6th Annual Meeting of the

European Society for the study of Human Evolution

14-17 September 2016
MADRID / SPAIN

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2015 Impact Factor*

3.767

*Journal Citation Reports published by Thomson Reuters 2016

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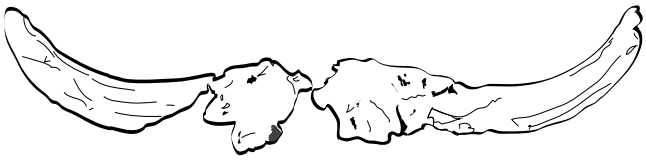

Proceedings of the European Society for the study of Human Evolution 5

Cover image: Bison Horns courtesy of the Museo Arqueológico Regional
Proceedings of the European Society for the study of Human Evolution Vol. 5
Citation: PESHE 5, 2016

PESHE 5 compiled and designed by Mikaela Lui

ISSN 2195-0776 (Print)
ISSN 2195-0784 (Online)

Podium Presentation: Session 7, Fr (16:40)

The Almonda karst system (Torres Novas, Portugal): a window into half a million years of long-term change in climate, settlement, subsistence, technology and culture

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The spring of the Almonda river, a tributary of the Tagus, is a karst outlet of the Central Limestone Massif of Portuguese Estremadura. The latter's boundary with the Tagus basin is tectonically active and eventually formed a >40 km-long escarpment that, at Almonda, is ca.70 m-high. Here, collapsed entrances connected to a "Swiss-cheese" network of underground passages document the successive stages of the spring's downward migration. These ancient outlets were identified through geophysics-aided speleoarcheological exploration of the system, and some have been excavated. Speleothems formed in the interior passages through the Pleistocene; human adaptation to climate change can thus studied based on immediate proxies and in a region that was extremely sensitive to the movements of the polar front along Iberia's Atlantic façade. The ecotonal position and geological setting at the crossroads between homogeneous domains of Paleozoic, Mesozoic and Cenozoic age allow ceteris paribus assessment of change over time in raw-material procurement, subsistence and mobility.

So far, the excavated and dated loci relate to: three moments of the Lower Paleolithic (Entrada Superior, Entrada do Vale da Serra, Gruta da Aroeira), the entire Middle Paleolithic (Gruta da Oliveira), the Solutrean and the Magdalenian (Galeria da Cisterna and Lapa dos Coelhos), later Prehistory (Galeria da Cisterna), and a Pleistocene hyena den (Gruta do Pinheiro). Here, we provide an overview of 30 years of research, and illustrate the potential of the system to address long-term change by reference to two much-debated issues of paleoanthropological significance it sheds light on: the use of fire in the Lower and Middle Paleolithic, and the exploitation of small prey.

Burnt bone is found in association with anthropogenic faunal assemblages in the basal deposit of Aroeira, ca. 400 ka, and is ubiquitous through the 70,000 years covered by the Middle Paleolithic sequence of Oliveira; in the latter, hearths were found at the base of layer 14, dated to MIS-4, and in layer 21, stratigraphically constrained to MIS-5. The layer 21 feature has a diameter of ca.1.5 m, was excavated into the underlying sediment along half of its periphery, and contained large amounts of burnt bone. In layer 22 below, the trench marginally cut through two features of similar size that extend outward to an unexcavated area of the site but are well apparent in cross-section. A nearly complete Levallois reduction sequence could be refitted from the flints scattered around the layer 21 hearth, corroborating the integrity of the context. The layer 14 hearth was smaller and lit on a bare ground but likewise associated with a scatter of burnt bone and refitting stone tools. In France, stratigraphic variation in the presence/absence of burnt bone and fire features has been used to argue that Neandertals did not master fire production, but in Oliveira such variation relates to changes in human use of the space relative to (a) changes in the morphology of the cave occurring through sediment accumulation and (b) the position of excavation trenches relative to the area of the site mainly occupied by humans at any given time.

Plains animals, namely horse, aurochs, rhino and red deer, form the bulk of hunted game through the entire Paleolithic. Rabbit, birds and tortoise are present through both the Aroeira and the Oliveira sequences, but so far only the tortoise remains from Oliveira show evidence of having been collected and processed by humans. River fish are found in significant amounts in the Late Magdalenian of Lapa dos Coelhos. Combined with patterns of raw-material procurement and isotope-derived data on the mobility of individuals, the evidence suggests that forager-type hunter-gatherer economies obtained in the area from the Acheulian onwards. It is not until the very end of the Pleistocene that increased territoriality and attendant dependence on small prey is documented.

Acknowledgements: Over the years, the principal sources of support for the archaeological investigation of the Almonda karst system have been Câmara Municipal de Torres Novas, Instituto Português de Arqueologia and Fundação para a Ciência e Tecnologia.