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Takarkori rock shelter (SW Libya): an archive of Holocene climate and environmental changes in the central Sahara

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ABSTRACT

Rock shelters in the central Saharan massifs preserve anthropogenic stratigraphic sequences that represent both a precious archive for the prehistory of the region and a powerful proxy data for Holocene palaeoenvironments. The geoarchaeological (micromorphology) and archaeobotanical (pollen analysis) approaches were integrated to investigate the anthropogenic sedimentary sequence preserved within the Takarkori rock shelter, a Holocene archaeological site located in the Libyan central Sahara (southern Tadrart Acacus massif). The site was occupied throughout the Early and Middle Holocene (African Humid Period) by groups of hunter–gatherers before and by pastoral communities later. The investigation on the inner part of the sequence allows to recognize the anthropogenic contribution to sedimentation process, and to reconstruct the major changes in the Holocene climate. At the bottom of the stratigraphic sequence, evidence for the earliest frequentation of the site by hunters and gatherers has been recognized; it is dated to c. 10,170 cal yr BP and is characterized by high availability of water, freshwater habitats and sparsely wooded savannah vegetation. A second Early Holocene occupation ended at c. 8180 cal yr BP; this phase is marked by increased aridity: sediments progressively richer in organics, testifying to a more intense occupation of the site, and pollen spectra indicating a decrease of grassland and the spreading of cattails, which followed a general lowering of lake level or widening of shallow-water marginal habitats near the site. After this period, a new occupational phase is dated between c. 8180 and 5610 cal yr BP; this period saw the beginning of the frequentation of pastoral groups and is marked by an important change in the forming processes of the sequence. Sediments and pollen spectra confirm a new increase in water availability, which led to a change in the landscape surrounding the Takarkori rock shelter with the spreading of water bodies. The upper part of the sequence, dating between c. 5700 and 4650 cal yr BP records a significant environmental instability towards dryer climatic conditions, consistent with the end of the African Humid Period. Though some freshwater habitats were still present, increasing aridity pushed the expansion of the dry savannah. The final transition to arid conditions is indicated by the preservation of ovicaprines dung layers at the top of the sequence together with sandstone blocks collapsed from the shelter's vault. On the contrary, the outer part of the sequence preserves a significantly different palaeoenvironmental signal; in fact, the surface was exposed to rainfall and a complex pedogenetic evolution of the sequence occurred, encompassing the formation of an argillic laminar horizon at the topsoil, the evolution of a desert pavement, and the deposition of Mn-rich rock varnish on stones. These processes are an effect of the general environmental instability that occurred in the central Sahara since the Middle Holocene transition. Finally, the local palaeoclimatic significance of the sequence fits well with Holocene regional and continental environmental changes

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recorded by many palaeohydrological records from North Africa. This highlights the potential of geoarchaeological and archaeobotanical investigations in interpreting the palaeoenvironmental significance of anthropogenic cave sediments in arid lands.

1. Introduction

Key to understand Holocene palaeoclimatic and palaeoenvironmental oscillations is disentangling and isolating climatic and human impacts on the landscape and environment and distinguishing the relative contribution of each (e.g., Cullen et al., 2000; Messerli et al., 2000; Bolle, 2003; Ruddiman, 2003, 2007; Butzer, 2005; Coombes and Barber, 2005; Kuper and Kröpelin, 2006; Roberts et al., 2008; Zanchetta et al., 2013). Within this framework, the geoarchaeological and archaeobotanical study of archaeological sequences, defined as human-disturbed deposits, is of crucial importance to understand the human overprint on climate-triggered palaeoenvironmental changes and geomorphic processes (e.g., Anderson et al., 2007; Cremaschi and Zerboni, 2011; Mercuri et al., 2011; Roberts et al., 2011b). However, to infer palaeoenvironmental and palaeoclimatic information from human-disturbed deposits, a multidisciplinary approach integrating the study of sediments, biological remains and material culture is required.

Cave sediments formed during the human occupation of rock shelters (e.g., Goldberg and Macphail, 2006; Weiner, 2010 and references cited therein) are an example of anthropogenic deposits with great potential for palaeoclimatic studies. Among such samples, the Holocene infillings of the rock shelters of the Tadrart Acacus Massif (Central Sahara, South-West Libya) play an important role in palaeoenvironmental reconstructions, as they resulted from peculiar depositional and post-depositional processes controlled by both natural and anthropic factors (e.g., Cremaschi, 1998; Cremaschi and di Lernia, 1999a; Mercuri, 2008a; Cremaschi and Zerboni, 2011; Biagetti and di Lernia, 2013). These deposits date back to a pivotal period for human development as they include the transition from hunter–gatherer subsistence to food production (e.g., Barich, 1987; Cremaschi and di Lernia, 1998; di Lernia, 1999, 2001, 2002). This event occurred in the Early Holocene, during the African Humid Period (AHP), c. 11,000–6000 cal yr BP, when the Sahara, different from its present aridity, was fed by monsoon rain and covered by patches of savannah (e.g., Lézine, 1989; Gasse and Van Campo, 1994; Gasse, 2000; Hoelzmann et al., 2004; Kuper and Kröpelin, 2006; Lézine et al., 2011).

Numerous caves and rock shelters dot the walls flanking the fossil drainage network that dissect the Tadrart Acacus massif. They formed under a Tertiary warm and humid (tropical) climate thanks to solutional processes (Cremaschi, 1998; Zerboni, 2011). Also, most of them are renowned for their rock art galleries (e.g., Mori, 1965; di Lernia and Zampetti, 2008), placed on the UNESCO World Heritage List in 1985. Since the 1960s, archaeological excavation carried out at several cave sites in Libya and Algeria (for instance, at Ti-n-Hanakaten, Ti-n-Torha, wadi Athal, Uan Telocat, Uan Tabu, Uan Afuda, Uan Muhuggiah, Fozzigiaren) has illustrated that the infillings of rock shelters preserve sequences of utmost archaeological and biological relevance, most of which include the Upper Pleistocene and the Early and Middle Holocene (Pasa and Pasa Durante, 1962; Barich and Mori, 1970; Aumassip and Delibrias, 1982; Hachi, 1983; Aumassip, 1984; Barich, 1987; Schulz, 1987; Wasylikowa, 1992; Cremaschi, 1998; Mercuri et al., 1998; Cremaschi and di Lernia, 1998, 1999a; Cremaschi and Trombino, 1999; di Lernia, 1999; Garcea, 2001; Mercuri, 2008b; Linseele et al., 2010; Cremaschi and Zerboni, 2011; Biagetti and di Lernia, 2013). The peculiarity of the sequences is the surprising preservation of organic matter, especially for the Holocene contexts; this has made these deposits high-quality archives in which archaeological evidence can be studied in its environmental context. Specifically, they offer the possibility to understand (if and) how human groups coped locally with environmental variations and changes in natural resource availability over the course of the Holocene.

In many cases, the human overprint on sediments, in combination with local processes (e.g., human-driven processes and micro-environmental factors), has increased the complexity of stratigraphic records. This makes it difficult to interpret such records from the perspective of palaeoenvironmental reconstruction. Taking this into consideration, the sequence of the Takarkori rock shelter (Fig. 1) was selected to perform an interdisciplinary study of the natural and anthropic depositional and post-depositional processes affecting a central Saharan cave filling.

Due to a thick and composite stratigraphic sequence that spans several millennia and a rich archaeological context, the Takarkori site might be considered representative of the central Saharan massifs, being one of the few locales in the central Sahara preserving the transition from hunting and gathering to food production. Some of the archaeological and bio-anthropological aspects have been already published (Biagetti et al., 2004, 2009; Tafuri et al., 2006; Biagetti and di Lernia, 2007, 2013; Olmi et al., 2011; di Lernia et al., 2012; Dunne et al., 2012; Biagetti and di Lernia, 2013; Cherkinsky and di Lernia, 2013; di Lernia and Tafuri, 2013), confirming that the site represents an outstanding laboratory for multidisciplinary archaeological research.

This paper focuses on processes that contributed to the formation of the stratigraphic sequence, mostly on the basis of geoarchaeological and palynological evidence. Data are interpreted from a palaeoclimatic and palaeoenvironmental perspective. In fact, besides human activities, global environmental factors and local environmental (or micro-environmental) settings are interpreted as actors in the formation processes. Furthermore, data from the site are compared with the regional and continental archives for Holocene environmental modifications, demonstrating the high sensitivity of Saharan cave sediments to global climate changes.

2. Palaeoclimate and past environments of the central Sahara

From the Early to the Middle Holocene, the central Sahara enjoyed a period of high rainfall, as did the entire region (e.g., Cremaschi, 1998, 2002; Gasse, 2000; deMenocal et al., 2000; Hoelzmann et al., 2004; Mayewski et al., 2004; Kuper and Kröpelin, 2006; Wendorf et al., 2007; Arbuszewski et al., 2013). Data from interdune lake deposits (Cremaschi, 1998; Zerboni, 2006; Cremaschi and Zerboni, 2009; Zerboni and Cremaschi, 2012), spring tufa (Cremaschi et al., 2010) and anthropogenic sequences inside rock shelters (Cremaschi, 1998; Mercuri, 2008b; Cremaschi and Zerboni, 2011) indicate that the renewal of water reservoirs and the expansion of the savannah vegetation date to the beginning of the Holocene. The recharge of the aquifers during the AHP was driven by the extension of the summer monsoon from the Gulf of Guinea and the migration of the ITCZ (Intertropical Convergence Zone) to northern positions (Gasse, 2000; deMenocal et al., 2000),