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Insights from Earth Sciences into Human Evolution studies: The example of prehistoric landscape use in Africa and the Levant

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ABSTRACT

Fossil remains are embedded in a continually evolving landscape. Earth scientists have the methods and approaches to study the processes that shape the landscape at various temporal and spatial scales. Some of these methods can generate insights that are of potential use for researchers in other fields, such as archaeology and palaeoanthropology. Here we present two case studies to illustrate how a broader landscape perspective can provide new insights into the land use by Pliocene hominins in southern Africa, and more recently, by Palaeolithic hominins in the southern Levant. Key landscape attributes can help explain why humans, hominins and the wider animal community exploit certain types of landscapes in predictable ways. Our first case study examines how active tectonics or volcanism appears to be important in creating fertile regions with reliable water sources and complex topography. While relatively easy for agile primates such as hominins to negotiate, zones of complex topography are harder for certain predators and prey animals to traverse. In the second case study, we consider that differences in soil edaphics can exert a major control on animals by supplying or failing to supply necessary trace elements, such as selenium, copper, phosphate and potassium (Henkin et al., 1995). We show that the pattern of trace element distribution can accurately map animal movements between areas of suitable grazing. This predictability could have enabled Levantine humans to ambush megafauna during these seasonal migrations. By studying the landscape attributes around fossil site locations, Earth scientists can offer new insights and perspectives into the past, particularly on the ways in which the inhabitants would have used their landscapes.

1. Introduction

The landscape is the background from which the habitats used by animals and humans derive. Studying the interaction between the fauna and the environment requires therefore, in the first place, understanding the ways in which landscapes evolve through space and time. Earth scientists study this evolution at multiple scales

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while investigating the underlying geodynamical processes. Here we provide examples demonstrating that the knowledge and techniques derived from Earth sciences can be adapted to research in other fields, such as palaeoanthropology and archaeology.

Combining evidence in the fossil and archaeological record with a better knowledge of landscape processes, we show that it is possible to gain greater insight into past human and animal behaviour. The approaches we advocate are particularly concerned with placing the hominins (and humans) within the broader faunal community and, in turn, locating the community itself into a very much wider landscape than in traditional approaches. It requires the use of types of data sources and techniques that are commonly used in Earth Sciences but are less commonly employed in questions regarding human evolution and past land use (such as GIS data, fieldwork and satellite imagery).

We highlight and expand upon selected aspects of the reconstruction of ancient land use under the following topics. First, we consider the role of topography when reconstructing the habitats of early hominins in the past. Second, we consider the role of topography and edaphics in constraining the seasonal movements of large herbivores between areas of suitable grazing (Owen-Smith, 1988). We show how humans may have exploited these predictable animal movements for hunting purposes. We present two case studies as illustrations. In the first case, we discuss the example of landscapes around hominin sites in Africa. In the second case, we explore how humans could have exploited megafaunal movements in the southern Levant.

2. Topographic studies in Africa and potential insights into human evolution

It is widely accepted that a progressive, stepwise drying of the climate resulted in the gradual disappearance of tropical forest, starting in the Miocene and becoming well-established by 5 Ma. It affected the range of forest species in substantial parts of Africa, and specifically in East Africa (Bobe, 2006; Cerling et al., 1997; deMenocal, 2004). As forest cover reduced, fauna began to exploit more open savannah conditions characterised by grasslands, smaller tree and shrub vegetation types. Savannah supports today a larger fauna biomass per square kilometre than any other zone of the planet, but forest contains a larger diversity of species (Fig. 1, Maglio and Cook, 1978). Several faunal lineages show radiations as species began to exploit the new ecological niches associated with the increasing grassland (Bobe and Eck, 2001; Bobe and Behrensmeyer, 2004). This is also true for hominins; the fossil record indicates several species of early hominin genera (*Sahelanthropus, Orrorin, Kenyanthropus Ardipithecus, Australopithecus*), which may reflect different evolutionary strategies to living in new habitat types. Of these genera, only *Homo* has remained, becoming with time the top predator we know today (e.g., Wood, 2005).

The key to how hominins may have adapted to living in novel, challenging environments may well lie in the types of landscapes they exploited. Here we refer to landscapes as the physical landscape Earth scientists are used to exploring (i.e. landform, rock and soils composition, etc.), and we refer to environments as the combination of vegetation and landscapes together. Within this context, "savannah" corresponds more to a vegetation biome as part of the environment, rather than to the physical landscape. While vegetation types are quite sensitive to climate change, features of the physical landscape are not affected to the same extent. Landscapes evolve in response to geodynamical processes such as active tectonics, volcanism, erosion and deposition processes. These processes shape landscape geomorphology, act on the geology and on soil composition, which can in turn affect the "nutrient potential" of a given area. The simple picture one might have of "savannah" becomes more complex when one starts considering the features of the underlying physical landscape. The physical landscape underlying the "savannah" can be made of various types of rocks and soils. It can be rough or flat, covered by volcanics or actively deformed by active tectonics. As a result, it can be more or less sensitive to climatic oscillations.

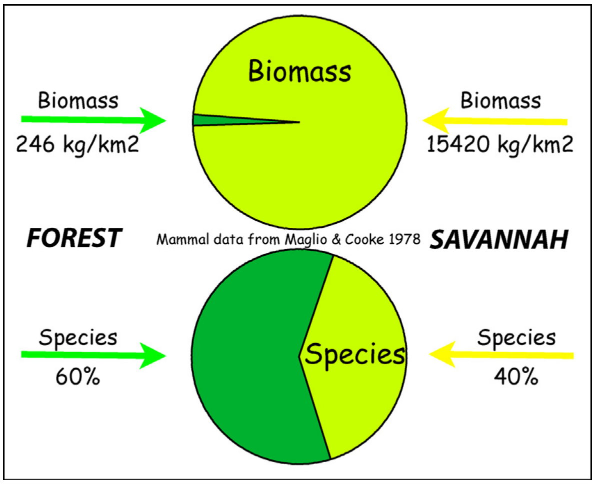

Fig. 1. (Colour online). Mammal carrying capacity of forest and savannah (Maglio and Cook, 1978).

Habitats are the suitable environmental (vegetation and landscape) conditions that pertain to a particular species (Vrba, 1992). Suitable habitat regions need to meet the key habitat requirements of hominins, namely a range of forage (C_3 browse and C_4 grass food types), refuge from predation and a source of potable drinking water (e.g., Reynolds et al., 2011). There are specific geomorphological contexts that can provide these habitat requirements, in particular those affected by active tectonic activity.

2.1. *Complex topography creates habitats that are suitable for hominins*

King, Bailey and collaborators have shown that the locations of Palaeolithic sites are closely associated with topographically complex landscapes (Bailey et al., 2011; King and Bailey, 2006). Fig. 2 illustrates this for Lower Palaeolithic hominin sites. In the majority of cases, tectonic and/or volcanic activity was ongoing when hominins exploited them. These areas are associated with a wide variety of landforms (e.g., rocky outcrops, cliffs, gorges,