



Short Paper

Holocene environment and subsistence patterns near the Tree Shelter, Red Sea Mountains, Egypt

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ABSTRACT

The Tree Shelter site dates to the Early to Mid-Holocene (8000 to 4900 ¹⁴C yr BP). Present conditions around the site are hyperarid, but charcoal remains indicate less severe aridity at the time of its occupation. The environment around the site then supported a rich wadi vegetation, which allowed hunting during the Epipaleolithic and herding during the Neolithic occupation. Although more favorable than today, the environmental conditions also displayed a desert character and seem to have limited the range of domestic herbivores introduced in the area.

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Introduction

During the Early to Mid-Holocene changes of the precipitation patterns, connected with an intensification of monsoon activities, shaped the climate and vegetation of the arid and sub-arid belt of the Sahara, Sahel and Arabian Peninsula (Hoelzmann et al., 2004). They led to the wetter climate of the so called “African Humid Period” (de Menocal et al., 2000), which supported denser and more diverse vegetation during this period. Palaeoecological and anthracological studies from the Sahara west of the Nile and the Nile Valley itself revealed vegetation responses to these patterns and the human impact on the vegetation in the period (Barakat, 2001; Neumann, 1989; Newton, 2005; Newton and Midant-Reynes, 2007; Vermeersch et al., 1992). Such information is still scarce for the Sahara east of the Nile and in general little is known about the Early to Middle Holocene paleoenvironment of the Red Sea Mountains. Valuable clues on the desert environment in the past might be provided by proxy data (e.g., faunal remains, plant macrofossils, phytoliths, etc.) from archaeological cave sites where preservation is better, than in most sediments of desert regions, where due to low primary production, usually oxygen rich conditions and lack of anoxic deposits fossils are not easily preserved (Scott, 2005). The recent analyses carried out on wood charcoal and animal bones, collected at the site Tree Shelter, give a possibility, rare for the region, to get information on the prehistoric environment and its use by humans during their visits there.

Site description and natural environment

At the Tree Shelter site (26°16'33.2" N; 33°57'37.9" E), excavated between 1995 and 1996, several habitation levels were recognized; they could not be individualised and have been attributed to five different archaeological horizons (AH), defined and described by Vermeersch et al. (2008). Their division is based on field data (measured XYZ-coordinates of artifacts) and lithostratigraphic members (Fig. 1). This division, combined with careful sampling allowed minimizing the potential biases, which the bioturbation typical for cave and shelter sites could cause. Available radiocarbon dates are summarized in Table 1. AH 1 is considered as subrecent, AH 2 and AH 3 are comparable to the Late and Middle Neolithic from the Egyptian Western Desert (Wendorf et al., 1984). The lowermost AH5 has been attributed to the Elkabian (Vermeersch, 1978). For all periods, repeated and short occupations of the site are likely (Vermeersch et al., 2008).

The Tree Shelter site is located in a tributary wadi of the Wadi Sodmein in the Gebel Umm Hammad, running parallel to the Egyptian Red Sea coast for a distance of about 30 km and 25 km inland from Quseir (Fig. 1). The climate is hyper-arid. At inland locations like the surroundings of the Tree Shelter site, winter rains occasionally occur (Moeyersons et al., 1996, 1999).

The arboreal vegetation of the wadi is limited nowadays to a lonely *Acacia* tree at its entrance. The modern vegetation in the broad area of the Red Sea coastal land between Wadi Qena and the Nubian desert (lat. 26°–24°N) in the main wadis is dominated by associations of *Acacia raddiana*, *A. tortilis* and *A. ehrenbergiana*. There are also associations of *Salvadora persica* and *Leptadenia pyrotechnica*, and more limited communities of *Balanites aegyptiaca*.

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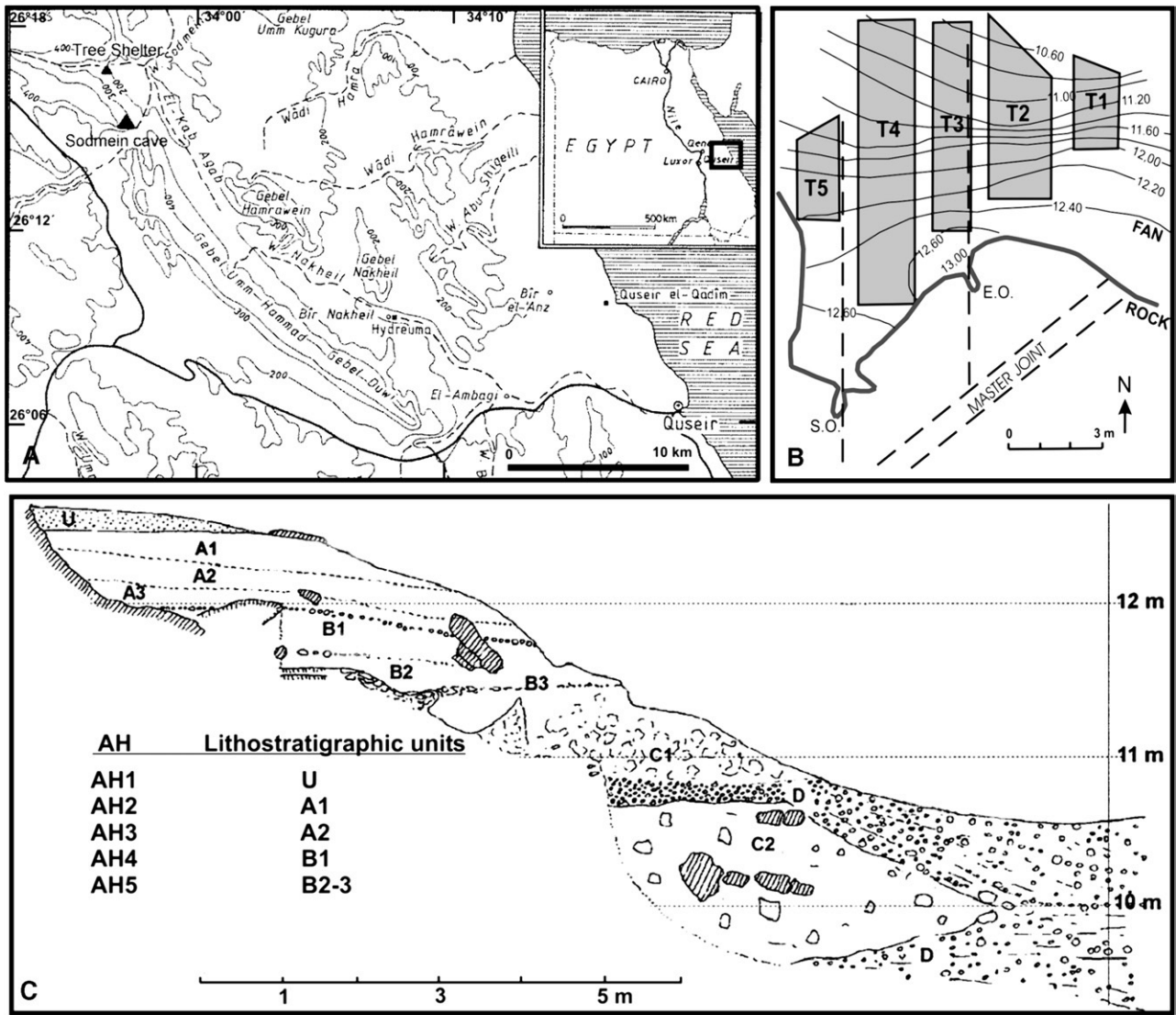


Figure 1. (A) Geographical position of the site; (B) Topographic plan of the shelter with excavation trenches (T), joints – interrupted line, the orifices (S.O. and E.O.) and the delimitation of the shelter roof (thick dark grey line), after Vermeersch et al 2008; (C) Generalised lithostratigraphic sequence of the Tree Shelter deposits, according to Trench 4 (after Vermeersch et al., 2008).

In wadis with higher groundwater *Tamarix* communities occur (Kassas and Girgis, 1970; Zahran and Willis, 1992). Over-exploitation and partial extinction of the tree vegetation in the area was

apparent by the beginning of the 20th century AD, increasing after 79 further cutting of the perennial vegetation in the 1950–60s AD 80 (Hobbs, 1989) and continuing to the present day (Andersen and 81

Table 1
Radiocarbon dates from the Tree Shelter site based on dating of wood charcoal (after Vermeersch et al., 2008); calibration carried out with the program CALIB 5.0.2. (Stuiver and Reimer, 1993); calibration data set according to Reimer et al. (2004)

	Lab nr.	¹⁴ C yr BP	Cal yr BP (2 σ age ranges)	Relative area under distribution	Method	
t1.2	AH 1	GrN-22559	200±35	0.54	Conv.	
t1.3			137–223	0.27		
t1.4	AH 3	GrN-22561	4930±30	1.00	Conv.	
t1.5			5600–5720	0.03		
t1.6			Lv-2185	5330±60	0.88	Conv.
t1.7				5947–5967	0.09	
t1.8				5988–6222	1.00	
t1.9	UtC-5390	5835±30	6230–6277	1.00	AMS	
t1.10			6560–6734	1.00		
t1.11	GrN-22510	6630±45	7438–7575	1.00	Conv.	
t1.12			7510–7543	0.05		
t1.13	GrN-22562	6770±60	7557–7718	0.95	Conv.	
t1.14			7557–7718	1.00		
t1.15			7557–7718	1.00		
t1.16	Beta-229537	7630±50	8369–8540	1.00	AMS	
t1.17	UtC-5388	7790±70	8411–8776	0.99	AMS	
t1.18			8837–8851	0.01		
t1.19	UtC-4193	7910±90	8546–9004	1.00	AMS	
t1.20			8546–9004	1.00		
t1.21	UtC-5389	8120±45	8988–9144	0.90	AMS	

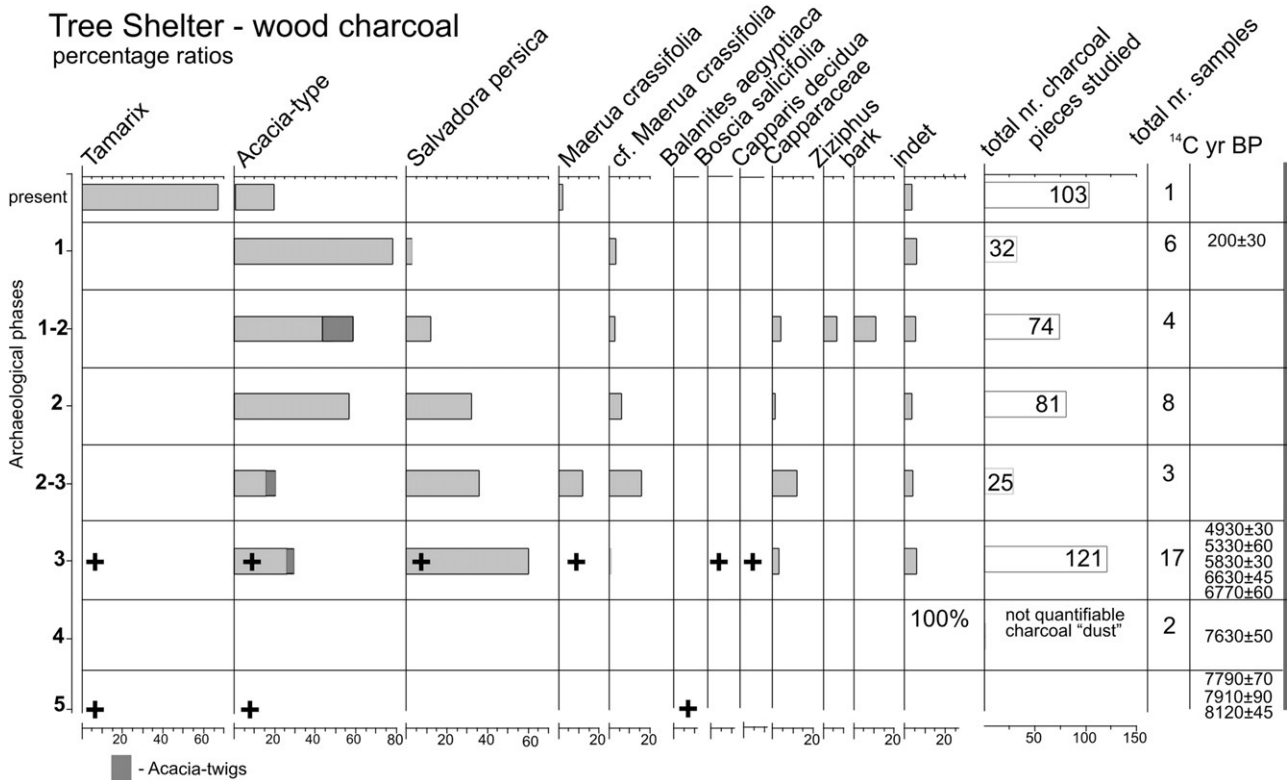


Figure 2. Diagram showing the percentage abundance of the wood charcoals found in each horizon. Results of previous wood charcoal determinations published by Moeyersons et al (1999) are given as presence/absence indicated by "+".

82 Krzywinski, 2007). This has also affected the wildlife population of
 83 the Eastern Desert. The clearance of *Acacia* has, for example, caused a
 84 decline of rock dassie (*Procavia capensis*) populations (Osborn and
 85 Helmy, 1980). Intensive hunting furthermore has much reduced
 86 wildlife in the Eastern Desert, including Barbary sheep (*Ammotragus*
 87 *lervia*) and ibex (*Capra ibex nubiana*) populations, both typical species
 88 of mountainous desert areas (Osborn and Helmy, 1980). Dorcas gazelle
 89 (*Gazella dorcas*), an inhabitant of vegetated wadis, is still widely spread
 90 in the Eastern Desert, although populations of this animal have also
 91 declined under anthropogenic pressure (Osborn and Helmy, 1980).
 92 Domestic stock in the Eastern Desert consists of dromedary (*Camelus*
 93 *thomasi* f. *dromedarius*), goat (*Capra aegagrus* f. *hircus*) and sheep (*Ovis*
 94 *ammon* f. *aries*), and is kept by nomadic groups (Cappers, 2006).

95 **Methods and material**

96 Available for analyses were 54 samples of wood charcoal from
 97 the Tree Shelter, with a total number of 436 charcoal fragments.
 98 The wood charcoal originates mainly from hearths, but also
 99 occasionally from stray finds outside hearths. There is considerable
 100 variation between the different archaeological horizons in the
 101 available number of wood charcoal fragments and samples.
 102 Altogether about 1000 faunal remains, mostly bones, were collected
 103 from AH 5-1. The archaeobiological remains were retrieved by
 104 handpicking and dry sieving of sediment on 2 or 6 mm meshes,
 105 depending on the context. The laboratory study of the wood
 106 charcoals (>2 mm) was carried out with reflected light microscopy
 107 in three anatomical views (transverse, tangential and radial).
 108 Identification literature (Fahn et al., 1986; Schweingruber, 1990;
 109 Neumann et al., 2001) was used in combination with the reference
 110 collection of modern wood housed at the Laboratory of the
 111 Archaeobotany of Africa, University of Frankfurt. The animal
 112 remains were identified mainly through comparisons with recent
 113 skeletons of reference specimens housed at the Royal Belgian

Institute for Natural Sciences. In addition also identification 114
 literature was consulted, mainly for the distinction between the 115
 different possible bovid species (Boessneck et al., 1964; Gabler, 116
 1985; Peters, 1986). 117

118 **Results**

For the studied AH 4-1, the counts of charcoal fragments of each 119
 taxon are presented as percentage ratios of abundance, based on the 120
 total number of charcoal fragments studied in each of them (Fig. 2). In 121

121 **Table 2**
 Animal remains found at the Tree Shelter site (numbers of identified specimens)

	Archaeological horizon					Sum
	1	2	3	4	5	
Red Sea shells	1	-	3	1	5	10
Terrestrial snail (<i>Zootecus insularis</i>)	-	-	-	41	77	118
Large freshwater bivalve	-	-	-	-	1	1
Red Sea fish	3	2	11	-	-	16
Small lizard (Agamidae?)	1	-	2	-	-	3
Small snake	3	-	1	-	-	4
Small bird	-	-	1	-	-	1
Ostrich eggshell	-	1	-	3	30	34
Gerbil (<i>Tatera</i> sp.)	-	-	1	-	-	1
Small rodent	1	-	4	-	-	5
Rock dassie (<i>Procavia capensis</i>)	-	-	-	-	1	1
Dorcas gazelle (<i>Gazella dorcas</i>)	-	3	3	-	-	6
cf. Sheep (cf. <i>Ovis ammon</i> f. <i>aries</i>)	1	-	-	-	-	1
Goat (<i>Capra aegagrus</i> f. <i>hircus</i>)	1	-	2	-	-	3
Sheep (<i>Ovis ammon</i> f. <i>aries</i>) or goat (<i>Capra aegagrus</i> f. <i>hircus</i>)	-	1	-	-	-	1
Sheep, goat, Barbary sheep (<i>Ammotragus lervia</i>) or ibex (<i>Capra ibex</i>)	-	3	1	1	1	6
Small bovid	4	12	36	3	5	60
Small or large bovid	1	1	1	-	-	3
Unidentified mammal	52	92	428	12	61	645

addition, the results of the wood charcoal determinations mentioned in Moeyersons et al (1999) are integrated in the diagram. Because of the morphological resemblance of the various species, the identifications of *Acacia* wood are indicated as “*Acacia*-type.” In the area under consideration the most probable *Acacia*-species are *Acacia tortilis*, *A. raddiana* and *A. ehrenbergiana* (Kassas and Girgis, 1970). The charcoal assemblages from AH 3-1 are more or less homogenous in their composition, with a predominance of *Acacia* and *Salvadora persica*. In the AH 2-1 (the period after 5000 ¹⁴C yr BP to subrecent) wood of *Ziziphus* also appears.

Despite poor preservation, 17 different taxa, including mollusk shells, fish, reptiles and mammals, could be identified among the faunal remains (Table 2). Most animals were probably obtained locally, while the marine shells and marine fish, found only in the Neolithic and subrecent horizons, must have been brought in from the Red Sea. The animal remains of the Elkabian occupation (AH 5) at the Tree Shelter site are mainly connected with hunting. In the Neolithic horizons (AH3 and AH2) bones of domestic ovicaprines appear and herding continued in the subsequent horizons. In the former only goat could be identified, while the subrecent horizon (AH 1) yielded one bone that is possibly of sheep.

Discussion

Reconstruction of the vegetation around the site

In general the plant material found represents the typical contracted desert vegetation of wadis and depressions where water accumulation allows growing of perennials with a deep root system (Walter, 1990). This group, particularly *Acacia* and *Salvadora*, dominates the charcoal assemblage. Other evidence shows that after 8.0 ka more stable conditions with regular and less heavy rains – compared to the Early Holocene torrential rains – occurred near the site (Moeyersons et al., 1999). During the occupation of AH 3-1 at the Tree Shelter, most probably stands of *Acacia* and *Salvadora* developed at the wadi edges (*A. raddiana* dominates today in the main wadis, *A. tortilis* and *A. ehrenbergiana* in the tributaries). The *Acacia* trees grow usually on more coarse sediment (Kassas and Girgis, 1970). Modern communities of *Salvadora persica* are associated with silt deposits of the principal wadis. The wood charcoal found at the Tree Shelter from *Maerua crassifolia* and *Ziziphus* might originate from specimens, which grew as shrubs or as trees in the *Acacia* stands. Today only sporadic trees of *Salvadora* and few specimens of *Maerua crassifolia* can be found in the area of the Red Sea Hills, roughly between 28–26°N (Hobbs, 1989).

Earlier identifications of wood charcoal from AH 3, from samples given for ¹⁴C analysis, showed the presence of *Acacia*-type, *Salvadora persica*, *Cadaba farinosa*, *Maerua crassifolia*, *Capparis decidua* and *Tamarix* sp. (Moeyersons et al., 1999). The charcoal from the contemporaneous layers of the nearby cave of Sodmein (ca. 7152–7435 BP cal yr BP) gave a similar picture of the wadi vegetation, with a predominance of *Acacia* cf. *tortilis*, *Cadaba farinosa* and *Salvadora persica* (Moeyersons et al., 2002). These wood charcoal assemblages resemble those of the current study. *Tamarix* is absent in the samples analysed in the present study, except in the uppermost levels of the site (Fig. 2). The wood charcoal from AH 3, analysed prior to ¹⁴C dating (Moeyersons et al., 1999), contains *Tamarix* identifications, which are absent in the newly studied samples. A possible explanation for this is limited availability of *Tamarix* in the surrounding of the Tree Shelter as it predominantly grows in oases and along the Nile River.

Some idea of the vegetation prior to AH 3-1 at the Tree Shelter is given by the previously done wood charcoal analyses from the ¹⁴C sample from AH 5 which consist of *Tamarix*, *Acacia*-type, *Celtis* type and *Balanites aegyptiaca* (Moeyersons et al., 1999). However, the identifications published by Moeyersons et al (1999) are not

precisely quantified, hampering their integration with the new data from Tree Shelter. From AH 5 at the Tree Shelter a humerus of a rock dassie (*Procapra capensis*) was identified. This animal can still be found in the Red Sea Mountains. Its habitat is restricted to rocky areas with cliffs, where acacia trees are available (Osborn and Helmy, 1980). Such habitats were presumably present in the surroundings of the site.

Paleoenvironmental and paleoeconomic implications

The wood charcoals from AH 5 and AH 3 at the Tree Shelter, used for radiocarbon dating (Moeyersons et al., 1999), and from contemporary layers at Sodmein Cave (Moeyersons et al., 2002), give a picture quite similar to that established for AH 3 by the present study. In both AH 4 and 3 Sahelian elements, like *Salvadora persica* and *Maerua crassifolia*, are present. The appearance of such vegetation in the Eastern Sahara during the period around 8000–7300 cal yr BP was interpreted as a consequence of increased precipitation and temperatures in the region (Neumann, 1989), and in addition to less anthropogenic pressure than in later periods (see above). This small tree is less tolerant of soil drought and is confined to localities where the topographic and climatic conditions lead to increased moisture and higher temperatures (Kassas and Girgis, 1970). This corresponds well with the more humid climatic conditions for the period roughly between 9252–8988 to 5720–5600 cal yr BP documented by previous studies at the Tree Shelter site (Moeyersons et al., 1999) and at the nearby Sodmein Cave (Moeyersons et al., 2002), the Red Sea Hills (Butzer, 1999) and in regional correlations (Neumann, 1989; Gasse, 2000; Hoelzmann et al., 2001; Kuper and Kröpelin, 2006; Bubbenzer and Riemer, 2007). This tendency is observed also in marine sediments from the northern Red Sea. There a humid interval was recorded for the period between approximately 9.25 and 7.25 ka, which was finally terminated at about 6.25 ka (Seeberg-Elverfeldt et al., 2004). This humid period can be explained by enhancement and southward extension of rainfall from Mediterranean sources (Arz et al., 2003).

The predominance of *Salvadora persica* in the wood charcoal assemblage from the period 7718–7510 to 5720–5600 cal yr BP or AH 3 is consistent with the sedimentological evidence from the site surroundings, pointing to a higher humic content of the valley slopes, proving more frequent, but less heavy rains (Moeyersons et al., 2002). *Salvadora persica* prefers areas where groundwater is readily available, for example in seasonally wet sites and along drainage lines in arid zones. The tree is able to tolerate a very dry environment with mean annual rainfall of less than 100 mm. Highly salt tolerant, it can grow on coastal regions and inland saline soil (Kassas and Girgis, 1970). *Salvadora's* abundance in the wood charcoal assemblages from fifth millennium BC of Makhadma 4 (Vermeersch et al., 1992) and third millennium BC (period contemporaneous with the final phases of AH 3) from Adaïma (Newton, 2005) indicates that its distribution in the region was extensive during the Middle Holocene.

The decreasing number of *Salvadora persica* finds during the Neolithic occupation at the Tree Shelter (AH 3-2) could be connected with a more intense use of the plant as both fuel and fodder, but the small number of samples do not allow to draw reliable conclusions about this. The Neolithic economy with the presence of domesticated ovicaprines (Vermeersch et al., 2002) may have had a greater impact on the plant ecosystem, than that of the earlier AH 4 and 5. Large amounts of dung found in the Neolithic layers of nearby Sodmein Cave site indicate that herds of domestic stock were probably larger than suggested by the sparse ovicaprine bones collected (Linseele, personal communication).

Another useful plant in the charcoal assemblage is *Ziziphus* sp. The presence of *Ziziphus spina-christi* in the Sahara is considered as an anthropogenic introduction during the Neolithic, due to its fruits

249 which could be eaten and transported by humans and animals
250 (Barakat, 2001). The appearance of *Ziziphus* sp. at Tree Shelter site in
251 the final occupation phases (AH 1–2) might be an indication of such an
252 anthropogenic introduction.

253 Wadi vegetation, especially *Acacia*, is attractive for human groups
254 as fuel wood and animal fodder. Most probably the wood charcoal
255 assemblage derives from such uses. Leaves of young trees of *Acacia*
256 *tortilis* are eaten by goats and sheep, but the main value of this species
257 is in its pods, which can be eaten by all African livestock. At the time
258 when pods are mature, they are often the main source of food for
259 sheep and goats (Briggs et al., 1999). *Salvadora* fruits are sweet and
260 edible. The pulp contains glucose, fructose and sucrose. It is a rich
261 source of calcium containing about 15 times the amount present in
262 wheat (von Maydell, 1986). The use of *Salvadora* as fodder plant at the
263 site is quite plausible too. Leaves and young shoots are browsed by all
264 stock, but normally cattle do not occur in the driest part of the *S.*
265 *persica* distribution range and it tends to be valued more as a camel,
266 sheep and goat forage.

267 The scarce animal remains from AH 3 at the Tree Shelter, did not
268 yield evidence for more humid conditions in the area than today. This
269 horizon (AH3) displays the remains of several occupation periods
270 dating from ca 7718–7510 to 5720–5600 cal yr BP, with a large number
271 of hearths and dense horizontal scatter of lithic and faunal remains.
272 Among them bones of domestic ovicaprids appear. They are between
273 the oldest finds of domesticated animals on the African continent,
274 together with finds from Sodmein (Vermeersch et al., 1994, 1996) and,
275 in the Western desert, the Middle and Late Neolithic of the Bir Kiseiba
276 and Nabta Playa area (Gautier, 2001) and from the Bashendi B period
277 in Dakhla Oasis (McDonald, 1991). As at the Tree Shelter site, only
278 ovicaprids have been identified at Sodmein and only goat is certainly
279 present. In the Bir Kiseiba and Nabta Playa area, on the other hand,
280 goat was found accompanied by remains of cattle as well as sheep
281 (Gautier, 2002). In fact, sheep are predominant among the small
282 livestock remains from the Middle and Late Neolithic period there. In
283 the Bashendi B phase, contemporary with the Late Neolithic, at Dakhla
284 Oasis only cattle bones have been reported together with goat remains
285 (McDonald, 1991). The faunas from Sodmein and the Tree Shelter
286 suggest that Neolithic herds in the Eastern Desert only consisted of
287 small livestock, and perhaps only of goat. Cattle need more drinking
288 water and better pasture than ovicaprids (Dahl and Hjort, 1976). They
289 could be kept successfully in the Western Desert thanks to the
290 available playas, which provided sufficient surface water and pasture
291 (Bolten and Bubenzer, 2007). The absence of such features in the
292 Eastern Desert may have made cattle keeping there impossible. The
293 lack of sheep remains is possibly also related to environmental
294 circumstances. Goat is much better adapted to living in arid areas
295 which lack good pasture (Dahl and Hjort, 1976).

296 Conclusion

297 The charcoal assemblages from Tree Shelter do not differ greatly
298 throughout the studied sequence, indicating more or less stable and
299 probably more favorable conditions than today throughout the period
300 7718–7510 to 5720–5600 cal yr BP. They show that during the so called
301 “African Humid Period” in the Red Sea Mountain area similar to the
302 Egyptian Western Desert well-developed wadi vegetation dominated
303 by *Acacia* and *Salvadora persica* was present and used by the prehistoric
304 population. Most probably the humans visited the area after occasional
305 rains that are characteristic for the study area. After such rains, which
306 have shown to be rather recurrent in the Early to Middle Holocene of
307 the arid and sub-arid belt of the Sahara, Sahel and Arabian Peninsula,
308 the area around the site became attractive for nomadic groups,
309 practicing pasture. The archaeozoological data indicate that small
310 livestock had reached the Eastern Desert by 7718–7510 to 5720–
311 5600 cal yr BP. Cattle could probably not spread to the area because of
312 unsuitable environmental conditions.

Uncited reference

Kassas, 1952

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