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Sites with Holocene dung deposits in the Eastern Desert of Egypt: Visited by herders?

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ABSTRACT

The Tree Shelter and Sodmein Cave are two sites in the Egyptian Eastern Desert with stratified archaeological deposits. In Middle Holocene contexts of both sites, dated to the 7th millennium BP and later, animal dung has been found, in the shape of small concentrations of pellets at the Tree Shelter and of large accumulations at Sodmein Cave. The combination of several lines of evidence, including the size and weight of the excrements, the dimensions of the dung layers from Sodmein and the presence of hearths and artefacts inside them, and the species represented in the bone assemblages from Sodmein and the Tree Shelter, indicates that the dung was mostly deposited by herds of domestic ovicaprines. Sodmein Cave and the Tree Shelter belong to the oldest sites of the African continent where evidence for domestic small livestock has been attested. The importance and size of the herds seems to have been greater than would be suspected from the scant bone remains that were found. The visits to the caves were probably short but repeated over a long time period. Macrobotanical remains recovered from the dung suggest that these visits took place after seasonal winter rains.

1. Introduction

1.1. Sodmein Cave site and the Tree Shelter site

Sodmein Cave site is situated approximately 40 km Northeast of Quseir, in the Egyptian Eastern Desert. It is located along Wadi Sodmein in the Red Sea Mountains (Fig. 1). The cave is a cliff recession in Thebes limestone originating from karstic activity occurring since the early Pleistocene (Moeyersons et al., 1996, 2002). It has a slightly sloping floor of about 41 m wide and 10–20 m deep (Fig. 2). The Tree Shelter is a site a few kilometres north of Sodmein Cave, in a small wadi tributary of the Sodmein Valley (Fig. 1). It is a local cliff foot recession, at the southern side of the wadi bed, of about 6 m deep, 4 m wide at its centre and about 3 m high at the entrance. Sodmein Cave and the Tree Shelter were investigated by the Belgian Middle Egypt Prehistoric Project of Leuven University under the direction of P.M. Vermeersch (Vermeersch et al., 1994, 1996, 2002; Vermeersch, 2008). Climatic conditions at Quseir on the Red Sea Coast are hyperarid, but at inland locations, such as the surroundings of the Sodmein Cave site, winter rains occasionally occur (Moeyersons et al., 1996, 1999). Vegetation is extremely sparse. Some halophytes can be found in the wadi beds and occasionally there is an acacia tree (Moeyersons et al., 1996).

During excavations at the Sodmein Cave site, stratified archaeological levels ranging from the Middle Palaeolithic to the Neolithic were recorded for the first time in the Eastern Desert. According to TL dates obtained from burned chert fragments, the stratigraphical succession goes back farther than 115 ka BP (Mercier et al., 1999). The Neolithic deposits contain chert artefacts, bones and a few sherds. At least 12 hearths were recorded at different depths. The top of the Neolithic deposits has been dated to 6360 ± 90 BP (Lv-2085) (5488–5073 cal BC, see Table 1 for other radiocarbon dates). The other site, Tree Shelter, seems to have been visited by human groups from about 8000 BP onwards. Several habitation levels were recognised, but could not be individualised and have been attributed to five different archaeological horizons (AH1–5). The AH2 and 3 are Neolithic and were deposited between about 6800 and 4900 BP, in Middle Holocene times (see Table 1 for radiocarbon dates). The Neolithic of Sodmein and the Tree Shelter is comparable to the Middle and Late Neolithic from the Egyptian Western Desert (Wendorf et al., 1984). Judging from the discontinuous accumulation of their archaeological

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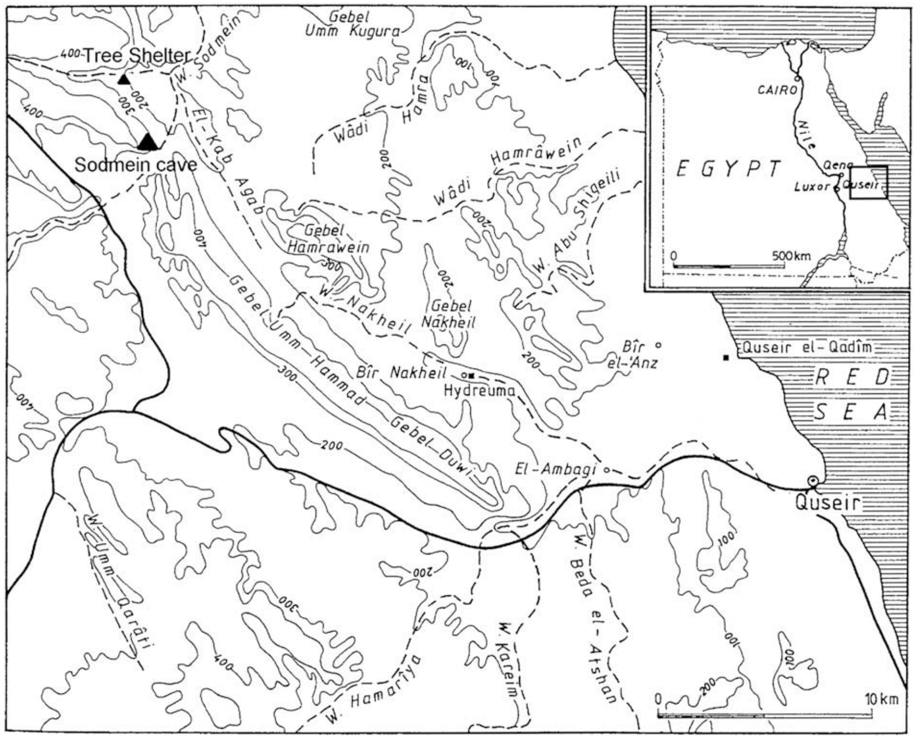

Fig. 1. Map with location Sodmein Cave and the Tree Shelter.

deposits, both Sodmein Cave and the Tree Shelter were probably used repeatedly for short periods during their entire period of occupation.

Organic preservation at Sodmein Cave site is exceptionally good, especially in the uppermost layers where soft tissues, such as skin, meat and tendons, were sometimes preserved on the animal bone remains. Conditions inside the cave seem to have been as good as permanently dry, without much microbial and microfaunal attack (Vermeersch et al., 1994). Preservation at the Tree Shelter, on the

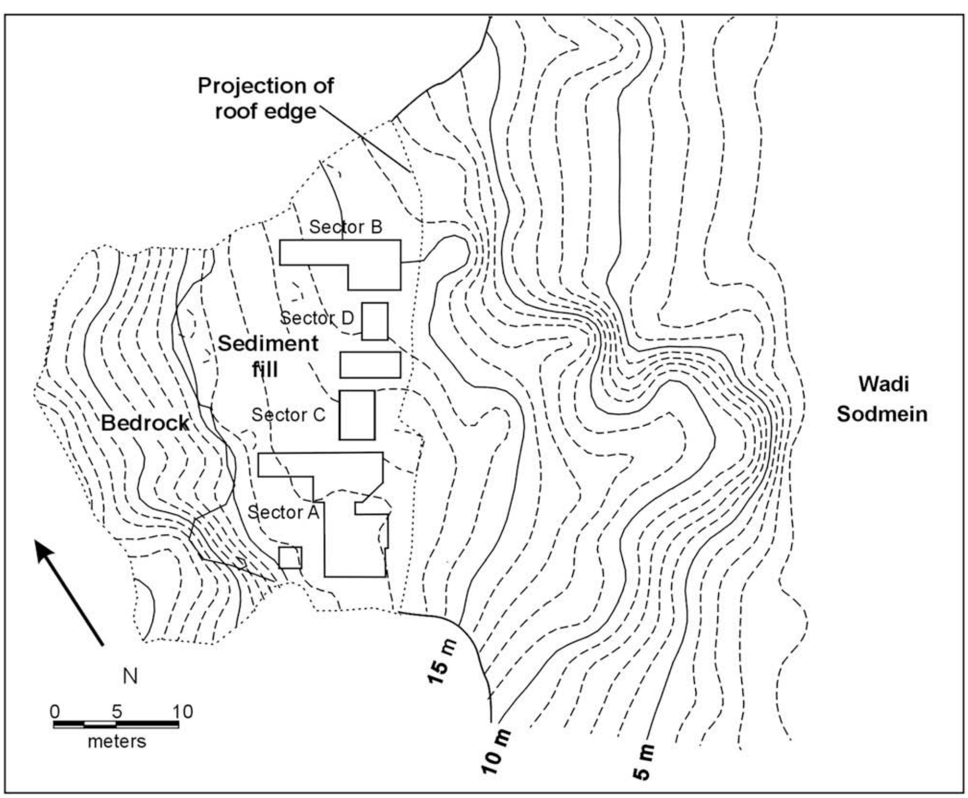

Fig. 2. Topographical map of Sodmein Cave with excavation plan.

Table 1
Radiocarbon dates obtained on charcoal from Neolithic levels at Sodmein and the Tree Shelter.

		^{14}C BP	Lab ref.	calBC (2 sigma)	Reference
Sodmein					
Layer					
1	Conv.	6360 ± 90	Lv-2085	5488–5073	Vermeersch et al. (1994)
Transition 1–2	Conv.	6320 ± 100	Lv-2082	5481–5046	Vermeersch et al. (1994)
3	Conv.	6940 ± 200	Lv-2083	6222–5511	Vermeersch et al. (1994)
Tree Shelter					
Archaeological horizon					
3	Conv.	4930 ± 30	GrN-22561	3772–3651	Vermeersch (2008)
3	Conv.	5330 ± 60	Lv-2185	4328–3999	Vermeersch (2008)
3	AMS	5835 ± 30	UtC-5390	4786–4611	Vermeersch (2008)
3	Conv.	6630 ± 45	GrN-22510	5627–5489	Vermeersch (2008)
3	Conv.	6770 ± 60	GrN-22562	5773–5561	Vermeersch (2008)

Dates calibrated with Ox.Cal 4.0.

other hand, is much poorer. Faunal remains from both the Tree Shelter and Sodmein have been analysed (Linseele and Van Neer, 2008; Vermeersch et al., 1994, 1996, 2002). The total faunal sample from Sodmein includes over 2000 animal bone remains, of which around 200 are Neolithic (Table 2). From the Tree Shelter nearly 900 bones were collected, including 600 from the Neolithic horizons (Table 2). A few remains of domestic ovicaprines – only goat is certainly present – were identified in the Neolithic levels at both sites. They could be distinguished from bones of Barbary sheep (*Ammotragus lervia*) and ibex (*Capra ibex*) using osteomorphological and osteometric criteria described in Gabler (1985), and through comparison with modern reference specimens at the Royal Belgian Institute of Natural Sciences and at the "Staatssammlung für Anthropologie und Paläoanatomie" in Munich (Germany). There are no indications for later intrusions in the Neolithic layers at Sodmein and the Tree Shelter (e.g., see Table 1) and the bones of domestic ovicaprines found inside the layers can thus be assumed to be Neolithic. Dating back to at least the 7th millennium BP, these bones from the Tree Shelter and Sodmein are the earliest evidence for domestic ovicaprines in the Eastern Desert and, indeed, are among the oldest attestations of the animals on the entire African continent. Environmental circumstances at that time would have been more favourable than today, with rainfall more frequent and regular than nowadays (Moeyersons et al., 1999). This allowed a well-developed wadi vegetation with a predominance of *Acacia* and *Salvadora persica* (Marinova, 2008; Marinova et al., 2008).

1.2. Dung deposits

Trenches dug in the largest open space of Sodmein Cave (Sector A) showed that the Neolithic deposits in this part are very rich in organic remains and mainly consist of an important accumulation of animal droppings (Vermeersch et al., 1994) (Fig. 3). The deposits are very loose and individual pellets are usually still recognisable. The animal droppings have probably been concentrated by mass transport into the depression created by the accumulation of the deposits originating from the interior of the cave and rockfall from the cliff above the cave. It is only at the entrance of the cave that the excrements have been compacted, as a consequence of dripping water coming down from the cliff above the cave. Rosen et al. (2005), who worked on material from caves and rock shelters in the Negev Desert distinguish between "dung" and "faeces" on the basis of compaction and agglomeration. They use the term "faeces" for isolated pellets, whereas "dung" is used to indicate packed matrix. In that terminology, only the compacted deposits from Sodmein Cave site would

Table 2
Number of bones identified by animal taxon for the Neolithic levels at Sodmein and the Tree Shelter.

	Sodmein	Tree Shelter
Red Sea gastropods		
Nerita albicilla	–	1
Conus sp.	–	2
Cypraea sp.	1	–
Fish		
Parrotfish (Scaridae)	–	2
Jacks (Carangidae)	–	7
Unidentified fish	–	4
Reptiles		
Small lizard (Agamidae?)	5	2
Small snake	–	1
Birds		
Small bird	1	1
Unidentified bird	1	–
Ostrich eggshell	2	1
Mammals		
Gerbil (*Tatera* sp.)	–	1
Gerbil (*Gerbillus* sp.)	8	–
Small rodent	21 (MNI)	4 (MNI)
Microbats (Microchiroptera)	1	–
Cat (*Felis* sp.)	1	–
Rock dassie (*Procavia capensis*)	8	–
Dorcas gazelle (*Gazella dorcas*)	4	6
Small antelope	2	–
Goat (*Capra aegagrus* f. hircus)	1	2
Sheep (*Ovis ammon* f. aries) or goat (*Capra aegagrus* f. hircus)	11	1
Goat (*Capra aegagrus* f. hircus) or ibex (*Capra ibex*)	2	–
Sheep, goat, Barbary sheep (*Ammotragus lervia*) or ibex (*Capra ibex*)	3	4
Small or medium-sized bovid	22	48
Large bovid	2	–
Identified mammal	87	68
Unidentified mammal	133	522

Data for Sodmein are preliminary since final attributions of finds to archaeological layers still needs to be done. Data for the Tree Shelter from Linseele and Van Neer (2008). MNI, minimal number of individuals.

be labelled as "dung", but in the present paper "dung" refers to all types of deposits of animal droppings. Some pellets were also collected from Middle Palaeolithic levels at Sodmein. Dung was also recorded at the Tree Shelter (Fig. 4), although in much smaller quantities than at Sodmein. A few concentrations were found in the Neolithic archaeological horizons at the site (AH2 and AH3).

It is suspected that the dung from Neolithic levels at both Sodmein Cave site and the Tree Shelter site was deposited by domestic ovicaprines. In this paper we aim to test this hypothesis through several lines of evidence. If the dung was indeed deposited by domestic goat and/or sheep, these findings can shed new light on early African herding (Gautier, 2002).

2. Analyses carried out

During the excavations at Sodmein and the Tree Shelter, several soil samples containing animal droppings were taken. Small amounts of dung pellets could be analysed for all Neolithic levels from Sodmein Cave and larger samples were also available from three superimposed layers in sector A (from top to bottom: layer 1A1, layer 2b–2c, layer 3d). Judging from the radiocarbon dates (Table 1) the upper (1) and the lowermost layer (3) are separated by not more than a few hundred years. Middle Palaeolithic pellets that were collected at Sodmein were included in the analyses as well. These come from several Palaeolithic stratigraphic units, including the so-called J-complex, which yielded the oldest date for the entire site (115 ka BP, Mercier et al., 1999). For the Tree Shelter, samples of

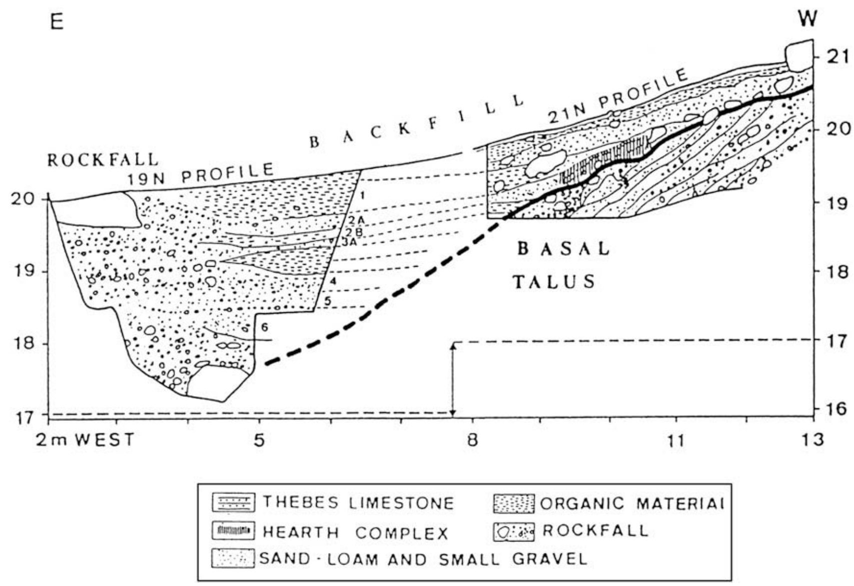

Fig. 3. East–West profile of Sodmein Cave through Sector A (from Moeyersons et al., 1999). "Organic material" consists mainly of animal droppings.

pellets from all six dung concentrations could be studied. In archaeological contexts, dung is often attributed to a certain species without much argumentation, or worse, ignored completely. However, in order to identify the species that produced them, the shape, size and weight of the dung pellets from Sodmein and the Tree Shelter were studied in detail, and the surrounding sediments were examined for arthropods. The botanical content of the pellets from Sodmein and the Tree Shelter was also examined, mainly in order to determine in what parts of the year the animals might have been present at the sites.

2.1. Study of the shape and size of the pellets

Since we are dealing with small, ovoid, pellets, the species responsible for the dung from Sodmein and the Tree Shelter must be either small or medium-sized bovids, or hare (*Lepus capensis*) or dassie (*Procavia capensis*), two other herbivorous species (Liebenberg, 1990, p. 14). Dassie was present in the animal bone remains of the sites but hare was not. Both can be excluded because they produce faecal pellets that are more rounded than those collected from Sodmein Cave and the Tree Shelter site (Walker, 1981). Bovids are more likely candidates. Possible species for the Egyptian Eastern Desert include gazelle, mostly dorcas gazelle (*Gazella dorcas*), Barbary sheep (*Ammotragus lervia*), ibex (*Capra ibex*) (Osborn and Helmy, 1980) and of course domestic goat and sheep. Of these species, only dorcas gazelle and domestic ovicaprines have been positively identified among the Neolithic bone remains from Sodmein Cave and the Tree Shelter Fig. 4.

Recent droppings of the aforementioned bovid species have been collected to study their variation in shape and size. Those of domestic goat and sheep come from herds living in the western Taurus Mountains in Turkey. They were obtained from the rectal channel of animals slaughtered for the study of their skeletons and the microwear on their teeth (Beuls, 2004). Domestic goat excrements were also collected during fieldwork in Wadi Shenshef, in the Eastern Desert in the south of Egypt (Van Neer and Ervynck, 1999). All recent droppings of wild species were obtained in game parks. The excrements are usually from adult animals. Only for goat were droppings of young individuals (4–5 months old) also available (more details on the recent pellets are listed in the legends of Figs. 5 and 8). All specimens were analysed according to a method used by Riemer et al. (in prep.), developed for the study of dung from a cave in the Egyptian Western Desert, and which refers back to the research of Landsberg et al. (1994). The greatest length (GL) and width (GB) of the individual droppings were measured and their weight was recorded. They were moreover classified by shape in four types: (1) pellets pointed at both ends (double-pointed); (2) pointed at one end (single pointed); (3) dimpled (hollow-based); and (4) cylindrical pellets rounded at both ends. The same data were recorded for the archaeological material. Usually at least 30 pellets were studied for each sample, but some of the archaeological samples contained fewer droppings. For the recent Turkish sheep and goat only 10 droppings were studied per sample, because it appeared that they showed less variation since each sample represents one individual.

The data collected on the recent bovid droppings are in agreement with the results of Riemer et al. (in prep.). Droppings of dorcas gazelle are smaller and lighter than those of the other species, except for some minor overlap with very light and small goat or ibex droppings (Figs. 5 and 8). Ibex and Barbary sheep droppings are also well separated by their size and weight (Figs. 5 and 8). The

Fig. 4. Dung sample from the Tree Shelter.

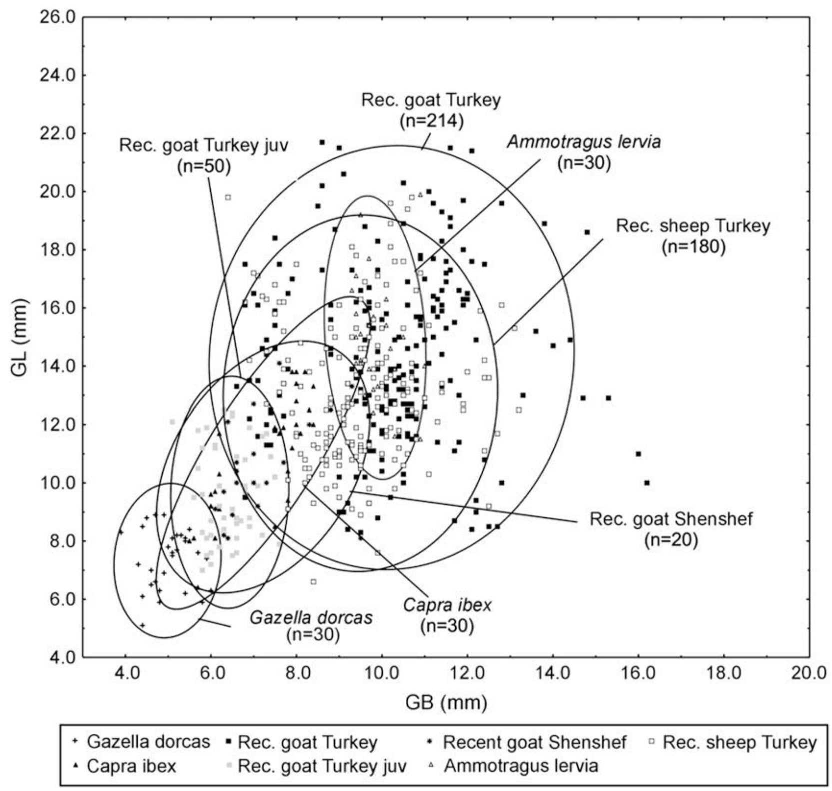

Fig. 5. Greatest length (GL) and width (GB) of recent small bovid droppings (95% confidence ellipses, calculated in Statistica 7). "*Gazella dorcas*" from enclosure in Hurghada (Egypt); "*Capra ibex*" from gamepark in Muizen (Belgium); "Rec. goat Turkey" from 22 adult individuals; "Rec. goat Turkey juv" from five individuals of 4–5 months; "Rec. goat Shenshef" from one larger and one smaller individual in Wadi Shenshef (Eastern Desert, southern Egypt); "*Ammotragus lervia*" from gamepark in the Netherlands; "Rec. sheep Turkey" from 18 adult individuals.

latter are heavier, generally larger and also rounder (wider for comparable lengths). In the study of Riemer et al. (in prep.), the size and weight of domestic goat droppings cluster around ibex, while those of sheep cluster around Barbary sheep. The droppings of domestic ovicaprines they studied were collected from dry environments in Sicily and Egypt. Their results show that, with some overlap, pellets of domestic sheep and goat are separated from each other, but not from those of Barbary sheep and ibex respectively. Our analysis of recent samples from Turkey shows that the variability of sheep, and especially of goat, droppings is larger than indicated by Riemer et al. (in prep.) and that the overlap in size and weight can be complete. The variability in shape and size of droppings of these domestics is probably connected to the variability of environments and diets to which they are exposed. The goat pellets we analysed from Wadi Shenshef in the Egyptian Eastern Desert do compare well with the data in Riemer et al. (in prep.). In the case of domestic species, it is therefore probably better to limit comparisons to specimens from similar environments. The faeces of the young goats we studied are systematically smaller and lighter than those of the older individuals, but are still distinguishable from those of dorcas gazelle. Our classification of the droppings in shape categories did not indicate any differences in dominant shape between the species, contrary to the finds of Riemer et al. (in prep.) and Landsberg et al. (1994). They found that double-pointed and cylindrical pellets mostly occur in goat, while the dimpled shape predominates in sheep.

The three large samples studied from superimposed Neolithic layers at Sodmein have shown that archaeological droppings from the site are smaller and especially lighter the lower down they occur in the stratigraphy (Figs. 6 and 8). Droppings shrink as they dry out and archaeological pellets may therefore be much smaller than fresh ones (Liebenberg, 1990, pp. 14–15). It is unlikely, however, that the older pellets from Sodmein are smaller because they are drier than the younger ones. Once all water has disappeared from them, excrements cannot shrink any further. This must already be the case when only a few years have passed since defecation. The pressure exerted by the deposits lying on top of them probably also did not affect the size of the excrements from Sodmein, at least no obvious indication for this, such as compression of the droppings, was noted. It has therefore been assumed that the differences between the excrements from levels 1A1, 2b–2c and 3d, are not related to taphonomy. Despite possible (minor) differences between recent and archaeological droppings, all specimens from the Tree Shelter compare well in size and weight with ibex droppings and with domestic goat droppings collected in Wadi Shenshef (Figs. 7 and 8). The specimens from the Middle Palaeolithic levels at Sodmein seem to fall in the range of ibex and domestic goat as well. The same is true for the lower Neolithic layer at the site (3d), while the two higher levels (2b–2c and 1A1) also have droppings in the range of domestic sheep and Barbary sheep. Although the occasional presence of gazelle droppings at both the Tree Shelter site and Sodmein Cave site cannot be excluded, it is clear that the bulk is not of this species.

2.2. Arthropod study

Sediment samples from all layers at Sodmein, including two one-litre samples from Neolithic layers, were floated according to methods described in Schelvis (1990) in order to retrieve arthropod remains. The aim of this analysis for the Neolithic levels was to look for possible parasitic mites that would indicate a specific host

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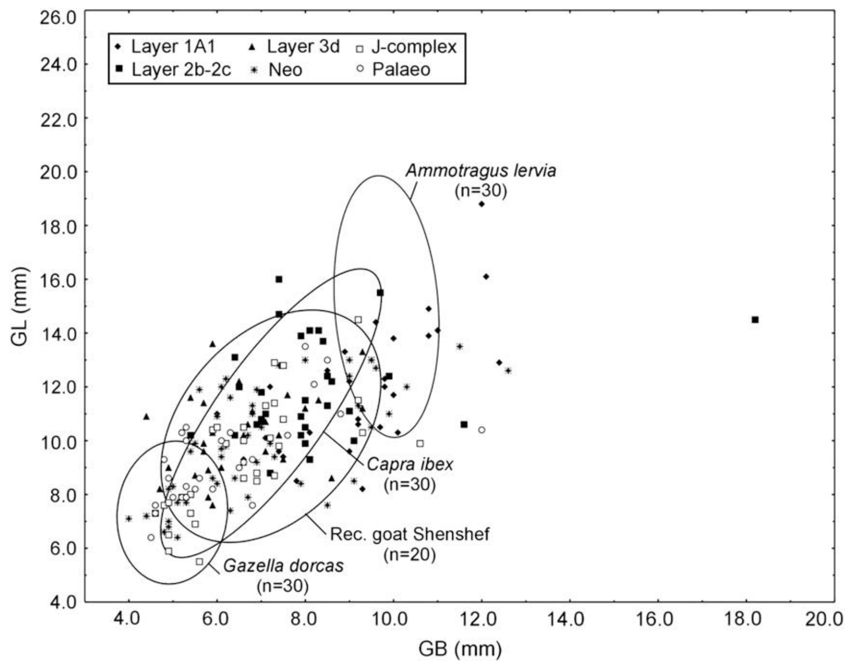

Fig. 6. Greatest length (GL) and width (GB) of droppings from Sodmein Cave Site, with indication of the size ranges of pellets of *Gazella dorcas*, *Capra ibex*, recent goat from Wadi Shenshef and *Ammotragus lervia* (95% confidence ellipses, calculated in Statistica 7). Pellets of domestic goats herded in arid environments cluster around *Capra ibex*, those of domestic sheep from arid areas around *Ammotragus lervia* (Riemer et al., in prep.).

species. Unfortunately, none of the chitinous remains of arthropods found were of mites (Schelvis, 1999).

2.3. Contextual evidence for dung identification

Objective, metrical, characteristics did not permit distinguishing between dung of ibex and goat on the one hand, and of sheep and Barbary sheep on the other. However, there are other, indirect, lines of evidence allowing more precise statements on the species responsible for the dung.

The Neolithic dung layers at Sodmein represent enormous amounts of faeces. There are absolutely no indications, in the form of burnt pellets or dung cakes (a set of pellets that has been worked into large lumps) for example, to assume that the dung was carried there by humans to be used as fuel. There seems to be no other possibility than that the dung layers are the result of defecation

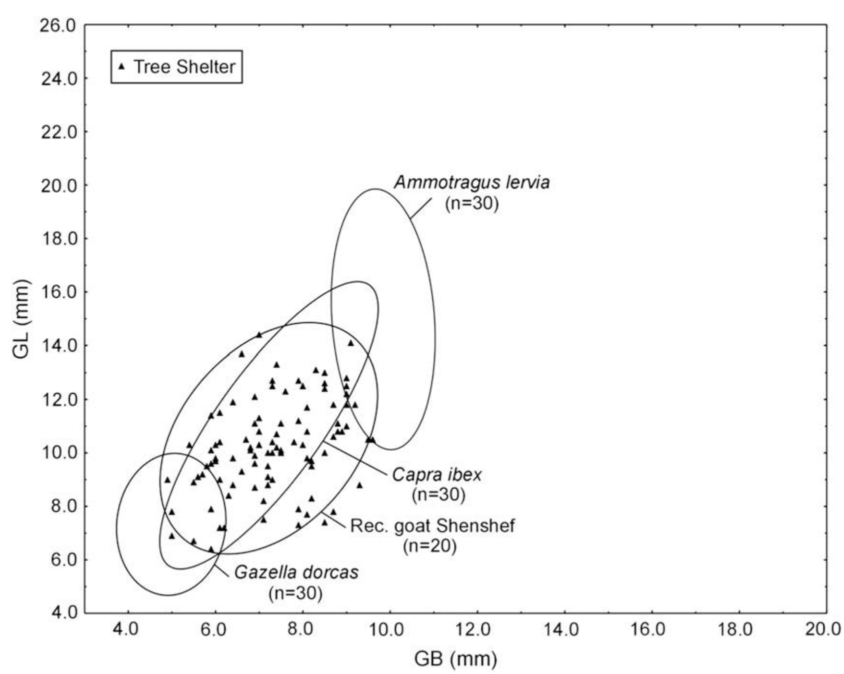

Fig. 7. Greatest length (GL) and width (GB) of droppings from the Tree Shelter, with indication of the size ranges of pellets of *Gazella dorcas*, *Capra ibex*, recent goat from Wadi Shenshef and *Ammotragus lervia* (95% confidence ellipses, calculated in Statistica 7). Pellets of domestic goats herded in arid environments cluster around *Capra ibex*, those of domestic sheep from arid areas around *Ammotragus lervia* (Riemer et al., in prep.).

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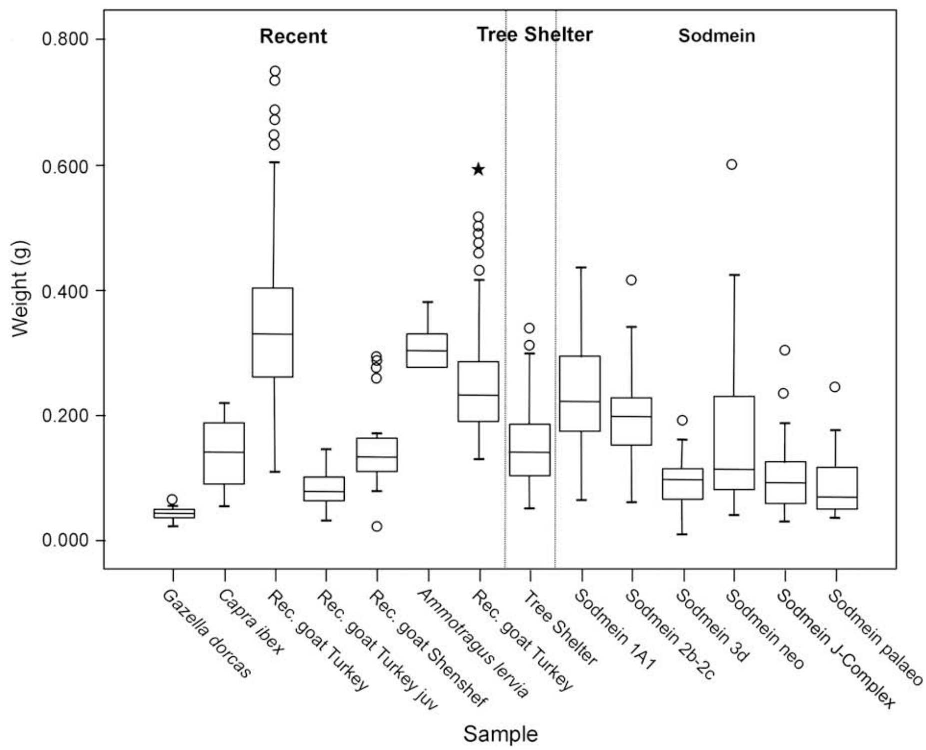

Fig. 8. Weight of recent small bovid droppings and of droppings from Sodmein Cave Site and the Tree Shelter. "*Gazella dorcas*" from enclosure in Hurghada (Egypt); "*Capra ibex*" from gamepark in Muizen (Belgium); "Rec. goat Turkey" from 22 adult individuals; "Rec. goat Turkey juv" from five individuals of 4–5 months; "Rec. goat Shenshef" from one larger and one smaller individual in Wadi Shenshef (Eastern Desert, southern Egypt); "*Ammotragus lervia*" from gamepark in the Netherlands; "Rec. sheep Turkey" from 18 individuals.

events inside the cave. Sheep and goat produce on average about 30–40 droppings at a time (Landsberg et al., 1994), which represents a maximal volume of about 50 cm^3, looking at the modern samples we collected. The thickness of the dung layers at Sodmein Cave varies between a few centimetres and more than half a metre (Fig. 3). Dung was moreover present over the entire excavated surface in sector A, which totals to more than 50 m^2 (Fig. 2). If we take an average thickness of 5 cm for the layers, which is an absolute minimum, then we arrive at a minimal volume of 2,500,000 cm^3 of dung in sector A at Sodmein, which represents at least 50,000 defecation events. No wild bovids are known with defecation habits that naturally would produce such a massive quantity of dung in a rock shelter or cave as at Sodmein Cave. Walther (1979, p. 35) mentions that when small bovids, including gazelles for example, re-use the same spot regularly for defecation this can produce piles of between 0.5–1 m in diameter, while in large species the piles can measure up to 4 m in diameter, which is still far smaller than the accumulations at Sodmein. The amount of dung at Sodmein Cave thus indicates that it was produced by animals driven there by humans. Maybe these should not necessarily be domestic, as suggested by Uan Afuda Cave in the Libyan Acacus where Barbary sheep appear to have been penned about 8000 years ago (di Lernia, 2001). The internal part of Uan Afuda Cave had dung deposits of about 40 cm thick, which appeared as an undifferentiated pile of strongly bioturbated dung. The deposits covered a surface of about 10 m long and 2–4 m wide.

Besides the sheer size of the dung layers at Sodmein, there are further arguments that herds under human control are responsible for the deposits. Archaeological material has been collected from the dung accumulation and at least 12 hearths were found within it at different depths. Since the accumulation shows different layers, the dung was probably deposited in phases. The top of this accumulation has been dated at 6360 $\pm$ 90 BP (Lv-2085) (5488–5073 cal BC). At a lower level, an important artefact concentration extended over a surface of about 4 m^2. There were at least three hearths in situ in this occupation horizon. A ^{14}C date on charcoal from one of the hearths gave a date of 6320 $\pm$ 100 BP (Lv-2082) (5481–5046 cal BC). Judging from the radiocarbon dates, the dung accumulation must have happened rapidly. The high speed of accumulation and the presence of hearths and artefacts inside the dung deposits of Sodmein are both in favour of deposition by herds controlled by humans, following Rosen et al. (2005). The features are associated with penning, but the possibility of the penning of wild animals can still not be ruled out.

As said, the size and weight of the dung pellets collected in the Palaeolithic levels and in the lowest Neolithic layer (3d) at Sodmein fit best with ibex and/or domestic goat. In the higher Neolithic layers (2b–2c and 1A1) there are in addition specimens in the range of sheep and/or Barbary sheep. It is striking that the large dung deposits at Sodmein occur in the site's Neolithic levels only. Judging from the animal bone remains, domestic ovicaprines were present at the site from then onwards. Only goat could be identified, for the other ovicaprine bones the distinction between sheep and goat could not be made. No bones of either ibex or Barbary sheep have been positively identified in the Neolithic levels at Sodmein. The animal bones found in the dung layers thus point to domestic ovicaprines as the dung makers. The same is true for the Tree Shelter, where pellets were only present in its Neolithic levels in which, among the bovid bones, only domestic ovicaprines, and in fact again only goat, could be identified with certainty. Since the Tree Shelter is a very small site, apparently visited by humans on a limited scale only, such large dung deposits as at Sodmein were not formed. The droppings from the Middle Palaeolithic levels at Sodmein were not deposited in massive amounts either. Their size shows most resemblance with ibex and domestic goat, but the latter had not reached the Eastern Desert by that time. Ibex may

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thus well be responsible for the dung in the Middle Palaeolithic levels at Sodmein.

The use of caves for the penning of domestic herds is still evident in the Near East (Rosen et al., 2005) and in parts of Europe (Brochier et al., 1992). Especially overnight, this protects them against the cold or against predators. A picture in Riemer et al. (in prep.) shows an example of a rock shelter on the South Galala Plateau, in the Eastern Desert of Egypt, recently used for the penning of goats. The shelter, with drystone walls to better keep the animals inside, contains a mass of dung. Such walls have not been recorded at Sodmein Cave or the Tree Shelter. Brochier et al. (1992) used the presence of rock polish, produced by hooves or fleece of animals on cave walls and stone blocks, as a criterion to recognise Neolithic pastoral sites in the Western Mediterranean. Thus far, rock polish has not been investigated for Sodmein or for the Tree Shelter.

2.4. Archaeobotanical analyses

Thirty-one pellets from Sodmein were analysed for their archaeobotanical remains. They were taken from the Neolithic layers 1A1, 2b–2c and 3d and from the Middle Palaeolithic J-Complex and layer G. From the Tree Shelter, 15 specimens from AH three were studied. The archaeobotanical study of the pellets consisted mainly of an analysis of the plant macrofossils that are preserved in them. The methodology of Kühn and Hadorn (2004) was followed, with slight modifications. The pellets were gently broken and the preserved structures were observed under light reflecting microscope. Six additional pellets, three from each site, were taken to check them for pollen preservation. They were soaked in distilled water for 24 h and sieved for macrofossils through a 250 μm filter. The filtrate was prepared through a standard procedure for pollen analysis by treatment with KOH, HCl and HF. No pollen was found preserved, and therefore no further palynological samples were prepared for study.

The preservation of plant material is, on average, better in the dung from Sodmein than in that from the Tree Shelter. The pellets from Sodmein contain in general less mineralised material and the organic matter is visibly better conserved. The recognisable plant macrofossils found in the pellets consist mainly of small seeds and wood material. The pellets from the site Tree Shelter show a more homogenous composition compared with those from Sodmein, with a predominance of wood materials in them. This is possibly connected with the greater degradation of the organic matter from this site as mentioned above.

The plant remains identified in the dung from Sodmein and the Tree Shelter are summarised in Table 3 (Fig. 9). Some larger fragments of wood could be attributed to Leguminosae, in two cases to cf. *Acacia*-type. In addition, seeds of *Acacia* were found. Most of the small seeds collected from the dung could be determined as belonging to the Poaceae (including some Panicoideae) and Asteraceae families (including cf. *Pulicaria* sp. and *Artemisia* sp.). A couple of seeds of the salt tolerant *Aizoon canariensis* were also present. In a few cases small leguminous seeds (like cf. *Lotus* sp.) also appeared in the studied material. Other plant remains that could be recognised are leaf epidermis, leaf fragments, charcoals and fragments of seed testa/fruit coat. The leaf epidermis, wood fragments and the seeds of *Acacia* found in the pellets indicate browsing of the tree vegetation by the bovids that produced the dung. Leaves of young trees of *Acacia tortilis* are nowadays eaten by goats and sheep, but the main value of *Acacia* is in its pods, which can be very numerous and are picked up from the ground and eaten by all African livestock. At the time when pods are mature, they are often the main source of food for sheep and goats (Briggs et al., 1999). As the wood charcoal analysis of the Tree Shelter site showed (Marinova, 2008; Marinova et al., 2008), *Salvadora persica* was also used by the prehistoric visitors of the area. Some of the unidentifiable fruit fragments inside the dung could come from this tree. *Salvadora* fruits are sweet and edible. The pulp contains glucose, fructose and sucrose. It is a rich source of calcium containing about 15 times the amount present in wheat (von Maydell, 1986). The leaves of *Salvadora* also make good fodder as their water content is high (15–36%) (von Maydell, 1986).

Table 3
Numbers of plant remains identified in the dung from Sodmein and the Tree Shelter.

Period Site	Neolithic Sodmein			Tree Sh.	Neo./Pal. Sodm.	Palaeolithic Sodmein	
Stratigraphic units	Layer 1A1	Layer 2b–2c	Layer 3d	AH 3	Layer D	Layer G	J-Complex
Number of studied coprolites	12	5	5	15	1	2	5
Seeds/fruits							
cf. *Acacia*	1	–	–	2	–	–	–
Aizoon canariense	1	1	–	–	–	–	3
Asteraceae-type 1	1	4	1	–	–	–	1
Asteraceae-type 2	10	4	–	–	–	–	7
Asteraceae	2	3	–	–	–	–	–
cf. Geraniaceae	8	5	1	1	–	–	–
Fabaceae	2	–	–	–	–	–	–
cf. *Lotus*	–	1	–	–	–	–	1
Panicoideae	3	1	–	–	–	–	2
Poaceae type 1	18	10	5	28	–	–	–
Poaceae type 2	1	2	–	4	–	–	–
Poaceae	15	3	1	5	–	2	–
cf. *Plantago/Veronica*	2	–	–	–	–	–	9
Unidentified “Embryo”	4	2	–	31	–	1	–
Unidentified small seed/fruit	9	5	2	70	–	–	–
Fruit/seed fragment	+	–	+	++	–	–	–
Other plant remains							
cf. *Acacia* wood	–	–	–	2	–	–	–
Fabaceae wood	–	1	–	5	–	–	–
Leaf epidermis fragment	+	+	+	+	–	+	++
Leaf nerve	+	+	–	+	–	–	–
Wood fragment	++	+++	+	+++	+	–	+
Poaceae stem fragment	+++	++	++	++	+++	+++	+++
Charcoal fragment	+	–	–	+	–	–	–

+: less than 10, ++: between 10 and 30, +++: more than 30.

3. Discussion and conclusions

Combining several lines of evidence, it can be concluded that the Holocene dung at both Sodmein Cave and at the Tree Shelter was deposited by domestic ovicaprines. No other archaeological examples for caves where domestic animals were penned have been described for the Egyptian Eastern Desert. Parallels do exist for the Acacus Mountains in the Central Sahara (Cremaschi et al., 1996) where more than ten different shelters and caves were recorded with dung deposits of domestic ovicaprines, dating from 5000 BP onwards. In sites protected from eolian erosion, dung was preserved and covered the entire floor of the cavities, which measured up to hundreds of square metres. The dung from the Tree Shelter and Sodmein belongs, together with bone remains identified from the sites, to the oldest evidence for domestic ovicaprines on the African continent (cf. Gautier, 2002). Their wild ancestors have never lived in Africa. The animals were domesticated in an area encompassing the Northern Levant and the Zagros Mountains (Peters et al., 2005) and propagated from there. By 7000 BP they had apparently reached the Negev Highlands, as was demonstrated through finds of dung in rock shelters in the area (Rosen et al., 2005). The penning of domestics at Sodmein Cave and at the Tree

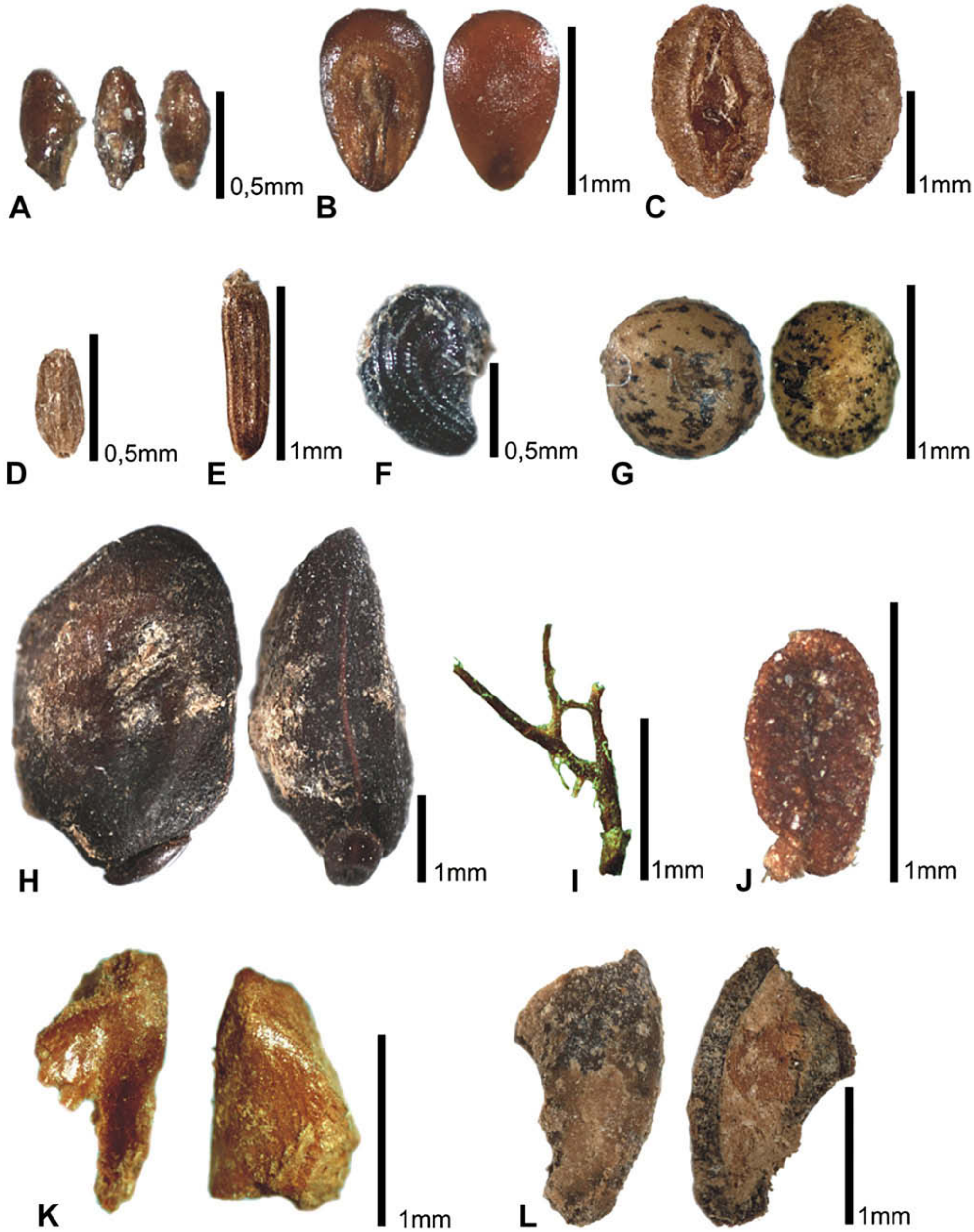

Fig. 9. The most typical plant remains found. (A) Poaceae type 1 (cf. *Eragrostis/Sporolobus*), (B) Poaceae type 2 (cf. *Pennisetum*), (C) cf. *Plantago/Veronica*, (D) Asteraceae type 1 (cf. *Artemisia*), (E) Asteraceae type 2 (cf. *Pulicaria*), (F) *Aizoon* cf. *canariense*, (G) cf. *Lotus* sp., (H) Fabaceae (cf. *Acacia*), (I) leaf nerve fragment, (J) unidentified "Embryo" (cf. *Salicornia*), (K, L) unidentified fruit/seed fragment.

Shelter may well be a continuation of a practice that has its roots there.

At both Sodmein and the Tree Shelter, bones of domestic ovicaprines were very rare. This is in contrast with the vast amounts of dung at Sodmein where the dung was moreover deposited in a short time span. This is shown by radiocarbon dates from different levels in the accumulation, and is probably indicative of short, intermittent, visits to the cave only. The importance and size of the herds of domestics must thus have been considerably larger than would be suspected from the scant animal bone remains found. From the estimates mentioned above, at least 50,000 defecation events, but probably many more, took place in sector A at Sodmein Cave. How large the herds must have been to arrive at such a figure is hard to estimate. Much depends on how long the periods of confinement of the animals in the cave were. Presumably these were rather short, if the animals were only penned seasonally and overnight. The scarcity of bones of domestics at Sodmein and the Tree Shelter can have several possible reasons. The domestic animals may simply not have been consumed at the sites themselves, but elsewhere. Alternatively, domestic stock may not have been an important food resource yet and can have served as a kind of "food reserve on the hoof", as has been proposed by Marshall and Hildebrand (2002) for early stock keepers in Africa in general. This may also have been the case at the sites in the Negev Desert where ovicaprine bones were completely missing (Rosen et al., 2005).

In contrast to contemporary sites in the Western Desert of Egypt (Gautier, 2002), cattle are missing in the Neolithic of Sodmein and the Tree Shelter. Cattle could probably be kept successfully in the Western Desert thanks to geographic features in the area that provided sufficient surface water and pasture, and around which human settlement apparently concentrated (Bolten and Bubenzer, 2007). The absence of such features may have made cattle keeping impossible in the Eastern Desert. While goat was certainly present, more archaeological evidence is needed in order to confirm or reject the absence of sheep in the earliest herds that visited the Eastern Desert. In any case sheep must have been more difficult to keep than goat, which is much better adapted to living in arid areas, with pasture of poor quality (Dahl and Hjort, 1976). If sheep were not kept by the first herders of the Eastern Desert, then the species must have been added to the livestock herds of the area in a later phase. It is part of the livestock in the region nowadays, but cattle were apparently never really kept successfully.

A great number of certain (undigested) seeds or fruits in dung pellets reflects their abundance in the consumed vegetation (Kühn and Hadorn, 2004). Considering this, the macrobotanical evidence from the Tree Shelter and, especially, Sodmein Cave indicates the presence of a well-developed herb vegetation near the sites at the time when they were visited. The small seeds found in the pellets are most likely to have come from the same kind of ephemeral herbal vegetation that nowadays appears in the study area after occasional rains. After such occasional winter rains, which seem in fact have to been more regular during the Middle Holocene (Linstädter and Kröpelin, 2004), the area around the studied sites must have been attractive for nomadic groups as pasture grounds for their herds. Winter rains also fit with a Mediterranean source of humidity that has been proposed for the northern Red Sea area during the Early to Middle Holocene (Arz et al., 2003). Ethnographic observations from the Eastern Desert (Briggs et al., 1999) show that it is very common for groups of Bedouins to exchange information about locations of recent rainfall and ephemeral grazing in the Red Sea Hills, and that such information is of major importance for survival. The use of ephemeral vegetation was probably the main reason for visiting Sodmein Cave and the Tree Shelter.

The Middle Holocene dung deposits and bone remains at Sodmein Cave and the Tree Shelter indicate that herders with flocks of small livestock were present in the Egyptian Eastern Desert by the 7th millennium BP. Herds must have been larger than suggested from the scant bone remains, although it is not possible to give a good estimate of their size. Human groups were mobile, and probably visited the area near the sites to allow their stock to feed on vegetation that grew there after winter rains.

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