamate fossil remains used for this study consist of disarticulated elements collected by ~~means of the~~ water screening of sediment obtained during archaeological excavations at both sites, during ~~the~~ field campaigns from 2015 to 2017 in FN 3 and from 2015 to 2018 in BL. The total amount of water-screened sediment has been evaluated to be approximately 8.3 tons, 6.2 tons for BL and 2.1 tons for FN 3 (Table 1). All the sediment was water-screened during the successive summer field seasons using superimposed 10, 5 and 0.8 mm mesh screens and bagged by excavation layer. In subsequent years, the microfossils were processed, sorted and classified into broad categories at the Institut Català de Paleoecologia Humana i Evolució Social (IPHES, Tarragona, Spain).

3.2 Systematic study

Part of the material used in this study (from levels D1 and D2 from BL) w~~h~~as already ~~been~~ studied and published in Agustí et al. (2015a). Updated classification of this old material leads to a revision of the specific attribution of the fossils attributed to the genus *Coronella* (*Coronella* cf. *girondica* becomes cf. *Coronella* sp.) and the nomenclature for fossil anguids (*Dopasia* becomes *Ophisaurus*) and extant snakes (*Rhinechis scalaris* becomes *Zamenis scalaris*). Fossil amphibians and reptiles used in other studies (Blain, 2005, 2009; Blain et al., 2011, 2016a) come from older excavations, where the levels were not yet individualized and consequently have not been included in this work. Systematic attribution basically follows the osteological criteria established by Szyndlar (1984), Bailon (1991, 1999), Barahona and Barbadillo (1997), Holman (1998), Gleed-Owen (1998), Blain (2005, 2009) and Blain et al. (2008, 2011).

The fossils were grouped by the minimum number of individuals (MNI) method, determining the number of individuals for a particular species represented in each site by counting a diagnostic element. In the case of snakes, which are virtually only represented by vertebrae, the MNI was assessed for each sample taking into account the size of the dorsal vertebrae (i.e. centrum length).

3.3 Analyses of species interrelationships

To analyze the changes in the faunal composition as well as the interrelationships between the various fossil species and their possible ~~paleo~~palaeoenvironmental and chronostratigraphic implications, first a binary data matrix was generated based on the presence/absence of the taxa recorded for each level throughout the sequence under study, where ‘presence’ is represented by ‘1’ and ‘absence’ by ‘0’. Where the taxa could not be identified to species level (Anura indet., Bufonidae indet., Ophidia indet., cf. Colubrinae indet. and *Natrix* sp.), they are not included. However, Lacertidae indet. is included in spite of being taxonomically indeterminate, on account of ~~its~~ their significance for ~~the~~ assessing the environmental ~~reading~~ context (as they represent a ~~dude to all the lacertidae species have~~ terrestrial indicator not documented in FN 3 and BL by any other lower taxonomic category)~~habits and because we have not recovered any other lacertidae remains.~~.

A correspondence analysis (CA) was applied to the resulting data matrix, a method recommended for comparing and highlighting the proximity or difference between the taxa (assigned to the rows in the matrix) in different associations or concurrences (assigned to the columns) (Greenacre, 2010), grouping them more closely together the greater the degree of concurrence. This statistical analysis ~~makes it possible to~~ relates different taxa through their recorded concurrences~~, and has yielded solid results in synchronic and diachronic regional studies~~ (Bisbal-Chinesta and Blain, 2018). The software PAST3 was used to perform the statistical analysis (Hammer et al., 2001).

3.4 ~~Paleo~~Palaeoenvironmental reconstruction

The ~~paleo~~palaeoenvironmental reconstruction of the sites of BL and FN 3 was carried out using the habitat weighting method (Blain et al., 2008). As the amphibians and reptiles of the Pleistocene of the Iberian Peninsula are considered specifically identical to present-day populations, the current distribution of the habitat of the species can be used to obtain the habitat weightings (Blain, 2005). This method is based on the distribution of each species in the habitat or habitats they presently occupy in the Iberian Peninsula. These habitats are divided into five major categories: open-dry, open-humid, woodland and woodland-edge, rocky and water-edge (Table 2). Each species may have a maximum weighting of 1.0~~0~~, obtained on the basis of its habitat preferences. If a species shows preferences for more than one of the defined types of habitat, the resulting weighting is proportional to a greater or lesser preference (Blain et al., 2008, 2011).

~~Paleo~~Palaeoenvironmental inferences were based on current chorological data (mainly geographical distribution and ecological requirements) for the extant herpetofauna of the Iberian Peninsula, available in general atlases (Gasc et al., 1997; Pleguezuelos and Martínez Rica, 1997; Pleguezuelos et al., 2002), in regional works (Pleguezuelos, 1989; Fernández-Cardenete et al., 2000) and in biogeographical studies (Antúnez et al., 1988; Real et al., 2001).

4. Results

4.1 Amphibians and squamate reptiles from Barranco León and Fuente Nueva 3

Slightly less than 2000 bones of amphibians and squamate reptiles, including toads and frogs, lizards and several snakes, are recognized in this study (Tables 3 and 4). With the material from the new field seasons, the faunal list recorded at BL in the present study is composed, without taking the levels into account, of a total of 14 species: ~~seven~~ six anurans (*Discoglossus* sp., *Pelobates cultripes*, ~~Bufonidae indet.,~~ *Epidalea calamita*, *Bufotes viridis* s.l., *Hyla* sp. and *Pelophylax* cf. *perezi*), two lizards (an indeterminate large-sized lizard and *Ophisaurus* sp.) and five snakes (*Malpolon monspessulanus*, *Natrix maura*, *Natrix natrix* s.l., cf. *Coronella* sp. and *Zamenis scalaris*). By contrast, the faunal list recorded for FN 3 is somewhat poorer, consisting of seven species: three anurans (*Discoglossus* sp., *Pelobates cultripes* and *Pelophylax* cf. *perezi*.), one lizard (an indeterminate large-sized lizard) and three snakes (*Malpolon monspessulanus*, *Natrix maura* and cf. *Coronella* sp.). The amphibian and reptile species identified in the present study coincide with those identified in previous studies (Blain, 2005, 2009; Blain et al., 2011, 2016a), apart from the fact that the taxonomic lists obtained are poorer, especially for the site of FN 3. In the above-cited studies, the presence of various species of bufonids is recorded (*Bufo bufo* s.l., *Epidalea calamita* and *Bufotes viridis* s.l.), ~~yet~~ although we did not identify any remains belonging to this family in FN 3.

In general, the sequences of BL and FN 3 show a predominance of anurans over reptiles. Particularly abundant is the frog *Pelophylax* cf. *perezi*, a green frog that is very typical of the aquatic environments of the Iberian Peninsula and is most abundant in the areas with the greatest Mediterranean influence. The taxon with the second greatest record in the sequence as a whole is the genus *Discoglossus* sp., currently represented in the Iberian Peninsula by the endemic species *Discoglossus galganoi*, another thermophilic species typical of warm environments with a Mediterranean influence. Indeed, as both sites are situated on the banks of a ~~paleo~~palaeolake, there is an over-representation of ~~fully~~ aquatic species (*Discoglossus* sp., *Pelophylax* cf. *p~~P~~erezi* and *Natrix m~~M~~aura*; Blain et al., 2011, 2016a). For this reason, the ~~paleo~~palaeoenvironmental reconstruction for each of the levels under study was produced firstly, including these taxa in the analyses (with ~~water~~ aquatic taxa) and secondly, excluding them (without ~~water~~ aquatic taxa), with a view to gaining a better view of the environmental characteristics of the landscapes around the ~~paleo~~palaeolake, since this would have been the ecosystem in which the hominins would have li~~mo~~ved in the Early Pleistocene.

The rest of the recorded herpetofauna also shows affinities for Mediterranean environments, and most of the species still have present-day representatives in the region of Orce. The only taxa not currently represented in the Iberian Peninsula are the anuran *Bufotes viridis* s.l. and the anguid *Ophisaurus* sp. (Blain et al., 2016b; Blain and Bailon, 2019).

4.2 Analyses of species interrelationships at Barranco León and Fuente Nueva 3

The correspondence analysis (Fig. 2A), pertaining to the taxa, shows two main groups, one formed by the aquatic binomial *Discoglossus* sp. and *Pelophylax* cf. *perezi*, the predominant species in the herpetological record, and a second group made up of the rest of the taxa, mainly terrestrial ones, though also including some species partially associated with aquatic environments (as is the case with the amphibians and the ~~semiaquatic~~ aquatic snake *Natrix maura*). In the diagram (Fig. 2A), this latter grouping shows an ascending internal arrangement, such that the lower part includes the taxa with preferences for open, dry environments (such as *Malpolon monspessulanus* and *Pelobates cultripes*).~~,~~ ~~by~~ C~~c~~ontrastingly, ~~with~~ the taxa grouped in the upper right-hand quadrant ~~,~~ ~~which~~ show tendencies that are more hydrophilic and more typical of environments with greater plant cover (such as *Hyla* sp. and *Natrix natrix* sensu lato), compared to the other species in the record.

At the level of concurrences, FN 3 displays an environment that is more aquatic than BL, levels 2 and 6 being the ones in which the aquatic factor is most predominant. This observation is completely consistent with the sedimentology and the invertebrate record (Fig. 1C). The fact that FN 3 is an in situ accumulation (there is no traction except for some sands in level 5) is also observed in the aquatic character of the herpetofauna. The rest of the levels show the presence of terrestrial environments, yet without ever impinging upon the preeminence of aquatic environments.

The correspondence analysis, from which we excluded the ~~fully~~ aquatic species (*Discoglossus* sp., *Pelophylax* cf. *perezi* and *Natrix maura*) (Fig. 2B), shows BL to be more associated with terrestrial environments~~-~~ and ~~ones~~ settings with greater plant cover than FN 3;~~,~~ its three analyzed levels being grouped together in the upper right-hand quadrant of the diagram. It further allows us to analyze the environmental tendencies of both sites in ~~the~~ light of the specificities of each stratigraphic sequence ~~of each one~~. This input of non-typically aquatic species in all B~~arranco~~ L~~eón~~ levels (particularly D1 and

D2), is also consistent with the slightly reworked character observed in macrovertebrates. The 'y' axis of the graph shows that the variables are distributed mainly in ~~function~~ relation to~~of~~ greater humidity (upper part of the graph) or greater aridity (lower part of the graph). Accordingly, the levels of both sites tend to present a certain tendency to increased aridity as they progress from older to more recent.

Having ascertained the relationships between the different species of amphibians and reptiles identified at a qualitative level by their ethological and biological attributes, we proceed to analyze the taxonomic groupings applying the habitat weighting method, ~~with~~ in order to~~a view to~~ obtain~~ing~~ an environmental interpretation at a quantitative level. Finally, t~~T~~he two interpretations are ~~finally~~ analyzed ~~in conjunction~~together.

4.3 ~~Paleo~~Palaeoenvironmental reconstructions for Barranco León

~~It was~~ Enough identifiable amphibian and reptile remains were recovered only from levels D1, D2 and E of the BL site ~~of BL~~ that ~~enough identifiable amphibian and reptile remains were recovered~~. A minimum number of 179 individuals (MNI) were identified on the basis of the 1656 bone remains recovered (Table 3). The results by level are shown in Figure 3 and Table 5.

4.3.1 Level D1

Level D1 has higher humidity values ~~for humidity~~ than levels D2 and E. The highest values are those ~~for~~ of an open-humid environment (28.3~~3~~%), followed by those ~~for~~ of open-dry (25.7~~65~~%), wooded (25.6~~56~~%), water-edge (11.7~~67~~%) and rocky (8.9~~89~~%)

environments. The resulting landscape in this level would have been composed of more arid and rocky areas together with areas of ~~warm,~~ humid Mediterranean-type woodland.

4.3.2 Level D2

Level D2 appears rather similar to level D1, but has fairly homogeneous values as regards aridity and humidity. The highest values correspond to open-dry ~~environments~~ (28.3~~3~~%) and woodland environments (28.3~~3~~%), followed by ~~those for~~ open-humid (23.3~~3~~%), rocky (10.8~~3~~%) and water-edge (9.2~~17~~%) environments. The landscape presented ~~by~~ in level D2 ~~would have been~~was similar to that of level D1, but ~~less humid~~drier, consisting of arid, rocky areas alternating with others zones of~~with warm,~~ humid woodlands.

4.3.3 Level E

Level E shows a predominance of open-dry (46%) and rocky (13%) environments, in stark contrast with open-humid (18%) and water-edge (13%) environments and with some shrub vegetation (13%). In short, this level is characterized by an open landscape, with scarce humid areas and ~~little~~ sparse tall vegetation.

4.3.4 Environmental characterization of the stratigraphic sequence of Barranco León

~~Putting~~ Combining~~together~~ the ~~paleo~~palaeoenvironmental results for the three levels and without taking the aquatic species into account (Table 5), we obtain a predominance of open-dry (33.3%) and somewhat stony or rocky (10.9~~1~~%) environments, with a lateral presence of humid (23.2~~2~~%) and water-edge areas (10.3~~28~~%) with ~~a certain amount of~~some shrub vegetation (23.3%).

The stratigraphic sequence of BL displays a tendency towards greater aridity, with an increase in open-dry landscapes and a simultaneous decrease in arboreal density (woodland) and open-humid and water-edge environments. Levels D1 and D2 are the most humid and the richest in vegetation in the sequence under study, with D2 slightly more arid. In level E there is an increase in open, arid environments (which rise from 28.3~~3~~% to 46%), whereas there is a drop in more closed, wetter environments.

4.4 ~~Paleo~~Palaeoenvironmental reconstructions for Fuente Nueva 3

At the site of FN 3, a minimum number of 66 individuals were identified on the basis of the 285 bone remains recovered from the levels 2, 4, 5, 6, 7 and the sample 2sup (Table 4).~~At the site of FN 3, levels 2, 3, 4, 5, 6 and 7 were studied. A minimum number of 66 individuals were identified on the basis of the 285 bone remains recovered (Table 4).~~ The results are displayed by level in Figure 4 and Table 5.

4.4.1 Level 2

The bone remains of amphibians and reptiles recovered from this level are too few (NR = 3) to ~~be able to~~ apply the habitat weighting method. These remains represent just two individuals, belonging to aquatic species (*Discoglossus* sp. and *Pelophylax* cf. *perezi*). The ~~poverty~~ scarcity of remains from~~of~~ level 2 can be due~~may in certain measure be due~~ to the fact that, as one of the lowest archaeological levels, it has not yet been fully excavated~~possible to excavate it extensively~~, thus resulting in less sediment being washed than in the other, overlying levels (Table 1).

4.4.2 ~~Level 3~~ Sample 2sup

The results of the ~~paleo~~palaeoenvironmental analyses for ~~level 3~~ sample 2sup- reveal a predominance of open-dry (50%) and rocky (15%) environments, in stark contrast to open-humid environments (35%). ~~Among~~ In the material under study, we did not identify any species showing preferences for woodland habitats. The landscape ~~presented by~~in ~~level 3~~ sample 2sup can be characterized as open, dry and stony or rocky, with high aridity and a scarcity of wooded areas.

4.4.3 Level 4

In spite of having washed 200 kg of sediment from this archaeologically sterile level (Table 1), the herpetofaunal bone remains recovered ~~from this level~~ are too scarce and too indeterminate to apply the habitat weighting method. As a result, it was not possible to take level 4 into consideration within the present study.

4.4.4 Level 5

Level 5 displays a predominance of ~~the~~ an open-dry environment (65%), with low values for the open-humid (17.5%), rocky (10%) and aquatic (7.5%) environments. No species typical of woodland habitats were identified. This level is characterized by an open, arid and rather dry landscape, with ~~small~~ limited rocky areas.

4.4.5 Level 6

~~We were unable to apply the habitat weighting method to this level~~ B~~b~~ecause the 33 bone remains recovered from this level ~~it~~ all belong to aquatic species (*Discoglossus* sp. and *Pelophylax* cf. *perezi*), ~~.~~we were unable to apply the habitat weighting method.

4.4.6 Level 7

Level 7 exhibits the same value (25%) for all the habitats under consideration in the present study, with the exception of the aquatic habitat (0%). Given these results, it is difficult to characterize the landscape presented by this level. ~~However, the values obtained are consistent with the overall characterization of the site of FN 3.~~

4.4.7 Environmental characterization of the stratigraphic sequence of Fuente Nueva 3

Putting together the ~~paleo~~palaeoenvironmental results for the six levels and leaving out of account the aquatic species (Table 5), we ascertain a predominance of open dry (46.7~~67~~%) and somewhat rocky (16.7~~67~~%) environments, with a lateral presence of more humid areas such as meadows (25.8~~3~~%) and waterside areas (2.5%), with scarce tall vegetation (8.3~~3~~%).

In its lower part, the stratigraphic sequence of FN 3 shows a certain tendency towards greater aridity, with values for open dry environments increasing by 15% between ~~level~~ sample 2sup~~3~~ and level 5, whereas humid environments decrease by 17.5%. In the upper part between level 5 and level 7, however, the environmental tendency changes, with a 7.5% increase in humid environments and a 40% reduction in open dry environments.

4.5 Comparison between Barranco León and Fuente Nueva 3

The amphibian and squamate reptile assemblages from the archaeo-~~paleo~~palaeontological sites of BL and FN 3 testify to the presence of a ~~major~~ large body of water that has already been recorded at a geological level (i.e. a ~~paleo~~palaeolake), as well as by ~~and through~~ other proxies such as pollen analyses (Jiménez Moreno, 2003) and the composition of the large-mammal assemblages (Martínez-Navarro et al., 2003, 2010). The aquatic species *Pelophylax* cf. *perezi*, *Discoglossus* sp. and *Natrix maura* are by far the prevalent ones ~~over~~ compared to the rest of the species at both sites. The landscapes surrounding the lake display some rather irregular environmental features. Open landscapes are well represented, with species characteristic of arid, rocky areas such as *Pelobates cultripes*, *Epidalea calamita* and *Malpolon monspessulanus*. In ~~parallel~~addition, *Ophisaurus* sp., Bufonidae indet., *Hyla* sp. and *Natrix natrix* s.l. suggest the existence of ~~warm,~~ humid shrubland areas with soft soils.

The environmental interpretation suggested by this graded series of landscapes is the existence, throughout the stratigraphic sequence recorded at BL and FN 3, of a permanent body of water whose limits with the bordering terrestrial environments (waterside woodland and hygrophilous vegetation, Mediterranean shrubland, flood plains, sandy areas, etc.) change over the course of the sequence. In theory, therefore, the number of remains from terrestrial species ~~will rise~~rose with the regression of the ~~water~~ lakeshore~~body~~, whil~~e~~ile~~ereas~~ in periods of aquatic transgression their presence ~~will be~~was reduced.

A comparison of the two sites (Fig. 5) brings to light a predominance of woodland areas in BL, with more humid, water-edge environments. In FN 3, by contrast, ~~there is~~ a preponderance of open, drier, more arid and rocky environments is evidenced. Three of the archaeologically most significant levels (levels D2 and D1 of BL and level 5 of FN 3) are characterized by open, more humid environments, with a greater presence of the aquatic element and, in the case of BL, with a greater representation of wooded areas and mild environmental conditions that would have been favorable for hominins.

5. Discussion and comparisons

The present work makes it possible, for the first time, to place the previously obtained ~~paleo~~palaeoenvironmental results within a more detailed stratigraphic context. Overall, our data ~~are~~ is consistent with the general data obtained from the previous studies of the amphibian and reptile assemblages, which describe the landscape surrounding the ~~paleo~~palaeolake as a mosaic made up of humid woodland and of drier areas with shrubs as well as more open, rocky habitats (Blain, 2005, 2009; Blain and Bailon, 2010; Blain et al., 2011, 2016a). Nonetheless, thise study ~~we present~~ reveals certain differences between the various levels that may be associated with the inherent climatic cyclicity of the end of the Early Pleistocene. As ~~has been~~ demonstrated above, the successive amphibian and reptile assemblages of BL show a certain tendency towards increased aridity, whereas FN 3 records a tendency towards aridity from the basal part of the stratigraphic sequence as far as level ~~7, where the environment becomes more humid again.~~ 5, corresponding to the aridity maximum~~ in aridity~~, and after which (level 7) the environment bec~~o~~a~~o~~mes~~s~~ more humid again.

There are few proxies with which we can compare our results in detail, since practically all the previous studies have considered a single faunal list for each of the sites, without providing data by level. A preliminary study of the chelonian remains recovered from BL identified three species: *Testudo* sp., *Emys* cf. *orbicularis* and *Mauremys* cf. *leprosa* (Bailon, 2010). The latter two testify to the presence of humid areas with permanent still waters rich in vegetation, coinciding with the results we inferred primarily from the presence of fully aquatic species (*Pelophylax* cf. *perezi*, *Discoglossus* sp. and *Natrix maura*) as well as species with a preference for habitats with plant cover such as *Hyla* sp. and *Natrix natrix* s.l. As far as large mammals are concerned, the various studies carried out are consistent with the results of our work. These reveal that the landscapes surrounding the lake consisted of a mixed environment with a preponderance of open plains and with some wooded areas (Martínez-Navarro et al., 2003; Abbazzi, 2010). The presence of ~~wet~~ humid woodlands around both sites is well supported by the occurrence of large cervids such as *Praemegaceros* cf. *verticornis* and *Metacervocerus rhenanus*. Large herbivores such as *Mammuthus meridionalis* and *Stephanorhinus* cf. *hundsheimensis* as well as the prevalence of *Equus altidens* suggest wet, open meadows. The occurrence of *Hippopotamus antiquus* provides evidence supporting the presence of large water ~~edges~~areas. New, as yet unpublished dental mesowear analyses of ungulates and mammoths from both sites indicate largely browse-dominated diets for most of the species, with *Equus altidens* being the only notably grass-dominated feeder (Saarinen, personal observation). This observation is consistent with the interpretation of Mediterranean woodland and perhaps some more open shrubland

~~paleo~~palaeoenvironments, and the presence of wetlands, but it does not suggest the presence of extensive grasslands. Nevertheless, further studies are needed in order to more clearly delimit that broad scenario.

To date, only the microvertebrates and isotopic values of biogenic lacustrine carbonates have been studied ~~by~~ in accordance to each level. On the basis of a reduced number~~very limited sample~~ of amphibians, reptiles and micromammals (83 individuals in total) from levels D1 and D2 of the BL site, Agustí et al. (2015a) undertook a ~~paleo~~palaeoenvironmental characterization of these levels by means of the habitat weighting method. The results demonstrated the existence of significant bodies of water at the time when both levels were being formed and showed that an open landscape was always present in the area around the lake. The results from level D1 revealed a predominance of woodland elements (35%), followed by open humid (27.1%), rocky (20%), and open dry elements (17.9%). The results for level D2, by contrast, showed open humid elements (41.2%) to be predominant, followed by woodland elements (30%) and open dry elements (27.1%) with a few small mammals characteristic of rocky habitats (3.8%). These results hinted at a possible tendency towards more humid conditions with a greater prevalence of woodland elements moving upwards from the base of the stratigraphic sequence. The results for these levels in the present study, which also includes an analysis of level E, likewise show an increase, albeit only a slight one, in woodland elements (25.7~~56~~ % in level D1 as opposed to 28.3~~3~~% in D2). By contrast, the amphibian and reptile assemblages indicate a tendency towards slightly more arid conditions in level D2 compared with D1. The difference in these values between the two levels is hardly significant, making it difficult to interpret. However, taken in conjunction with those for level E, with 46% open-dry elements and 13% woodland elements, the results reveal more clearly that the stratigraphic sequence of BL shows a tendency towards more arid conditions with a lower woodland density. A complementary proxy at BL section are isotopic ($\delta^{13}C$ and $\delta^{18}O$) values of biogenic lacustrine carbonates (Anadón et al., 2015). Such palaeoenvironmental data display similar conditions for both C, D and E units, but a slight positive shift in oxygen values is observed in the D to E transition. This could suggest a slight evolution to more concentrated waters, i.e. with more evaporation and/or less rainfall, as it would be expected for a relative interglacial (wet) to glacial (dry) transition.

As far as the site of FN 3 is concerned, new data ~~on~~ from rodents ~~from~~ collected during the most recent field seasons (Agustí et al., 2019), provide an interesting new point of comparison for our study. According to Agustí et al. (2019), there are two elements that are almost omnipresent at FN 3. These are *Mimomys savini* and *Mimomys* sp., a new species yet to be defined which is also present at the Early Pleistocene site of Quibas (Murcia, Spain). *Mimomys savini* is the direct ancestor of *Arvicola*, the water vole, and as such, it can be presumed to have aquatic habits implying the presence of water. By contrast, *Mimomys* sp. is a hypsodont species without tooth roots that is practically absent from BL, yet it is the only arvicolid present at Quibas, where there is scarcely a trace of water. Accordingly, we assume it to be an ubiquist form or one adapted to open environments. Together with the presence of *Allophaiomys* aff. *lavocati*, this suggests an interpretation of FN 3 as representing a habitat that is more open and less aquatic than BL, a result consistent with our study. According to Agustí et al. (2019), moreover, the presence of *Apodemus* aff. *sylvaticus* in level 5 indicates a more wooded habitat than those in levels 4, 6 and 7, where the murid present is *Castillomys rivas*, characterized by its stephanodont dentition. These latter data cannot be confirmed by our study, since many of the levels of FN 3 lack any amphibians and reptiles typical of wooded environments, certainly due in large measure to the poverty of our samples in terms of number of remains and/or individuals.

Putting our results within a broader ~~paleo~~palaeoenvironmental and ~~paleo~~palaeoclimatic context also reveals a knowledge gap in quantitative data for the end of the Early Pleistocene. Nevertheless, a recent pollen study ~~has analyzed~~is available from the Palominas Core (Baza Basin; i.e. some 40 km from FN 3 and BL), ~~with a view to~~ casting light on the climatic conditions in the southeast of the Iberian Peninsula in the Early Pleistocene (Altolaguirre et al., 2019, 2020). The quantitative results obtained by means of the coexistence approach show that the vegetation of the Iberian Peninsula ~~in~~ during the Early Pleistocene was controlled by cyclical climate changes. ~~Woodland flourished during the warm, humid phases whereas during the cold, dry phases the landscape was dominated by steppes, savannahs and open woods. In the southeast of the Iberian Peninsula, the vegetation during these dry phases consisted primarily of herbaceous elements, whereas the humid phases saw an increase in the arboreal component, creating wooded steppe or Mediterranean woodlands.~~ In the southeast of the Iberian Peninsula, during the cold, dry phases, the landscape was dominated by steppe~~s~~, savannah~~s~~ and open woodland~~s~~ and the vegetation consisted primarily of herbaceous elements, whereas during the warm, humid phases, the woodland flourished and the vegetation ~~saw~~experienced an increase in the arboreal component, creating wooded steppe or Mediterranean woodlands. For the multi-cyclic sequence at Palominas, the results show first and foremost that the “interglacial” periods were much warmer than at present, whereas the “glacial” periods were characterized by temperatures ~~identical~~ more similar to ~~current~~ modern ones. They also reveal that the oscillations in precipitation recorded between the “interglacial” and “glacial” phases were not extreme, which could have facilitated the development of mosaic environments in the glacial phases of the Iberian Peninsula. In short, Altolaguirre et al. (2019, 2020) suggest that there were long warm, humid periods, interspersed with short periods of a more temperate and above all drier climate, visible in particular in the Upper and Lower Sections of Palominas, whereas in the Middle Section of Palominas the climate was cooler and humid during interglacials (Altolaguirre et al., 2020: fig. 8).

Th~~ese~~is data shed~~~~s light on the small differences observed between the different levels of BL and FN 3. The analyzed stratigraphic sequence of BL displays a tendency towards increased aridity from level D1 to level E, which might be interpreted —within the environmental cyclicity of the Early Pleistocene —as a tendency towards a “glacial” period. Likewise, in FN 3, the initial tendency towards aridity, culminating in level 5, would also correspond to a tendency towards a “glacial” period, followed in the more humid level 7 by a return to environmental conditions in line with an “interglacial” period (Fig. ~~6~~ 5). In this case, level ~~6~~ 5 of FN 3 might represent a period of “glacial maximum”, as it is the driest and less wooded landscape of the whole sequence. It should be highlighted here that the low number of remains in level 4 of FN 3 precludes establishing whether the tendency towards aridity between levels 3 and 5 was continuous or whether the ~~dearth~~ scarcity of herpetofaunal remains in level 4 should be interpreted as another “glacial” period, in which case the FN 3 sequence would also represent a multi-cyclical ~~paleo~~palaeoenvironmental model.

The present study also permits a more detailed approach to the quantitative ~~paleo~~palaeoclimatic data obtained by applying the mutual ecogeographic range method to the amphibians and reptiles from the earlier field seasons at BL and FN 3 (Blain et al., 2011, 2016a). In methodological terms, the mixture of levels at the two sites means that the richer levels (normally corresponding to "interglacials") hide the lower diversity of the levels that are poorer (corresponding to the "glacials"), where there tend not to be any taxa indicative of a cold climate. As a result, the presence of "glacial" periods in the sequences of FN 3 and BL was not detected in previous studies, ~~yet~~ nor is it in contradiction with our new ~~paleo~~palaeoenvironmental data. The higher temperature and precipitation values ~~were~~ obtained for BL, corresponding to the assemblages from levels D1 and D2 ~~and squaring~~correlate well with the presence of more developed wooded areas. Meanwhile, the lower temperature and precipitation values obtained at FN 3 (though higher than the present-day values for the study area) are consistent with a more open, dry landscape typical of a "glacial" period or at least an "interglacial/glacial" transition period, corresponding to levels 5 and 7.

A further~~, final~~ aspect of this study is that the ~~paleo~~palaeoenvironmental data obtained from the amphibians and reptiles from each level provide an additional indication, apart from those already ~~given~~suggested by ~~based on the~~some ~~–~~evolutionary differences between the *Mimomys savini* populations of both sites~~, –~~ that – environmentally and probably also chronologically – the sites of BL and FN 3 do not correspond to the same period. The joint analysis of the amphibian and reptile assemblages of the two sites leads us to infer certain ~~paleo~~palaeoenvironmental similarities between level 5 of FN 3 and level E of BL. Corresponding to the most arid phases in the sequence, these might represent or lie very close to the brief "glacial maxima" of the Early Pleistocene (Fig. 6). By focusing on the levels with the highest degree of anthropic activity and the greatest archaeological significance (~~levels~~ sample 2sup~~3~~ and level 5 of FN 3 and levels D1 and

D2 of BL), it can be seen that they are situated within different environmental (and probably also climatic) conditions, lending support to the notion that the hominins of the Early Pleistocene, though conditioned to a certain extent by the climate (see Agustí et al., 2009, 2015a), were capable of coping with and adapting to conditions that were both “interglacial” (levels D1 and D2) and “glacial” (~~levels~~ sample 2sup~~3~~ and level 5) in the southwest of the European continent.

6. Conclusions

In this study, the successive fossil assemblages of amphibians and reptiles from the Early Pleistocene sites of Barranco León and Fuente Nueva 3 (Granada, Spain) are for the first time studied from a ~~paleo~~palaeoenvironmental point of view, taking into account the different layers of the depositional sequences. Our conclusions are as follows:

1. The successive herpetofaunal assemblages from Barranco León show a certain tendency towards more arid conditions from ~~layer~~ level D1 to ~~layer~~ level E, whereas the environmental reconstructions of Fuente Nueva 3 reveal oscillating conditions, showing a tendency towards more arid conditions in the basal part of the sequence up to ~~layer~~ level 7, where this tendency shifts back to more humid conditions.

2. The joint analysis of the amphibian and reptile assemblages from the two sites leads us to infer certain ~~paleo~~palaeoenvironmental resemblances between level 5 of FN 3 and level E of BL. Corresponding to the most arid phases of the sequence, these might represent or be very close to the brief periods of “glacial maximum” of the Early Pleistocene.

3. The layers used in this study with the highest density of anthropic evidence used in this study (such as sample 2suplayers 3 and level 5 in FN 3 and layers levels D1 and D2 in BL) are situated within the late Early Pleistocene climatic and environmental cyclicity, yielding different environmental conditions: a humid, wooded biotope for BL, and a more open, drier biotope for FN 3.

4. This suggests that the hominins of the late Early Pleistocene, although conditioned to some extent by climatic factors, were able to cope with changing environmental conditions, both “interglacial” and “glacial”, in the southwestern extremity of the European continent.

5. The paleopalaeoenvironmental data obtained for each of the levels provides further evidence that the sites of BL and FN 3 correspond to neither the same environmental context nor probably the same chronological period (in accordance with thesome evolutionary differences betweenobserved in the *Mimomys savini* populations of both sites)..

6. As perspective of future, the sterility of level 3 concerning small-vertebrates has to be checked again, as well as the correct stratigraphic position of the sample 2sup.

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References

Abbazzi, L., 2010. La fauna de cérvidos de Barranco León y Fuente Nueva-3. In: Toro, I., Martínez-Navarro, B., Agustí, J. (Eds.), Ocupaciones humanas en el Pleistoceno inferior y medio en la Cuenca de Guadix-Baza. Arqueología Monografías, Sevilla, pp. 273–290.

Agustí, J., 1986. Synthèse biostratigraphique du Plio-Pléistocène de Guadix-Baza (province de Granada, sud-est de l'Espagne). Geobios 19, 505–510.

Agustí, J., Moyà Sola, S., Martín Suárez, E., Martín, M., 1987. Faunas de mamíferos en el Pleistoceno inferior de la región de Orce (Granada, España). Paleontologia i Evolució, Memoria especial 1, 287–295.

Agustí, J., Madurell, J., 2003. Los arvicólidos (Muroidea, Rodentia, Mammalia) del Pleistoceno inferior de Barranco León y Fuente Nueva 3 (Orce, Granada). Datos preliminares. In: Toro, I., Agustí, J., Martínez Navarro, B. (Eds.), El Pleistoceno inferior de Barranco León y Fuente Nueva 3, Orce (Granada). Memoria Científica campañas 1999–2002. Junta de Andalucía. Consejería de Cultura. E.P.G.P.C. Arqueología Monografías, Sevilla, pp. 137–147

Agustí, J., Blain, H.-A., Furió, M., De Marfà, R., Santos-Cubedo, A., 2010. The early Pleistocene small vertebrate succession from the Orce región (Guadix-Baza Basin, SE Spain) and its bearing on the first human occupation of Europe. Quaternary International 223-224, 162–169.

Agustí, J., Blain, H.-A., Lozano-Fernández, I., Piñero, P., Oms, O., Furió, M., Sala, R., 2015a. Chronological and environmental context of the first hominin dispersal into Western Europe: The case of Barranco León (Guadix-Baza Basin, SE Spain). Journal of Human Evolution 87, 1–8.

Agustí, J., Lozano-Fernández, I., Oms, O., Piñero, P., Furió, M., Blain, H.-A., López-García, J.M., Martínez-Navarro, B., 2015b. Early to Middle Pleistocene rodent biostratigraphy of the Guadix-Baza Basin (SE Spain). Quaternary International 389, 139–147.

Agustí, J., Blain, H.-A., Sánchez-Bandera, C., Lozano-Fernández, I., Piñero, P., Furió, M., Oms, O., Barsky, D., Jiménez Arenas, J.M., 2019. Small vertebrates from Fuente Nueva 3 (Guadix-Baza Basin, SE Spain) and their bearing on the early Pleistocene hominin occupation of Western Europe. 20th Congress of the International Union for Quaternary Research (INQUA), Dublin, Ireland, 25-31th July, 2019 (poster).

Altolaguirre, Y., Postigo-Mijarra, J.M., Barrón, E., Carrión, J.S., Leroy, S.A.G., Bruch, A.A., 2019. An environmental scenario for the earliest hominins in the Iberian Peninsula: Early Pleistocene palaeovegetation and palaeoclimate. Review of Palaeobotany and Palynology 260, 51–64.

Altolaguirre, Y., Bruch, A.A., Gibert, L., 2020. A long Early Pleistocene pollen record from Baza Basin (SE Spain): Major contributions to the palaeoclimate and palaeovegetation of Southern Europe. Quaternary Science Reviews 231, 106199.

Alvarez, C., Parés, J.M., Granger, D., Duval, M., Sala, R., Toro, I. (2015). New magnetostratigraphic and numerical age of the Fuente Nueva-3 site (Guadix-Baza basin, Spain). Quaternary International 389, 224-234.

Anadón, P., Gabàs, M., 2009. Paleoenvironmental evolution of the early Pleistocene lacustrine sequence at Barranco León archeological site (Orce, Baza basin, southern Spain) from stable isotopes and Sr and Mg chemistry of ostracod shells. Journal of Paleolimnology 42, 261-279.

Anadón, P., Julià, R., de Deckker, P., Rosso, J.C., Soulié-Märsche, I., 1987. Contribución a la Paleolimnologia del Pleistoceno inferior de la cuenca de Baza (sector Orce- Venta Micena). Paleontologia i Evolució, Memoria Especial 1, 35–72.

Anadón, P., Julià, R., 2010. Estudio petrológico de los clastos de las excavaciones de Barranco León (BL-5) y Fuente Nueva -3 (FN-3). Pleistoceno inferior. Orce (Granada). In: Toro, I., Martínez-Navarro, B., Agustí, J. (Coord.), Ocupaciones humanas en el Pleistoceno inferior y medio de la Cuenca de Guadix-Baza. Junta de Andalucía, Consejería de Cultura. Arqueología Monografía, pp. 77–96.

Anadón, P., Julià, R., Oms, O., 2003. Estratigrafía y estudio sedimentológico preliminar de diversos afloramientos en Barranco León y Fuente Nueva (Orce, Granada). In: Toro, I., Agustí, J., Martínez, B. (Eds), El Pleistoceno inferior de Barranco León y Fuente Nueva 3, Orce (Granada). Memoria científica Campañas 1999-2002. Monografías de Arqueología. Junta de Andalucía. Consejería de Cultura 17, 47-72.

Anadón, P., Oms, O., Riera, V., Julià, R., 2015. The geochemistry of biogenic carbonates as a paleoenvironmental tool for the Lower Pleistocene Barranco León sequence (BL-5D, Baza Basin, Spain). Quaternary International 389, 70–83.

Antúnez, A., Real, R., Vargas, J.M., 1988. Análisis biogeográfico de los anfibios de la vertiente sur de la Cordillera Bética. Miscel·lania Zoològica 12, 51–72.

Bailon, S., 1991. *Amphibiens et reptiles du Pliocène et du Quaternaire de France et d'Espagne: mise en place et évolution des faunes.* Thèse 3ème cycle, Université de Paris VII, 499 p., 89 pls.

Bailon, S., 1999. Différenciation ostéologique des Anoures (Amphibia, Anura) de France. In J. Desse y N. Desse-Berset (Eds.) *Fiches d'ostéologie animale pour l'archéologie*, Série C: varia, Valbonne: Centre de Recherches Archéologiques-CNRS, 38p.

Bailon, S., 2010. Quelonios fósiles del yacimiento de Barranco León (Pleistoceno inferior, Orce, Granada, España). In: Toro, I., Martínez-Navarro, B., Agustí, J.(Eds.), Ocupaciones humanas en el Pleistoceno inferior y medio en la Cuenca de Guadix-Baza. Arqueología Monografías, Sevilla, pp. 185–195.

Barahona, F., Barbadillo, L.J., 1997. Identification of some Iberian lacertids using skull characters. Revista Española de Herpetología 11, 47–62.

Barsky, D., Garcia, J., Martínez, K., Sala, R., Zaidner, Y., Carbonell, E., Toro-Moyano, I., 2013. Flake modification in European Early and Early-Middle Pleistocene stone tool assemblages. Quaternary International 316, 140–154.

Barsky, D., Vergès, J.M., Sala, R., Menéndez, L., Toro-Moyano, I., 2015a. Limestone percussion tools from the late Early Pleistocene sites of Barranco León and Fuente Nueva 3 (Orce, Spain). Philosophical Transactions of the Royal Society B 370, 20140352.

Barsky, D., Sala, R., Menéndez, L., Toro-Moyano, I., 2015b. Use and re-use: Re-knapped flakes from the Mode 1 site of Fuente Nueva 3 (Orce, Andalucía, Spain). Quaternary International 361, 21–33.

Barsky, D., Vergès, J.M., Titton, S., Guardiola, M., Sala, R., Toro-Moyano, I., 2018. The emergence and significance of heavy-duty scrapers in ancient stone toolkits. Comptes Rendus Palevol 17 (3), 201–219.

Bisbal-Chinesta, J.-F., Blain, H.-A., 2018. Long-term changes in composition and distribution patterns in the Iberian herpetofaunal communities since the latest Pleistocene. Quaternary Science Reviews 184, 143–166.

Blain, H.-A., 2005. Contribution de la paléoherpétofaune (Amphibia & Squamata) à la connaissance de l'évolution du climat et du paysage du Pliocène supérieur au Pléistocène moyen d'Espagne. PhD Dissertation, Muséum national d'Histoire naturelle, Département de Préhistoire, 402p., 67 pls.

Blain, H-A., 2009. Contribution de la paléoherpétofaune (Amphibia & Squamata) à la connaissance de l'évolution du climat et du paysage du Pliocène supérieur au Pléistocène moyen d'Espagne. Treballs del Museu de Geologia de Barcelona 16, 39–170.

Blain, H.-A., Bailon, S., Cuenca-Bescós, G., 2008. The Early-Middle Pleistocene palaeoenvironmental change based on the squamate reptile and amphibian proxies at the Gran Dolina site, Atapuerca, Spain. Palaeogeography, Palaeoclimatology, Palaeoecology 261, 177–192.

Blain, H.-A., Bailon, S. (2010). Anfibios y escamosos del Pleistoceno inferior de Barranco León y de Fuente Nueva 3 (Orce, Andalucía, España). In: Toro, I., Martínez-Navarro, B., Agustí, J. (Eds.), Ocupaciones humanas en el Pleistoceno inferior y medio en la Cuenca de Guadix-Baza. Arqueología Monografías, Sevilla, pp. 165-183.

Blain, H.-A., Bailon, S., Agustí, J., Martínez-Navarro, B., Toro, I., 2011. Paleoenvironmental and paleoclimatic proxies to the Early Pleistocene hominids of Barranco León D and Fuente Nueva 3 (Granada, Spain) by means of their amphibian and reptile assemblages. Quaternary International 243 (1), 44–53.

Blain, H.-A., Lozano-Fernández, I., Agustí, J., Bailon, S., Menéndez, L., Patrocinio, M., Ros-Montoya, S., Manuel, J., Toro-Moyano, I., Martínez-Navarro, B., Sala, R., 2016a. Refining upon the climatic background of the Early Pleistocene hominid settlement in Western Europe: Barranco León and Fuente Nueva-3 (Guadix-Baza Basin, SE Spain). Quaternary Science Reviews 144, 132–144.

Blain, H.-A., Bailon, S., Agustí, J., 2016b. The geographical and chronological pattern of the herpetofaunal Pleistocene extinctions on the Iberian Peninsula. Comptes Rendus Palevol 15 (6), 731–744.

Blain, H.-A., Bailon, S., 2019. Extirpation of *Ophisaurus* (Anguimorpha, Anguidae) in Western Europe in the context of the disappearance of subtropical ecosystems at the Early-Middle Pleistocene transition. Palaeogeography, Palaeoclimatology, Palaeoecology 520, 96–113.

Díaz-Hernández, J.L., Julià, R., 2006. Geochronological position of badlands and geomorphological patterns in the Guadix-Baza basin (SE Spain). Quaternary Research 65, 467–477.

Cuenca-Bescós, G., Rofes, J., López-García, J.M., Blain, H.-A.., De Marfà, R., Galindo-Pellicena, M.A., Bennàsar-Serra, M.L., Melero-Rubio, M., Arsuaga, J.L., Bermúdez de Castro, J.M., 2010. Biochronology of Spanish Quaternary small vertebrate faunas. Quaternary International 212, 109–119.

Cuenca-Bescós, G., Rofes, J., López-García, J.M., Blain, H.-A., Rabal-Garcés, R., Sauqué, V., Arsuaga, J.L., Bermúdez de Castro, J.M., Carbonell, E., 2013. The small mammals of Sima del Elefante (Atapuerca, Spain) and the first entrance of *Homo* in Western Europe. Quaternary International 298, 28–35.

Duval, M. (2008). Evaluation du potentiel de la méthode de la datation par Résonance de Spin Electronique (ESR) appliquée aux gisements du Pléistocène inférieur: étude des gisements d’Orce (bassin de Guadix-Baza, Espagne) et contribution à la connaissance des premiers peuplements de l’Europe. PhD. Dissertation, Museum national d’Histoire naturelle de Paris.

Duval, M., Toro-Moyano, I., Falguères, C., Mestour, B., Perrenoud, C., Patrocinio Espigares, M., Ros, S., 2010. Estudio litoestratigráfico del yacimiento arqueológico de Fuente Nueva 3 (Orce, cuenca de Guadix-Baza, España). In: Toro-Moyano, I., Martínez-Navarro, B., Agustí, J. (Eds.), Ocupaciones humanas en el Pleistoceno inferior y medio de la Cuenca de Guadix-Baza, Junta de Andalucía, Consejería de Cultura, pp. 57–76.

Duval, M., Falguères, C., Bahain, J. J., Grün, R., Shao, Q., Aubert, M., Toro-Moyano, I., 2012. On the limits of using combined U-series/ESR method to date fossil teeth from two Early Pleistocene archaeological sites of the Orce area (Guadix-Baza basin, Spain). Quaternary Research 77 (3), 482–491.

Espigares, M.P., Martínez-Navarro, B., Palmqvist, P., Ros-Montoya, S., Toro, I., Agustí, J., Sala R., 2013. *Homo* vs. *Pachycrocuta*: Earliest evidence of competition for an elephant carcass between scavengers at Fuente Nueva-3 (Orce, Spain). Quaternary International 295, 113–125.

Fernández-Cardenete, J.R., Luzón-Ortega, J.M., Pérez-Contreras, J., Tierno de Figueroa, J.M., 2000. Revisión de la distribución conservación de los anfibios reptiles en la provincia de Granada (España). Zoologia Baetica 11, 77–104.

Garcés, M., Agustí, J., Parés, J.M., 1996. Late Pliocene continental magnetochronology in the Guadix-Baza Basin (Betic ranges, Spain). Earth and Planetary Science Letters 146, 677–688.

Gasc, J.-P., Cabela, A., Crnobrnja-Isailovic, J., Dolmen, D., Grossenbacher, K., Haffner, P., Lescure, J., Martens, H., Martínez Rica, J.P., Maurin, H., Oliviera, E., Sofianidou, T.S., Veith, M., Zuiderwijk, A., 1997. *Atlas of Amphibians and Reptiles in Europe.* Societas Europaea Herpetologica et Muséum National d'Histoire Naturelle (Ed.), Paris, 494 p.

Gibert, J., Gibert, L., Iglesias, A., Maestro, E., 1998. Two 'Oldowan' assemblages in the Plio Pleistocene deposits of the Orce region, Southeast Spain. Antiquity 72, 17–25.

Gleed-Owen, C.P., 1998. Quaternary herpetofaunas of the British Isles: taxonomic descriptions, palaeoenvironmental reconstructions, and biostratigraphic implications. PhD Dissertation, Coventry University, 550 p.

Greenacre, M.J., 2010. Correspondence analysis. WIREs computational statistics 2 (5), 613–619.

Hammer, O., Harper, D.A.T., Ryan, P.D., 2001. PAST: Paleontological statistics software package for education and data analysis. Palaeontologia Electronica.

Holman, J.A., 1998. *Pleistocene amphibians and reptiles in Britain and Europe.* Oxford Monographs on Geology and Geophysics, Oxford University Press, New York and Oxford, 38, 254 p.

Jiménez Moreno, G., 2003. Análisis polínico de las secciones de Barranco León y Fuente Nueva de Orce (Granada). Primeros resultados. In: Toro Moyano, I., Agustí, J., Martínez-

Navarro, B. (Eds.), El Pleistoceno inferior de Barranco León y de Fuente Nueva 3, Orce (Granada). Junta de Andalucía, Consejería de Cultura. Sevilla, pp. 173–181.

Lozano-Fernández, I., Blain, H-A., López-García J.M., Agustí, J., 2015. Biochronology of the first hominid remains in Europe using the vole *Mimomys savini*: Fuente Nueva 3 and Barranco León D, Guadix-Baza Basin south-eastern Spain, Historical Biology 27(8), 1021–1028.

Martínez-Navarro, B., Turq, A., Oms, O., 1997. Fuente Nueva-3 (Orce, Granada, Spain) and the first human occupation of Europe. Journal of Human Evolution 33, 611–620.

Martínez-Navarro, B., Espigares, M.P., Ros, S., 2003. Estudio preliminar de las asociaciones de grandes mamíferos de Fuente Nueva-3 y Barranco León-5 (Orce, Granada, España). In: Toro Moyano, I., Agustí, J., Martínez-Navarro, B. (Eds.), El Pleistoceno inferior de Barranco León y de Fuente Nueva 3, Orce (Granada), Junta de Andalucía. Consejería de Cultura, Sevilla, pp. 115–136.

Martínez Navarro, B., Palmqvist, P., Madurell Malapeira, J., Ros Montoya, S., Espigares, M.P., Torregrosa, V., Pérez Claros, J.A., 2010. La fauna de grandes mamíferos de Fuente Nueva-3 y Barranco León-5: estado de la cuestión. In Ocupaciones humanas en el Pleistoceno Inferior y Medio de la cuenca de Guadix-Baza, Consejería de Cultura, pp. 197–236.

Oms, O., Gabàs, M., Anadón, P., 1998. Lithostratigraphy of the Galera-Orce-Fuente nueva sector (NE of the Guadix Baza basin). In: Agustí, J., Oms, O., Martín- Suárez, E.

49 (Eds.), Excursion to the Guadix Baza Basin. II Euromam (INQUA-SEQS) Field Seminar Guidebook, Granada, 4-7 June. Junta de Andalucía, Granada, pp. 11–14.

Oms, O., Parés, J.M., Martínez-Navarro, B., Agustí, J., Toro, I., Martínez Fernández, G., Turq, A., 2000a. Early human occupation of Western Europe: paleomagnetic dates of two paleolithic sites in Spain. Proceedings of the National Academy of Science 97 (19), 10666-10670.

Oms, O., Agustí, J., Gabas, M., Anadón, P., 2000b. Lithostratigraphical correlation of micromammal sites and biostratigraphy of the Upper Pliocene to L~~l~~ower Pleistocene in the Northeast Guadix-Baza Basin (southern Spain). Journal of Quaternary Science 15, 43–50.

Oms, O., Pares, J.M., Agustí, J., 2003. Datación magnetoestratigráfica de los yacimientos de Fuente Nueva 3 y Barranco León 5 (Orce, Granada). In: Toro Moyano, I., Agustí, J., Martínez-Navarro, B. (Eds.), El Pleistoceno inferior de Barranco León y de Fuente Nueva 3, Orce (Granada). Junta de Andalucía, Consejería de Cultura, Sevilla, pp. 105–114.

Oms, O., Agustí, J., Parés, J.M., 2010. Litoestratigrafía, magnetoestratigrafía y bioestratigrafía de los yacimientos de Barranco León 5 y Fuente Nueva 3 (Cuenca, Guadix-Baza). In: Martínez-Navarro, B., Agustí, J., Toro Moyano, I. (coords.), Ocupaciones humanas en el Pleistoceno Inferior y Medio de la Cuenca de Guadix-Baza. Junta de Andalucía, Consejería de Cultura. Sevilla, pp. 107-120.

Oms, O., Anadón, P., Agustí, J., Julià, R., 2011. Geology and chronology of the continental Pleistocene archaeological and paleontological sites of the Orce area (Baza basin, Spain). Quaternary International 243, 33–43.

Pleguezuelos, J.M., 1989. Distribución de los reptiles en la provincia de Granada (SE. Península Ibérica). Doñana, Acta Vertebrata 16 (1), 15–44.

Pleguezuelos, J.M., Martínez-Rica, J.P., 1997. *Distribución Biogeografía de los anfibios reptiles de España*. Monografías Revista Española de Herpetología 3, Universidad de Granada, 542 p.

Pleguezuelos, J.M., Márquez, M., Lizana, M., 2002. Atlas y libro rojo de los Anfibios y Reptiles de España. Dirección General de Conservación de la Naturaleza. Asociación Herpetologica Española, Madrid, p. 584.

Real, R., Guerrero, J.C., Antúnez, A., Olivero, J., Vargas, J.M., 2001. Respuestas cronológicas de las especies de anfibios frente a los gradientes ambientales en el Sur de España. I. Patrones individualistas. Boletín Real Sociedad Española de Historia Natural (sección Biología) 96 (3-4), 243–249.

Rodríguez Rivas, J., 2009. Las ocupaciones humanas en la cuenca de Guadix-Baza durante el Pleistoceno Inferior en el yacimiento de Barranco León y su contexto paleoambiental: Acercamiento Edafo-Sedimentario. Master thesis. Universitat Rovira i Virgili, Tarragona, Spain.

Rook, L., Martínez-Navarro, B., 2010. Villafranquian: the long story of a Plio-Pleistocene European large mammal biochronologic unit. Quaternary International 219, 134–144.

Szyndlar, Z. (1984). Fossil snakes from Poland. Acta zoologica cracoviensa 28 (1), 1–156.

Titton, S., Barsky, D., Bargallo, A., Vergès, J.M., Guardiola, M., Solano, J.G., Arenas, J.M., Toro-Moyano, I., Sala-Ramos, R., 2018. Active percussion tools from the Oldowan site of Barranco León (Orce, Andalusia, Spain): The fundamental role of pounding activities in hominin lifeways. Journal of Archaeological Science 96, 131–147.

Titton, S., Barsky, D., Bargalló, A., Serrano-Ramos, A., Vergès, J.M., Toro-Moyano, I., Sala, R., Jiménez-Arenas, J.M., 2020. Subspheroids in the lithic assemblage of Barranco León (Spain): Recognizing the late Oldowan in Europe. PLoS ONE 15(1), e0228290.

Toro-Moyano, I., De Lumley, H., Barrier, P., Barsky, D., Cauche, D., Celiberti, V., Grégoire, S., Lebègue, F., Mestour, B., Moncel, M.-H., 2010. Les industries lithiques archaïques de Barranco León et de Fuente Nueva 3. CNRS éditions, Paris.

Toro-Moyano, I., Barsky, D., Cauche, D., Celiberti, V., Gregoire, S., Lebegue, F., Moncel, M.H., Lumley, H. de, 2011. The archaic stone tool industry from Barranco León and Fuente Nueva 3 (Orce, Spain): evidence of the earliest hominin presence in southern Europe. Quaternary International 243 (1), 80–91.

Toro-Moyano, I., Martínez-Navarro, B., Agustí, J., Souday, C., Bermúdez de Castro, J. M., Martinón-Torres, M., Palmqvist, P., 2013. The oldest human fossil in Europe, from Orce (Spain). Journal of Human Evolution 65(1), 1–9.

Vera, J. A., Fernández, J., López, A. C., Rodríguez, J., 1985. Geología y estratigrafía de los materiales Plio-Pleistocenos del sector Orce-Venta Micena (Prov. Granada). Paleontología i Evolució 18, 3–11.

Viseras, C., 1991. Estratigrafía y sedimentología del relleno aluvial de la cuenca de Guadix (Cordilleras Béticas). PhD Dissertation. Departamento de Estratigrafía y Paleontología de la Universidad de Granada - Instituto Andaluz de Geología Mediterránea, Granada, Spain.

Figures and Tables

Figure 1. A: Location of the Guadix-Baza Basin in the context of the Cenozoic basins of the Iberian Peninsula. B: Geological units around Orce and location of the Barranco León and Fuente Nueva 3 sites. C: Barranco León and Fuente Nueva 3 sections with indications of the levels and environmental conditions of deposition documented by sedimentology and invertebrate organisms.

Figure 2. Graphic representation of correspondence analyses of fossil assemblages from Barranco León and Fuente Nueva 3 (Guadix-Baza Basin, SE Spain). **A**: correspondence analysis including ~~water-edge~~aquatic taxa (in blue: *Discoglossus* sp., *Pelophylax perezi*

and *Natrix maura*); **B**: correspondence analysis without ~~water-edge~~aquatic taxa. Abbreviations: D sp., *Discoglossus* sp.; Pc, *Pelobates cultripes*; Ec, *Epidalea calamita*; Bv, *Bufotes viridis* s.l.; H sp., *Hyla* sp.; Pp, *Pelophylax* cf. *perezi*; L. indet., Lacertidae indet.; O sp., *Ophisaurus* sp.; Mm, *Malpolon monspessulanus*; Nm, *Natrix maura* ; Nn, *Natrix natrix* s.l.; C sp., cf. *Coronella* sp.; Zs, *Zamenis scalaris*. For data matrix see Supplementary Material (Appendix 1).

Figure 3: Quantitative reconstruction of landscapes according to the habitat weighting method (see text and Table 2) for the Early Pleistocene site of Barranco León (Granada, Spain), with (left) and without (right) ~~water-edge~~aquatic taxa included in the analyses.

Figure 4: Quantitative reconstruction of landscapes according to the habitat weighting method (see text and Table 2) for the Early Pleistocene site of Fuente Nueva 3 (Granada, Spain), with (left) and without (right) ~~water-edge~~aquatic taxa included in the analyses.

Figure 5: Habitat interpretation for the stratigraphic sequences of the Early Pleistocene sites of Barranco León and Fuente Nueva 3 (Granada, Spain), based on amphibian and squamate assemblages. From bottom to top: archaeological levels excavated during the 2015–2018 field seasons. Adjacent columns show the distribution of open-dry, open-wet, woodland, rocky and ~~water-edge~~aquatic dwellers, expressed as a percentage.~~, and the rightmost column shows the minimum number of individuals (MNI) throughout the sequence~~.

Figure 6: Hominin activities at the Early Pleistocene sites of Barranco León and Fuente Nueva 3 (Granada, Spain) put into the ~~paleo~~palaeoenvironmental context obtained from

the amphibian and squamate reptile fossil assemblages without considering water-edgeaquatic species. Lithic elements represent knapping and percussive activities (size in accordance with the density of recovered artifacts); animal silhouettes represent the main taxonomical category of large and very large mammal butchered in the level. The human tooth from Barranco León cannot confidently be ascribed to level D1 or D2.

Table 1: Main archaeological characterization throughout the stratigraphic sequence of Barranco León and Fuente Nueva 3 (Granada, Spain) and indication of the weight of water-screened sediment by level from the 2015 to 2018 excavation campaigns. * Some samples have been labelled as pertaining to level 3 during the excavation process, but according to sedimentological studies, characterizing level 3 as sterile, they must probably come from the upper part of level 2. In order to not mix such samples with those labelled as level 2, we provisionally rename them here as 2sup.

Table 2: Distribution by habitat(s) of the amphibians and reptiles recovered as fossils in the Early Pleistocene of Barranco León and Fuente Nueva 3 (Granada, Spain). (x) indicates that weighting was not possible because the taxon was probably extinct (*Bufotes viridis* s.l. and *Ophisaurus* sp.) or because the higher taxonomic category contained species with different requirements (Lacertidae indet.).

Table 3: Distribution of amphibian and squamate remains throughout the stratigraphic sequence of Barranco León (Granada, Spain) in terms of number of remains (NR) and minimum number of individuals (MNI).

Table 4: Distribution of amphibian and squamate remains throughout the stratigraphic sequence of Fuente Nueva 3 (Granada Spain) in terms of number of remains (NR) and minimum number of individuals (MNI).

Table 5: Distribution of the frequency of different habitats at the Barranco León and Fuente Nueva 3 sites (Granada, Spain). This is based on the amphibian and squamate contents of the different levels and sublevels, according to their habitat preferences as defined in Table 2.

Supplementary Information

Appendix 1. Data matrix of presence (1) and absence (0) for the successive levelsayers of the Early Pleistocene sites of Barranco León and Fuente Nueva 3 (Granada Spain). In bold: aquatic taxa excluded from the second analysis.

Figure 1

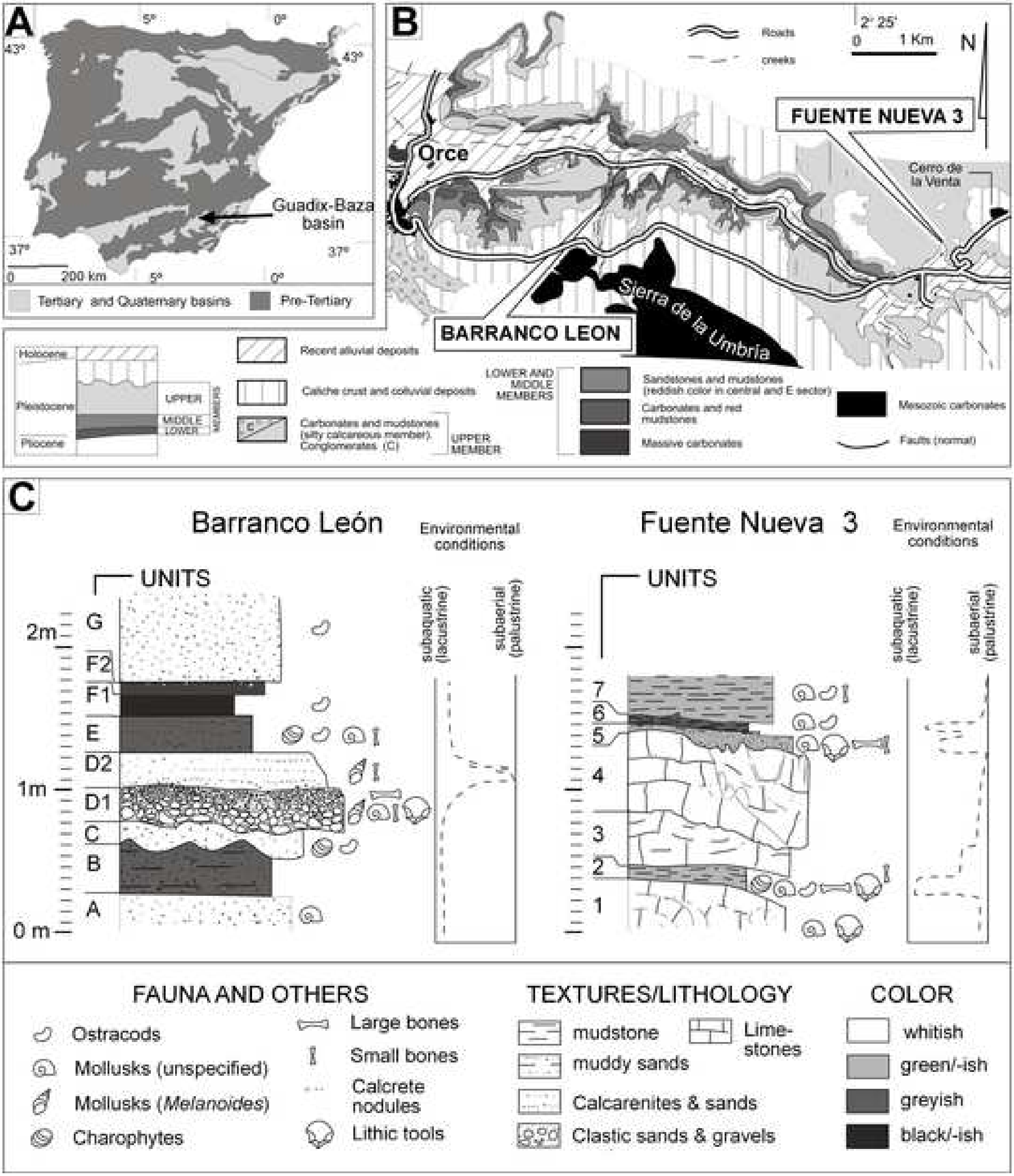
A
Guadix-Baza basin
200 km
Tertiary and Quaternary basins
Pre-Tertiary
B
Roads
creeks
1 Km
N
FUENTE NUEVA 3
Orce
Cerro de la Venta
Sierra de la Umbria
BARRANCO LEON
Holocene
Pleistocene
Pliocene
UPPER
MIDDLE
LOWER
MEMBERS
Recent alluvial deposits
Caliche crust and colluvial deposits
Carbonates and mudstones (silty calcareous member) Conglomerates (C)
UPPER MEMBER
LOWER AND MIDDLE MEMBERS
Sandstones and mudstones (reddish color in central and E sector)
Carbonates and red mudstones
Massive carbonates
Mesozoic carbonates
Faults (normal)
C
Barranco León
Environmental conditions
UNITS
subaquatic (lacustrine)
subaerial (palustrine)
Fuente Nueva 3
FAUNA AND OTHERS
Ostracods
Mollusks (unspecified)
Mollusks (Melanoides)
Charophytes
Large bones
Small bones
Calcrete nodules
Lithic tools
TEXTURES/LITHOLOGY
mudstone
muddy sands
Calcarenites & sands
Clastic sands & gravels
Lime-stones
COLOR
whitish
green/-ish
greyish
black/-ish

Figure 2

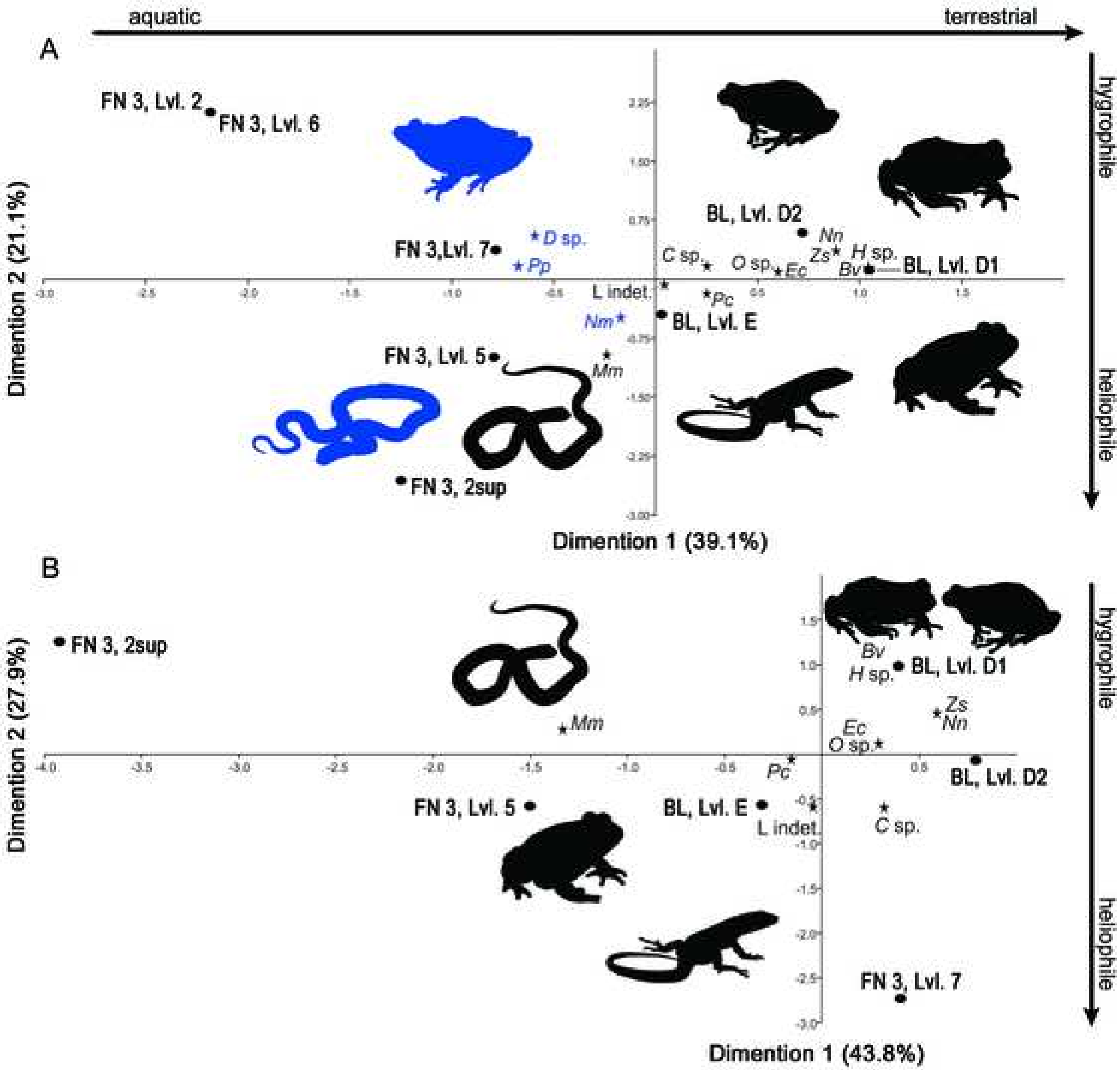
aquatic
terrestrial
hygrophile
heliophile
A
FN 3, Lvl. 2
FN 3, Lvl. 6
FN 3,Lvl. 7
D sp.
Pp
Nm
FN 3, Lvl. 5
Mm
FN 3, 2sup
BL, Lvl. D2
Nn
C sp.
O sp.
Ec
Zs
H sp.
Bv
BL, Lvl. D1
L indet.
Pc
BL, Lvl. E
Dimention 2 (21.1%)
Dimention 1 (39.1%)
B
FN 3, 2sup
Mm
Bv
H sp.
BL, Lvl. D1
Zs
Nn
Ec
O sp.
Pc
BL, Lvl. D2
FN 3, Lvl. 5
BL, Lvl. E
L indet.
C sp.
FN 3, Lvl. 7
Dimention 2 (27.9%)
Dimention 1 (43.8%)

Figure 3

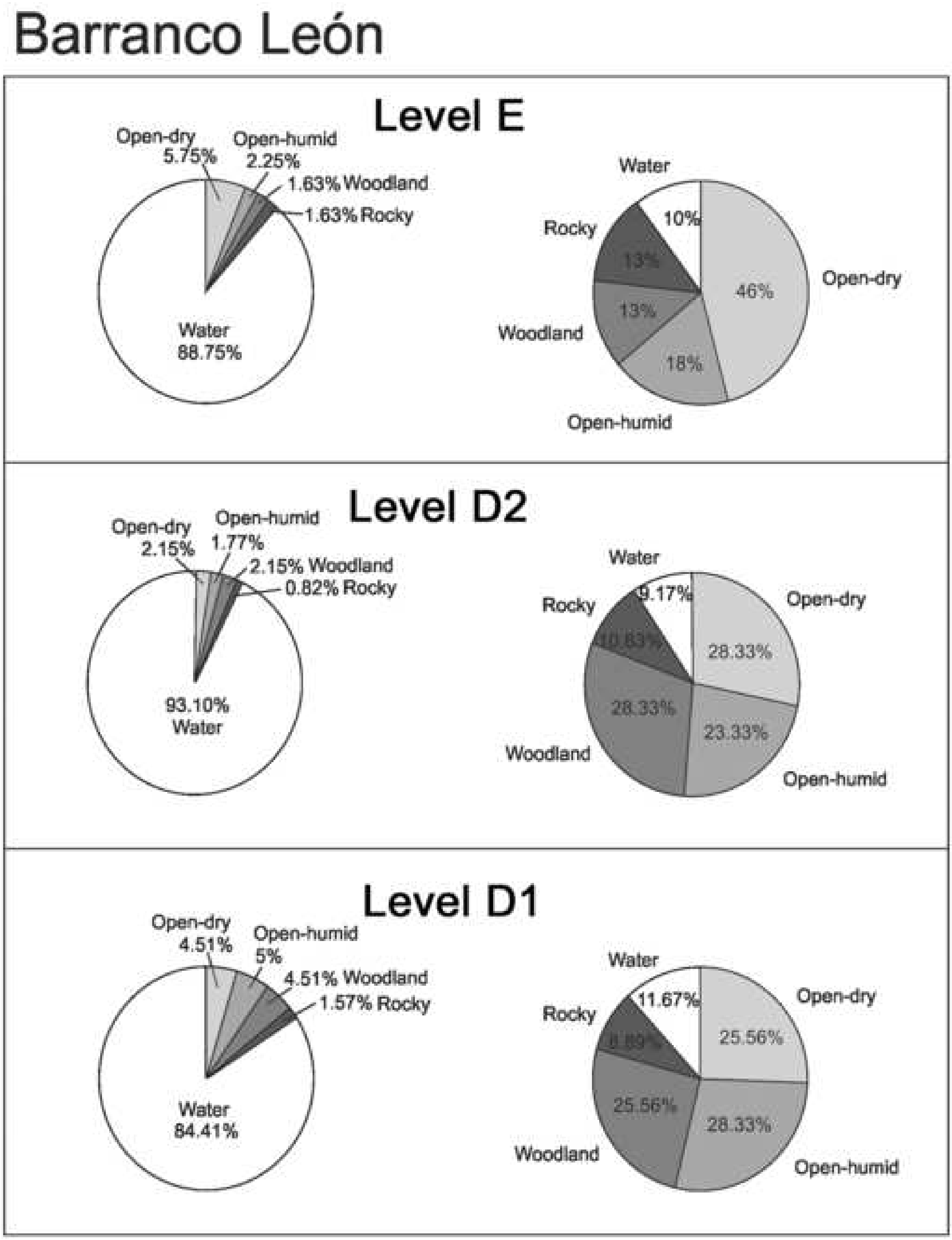
Barranco León
Level E
Open-dry 5.75%
Open-humid 2.25%
1.63% Woodland
1.63% Rocky
Water 88.75%
Water
10%
Rocky
13%
13%
Woodland
18%
Open-humid
46%
Open-dry
Level D2
Open-dry 2.15%
Open-humid 1.77%
2.15% Woodland
0.82% Rocky
93.10% Water
Water
9.17%
Rocky
10.83%
28.33%
Open-dry
28.33%
Woodland
23.33%
Open-humid
Level D1
Open-dry 4.51%
Open-humid 5%
4.51% Woodland
1.57% Rocky
Water 84.41%
Water
11.67%
Rocky
8.89%
25.56%
Open-dry
25.56%
Woodland
28.33%
Open-humid

Figure 4 Click here to access/download;Figure;renamed_fd1e9.jpg

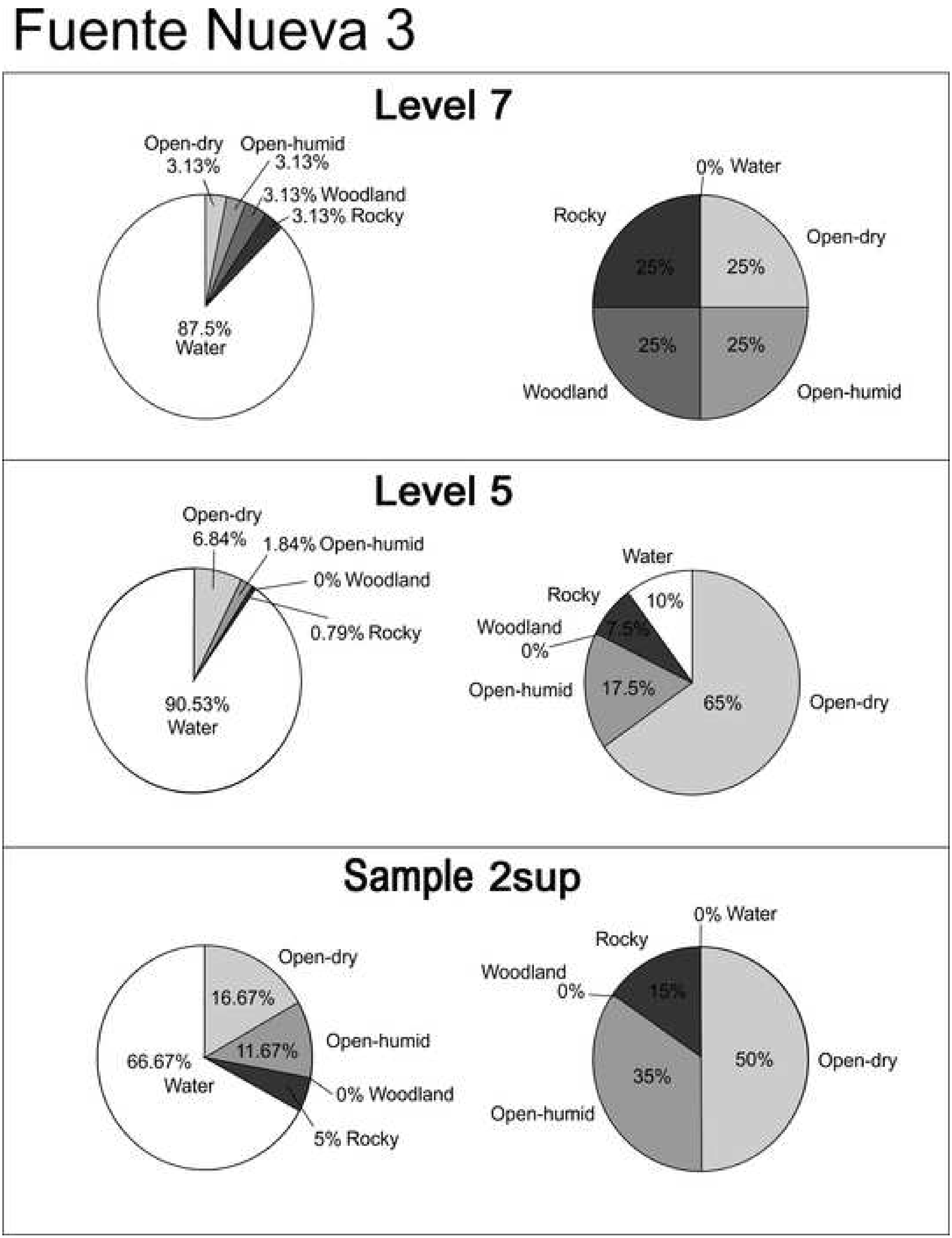

Figure 5 Click here to access/download;Figure;renamed_68295.jpg

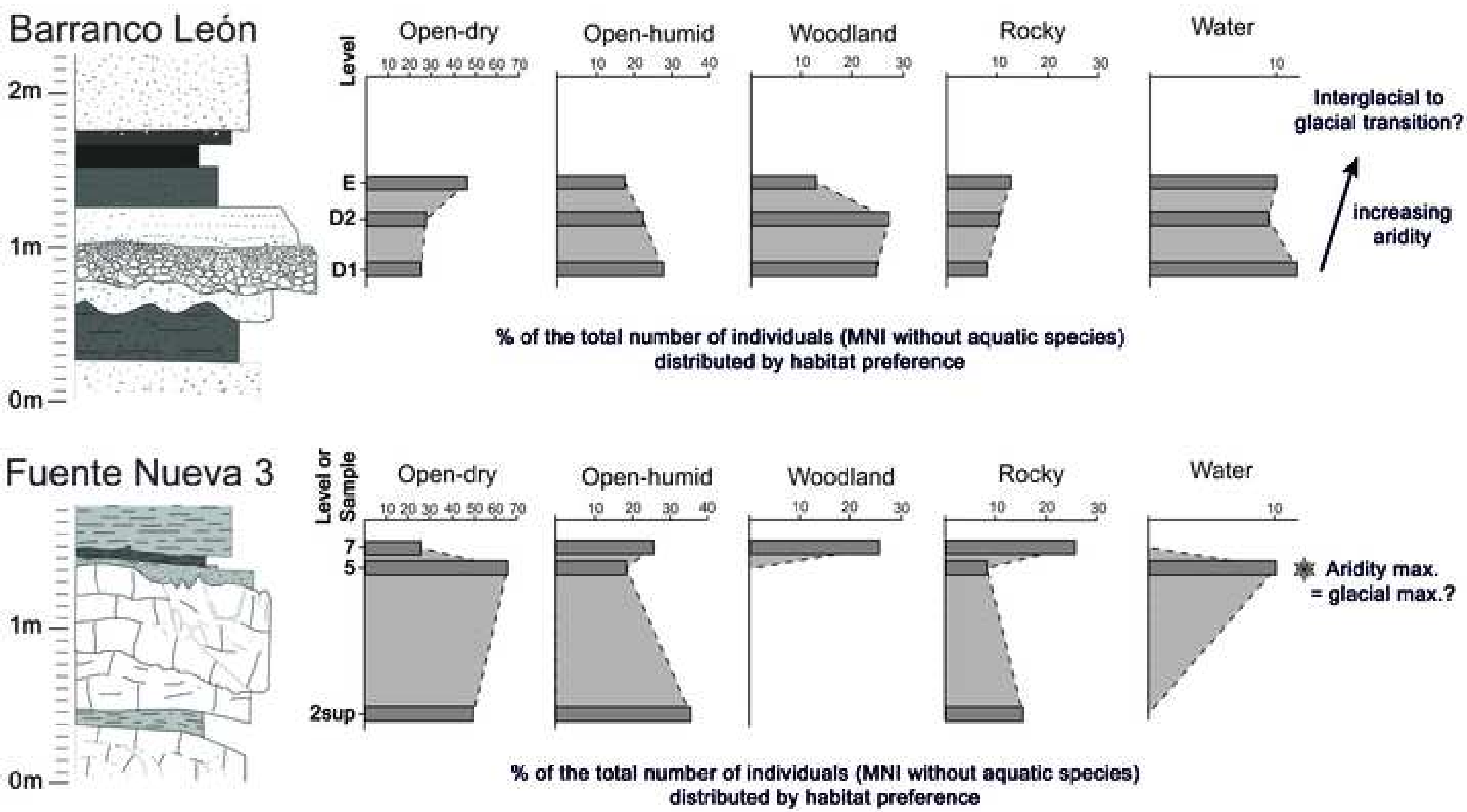

Figure 6

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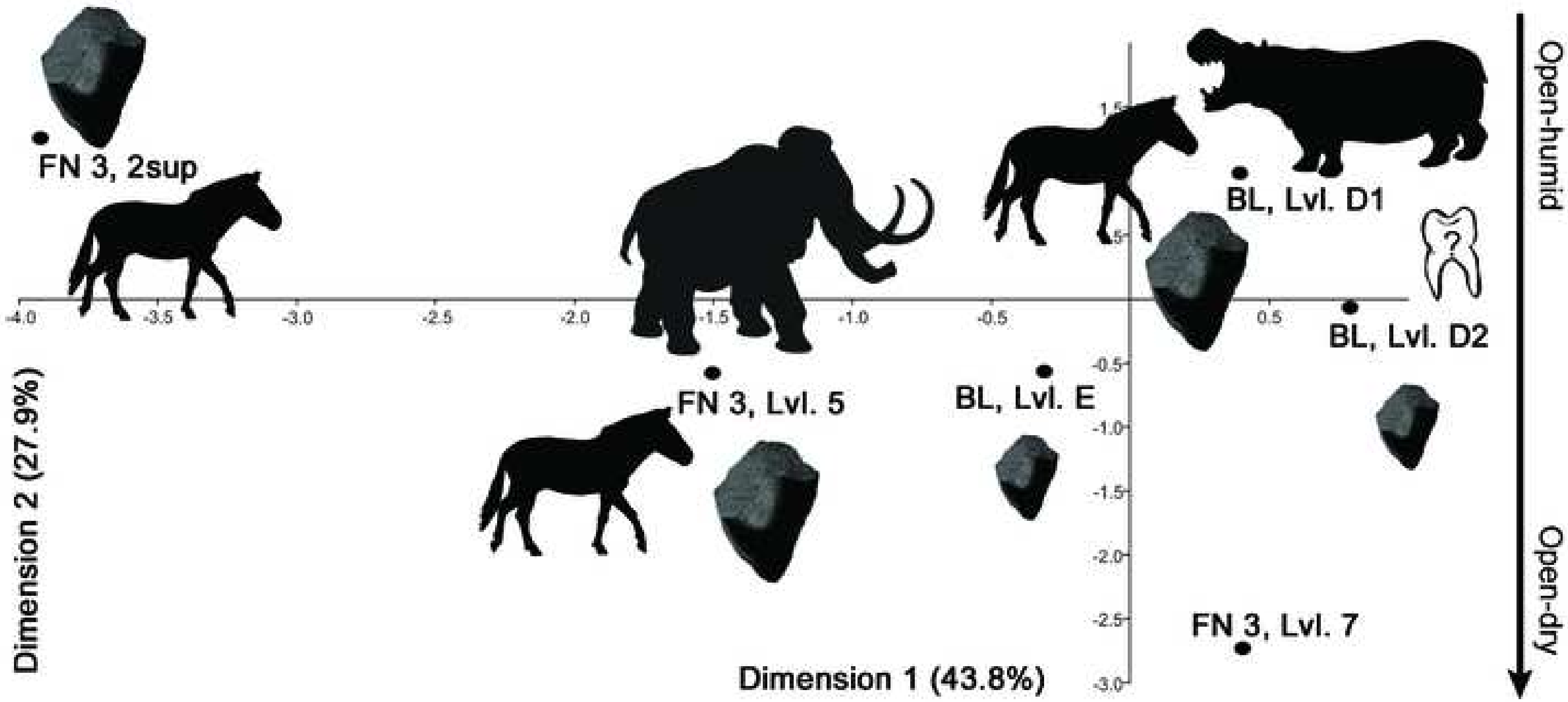

Table 1

Table 2

Table 3

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Table 5

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Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Author statement

Christian Sánchez-Bandera: Investigation; Formal analysis; Writing- Original draft preparation. **Oriol Oms:** Investigation; Formal analysis; Writing- Reviewing and Editing. **Hugues-Alexandre Blain:** Conceptualization, Methodology, Supervision; Funding acquisition. **Iván Lozano-Fernández:** Supervision, Writing- Reviewing and Editing. **Josep Francesc Bisbal-Chinesta:** Formal analysis; Writing. **Jordi Agustí:** Writing; Validation; Funding acquisition. **Juha Saarinen:** Writing; Validation. **Mikael Fortelius:** Writing; Validation. **Stefania Titton:** Reviewing and Editing; Validation. **Alexia Serrano-Ramos:** Reviewing and Editing; Validation. **Carmen Luzón:** Validation. **José Solano-García:** Reviewing and Editing; Validation. **Deborah Barsky:** Writing- Reviewing and Editing; Validation. **Juan Manuel Jiménez-Arenas:** Project administration; Funding acquisition; Supervision**.**