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A zooarchaeological approach to understanding desert kites

Kites have often been interpreted as traps built for hunting purposes. This is based on ethnographic parallels, and recurrent references of the habitat range of animals and possible migration routes. Faunal remains from limited zones and from a selection of sites around kites were studied, particularly from northern Syria and eastern Jordan. When considering the wide distribution of kites in the Middle East and Central Asia, some patterns of animal exploitation and hunting strategies are explored in testing the hypothesis of a cynegetic function of the kites across these regions. As a component of the Globalkites project, the zooarchaeological analyses are used to investigate data regarding the function of kites by reconsidering faunal assemblages recorded around their distribution area, as well as by mapping the historical animal distribution in the Near East and Caucasus. The function of kites is discussed on a large scale, through intensive analyses of the subsistence economy, animal habitat and hunting activities carried out by regional human communities. Cross-referencing these variables with the surrounding environment, settlement patterns and animal ethology and their role in ancient societies, leads to an assessment of the current hypothesis on the function of kites.

Keywords: desert kites, zooarchaeology, archaeological methods, ungulates, hunting strategies

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1. Introduction

The Globalkites project proposes a new research agenda for analysing desert kites (also simply called 'kites'), through interdisciplinary studies applied on a global scale (Barge *et al.* 2013; Crassard *et al.* 2014). The kites are stone-made giant structures, consisting of two or more long funnel-shaped lines ('antennae'), leading to an enclosure often surrounded by small circular rooms ('cells'). According to the latest investigations, more than 4500 kites were recorded across the Middle East and Central Asia (see www.globalkites.fr for a regularly updated interactive distribution map). The function of these kites is nevertheless difficult to assess from only archaeological and architectural studies, geoarchaeology or geomatics. Zooarchaeological insights are therefore needed, in combination with ethology and ethnographical studies, in order to contribute a better understanding of the uses of kites (Crassard *et al.* 2014).

Analysing the function of kites has been a subject of debate since their early discovery. The use of kites as hunting traps or as tools/processes in taming wild animals was proposed by travellers and through ethnographic parallels. Travellers' visits to the Middle East, as well as the observation of rock-art engravings depicting animals in kite-like structures, have led to a variety of interpretations for these built structures (Maitland 1927; Musil 1928; Burckhardt 1831; Fowden 1999; Harding 1953; Betts & Helms 1986; Picalause *et al.* 2004; Betts & Yagodin 2000). Only a very few kite sites have yielded animal remains or tools, while most of the sites do not show any archaeological material and thus provide no type specimen to establish dating and function. Kite structures have not yet yielded either animal remains indicating evidence of slaughter in large quantities (mass killing), or wild game or tools used for hunting. Kites from the north-western fringes of the Ararat depression are an exception because they have yielded lithic

tools dating between the third and the first millennia BC (Gasparyan *et al.* 2013). Excavation and surveys around the kite structures have not revealed any camping sites so far, which could have been used by kite builders or users. Today, no clear association is available between kite structures, settlement areas and cultures in a chronological framework. To date, the link between the structure and the builders and users remains a mystery.

Despite this lack of archaeological evidence, kites were mainly considered as tools for the mass slaughter of gazelles. Recent discussion has been put forward on this topic, especially following the discovery of potential gazelle mass-kill sites (Betts 2014; Zeder & Bar-Oz 2014). Bar-Oz, Zeder and Hole (2011) and Zeder *et al.* (2013) have linked kites with settlement sites from the Khabur River in northern Syria by means of high frequencies of wild prey, animal mortality patterns and carcass processing, leading to the hypothesis of gazelle overexploitation facilitated by the use of kites.

2. A review of available data

The overall approach to kites is directed toward finding evidence of hunting, as well as to establishing the date of their use. So far, almost no analysis has taken into account the morphological variability of kites and its relation to animal exploitation or hunting strategies. The validity of the available data has not been tested in relation to the ethology of animals; nor has ethnographic data been analysed on a global and interregional scale and perspective, an analysis that would cover the entire zones of the kites' distribution. The available data regarding the hunting and occurrence of wild ungulates are focused on special chronological periods such as the Epipalaeolithic to discuss hunting strategies, and on the transition to the Neolithic in order to study the origin of domestication. While scholars addressing kite structures have investigated the hunting and distribution of wild ungulates identified from different sites, especially in northern Syria and eastern Jordan, in order to discuss the function of kites. Thus, particular approaches are needed, firstly for collecting and comparing zooarchaeological studies and secondly for interpreting these analyses with a correlation to the global distribution areas of kites. An assessment is therefore addressed in order to review the data discussed in kite research.

2.2. The zooarchaeological remains

The available data from the region of kite distribution show that the function of kites remains ambiguous and

concrete evidence is widely lacking. The most discussed theory is that kites in the Middle East were meant to intercept herds of ungulates (especially gazelle) on their migration routes. Other animals such as *Equidae* (*Equus* spp.), *Cervidae*, other *Antilopinae* (*Saiga* sp., *Oryx* sp.), *Caprinae* (*Ovis* sp. and *Capra* sp.) and ostrich (*Struthio* sp.) are considered as targeted prey (Holzer *et al.* 2010; Échallier & Braemer 1995; Crassard *et al.* 2014). When assessing the available data regarding wild animal bones from Holocene settlements in the regions of kite distribution, however, the evidence of relevant hunting activity is less obvious. Available zooarchaeological studies that can relate to hunting strategies, and hence the exploitation of wild animals, are variable from each region of concentration of kites. Wild ungulates recorded from Holocene archaeological sites are rare from the Caucasus and Arabia (Chataigner 1995; Berthon 2014; Chahoud *et al.*, in press). Meanwhile, in the Near East (Fig. 1), recent comparative zooarchaeological studies on wild ungulate exploitation during the Holocene have been conducted (Conolly *et al.* 2011; Martin & Edwards 2013; Zeder *et al.* 2013; Munro 2004; Tsahar *et al.* 2009). The most frequently hunted wild game are *Gazella* spp., *Equidae* and *Cervidae*. According to Conolly *et al.* (2011), during the Neolithic gazelle made up between 11% and 21% of the total number of identified specimens (NISP) from the Jazirah region, the Syrian steppe and southern Levantine sites. In Jordan, during the Pre-Pottery Neolithic A (PPNA), gazelle were present in between 60% and 100% of NISP (Martin & Edwards 2013: 59). In the southern Levant between the sixth and fourth millennia BC, 3.8% of NISP are from wild ungulates (Tsahar *et al.* 2009) and between 2% and 4% from Levantine Bronze Age sites (Chahoud 2013).

When comparing each area of kite concentration, local disparities can be observed. Gazelle are more frequent; they comprise up to 70% of the faunal assemblage from eastern Jordan (e.g. at Dhuweila, Wadi Jilat and Jebel Najad, which are late Pre-Pottery Neolithic B, Conolly *et al.* 2011: 542) and up to 40% from that of the Khabur River in northern Syria, at Umm Qseir, Kuran and Ziyadeh sites (late Neolithic and Chalcolithic; Zeder *et al.* 2013: 122).

Equidae and *Cervidae* are less common in Neolithic, Chalcolithic and Bronze Age sites of the Jazirah region, the Syrian steppe and the Levant. Some exceptions were recorded: *Equidae* comprise up to 14.8% of the NISP from PPNA/early PPNB sites in the Jazirah region and the Syrian steppe (Conolly *et al.* 2011), up to 40% of the NISP from Late Neolithic/Halaf sites in the Jazirah region

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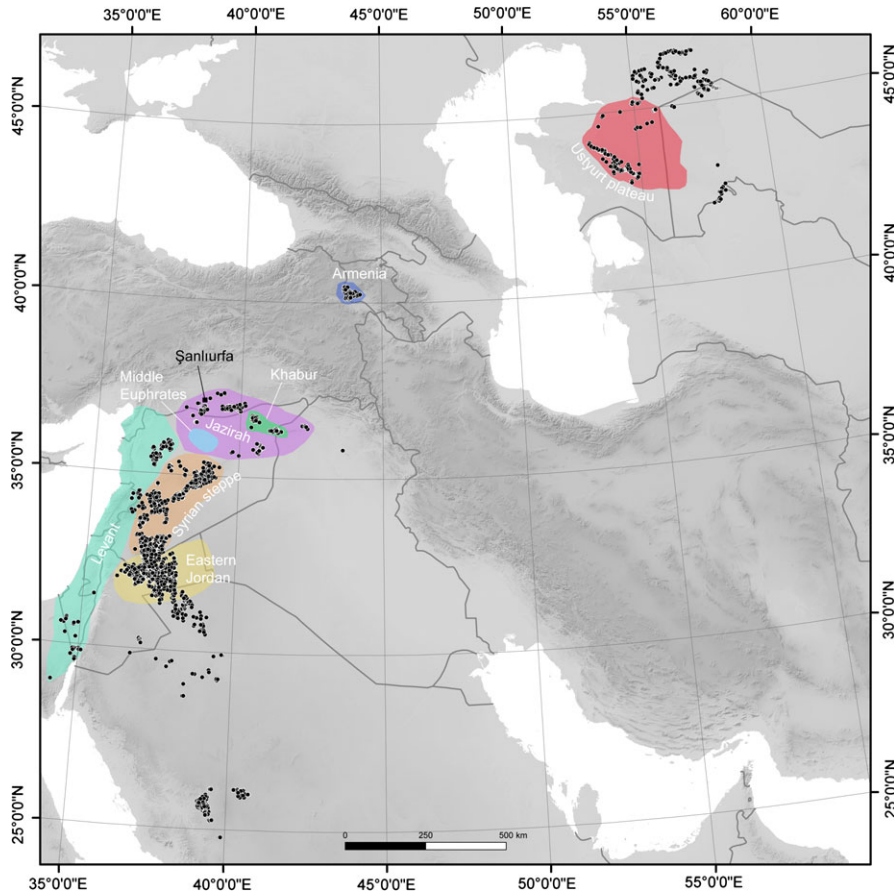


Fig. 1.

Regions mentioned in the text, where the zooarchaeological approach has been applied within the distribution area of kites (dots are individual kites, total= approx. 4500).

(Khirbet es-Shenef: Cavallo 2000; Shams ed-Din: Uerpman 1982; Zeydan: Grossman & Hinman 2013) and more than 20% of NISP from late Chalcolithic and Late Bronze Age sites in the Syrian steppe and the Jazirah region (El Kowm: Vila 1998; Mashnaqa: Vila 2006; Sabi Abyad: Cavallo 2002; and Tell Chuera [unpublished]). By contrast, *Cervidae* are most frequent during the Levantine Bronze Age (especially at coastal sites with up to 10% of NISP; Chahoud 2013).

Three sites were directly discussed in relation to kite hunting methods (Fig. 1): Abu Hureyra (Middle Euphrates, late Natufian: Legge & Rowley Conwy 1987, 2000), Dhuweila (eastern Jordan, late PPNB: Betts 1998, 2014; Martin 1998; Zeder *et al.* 2013; Zeder & Bar-Oz 2014) and Tell Kuran (Khabur River, fourth millennium BC: Bar-Oz, Zeder & Hole 2011; Zeder *et al.* 2013). These sites located in kite zones revealed high frequencies of gazelle, butchery and seasonal data, as well as yielding

lithic tools and rock art, the latter depicting gazelles in the sites' surroundings.

All these available comparison data of wild ungulate remains reveal the complexity of analysing hunting techniques, in this case with kites, focusing only on one site subsistence economy (e.g. Legge & Rowley Conwy 1987) or one region (e.g. Bar-Oz, Zeder & Hole 2011; Zeder *et al.* 2013) without considering the larger scale of animal exploitation, lack of kites dating results, diverse typology of kites and the wide areas of distribution of these structures across Arabia, the Near East and central Asia.

2.3. Occurrence and animal mobility

Hypotheses on the species proposed as targets of kites usually originate from the observation of ethnographic encounters, rock-art engravings, geographic occurrence and possible migration routes in an area of kites, especially in Syria, the southern Levant, Jordan and southern

Arabia. Available data on animal migration routes is scarce in the Middle East and Caucasus (Vereshchagin 1967; Harrison 1968; Martin 2000). Most known evidence for the long migration of large herds comes from Central Asia, Europe, America and Africa (Edwards & Ritcey 1959; Harrison 1968; Frison 1987, 2004; Benedict 1996; Bratlund 1996; Martin 2000; Mallon & Kingswood 2001; Fox & Dorji 2009; Singh *et al.* 2012; Middleton *et al.* 2013). Migration should be distinguished from other types of animal movements. It represents a shift in the habitat range of large herds with a large geographic scale, and depends mostly on mating seasons, climatic conditions and food and water availability. It occurs regularly or seasonally in a span of a year with onward and return journeys. Other population movements, however, are unpredictable mobility not necessarily correlated with seasons, and engage smaller population sizes with smaller spatial scale and short duration such as one-way evasion from a region and seasonal movements (Ricard 1968; Holdo *et al.* 2011; Dingle 2014: 13–24).

The occurrence and mobility of goitered gazelle (*Gazella subgutturosa*) in the Middle East are difficult to assess, due to the lack of ethological data, the overlap of different subspecies of gazelles and the current extinction of goitered gazelle in the steppe regions. An interpretation that potentially long migrations of large herds of goitered gazelles were possibly intercepted by kite users in the Middle East is mainly based on the observation of modern antelope migrations from Central Asia and Africa (Martin 2000). On the basis of kite distribution and ethnographic encounters of the seventeenth and eighteenth centuries AD (Musil 1928; Mendelssohn 1974), goitered gazelle migrations in the Near East were suggested by Legge and Rowley Conwy (1987) from northern Syria to the southern Levant. Meanwhile, seasonal movements were established following biological observations on *Gazella gazella* and *Gazella dorcas* in the southern Levant (Mendelssohn 1974). Recently, new research on *Gazella subgutturosa* from Şanlıurfa, south-eastern Turkey, provided reliable observations on modern goitered gazelle and revealed the species' seasonal movement, which was based on available water and food resources (Fig. 1; Durmuş 2010). The assessment of culling profiles and zooarchaeological investigations on goitered gazelle from northern Syrian Neolithic sites such as Mureybet, Jerf al-Ahmar, Dja'de (Middle Euphrates), El-Kowm and Qdeir (northern Syrian steppe) revealed the capture of gazelles during the winter and spring seasons at these settlements (Gourichon & Helmer 2008; Vila 1991) (Fig. 1). Other assemblages from

the Middle Euphrates (late Natufian and Neolithic Abu Hureyra: Legge & Rowley-Conwy 2000) suggest hunting activity during the winter, in south-eastern Turkey (PPNA Göbekli Tepe: Lang *et al.* 2013) between midsummer until autumn, and during spring at PPNB Dhuweila in eastern Jordan (Martin 1998). The question, therefore, of long-distance migrations implicating the absence of these species in northern Syria during winter contradicts the presence of gazelle year-round in the Jazirah region and the Syrian steppe (Gourichon & Helmer 2008; Vila 1991). Furthermore, according to Martin (2000: 28) the suggestion of long north–south migration in the Levant is rather incompatible with ethological studies of gazelle from Central Asia.

Meanwhile, in Central Asia recent ethological studies of modern goitered gazelles and *Saiga* antelope from Kazakhstan have revealed short seasonal movement from north to south on the Ustyurt plateau (Fig. 1; Bannikov 1958; Pfeffer 1964; Bekenov, Grachevand & Milner-Gulland 1998; Chilton 2011; Singh *et al.* 2010, 2012). The mobility of antelopes in this region overlapped with the distribution of kites recorded by other scholars (Yagodin 1998; Betts & Yagodin 2000; Barge *et al.* 2013).

The occurrence and mobility of animals have widely been the main focus while analysing the function of kites. But as stated above, accurate habitat ranges of wild ungulates and details on their migration pattern are merely lacking and most of the time confusing. Holzer *et al.* (2010) in that sense presented a synthesis of wild ungulates behaviour in the region of dispersal of kites. Therefore, clear evidence and concepts (e.g. distinction between long migrations, seasonal mobility and evidence of animal ethology) must be laid down and agreed among scholars before discussing the function of kites.

3. Suggestions for a research method

In order better to understand a kite's function, one needs to gather evidence from zooarchaeological or other archaeological records. If we assume kites were used for hunting purposes, one can therefore consider that wild game was hunted and consumed or raw materials from these animals were used. In addition to the fact that no animal remains have been found so far within a kite structure, ethnographic encounters (e.g. Aharoni 1946: 33 cited in Mendelssohn 1974; Burckhardt 1831: 220–222) describe prey carcasses transported from the capture zone to settlements and processing areas. Subsequently bone remains, as evidence of wild fauna use, ought to be found in processing

and/or consumption sites. Studies on the animal economy and the exploitation of fauna are thus mandatory in order to reconstruct probable function(s) of kites (Crassard *et al.* 2014).

The zooarchaeological approach to the Globalkites project consists of combining four major analyses (Fig. 1): subsistence and hunting strategies, animal/human mobility, habitat range of wild ungulates and animal behaviour. This approach is applied on the whole region of kites with special emphasis on kites' concentration areas such as the Jazirah region, the Syrian steppe, the Levant, eastern Jordan, Armenia and the Ustyurt plateau in Kazakhstan (Fig. 1).

First, reconstructing subsistence and hunting strategies from kite distribution areas is based on animal remains identified from archaeological sites in the wide region of kites (Fig. 1). It consists of analysing the recorded species from faunal remains by region in kite distribution areas, according to archaeological periods (from the Neolithic to the Iron Age). Animal remains then enable the reconstruction of patterns of meat consumption, the food economy and use of animal products and bones (faunal spectrum, cull pattern, skeletal part frequencies, sex groups of killed animals).

Second, reconstruction of animal/human mobility is based on zooarchaeological data (faunal spectrum, seasonality analysis, skeletal part frequencies, settlement types: permanent, seasonal, processing camp, consumption site). For example, Tell Kuran fauna (fourth millennium BC) reveals an assemblage of gazelle bones made up mainly from feet elements. These selective remains reflect discarded parts resulting from a butchery process (Bar-Oz, Zeder & Hole 2011; Zeder *et al.* 2013).

Third, the establishment of current, historical and pre-historic occurrence and habitat range of targeted preys—especially ungulates—is based on modern animal observation, museum collection and zooarchaeological data. This method was revealed to be a productive way of understanding the distribution of wildlife (e.g. Harrison 1968; Vereshchagin 1967; Uerpmann 1987).

Fourth, the correlation between ungulate behaviour (habitat preference, density and defence mechanisms), hunting techniques and capture zones is essential in order to test the hypotheses of kites' function and suggest links to a cultural timeline.

All these four analyses are integrated in a spatial database (Geographic Information System, GIS; see Barge *et al.* 2013; Barge, Brochier & Crassard, this volume) regrouping the mapping of kites' distribution, the distribu-

tion of wild animals from historical records and from the Globalkites zooarchaeological database. In addition, rock-art engravings, texts and ethnographic data from kite distribution areas are recorded to ensure a parallel analogy with the archaeological data.

4. Discussion of the methods' limitations

This approach presents some limitations that should be considered while addressing the use and function of kites.

4.1. Zooarchaeological analyses (Fig. 2)

To begin with, the weakness and problems in recording and interpreting zooarchaeological assemblages are mainly reflected by the lack of sites with discarded prey bones that can be linked to kites. In addition, comparative zooarchaeological studies are subject to variations in material, nature of deposit, number of sites per period, availability of archaeological sites, conservation of animal remains and disparities of zooarchaeological methods. On the latter point, data relevant to animal mobility, mortality profiles and identification of domestic or wild species are not available from all publications and, where accessible, are not necessarily standardised. In the case of gazelle exploitation in the Near East, for example, three species

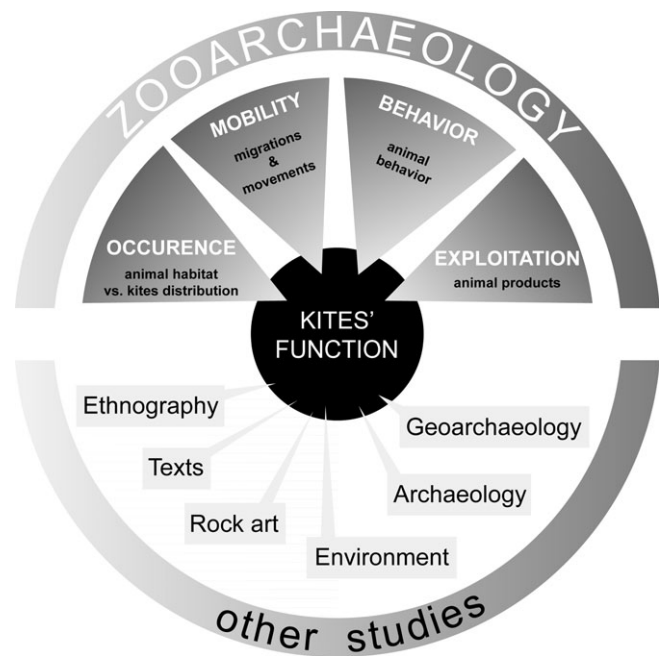


Fig. 2. Model of the zooarchaeological approach in testing the function of kites.

overlap in the region and the distinction of bones is therefore difficult to assess, especially in the Levant and in the marginal fringes between the Levant and Jazirah and eastern Jordan, where gazelle remains from archaeological sites could be attributed to the family (*Gazella* spp.) and not to the species (*Gazella gazella*, *Gazella subgutturosa*, *Gazella dorcas*). Thus, the assessment of the goitered gazelle's presence on a settlement is problematic. Another example of unclear identification is the distinction between wild and domestic equid, and between horses, onagers, asses/donkeys and their hybrids. Zooarchaeological data from a wide area, including the Middle East and Central Asia, should therefore be interpreted with caution, without pre-selection and based on raw data to enable statistical validation of comparison. Even in global studies such as the one proposed here, single cases and local characteristics should be noted.

Additional problems concern the capture zones. If one considers that kites were used for hunting, according to ethnographic chronicles this suggests hunting strategies focusing on special prey(s) and large quantities of wild fauna. Where was all of the large quantity of prey used, consumed or discarded? To what extent were the prey used by local communities, and to what extent traded around several cities or villages across boundaries? One should note the widespread distribution of kites and therefore the probable wide area of the kite 'economy' and catchment; the extent of products of the hunt has hence proved difficult to assess. In theory, wild animal remains on settlement sites are a good indicator of hunting strategies. Nevertheless, defining capture zones of wild game and their links to consumption or processing sites or to a special hunting technique is so far not possible when based solely on animal bones. Tell Kuran and Duweihla assemblages are good illustrations of this problem. In contrast, isotopic analyses applied to archaeological bones is a potentially useful technique to identify the geographic origin of hunting activities and to determine whether wild animals originated from one or multiple capture zones (Fenner 2008). Similar techniques were used to reconstruct gazelle capture zones at Palaeolithic southern Levantine sites (Rowland 2006), at the Neolithic site of Göbekli Tepe in southern Turkey (Lang *et al.* 2013) and for Neolithic sites from Jordan (Makarewicz & Tuross 2012).

Another limitation comes from the problem of the identification of targeted prey. How can one identify specialised faunal assemblages with targeted selective species? The frequency of NISP and/or minimum number of

individuals (MNI) is the main criterion (Costamagno 2004: 362–363). The NISP of the targeted prey must be very high, for example exceeding 50% of the total fauna (Lubinski 2013: 169). The frequency used to compare wild ungulates should be based on the percentage of the animal from the total NISP of all ungulates. The MNI should also be considered to supplement the NISP, in order to evaluate the importance of the prey in the economy. In addition, the counting of animal remains requires detailed identification to species level, as well as understanding the deposit's origin and site formation: do we see one single deposit from one single event, or repeated hunting activities that cause the accumulation of animal bones? In general, the species suitable for trapping by kites are mainly gregarious ungulates that live in herds, tend to run in the same direction when threatened, follow regular trails and have a valuable meat or raw material benefit for man. The selection of animals to trap or hunt requires a good knowledge of their ecological ethology, habitat range and anti-predator behaviour (Bignon 2006). To what extent is the specialisation on one targeted species and/or on multiple species based on the availability of these species in the landscape, their ethology and effort/energy/outcome strategies? For instance, could targeted gazelle hunting relate to a community's hunting preferences or only to the occurrence of the species in the surroundings? Accounting for this aspect of animal exploitation could help to test several hypotheses of animal procurement.

On the one hand, methods used to define mortality patterns should be clearly stated and consistently applied to each faunal assemblage; on the other hand, the cull pattern for a particular species is difficult to assess without considering the ethology of species in the local environment and during a particular season, the deposit formation and human mobility and behaviour. Thus, animal bone assemblages could reflect different hunting strategies and different herd formations according to seasons.

Finally, defining how to identify a mass-kill event from faunal assemblage is essential before using this criterion as evidence to reconstruct the function of kites. Several travellers' accounts describe the mass capture of gazelle using kites (Burckhardt 1831; Musil 1928; Mendelssohn 1974), but no accumulation of bones belonging to prey was attested from kite structures. By contrast, some faunal assemblages from settlement sites were interpreted as the result of mass killings from the Euphrates and southern Levant (Kuran site, Late Chalcolithic: Zeder *et al.* 2013; Abu Hureyra site, late Natufian: Legge & Rowley-Conwy 1987; Salibiya site, late Natufian: Campana & Crabtree

1990). The term ‘mass procurement’ is used to avoid interpreting the act of slaughter and to refer to the capture activities of large quantities of prey in a single event, regardless of the number of hunters involved. Several criteria should be made clear in order to define mass procurement assemblages, according to American Palaeolithic hunting strategies as exposed by Lubinski (2013). The line of investigation for a targeted single species mass procurement consists of a combination of evidence from a single deposit (contemporaneous chronology of sites and capture zones, bones found in one stratum with rapid accumulation), human-caused mortality (artefacts of hunt, carcass processing, butchery marks) and a single mortality event (single season, low variability of tooth wear, similar values of stable isotopes in bone composition, sex distribution according to season, age distribution correlated to herds groups) (Lubinski 2013). Even though bone remains are lacking from capture zones, these latter criteria are predictably valid for a hunting strategy using kites when assuming that kites were used in a specific season of the year and not continuously. The literature is full of discussion analysing mass-kill hunting sites, of which we can draw a parallel model for the kites’ function. There are several prehistoric sites in Europe, Russia and America, which possibly indicate mass-kill events and where there is evidence that animals were driven off or trapped and butchered at processing sites. Evidence of hunting techniques is identified by the animal remains found on sites (‘bone beds’) and through processing specialised areas associated with the capture zones such as ‘bison jumps’ (Frison 1987, 2004; Scott 1980; Bratlund 1996; O’Connor 2000; Hockett & Murphy 2009; Popov & Holliday 2010; Driver & Maxwell 2013).

4.2. *Ethological analyses*

Another means of analysing the hypothesis that these animals were being trapped is the study of ethology. When interpreting animal ethology in archaeology, one is nevertheless confronted by several misleading notions. Since behaviour patterns are highly species-specific, identifying species and subspecies is essential in understanding their behaviour. Indeed, the salient characteristics of one species cannot be applied to others. Unfortunately, taxonomic identification from zooarchaeological remains is often complex. Animal ethology is to be considered for the broader reconstruction of animal behaviour without targeting one facet and ignoring others. In the frame of the Globalkites zooarchaeological project, species occurrence, mobility, sex groups and behaviours are analysed based on

the concept of behavioural ecology, with consideration of past landscapes, a species’ adaptation and interaction with its environment and with other species, as discussed by Martin (2000: 14).

4.3. *Iconographical and ethnographical analyses*

Applying parallel interpretative models from ethnographical and rock-art data is something common in kite studies. While analysing kites, ethnographic chronicles are often confused with scientific evidence. The ethnographic approach is to be considered for its added value and insight into past traditions, and not as a scientifically proven fact conducive to archaeological interpretation. It should be taken with caution when proposing analogy, in the sense that ethnographic accounts are often incomplete and subjective data (Binford 1968: 268–273; Freeman 1968: 265). In addition, rock art and engravings are often the subject of debate on their chronology, their clear relation to a site or culture and the interpretation of the depicted act, and there is contention on the identification of decrypted animals.

Once the problems are considered in the three analyses described above, kites research should then be more accurate and probably more promising. Despite the limitations mentioned above, the zooarchaeological approach aims to establish patterns of faunal exploitation in the global area of kite distribution (Fig. 1). These analyses, combined with kite location, landscape features and current archaeological investigations, enable the testing of several function scenarios and consequently establishing several lines of evidence to validate what is feasible or not with kites, and eventually allow the proposal of theories regarding its function, the species hunted and exploited, the possible links between kites, processing sites and settlement sites and probably the users of kites and a timeline culture. In order to validate the (hunting and/or trapping) use of kite structures, a combination of criteria should be recorded:

- the architecture of a kite structure, and whether it is suitable for trapping animals;

- the occurrence of targeted species in the distribution areas of kites and during their time in function;

- evidence for hunting activities and remainders of animal exploitation by the inhabitants around areas of kites (if we believe that hunting activities were carried out locally and animals were exploited in the immediate vicinity).

5. Conclusion: to what extent can zooarchaeology help in understanding the function of kites?

The function of kites should not be discussed with preconceptions. In order to interpret animal remains and discuss kite function, several factors should be taken into account. The users of kites, the process of the act and the consumers of the products of kites are points to take into consideration while interpreting animal remains. All aspects should be investigated, from hunting activities to gathering animals, from single activity to continuous practice, from targeted species to multiple prey, from family-level to community-level use, from single-season use to multiple functions throughout the past. Despite the fact that the zooarchaeological record does not provide all the answers, it is likely to enable the establishment of a sufficient set of data, the testing of variable hypotheses and the examination of all patterns that might help shed some light on kite function.

The zooarchaeological approach applied to investigating kites aims to propose guidelines for ongoing research, in order to understand the function of kites and their links with the sociocultural and economic contexts of different regions in which they were built. Reflecting on the construction and the use of desert kites, on their economic value and thinking of the actors of the society involved (i.e. villagers, hunters, pastoralists, farmers) is of great importance in order to grasp the complex development of societies at the beginning of the Holocene. These could

provide insights on the ecological impact of a regional concentration of large game traps, and help explain the wide distribution of kites. Are kites then the result of adaptive phenomena that share special geographical, climatic and zoological constraints imposed by the natural environment, or are they evidence of the impact of diffusion techniques and exchange in savoir-faire, perhaps transmitted by mobile nomadic or pastoralist populations?

Mapping the distribution of wild ungulates in historic and prehistoric times combined with animal economy and kites typology and distribution is a very promising approach especially when applied simultaneously and systematically to different regions of concentration of kites in the Middle East and Central Asia. Furthermore, the correlation between this zooarchaeological approach and the multi-proxy approach of the Globalkites project (e.g. geomatics, archaeological excavation, geoarchaeology, etc.) should provide a new set of verified data that could help to develop new theories and encourage further discussion on kites.

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