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Editorial: Human behavior, cognition and environmental interactions for the Lower Palaeolithic.

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The Lower Paleolithic is commonly considered as a long period ca. 3.3 to 0.3 Ma, from the earliest evidence of lithic production to the apparition of new core technologies, such as the Levallois. Several Hominins (i.e. *Australopithecus*, *Homo habilis*, *Homo rudolfensis*, *Homo ergaster*, *Homo erectus*, *Homo heidelbergensis*, *Homo antecessor*...) as well as different "cultural traditions" (for instance Oldowan and Acheulean) have coexisted or have succeeded one another. Also considering the geographical extension (Africa, Asia, and Europe), we observe different Lower Palaeolithic cultural expressions under distinct environmental contexts and chronologies. Due to their latitudinal and longitudinal distribution, these traditions cover various climatic phases including roughly long and intense cold and cool periods.

This special issue, born under the impulse of the session "Lower Palaeolithic across time and space: what are we talking exactly about?" organized as part of the 19th UISPP worldwide congress, aims to investigate the variability of the Lower Palaeolithic cultural traditions across spatial and temporal scales, raising questions about the possible interaction between humans and climatic/environmental conditions:

- What exactly is the Lower Paleolithic and what environmental interactions could explain the variability of hominin adaptation? Were there common trends through the whole Lower Paleolithic independent of the environmental contexts?
- How hominins adapted to northern and cold conditions? What factors drove hominins to move north?
- How the raw material availability and the geological background influenced the Lower Palaeolithic traditions variability?
- Can we identify, during the Lower Palaeolithic, phenomena of convergence in hominin behavior and/or cognition flexibility to various geographical areas?
- Can we define the *Homo* migration events in relation to the diffusion of Lower Palaeolithic cultures? How much did the climate influence 'cultural regionalisms' and the spread of Oldowan and Acheulean traditions?

Increasing high-resolution paleoclimate proxies in many sites allow us to discuss the relationships between the environmental and archeological data, and the meaning of the lithic and faunal assemblages through technological and subsistence strategies.

Multidisciplinary research is necessary to deeply understand patterns of hominin behaviors during the Lower Paleolithic and adaptation to a significant variety of climatic/environmental contexts over time for this long period of time. Not being able to get a precise chronological framework (all radiometric dating, when available, has thousands of years of error), it is very complex to define a precise relationship between migration/diffusion, behavior, and climate on a

global scale. For this reason, the only way to answer the questions listed above is to draw data from precise contexts that are as chronologically and geographically differentiated as possible. This Research Topic proposes to assemble papers that relate hominin behavior and detailed environmental data by the available multiple proxies. Papers focus both on continental and local cases to describe the different types of adaptations to environmental conditions and test them over time. Methodological developments are also a way to focus on case-studies in order to discuss the quality of records and the best methods to highlight the influence of climate on the hominin responses and strategies, and the resilience of populations through innovations, dispersals, and networks of sites. These approaches bridge the gap between archeological data and the earth sciences.

The nine papers of this special issue cover a large geographical area, from Western Europe, the Levant to North Africa with examples of open air sites in their environmental conditions (Fig. 1). They also cover a large chronological period and offer the opportunity to compare evidence of the earliest occupations in North Africa ([El Kherba site](#) dated to 1.8 Ma) and the [Spanish sites of Orce](#) dated to 1.4-1.2 Ma. Evidence of the earliest evidence of Acheulean sites are focused on Western Europe, raising question on the environmental constraints related to the arrival of this new techno-complex in Europe ([Barranc de la Boella](#), 0.99 Ma, Spain; [British sites](#) of the MIS 15-11; [Moulin Quignon](#), 670 k, France; [Upper Guadiana River](#) basin of the second half of the Middle Pleistocene, Spain). The Levantine late Acheulean sites are reviewed through the sites of [Revadim](#) and [Jaljulia](#) where levels are dated to 500 ka.

Data indicate a large diversity in the technological strategies and the lithic assemblages for the earliest sites and a standardization (to the extent that this can be effectively recognized based on lithic assemblages) appears in late periods, such as the Late Acheulean Levantine sites or the British MIS 11 sites. That raises a question on hypotheses of first sporadic appearances of hominin in some areas and then massive spreads, with preliminary attempts at colonization or recurrent processes. Recently, methods used to study lithic industries have differed greatly, and questions to be able to compare results between sites, both for technology and for population movements in the environment (raw material supply areas). Compared to the past, a big step forward has been made in the approach to lithic assemblages, which are now analyzed from a global perspective that does not give different importance to the categories (e.g. shaping elements, tool kits, etc.). The concept of the “guide fossil” is certainly outdated in the context of a technological approach, and the characterization of lithic assemblages makes it possible to better highlight the peculiarities, but also the standardizations.

By the paleoenvironmental point of view, it seems that the Acheulean technology could have favored the dispersion of Hominins towards more northerly latitudes, reducing, at least in part, the impact of climatic conditions on the choice of territories to settle, punctually or continuously.

Particularly significant is also the discussion on the chronological limits of the Lower Palaeolithic (including Acheulean), which are defined on a cultural basis. This tradition is used with a global geographical meaning and is not defined on the basis of diffusion phenomena or major climatic changes. The articles presented in this Thematic Issue illustrate well how the upper limit of the Lower Palaeolithic is actually defined on the basis of a technical behavior whose actual importance/innovation is difficult to define. Can we still use the Levallois as a marker for the beginning of the Middle Palaeolithic?

