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Project Gallery

Unveiling the relevance of carbohydrate-rich underground plant foods in the archaeological record

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Rich in carbohydrates, underground storage organs played a key role in human history. This project aims to establish a systematic methodology for their multi-proxy study, creating an online reference collection, using different microscopy techniques for identification and establishing a reference guide to use-wear patterns on experimental archaeology tools used for the processing of underground storage organs.

Keywords: Iberian Peninsula prehistory, archaeological parenchyma, microscopy, plant resources

Underground storage organs are plant structures that store energy and water. Underground storage organs are a very valuable food resource (Singels 2013): they grow seasonally, are predictable and reliable, as well as relatively easy to gather and process. Their consumption is attested in a variety of ethnographic sources (Berihuete-Azorín *et al.* 2018), while data suggest that around 40 species of underground storage organs were used as food by recent northern hunter-gatherers (Kuhnlein & Turner 1991). Underground storage organs had a key role throughout human history. There is no doubt that they offered the most abundant and readily available source of carbohydrates in Palaeolithic and Mesolithic Europe (Kubiak-Martens 2016), and it is estimated that probably 20–30 species were used (Mears & Hillman 2007). Their importance, however, has been undervalued for multiple reasons such as recovery issues, identification difficulties and a focus on other food resources. This project aims to provide reference material that can be used for the identification of underground storage organs and their processing on any archaeological site, and thus fill a gap in the study of archaeological hunter-gatherer economies.

Macrobotanical remains regularly document the presence of fruits and seeds belonging to species that also produce underground storage organs. The direct presence of underground storage organs is rarely described, however, with very few recorded examples (e.g. Holden *et al.* 1995; Kubiak-Martens 1996, 1999, 2002; Pryor *et al.* 2013; Larbey *et al.* 2019; Florin *et al.* 2020; Wadley *et al.* 2020). Current reconstructions of hunter-gatherer diets are dominated by chemical analyses of animal and human bones, plant microremains (starch and phytolith), and use-wear analysis of lithic tools. This is partly because the recovery of plant macroremains requires sampling, sediment processing and sorting of the residues, whereas the aforementioned techniques can be applied without systematic sampling

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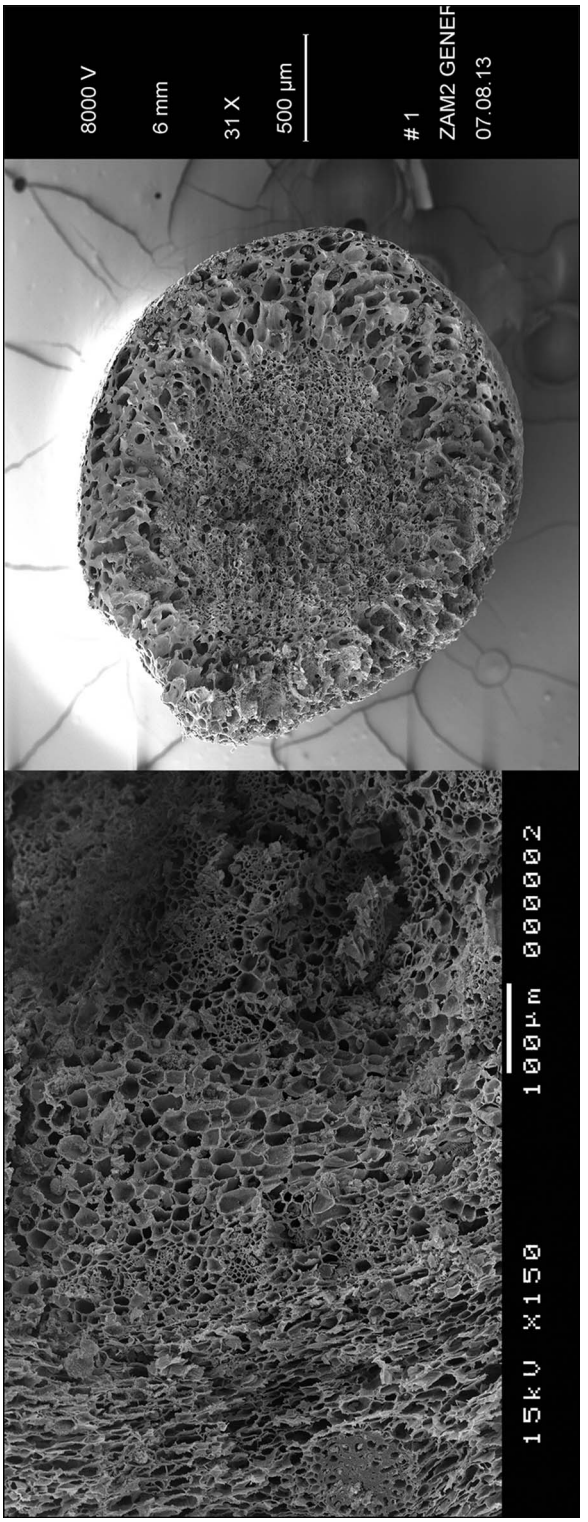

Figure 1. Unidentifiable underground storage organ remains: left) visible vascular bundles from La Draga, Spain (micrograph by L. Kubiak-Martens); right) underground storage organ remains from Zamotsje 2, Russia (micrograph by M. Berihuete-Azorín).

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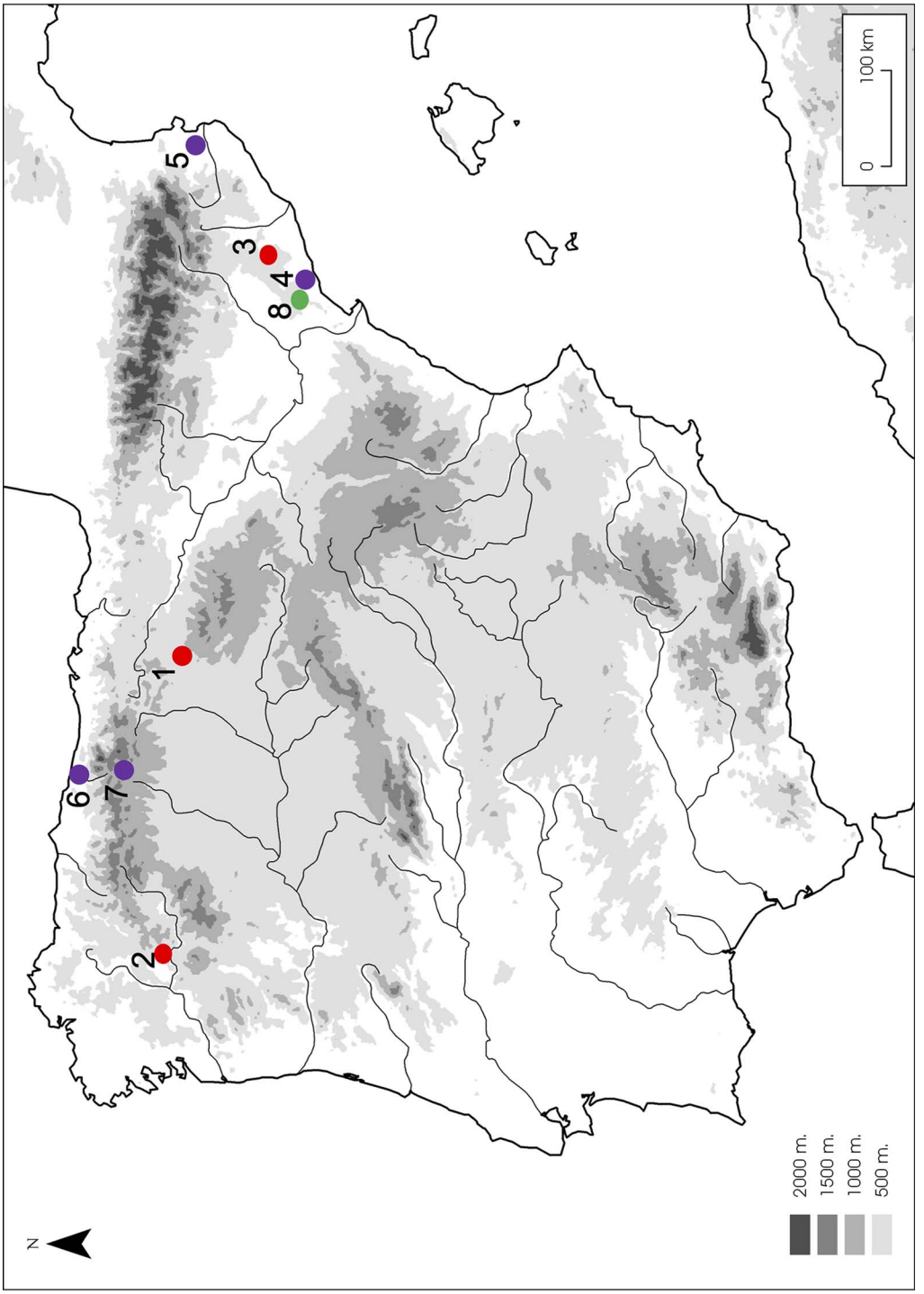

Figure 2. Early hunter-gatherer sites (red): 1) Trinchera Dolina, Atapuerca, (Burgos); 2) Cova Eirós, Tricastela (Lugo); 3) Abric Romaní, Capellades (Barcelona). Early Homo sapiens *hunter-gatherer sites (purple): 4) Molí de Salt, Vimbodí i Poblet (Tarragona); 5) Serinyà sites (Girona); 6) El Cierro, Ribadesella (Asturias); 7) El Aspio, Ruesga (Cantabria). Last hunter-gatherer sites (green): 8) Cova de Fems, Ulldemolins (Tarragona); 9) Poças de Sao Bento, Alcácer do Sal (Alentejo).*

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methods. The situation is even less favourable for underground storage organs because the recovery of archaeological parenchyma (meristematic and epidermal tissue of plants) requires special effort (Mason & Hather 2002) and entails numerous identification difficulties. While small-sized, complete tubers that retain features such as shape or detachment scars may allow easier identification; when dealing with fragmented storage organs, it is necessary to examine the internal anatomy, especially the organisation of vascular tissue and anatomy of parenchyma cells, for which scanning electron microscopy is required. Moreover, the limited availability of atlases and reference collections contribute to the underrepresentation of this resource in the archaeological record (Figure 1).

A first step to overcome this situation is the creation of a reference collection in an online repository. This project aims higher, however, by creating a larger corpus of information that will also link to examples of exploitation of underground storage organs by other means, namely use-wear and residue analyses on tools. We will create a set of wooden tools (digging sticks) and stone tools (knifes/scrapers and grinding stones) that ethnobotanical studies suggest are involved in harvesting and processing underground storage organs (e.g. Hurtado & Hill 1989). These three tool types will be used to harvest and process underground storage organs, and the use-wear of the used tools will be recorded; the tools will then be sampled for starches, which can be taxon distinctive, in order to create a reference collection for the selected species. A set of experiments to test how heat and different processing techniques may affect the starches will also be carried out. All data will be made available for reference in one repository.

The application of new imaging techniques has proven useful in identifying underground storage organs (Pritchard *et al.* 2019) and other food remains (González *et al.* 2017; Heiss *et al.* 2017). Some of these new methodologies (3D scanning and microCT) will also be tested and used to generate the underground storage organ reference collection. In addition to the methodological innovation, the project will systematically search the material archives of nine key prehistoric archaeological sites on the Iberian Peninsula to check for the presence of underground storage organs. Some of these sites, such as Trinchera Dolina, Atapuerca (Figure 2), where the earliest hominids of Europe were discovered (Carbonell *et al.* 2008), are fundamental to our understanding of Iberian Prehistory and human evolution.

These nine sites were selected to cover a wide chronological framework and allow the detection of variations in prehistoric resource management. This project crosses disciplinary boundaries to overcome the limitations in identifying archaeological underground storage organs. It brings together new and traditional archaeobotanical methods, and cutting-edge image-representation techniques that are complemented by use-wear analysis and a starch reference collection.

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