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Stratified Pleistocene vertebrates with a new record of a jaguar-sized pantherine (*Panthera* cf. *gombaszogensis*) from northern Saudi Arabia

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ABSTRACT

The reconstruction of Pleistocene faunas and environments of the Arabian Peninsula is critical to understanding faunal exchange and dispersal between Africa and Eurasia. However, the documented Quaternary vertebrate record of the Peninsula is currently sparse and poorly understood. Small collections have provided a rare insight into the Pleistocene vertebrate communities of northern Arabia, but the chronostratigraphic context of these collections is not clear. Resolving the taxonomic and chronostratigraphic affinities of this fauna is critical to emerging Quaternary frameworks.

Here, we summarise recent investigations of the fossiliferous locality of Ti's al Ghadah in the southwestern Nefud. Excavations yielded well-preserved fossil bones in a secure stratigraphic context, establishing the potential of this site to make a significant contribution to our understanding of vertebrate diversity and biogeography in the Pleistocene of Arabia. We describe the site and report our preliminary observations of newly-recovered stratified vertebrate remains, at present dated to the Middle Pleistocene, which include oryx (*Oryx* sp.), fox (*Vulpes* sp.), and notably stratified remains of the Elephantidae and a grebe (*Tachybaptus* sp.). Here, we give special attention to post-cranial evidence that confirms the presence of a jaguar-sized pantherine, which we refer to the Eurasian jaguar (*Panthera* cf. *gombaszogensis*). The occurrence of this taxon during the Middle Pleistocene has important implications for existing biostratigraphical and biogeographical models and for palaeoecological reconstructions of the southern Nefud at that time.

1. Introduction

The nature of and changes to the Pleistocene faunal communities and environments of Arabia are key issues for discussions of faunal exchange and hominid dispersal within and between Africa and Eurasia. However, the Quaternary vertebrate record from the Arabian Peninsula is at present poorly understood (O'Regan et al., 2011). In what remains a rare insight into the Pleistocene (2.6 Ma to 0.011 Ma) vertebrate fauna of the Peninsula, Thomas et al. (1998) reported a suite of vertebrate taxa (hereafter, "the Nefud fauna") that were identified from collections of fossil bones from three locations in the southwestern Nefud Desert, Kingdom of Saudi Arabia (Fig. 1; Table 1). These fossils were recovered as both surface finds and from in situ settings within Quaternary lacustrine (lake) sequences preserved in interdunal basins (Witney et al., 1983; Thomas et al., 1998; Rosenberg et al., 2013). During the Quaternary period, the climate of Arabia oscillated between extreme aridity – today, reflected by the expansive, hyper-arid sand seas (ergs) of the Rub' al Khali, An Nefud and Wahiba sands – and pluvial periods that occurred principally, but not exclusively, in interglacial periods (e.g. Parker, 2009). These pluvial periods were ephemeral, a-periodic and variable in duration and intensity and saw the activation of wadi (river) systems and the formation of marsh habitats and lakes (e.g. McClure, 1984; Parker, 2009; Petraglia et al., 2011, 2012; Groucutt and Petraglia, 2012; Breeze et al., 2015; Parton et al., 2015).

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Table 1
The Pleistocene "Nefud fauna" reported by Thomas et al. (1998), with preliminary results from the Palaeodeserts 2013 season at Ti's al Ghadah. X = present; / = no record.

	Locality#1	Locality#2	Layer 005	Locality#3
	Khall Amayshan	Ti's al Ghadah	Ti's al Ghadah (Palaeodeserts)	na
Taxa				
Actinopterygii				
Osteoglossiformes	/	X	/	/
Reptilia				
Testudines, Testudinidae				
Geochelone cf. *sulcata*	/	X	/	/
Squamata	/	/	X	/
Aves				
Podicipediformes, Podicipedidae				
Tachybaptus sp.	/	/	X	/
Mammalia				
Perissodactyla, Equidae				
Equus sp.	X	X	/	/
Proboscidea, Elephantidae				
cf. *Elephas (Palaeoloxodon) recki*	/	/	/	X
cf. *Palaeoloxodon* sp.	/	/	X	/
Artiodactyla, Hippopotamidae				
Hexaprotodon sp.?	X	/	/	/
Bovidae				
Pelorovis cf. *oldowayensis*	X	/	/	X
Oryx sp.	/	X	X	/
Alcelaphinae: gen. et sp. indet.	X	X	/	/
Camelidae				
gen. et sp. indet.	/	X	/	/
Carnivora, Felidae				
Panthera cf. *gombaszogensis*	/	X	X	/
Canidae				
Vulpes (cf. *vulpes*)	/	X	X	/
Hyaenidae				
Crocuta crocuta	/	/	/	X

The fossil collection reported by Thomas et al. (1998) provides an insight into the faunal communities of these Pleistocene landscapes and indicate the regional presence of large and very large mammals (Hippopotamidae: cf. *Hexaprotodon* sp?; Elephantidae: cf. *Palaeoloxodon*/*Elephas* sp.) a large extinct bovid, (*Pelorovis* cf. *oldowayensis*), a robust equid (*Equus* sp.), carnivores including fox (*Vulpes* sp.) and spotted hyena (*Crocuta crocuta*), an extinct camelid, and bovids including *Oryx* sp. On the basis of taxonomic composition and "stage of evolution" (Thomas et al., 1998, p. 150), an Early Pleistocene-age (2.6 Ma – 0.768 Ma) and an Ethiopian biogeographical affinity were proposed for this fauna (Table 1).

The sample reported by Thomas and colleagues included a left metacarpal III (JMI 27) from a large pantherine from "locality 2", a site known as Ti's al Ghadah, which yielded the most taxonomically diverse assemblage (Fig. 1B; Table 1). The fossils from this site were reported to be associated with a green to khaki clayey siltstone deposit that were overlain by a sequence of lacustrine white paper marls (Thomas et al., 1998). In addition to the felid bone, the identified specimens included a maxilla of a large Osteoglossiforme fish (possibly over a metre in length) and fragments of a large tortoise similar to the extant African spurred tortoise, *Geochelone sulcata*. The mammalian fauna is characterised by a relative abundance of the remains of bovids attributable to *Oryx* sp.; dental morphology was reported to be similar to desert-adapted *O. dammah* and *Oryx leucoryx*, but cranial morphology suggest that horn-core divergence in the Nefud specimens were distinct from these extant species. A metatarsal from a fox (*Vulpes* sp.) was the only other Carnivore represented in the assemblage. Indeterminate genera of camelid and archaic bovids were also noted, with a small number of molars attributable to alcelaphines. Specimens attributable to a relatively robust *Equus* sp. were described to be similar to equid fossils recovered from Early Pleistocene deposits from Olduvai (Upper Bed II) and the Middle Pleistocene of Garba III (Table 1).

In a brief description, the large felid metacarpal is reported, "to correspond in size and proportions" (Thomas et al., 1998, p. 147) with a left metacarpal IV (UB167) from the Early Pleistocene at 'Ubeidiya (1.4 Ma – 1.0 Ma) attributed to extinct felid *Panthera gombaszogensis* (Kretzoi, 1938; our spelling of "*gombaszogensis*" follows Wagner, 2011); the Eurasian jaguar (Ballésio, 1986; Martínez-Navarro et al., 2009). This extinct pantherine is known from fragmentary fossils from Early to Middle Pleistocene (2.0 Ma – c. 0.4–0.3 Ma) sites throughout Europe and into Asia (e.g. O'Regan and Turner, 2004; Hemmer et al., 2010; Marciszak, 2014). The Nefud specimen was conferred as *P.* cf. *gombaszogenesis*, although it is generally treated in reviews as an Early Pleistocene record of the taxon from the Arabian Peninsula (e.g. Dennell, 2010; Marciszak, 2014). However, no figures or measurements were published in the original report and the method of taxonomic diagnosis and the identity of this specimen have been queried (O'Regan, 2002, p. 250).

The precise age of the Nefud remains uncertain. Thomas et al. (1998) assigned the fauna to the Early Pleistocene on the basis of tentative comparisons with biostratigraphically significant species known from well-dated contexts in the Levant and east Africa. A recent comprehensive luminescence dating programme of lacustrine deposits and associated strata in the southwestern Nefud (Rosenberg et al., 2013) included two of the fossiliferous localities visited by Thomas et al. (including Ti's al Ghadah – Rosenberg and colleagues' site 17.1). The luminescence study produced a suite of dates that indicated that lake formation within the region took place during Marine Isotope Stages (MIS) 11, 9 and 5. By implication, components of the Nefud fauna may therefore be younger than the Early Pleistocene age proposed by Thomas et al. (1998) and contain elements of Middle and Late Pleistocene provenance: a Middle Pleistocene age is indicated for Ti's al Ghadah.

Resolving this apparent incompatibility of the faunal and radiometric evidence is critical to emerging Quaternary frameworks for Arabia. Collaborative investigations between the Saudi Commission for Tourism and Antiquities (SCTA) and the Palaeodeserts project (University of Oxford, UK) began in 2010. In late 2013, a programme of survey and excavation of fossiliferous localities in the southwestern Nefud was initiated to refine our understanding of the taxonomic and chronostratigraphic affinities of the Pleistocene fauna of this area. This work included the reinvestigation of sites described by Thomas et al. (1998) and here, we summarise our recent investigations at Ti's al Ghadah.

We describe the fossiliferous strata that were identified by excavation and preliminary observations of stratified vertebrate remains that were recovered. We make special reference to further post-cranial evidence of a jaguar-sized pantherine, which we refer to *P.* cf. *gombaszogensis*, and we describe morphological and morphometric data that were employed for taxonomic diagnosis. We consider the available evidence for the chronological context of this specimen and conclude with a discussion of our current understanding of the palaeoecology of the site.

2. Site location and description

Ti's al Gadah is situated in the southwestern Nefud desert, ~95 km SE of Tayma (Fig. 1B), within an interdunal depression. The