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Editorial

Archaeoecology. The Application of Palaeoenvironmental Sciences for the Reconstruction of Human-Environment Interactions

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The study of human–environment interactions is one of the mainstream topics in archaeological research, with increasing interest in the context of current societal challenges concerning environmental shifts related to climate change, sea-level rise, extreme natural events and also the exponential increase in anthropisation in recent decades. In thiscontext, long-term archaeological and palaeoecological data provide a reference period against which current conditions are compared [1] in order to understand the dynamics linking climate, the biotic and abiotic components of the geosystem and human activities.

Palaeoecological research has been relevant in archaeology, especially since the 1960–1970s, with the emergence of the *New Archaeology* [2–4] and the consequent integration of different methods and techniques from the natural sciences, such as geology, botany, zoology, chemistry or ecology. In fact, diverse methodological approaches have been systematised through disciplines such as archaeobotany, archaeozoology and geoarchaeology, and palaeoecological and palaeoclimatological studies have been considered essential tools to reconstruct and comprehend human and social evolution [5]. Nevertheless, the adoption of explanatory premises of cultural ecology [6] frequently leads to the consideration ofhumans as passive elements to external factors such as climate change, without response or action capacity, deriving in explanations based on an environmental determinism. These palaeoecological adaptationist approaches obviate the social production and human agency, precisely the main objective of the archaeological research. In that sense, to leave historical explanations outside the parameters of ecological adaptation, archaeoecology is defined as the study of the dialectical relationship between social and natural systems, in order to reconstruct the environmental framework and possible constraints on human and social evolution, as well as the impacts of anthropogenic work and human-induced disturbance processes in the landscape [7,8]. Originally, the geosystem was a purely natural system but, throughout history, it has become progressively constructed by anthropogenic work and innovations. Farming, metallurgy and the emergence of states represent evolutionary milestones in the exponential growth of anthropisation. Thus, the landscape has emerged as a historical product rejecting its original nature and becoming increasingly humanised.

The application of palaeoenvironmental sciences to archaeological records enables the reconstruction of past climate, environmental conditions and landscape transformation by human societies over time. However, the unit of study must transcend from the archaeological site to the landscape, understood as a historical product transformed by both natural and social processes. Therefore, the development of integrated in-site archaeological and off-site palaeoecological research is the best strategy to obtain a robust knowledge about past human–environment interactions.

This Special Issue offers a view of different interdisciplinary applications of palaeoenvironmental studies in archaeology centred on the reconstruction of human–environment interactions. In the following lines, a short summary is provided of each of the contributions presented in this volume.

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M. Ghilardi [9] provides a brilliant definition of the concept of geoarchaeology, which can work as a synonym of archaeoecology, based on the development of multidisciplinary research adopting a spatial resolution at the scale of geographical, geological or geomorphological features. In this work, M. Ghilardi reviews available data on costal geoarchaeology in Mediterranean islands, integrating both continental and marine dynamics, with a particular focus on Corsica.

P. Verhagen et al. [10] propose a method to integrate ecological, ethnographical and archaeological data through an interdisciplinary archaeoecological project. In this work, the authors present 'human-centred interaction networks' as a tool to synthesize and better understand the role of culture, ecology and environment in the long-term evolution of socio-ecological systems, based on the study case of the Neolithic transition of the Swifterbant culture in the northwestern Netherlands (~4700–4000 BCE).

J. Revelles [11] provides an overview of the potential of palynology within palaeoenvironmental research to reconstruct past landscapes and assess the relationship between vegetation and the first farming communities in the western Mediterranean, particularly in NE Iberia and Corsica. This work presents palynological studies conducted on the basis of an archaeoecological approach, considering in-site and off-site pollen records, addressing environmental changes at local, extra-local and regional scales, and providing significant data to assess the use of space and site formation processes in archaeological sites.

C. Val-Peón et al. [12] present a palynological study in SW Iberia, providing data on vegetation trends and climate conditions for the Early and Middle Holocene (~12,000–6000 cal BP), indicating warm conditions during the Early Holocene, increased moisture in 10,000–7000 cal BP and peaks in aridity at 8200 and 7500 cal BP. In this study, multi-proxy datasets (palynological and geochemical) were correlated with archaeological data to understand how human groups adapted to environmental changes during the Early–Mid Holocene, with special focus on the Mesolithic–Neolithic transition.

R. Piqué et al. [13] discuss whether human activities or climate were the main driver of vegetation changes during the Middle Holocene through the study of the archaeobotanical data from three Neolithic archaeological sites from NE Iberia: Cova del Sardo, La Draga and Coves del Fem. In this work, the application of diverse archaeobotanical techniques to the different plant remains provides a complete picture of the vegetation composition and plant uses.

M. Portillo and A. García-Suárez [14] evaluate the contribution of integrated geoarchaeological and ethnoarchaeological approaches on the identification of animal dung and its archaeological significance within farming-built environments. This work examines the variability of dung materials within agricultural and pastoral settlements and their potential for tracing continuity and change in ecological diversity, animal management strategies, grazing and foddering, and dung use. This study also highlights the value of modern reference frameworks of livestock dung for disentangling human–plant–animal dynamics through time and space.

M. Portillo et al. [15] illustrates the contribution of plant and faecal microfossil records to interdisciplinary approaches on the identification, composition, taphonomy and seasonality of livestock dung materials. This work focusses on the taphonomy of opal phytoliths and calcitic dung spherulites embedded within modern faecal pellets collected from pasture grounds and pens from a range of animals, including cattle, sheep and pigs from three different farms and seasons of the year in Menorca, Balearic Islands.

M. Le Bailly et al. [16] give an overview on the potential of palaeoparasitology to provide valuable clues about the lifestyles of ancient populations and reconstruct the history of diseases. This work reviews the history of this discipline, its theoretical and methodological concepts and presents particular applications in archaeological sites.

A. García-Escárzaga et al. [17] propose a novel methodology for paleoclimate applications in northern Spain, based on the measurement of Mg/Ca ratios using Laser-Induced Breakdown Spectroscopy (LIBS) in live-collected samples for limpet *Patella depressa*26 Pennant, 1777. The results showed a significant correlation between Mg/Ca ratio series

and both δ18O profiles and SST, highlighting the palaeoenvironmental and archaeological potential of LIBS analyses on this mollusc species that is frequently found in archaeological contexts in the western Europe. In addition, this approach enables one to estimate the season when archaeomalacological remains were gathered, with clear implications for the study of past human–environment interactions.

I.-Y. Montes et al. [18] present a multiproxy approach including sedimentological, biogenic silica, carbon and nitrogen isotopes and fossil pigments analysis in sediment cores from the Mediterranean region of Chile. This work reconstructs primary production and sedimentological changes spanning the past 2500 years in two coastal lakes: Laguna Grande (LGSP) and Laguna Chica de San Pedro (LCSP). In addition, I.-Y. Montes et al. show the potential of palaeolimnology to detect anthropogenic disturbance processes in terms of eutrophication. In that sense, recent decades evidenced increases inprimary production, probably resulting from anthropogenic disturbances, including the clearance of native vegetation, the introduction of exotic tree species and urbanisation.

In conclusion, this Special Issue presents multidisciplinary approaches of palaeoenvironmental and archaeological research to the study of past human–environment interactions. Firstly, some papers remark the value of holistic interdisciplinary research based on geoarchaeological [9] and archaeoecological [10] approaches to assess environmental and social dynamics. Second, the potential of palynology in the study of landscape transformation is addressed in [11,12], whereas [13] shows the high relevance of interdisciplinary archaeobotanical research in the study of plant uses and landscape reconstruction. Third, this Special Issue shows the potential of the interdisciplinary study of dung, based on geoarchaeological and ethnographical data [14], on taphonomy of opal phytoliths and calcitic dung spherulites [15], and the potential of palaeoparasitological analyses in archaeological sites to reconstruct the health of ancient populations and the history of diseases [16]. Finally, the biogeochemical study of molluscs has been proved as a relevant approach for palaeoclimate reconstructions; refs. [17,18] show the potential of palaeolimnology to detect human-induced eutrophication.

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References

1. Gillson, L.; Whitlock, C.; Humphrey, G. Resilience and fire management in the Anthropocene. *Ecol. Soc.* **2019**, *24*. [CrossRef]
2. Binford, L.R. Archaeology as anthropology. *Am. Antiq.* **1962**, *28*, 217–225. [CrossRef]
3. Binford, L.R. Archaeological Systematics and the Study of Culture Process 1. *Am. Antiq.* **1965**, *31 Pt 1*, 203–210. [CrossRef]
4. Steward, J.H. Causal factors and processes in the evolution of prefarming societies. In *Man the Hunter*; Lee, R., De Vore, I., Eds.; Aldine Publishing Company: Chicago, IL, USA, 1968; pp. 229–240.
5. Butzer, K.W. *Archaeology as Human Ecology: Method and Theory for a Contextual Approach*; Cambridge University Press: Cambridge, UK, 1982.
6. Steward, J.H. *Theory of Culture Change: The Methodology of Multilinear Evolution*; University of Illinois Press: Champaign, IL, USA, 1955.
7. Revelles, J. Arqueoecología, Arqueobotánica y Arqueopalinología: Una relación dialéctica entre sociedad y medio. In *Los Lugares de la Historia. Colección Temas y Perspectivas de la Historia*; Museud'Arqueologia de Catalunya: Barcelona, Spain, 2013; Volume 3, pp. 729–748.
8. Revelles, J. Archaeoecology of Neolithisation. Human-environment interactions in the NE Iberian Peninsula during the Early Neolithic. *J. Archaeol. Sci. Rep.* **2017**, *15*, 437–445. [CrossRef]

9. Ghilardi, M. Geoarchaeology: Where Geosciences Meet the Humanities to Reconstruct Past Human–Environment Interactions. An Application to the Coastal Areas of the Largest Mediterranean Islands. *Appl. Sci.* **2021**, *11*, 4480. [CrossRef]
10. Verhagen, P.; Crabtree, S.A.; Peeters, H.; Raemaekers, D. Reconstructing Human-Centered Interaction Networks of the Swifterbant Culture in the Dutch Wetlands: An Example from the Archaeo Ecology Project. *Appl. Sci.* **2021**, *11*, 4860. [CrossRef]
11. Revelles, J. The Role of Palynology in Archaeoecological Research: Reconstructing Human-Environment Interactions during Neolithic in the Western Mediterranean. *Appl. Sci.* **2021**, *11*, 4073. [CrossRef]
12. Val-Peón, C.; Santisteban, J.I.; López-Sáez, J.A.; Weniger, G.-C.; Reicherter, K. Environmental Changes and Cultural Transitions in SW Iberia during the Early-Mid Holocene. *Appl. Sci.* **2021**, *11*, 3580. [CrossRef]
13. Piqué, R.; Alcolea, M.; Antolín, F.; Berihuete-Azorín, M.; Berrocal, A.; Rodríguez-Antón, D.; Herrero-Otal, M.; López-Bultó, O.; Obea, L.; Revelles, J. Mid-Holocene Palaeoenvironment, Plant Resources and Human Interaction in Northeast Iberia: An Archaeobotanical Approach. *Appl. Sci.* **2021**, *11*, 5056. [CrossRef]
14. Portillo, M.; García-Suárez, A. Disentangling Human–Plant–Animal Dynamics at the Microscale: Geo-Ethnoarchaeological Case Studies from North Africa and the Near East. *Appl. Sci.* **2021**, *11*, 8143. [CrossRef]
15. Portillo, M.; Dudgeon, K.; Anglada, M.; Ramis, D.; Llergo, Y.; Ferrer, A. Phytolith and Calcitic Spherulite Indicators from Modern Reference Animal Dung from Mediterranean Island Ecosystems: Menorca, Balearic Islands. *Appl. Sci.* **2021**, *11*, 7202. [CrossRef]
16. Le Bailly, M.; Maicher, C.; Roche, K.; Dufour, B. Accessing Ancient Population Lifeways through the Study of Gastrointestinal Parasites: Paleoparasitology. *Appl. Sci.* **2021**, *11*, 4868. [CrossRef]
17. García-Escárzaga, A.; Martínez-Minchero, M.; Cobo, A.; Gutiérrez-Zugasti, I.; Arrizabalaga, A.; Roberts, P. Using Mg/Ca Ratios from the Limpet *Patella depressa* Pennant, 1777 Measured by Laser-Induced Breakdown Spectroscopy (LIBS) to Reconstruct Paleoclimate. *Appl. Sci.* **2021**, *11*, 2959. [CrossRef]
18. Montes, I.-Y.; Banegas-Medina, A.; Fagel, N.; El Ouahabi, M.; Verleyen, E.; Alvarez, D.; Torrejón, F.; Schmidt, S.; Lepoint, G.; Diaz, G.; et al. Late Holocene Paleonvironmental Evolution of Two Coastal Lakes in Mediterranean Chile and Its Implications for Conservation Planning. *Appl. Sci.* **2021**, *11*, 3478. [CrossRef]