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*Front (upper): Common millet (Panicum miliaceum);
(main image): threshing wheat with oxen-drawn sledge; (lower): boiling wheat grains for bulgur.
Back (upper left): steppe landscape; (upper right): flotation machine at Hallan Çemi excavations;
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Vegetation and subsistence of the Epipalaeolithic in Dakhleh Oasis, Egypt: Charcoal and macro-remains from Masara sites

Ursula Thanheiser

Introduction

Dakhleh is the largest oasis of the Egyptian Western Desert. It lies half-way between Luxor and the Libyan frontier and is centred at Mut, the capital, on 25°30'N at 29°07'E, in what is now the driest part of the eastern Sahara with less than 5mm annual precipitation. The modern oasis is some 80km long and about 25km wide. It sits beneath a 300m high escarpment and is surrounded by the sand and stone wastes of the eastern Sahara. The palaeo-oasis, however, was much larger, extending at least 15km to the east, south and west. Underlying Quaternary sediments of varying thickness is a Tertiary formation, the Nubian aquifer, which holds water in sealed caverns. This water, being under pressure, feeds to the surface along natural vents and through springs, forming the spring mounds and terraces in the southern part of the oasis. For most of recent history these underground water resources have been the only reliable ones available to the local population, augmented only by occasional (seasonal) rainwater filling the wadis.

The Dakhleh Oasis has been inhabited since the mid-Pleistocene but continuously only since about 3500 BC. During the early and middle Holocene the area witnessed extensive human activity, resulting in some 200 sites. Based on intensive archaeological work by Mary McDonald, carried out during the last two decades, settlement history of this period can be divided into three more or less consecutive cultural units, Masara, Bashendi and Sheikh Muftah, distinguishable by site location, architecture, artefact assemblages, and biological remains (McDonald 1993, 2001).

Masara is the earliest of the Holocene cultural units. A suit of 19 radiocarbon dates gives a time range of 9180 to 7730 BP (McDonald 2003; all radiocarbon dates uncalibrated). The sites are largely confined to the southern margin of the oasis and to the northern plateau, plus one quarrying site in the piedmont zone. The bulk of the rich Masara material, however, is concentrated in the south-eastern corner of the palaeo-oasis where the sites occupy an area immediately

beyond the terminus of a major wadi system originating atop the plateau. Based on site location, architecture and artefact assemblages, two subunits can be distinguished, labelled Masara A and C (McDonald 1991, 2003).

Here only Masara C sites are considered as, with one exception, only these yield plant remains. Ten radiocarbon dates for the four sites average at 8665 BP, suggesting a mid-ninth millennium date for Masara C (McDonald 2003).

Virtually all Masara C sites are confined to the south-eastern part of the palaeo-oasis and are located well beyond present day cultivation areas. Unlike Masara A sites and other contemporaneous occurrences elsewhere in the Western Desert, Masara C sites are not associated with playa floors but are found on a low sandstone ridge where they occupy shallow hollows. Many sites feature stone built structures and some show considerable labour investment in shelter construction with hut circles visible on the surface. These hut circles are rings of stone – oval, round and occasionally bilobed, averaging 3–4m in diameter – and usually consist of a single tier of vertical sandstone slabs, although these may stand three or four slabs thick in places. Occasionally a smaller ring about 1m in diameter occurs in a corner or the centre of a structure, while what appears to be stone pavement is found on some sites as well. Presumably the stone circles supported some kind of superstructure consisting of less permanent material. Scatters of fire-cracked rock and hearths capped with sandstone fragments are also present. Aside from the structures, Masara C sites feature chipped stone tools and debitage, grinding equipment, ostrich egg-shell fragments and beads. Each site is unique in some ways, each has a distinctive corpus of arrowheads for instance, and no two of them seem strictly contemporaneous (McDonald 1990, 1991, 2002). Faunal remains are rare on Masara sites. The collection so far consists of ostrich and other birds of various sizes, hartebeest, gazelle, hare, tortoise, lizard and toad (McDonald 2003).

Materials and methods

For the reconstruction of past environmental conditions, availability and utilisation of resources, and inter-site variation, it was considered necessary to combine different archaeobotanical methods: charcoal, macro-remains and phytolith analyses. Each method has its specific advantages and drawbacks and in combination they should complement each other and strengthen the results. Unfortunately pollen analysis, otherwise a powerful tool for the reconstruction of palaeoenvironments, proved impossible as no pollen is preserved (Ritchie 1999). The same applies to phytoliths. The number of recovered specimens per sample is extremely low and many samples contain no phytoliths at all, thus rendering an interpretation impossible.

The matrix in Dakhleh is usually loose and consists of a mixture of quartz sand, silt, shale, ferruginous sandstone, calcareous material and gypsum in varying proportions. In many sites soil salinity is high. The well established method of water flotation was not feasible due to the fact that in arid regions completely dry charred macro-remains tend to disintegrate when they come into contact with water. An alternative method would have been dry sieving and manual extraction of archaeobotanical remains, a rather time-consuming undertaking. Therefore, an alternative method for the processing of bulk soil samples was sought and found in electrostatic extraction. This method had been developed for mineralogy (Gaudin 1972) and palaeontology (Salmon 1983) and was adapted for archaeobotanical field use (Thanheiser 1995).

Charcoal was recovered from the sites in two ways: as hand-picked samples and by extraction from matrix samples. Hand-picked samples are pieces of charcoal directly recovered in the field. Given the fragile nature of the charcoal from many sites it was our intention to save every potentially identifiable piece. Macro-remains were recovered only from soil samples. For the extraction of archaeobotanical remains from matrix samples, the soil was sieved in the field camp using a stack of four geological test-sieves with mesh-widths of 4mm down to 0.5mm. Charcoal, twig fragments, fruits and seeds were picked out by hand from the 4mm fraction, while for the smaller ones the electrostatic device was used. The charcoal was handled in the conventional way, which is broken to reveal the transverse, radial and tangential sections. Identification was only attempted for fragments bigger than 2mm. The initial attempt to identify smaller fragments as well only produced enormous numbers of unidentifiable pieces plus a few from the most common taxa: *Tamarix* sp. and *Acacia* sp. For the identification of charcoal and macro-remains, modern reference collections and descriptions available in publications dealing with modern African flora were used (e.g. Ozenda 1991; Boulos 1999, 2000, 2002, 2005; Neumann *et al.* 2001).

Flora of Masara sites: Past and present

The subfossil flora of four Masara sites comprises 38 taxa belonging to at least 16 families. Fifteen taxa could be identified to species level. The proportion of unidentifiable specimens of charcoal lies between 23.6% in locus 265 and 34.2% in locus 264, and for macro-remains between 1.4 % in locus 308 and 13.1 % in locus 300, and is caused by the high degree of fragmentation and erosion. The flora comprises seven annuals, one herbaceous perennial, one herbaceous perennial with a woody base (fruitscent), seventeen trees and shrubs, and twelve taxa which could be either annual, perennial or fruitscent.

The results of the anthracological analysis are presented in Table 19.1. Here quantity (number of pieces) and ubiquity (percentage of samples containing a taxon) are given. Both quantity and ubiquity of charcoal are ambiguous figures and cannot be used as a direct measure of the proportions of woody species in the local vegetation. The composition of charcoal samples from archaeological contexts may be biased by preferential collection of certain species for specific purposes; by the protection or exemption from collection of species with edible fruit; by the type of fire, its temperature and the amount of oxygen present; by the burning properties of the wood itself and its suitability to charcoal formation; by taphonomic processes; and by recovery methods. Therefore it is highly unlikely that charcoal assemblages from archaeological contexts contain all woody species occurring in the environment, let alone represent them in their actual proportions in the local flora. An additional complication is the possible utilisation of dead wood, and in some regions fallen trees and branchwood are even preferred (Heizer 1963; Openshaw 1974). For all these reasons the presence of taxa in the assemblage is here only used as a general indication of the structure of the local vegetation and only high ubiquity is taken as a sign that a taxon was easily accessible in the surroundings of the sites.

With the exception of *Malcolmia aegyptiaca* Spr., *Faidherbia albida* (Del.) A. Chev. (syn. *Acacia albida* Del.) and *Leptadenia pyrotechnica* (Forsk.) Decne., all recovered arboreal taxa are still present in the oasis (Zahran and Willis 1992, Ritchie 1999) but their occurrence is by and large confined to the edges of irrigation canals or to other places where recent human activity is providing the necessary water supply. Only *Tamarix nilotica* with its huge root system penetrating deeply into the soil is independent from artificial irrigation and also grows along wadis in the surrounding desert. *Tamarix aphylla* needs much moisture. Although its roots can reach a depth of 20m, it can no longer be found in the eastern part of the oasis but is restricted to the west, where the groundwater level is higher. Characteristic features in the present landscape are the rows of dead acacias (*Acacia nilotica* (L.) Willd. ex Del.) along disused irrigation canals, indicating not only previous areas of irrigation but also illustrating the tree's demand for a sustained water supply.

Locus	Loc. 264	Loc. 265	Loc. 300	Loc. 308	TOTAL	Ubiquity
Number of Samples: matrix / hand-picked	5/3	6/2	6/1	8/4	25/10	
Chenopodiaceae		24		16	40	8.6
<i>Capparis decidua</i>		3			3	2.9
cf. <i>Malcolmia aegyptiaca</i>		4		3	7	5.7
<i>Acacia nilotica</i>	36	21		3	60	28.6
<i>Acacia nilotica</i> type	12	22	38		72	31.4
<i>Acacia tortilis</i> ssp. <i>raddiana</i> type	10	137		9	156	25.7
<i>Acacia</i> sp.	372	45	28	90	535	71.4
cf. <i>Acacia</i> sp.	1				1	2.9
<i>Faidherbia albida</i>	3			3	6	5.7
<i>Balanites aegyptiaca</i>	3	3	6	14	26	14.3
<i>Balanites aegyptiaca</i> / <i>Tamarix</i> sp.	9		6	4	19	11.4
<i>Salvadora persica</i>	3	6		30	39	22.9
<i>Tamarix</i> sp.	264	597	615	1429	2905	94.3
<i>Calotropis procera</i>	4	45		13	62	25.7
cf. <i>Calotropis procera</i>	1				1	2.9
<i>Leptadenia pyrotechnica</i>	3	11	23	49	86	22.9
Indet. Twig	1	7	3	15	26	
Indet. Parenchyma		2		17	19	
Indet.	373	274	309	669	1625	
Total	1095	1201	1028	2364	5688	

Table 19.1. Wood charcoal from Masara sites.

As for macro-remains, the results are presented in Table 19.2. Here quantity (actual numbers), abundance (the number of specimens as a percentage of the total number of plant remains) and ubiquity (percentage of samples containing a taxon) are given. Abundance was calculated for each taxon per site, while for ubiquity all four sites were amalgamated. Seven taxa are clearly dominant, representing almost 95% of the recovered specimens: *Portulaca oleracea* L., *Schouwia purpurea* (Forssk.) Schweinf., Viciaeae, *Tamarix aphylla* (L.) H. Karst., *Scirpus maritimus* L., Cyperaceae and Type 22. The figures for the tiny *Tamarix aphylla* twig fragments might be too high as post depositional breakage might have occurred. Unfortunately Type 22, which occurs in 60% of all samples and constitutes about 8.5% of all plant remains, could not be identified. It was previously identified as Malvaceae (McDonald 2002) but probably belongs to Amaranthaceae or a closely related family. Again, charred macro-remains from archaeological deposits are the result of deliberate or accidental burning of plants. Human activity considerably influences sample composition as does the diverse response of plant parts to fire exposure (Wilson 1984). Archaeobotanical assemblages therefore often represent a thanatocoenosis created by human activity and do not mirror the actual distribution of plants in the environment.

Today the south-eastern part of the palaeo-oasis is bare of vegetation. Only single dead shrubs of *Salsola imbricata* Forssk. ssp. *imbricata* (syn. *Salsola baryosma* (Roem. and Schult.) Dandy) and *Zygophyllum coccineum* L. occur in the wadis and on playas. Some of them were still green when

Mary McDonald started her excavations more than a decade ago, which indicates a diminishing water supply in the recent past. Even the heavy rains in winter 1999, resulting in pools of standing water, did not induce new growth. It may therefore be concluded that even the gamblers among the desert annuals are no longer present in the seed bank of the area.

Vegetation: Local and regional

Virtually all recorded Masara C sites are located in the south-eastern part of the palaeo-oasis where they occupy an area measuring less than 2km across. Today the landscape is structured on a small scale with a prominent sandstone ridge and several sandstone hills intersected by wadis. Pockets of playa sediments and clay pans indicate the occurrence of (periodically) standing water. Such topography with its various soil types and water regimes offers diverse living conditions.

The attempt to reconstruct past vegetation on the basis of charred remains from archaeological sites suffers from the fact that (all) recovered specimens were deliberately brought to the site and ended up being burnt either by accident or on purpose. It is therefore likely that many plants growing in the area were used on the spot without leaving a trace in the archaeobotanical record. In addition, several arboreal taxa bear edible fruit and might have been exempted from collection for fire-wood to ensure a continuous harvest. The subfossil assemblage will therefore represent only a small fraction of the plants present in the area. For the interpretation, three qualitative approaches are combined: the recovered taxa grew

<i>Locus</i>	<i>Loc. 264</i>		<i>Loc. 265</i>		<i>Loc. 300</i>		<i>Loc. 308</i>			
Number of Samples	5		6		6		8			
Sample size (Litres)	51.9		45.5		52.9		58.5			
Density	44.6		65.3		17.8		251.9			
	N	A	N	A	N	A	N	A	TOTAL	U
<i>Boerhavia</i> sp.	25	1.15	42	1.49			108	0.74	175	32
<i>Portulaca oleracea</i>	1713	78.76	655	23.24	88	10.73	514	3.54	2970	84
Caryophyllaceae type	8	0.37	2	0.07					10	8
<i>Cornulaca monacantha</i>			48	1.70	15	1.83			63	16
<i>Salsola imbricata</i> type flower			119	4.22	31	3.78	8	0.06	158	24
<i>Brassica nigra</i>							1	0.01	1	4
<i>Schoutwia purpurea</i>	37	1.70	92	3.26	42	5.12	1339	9.21	1510	68
Brassicaceae			4	0.14					4	4
<i>Astragalus</i> cf. <i>vogelii</i>							177	1.22	177	12
<i>Astragalus</i> type					12	1.46			12	8
Fabaceae type B							8	0.06	8	4
<i>Scorpiurus muricatus</i>	2	0.09						0.00	2	4
Trifolieae type A	8	0.37					2	0.01	10	8
Vicieae			378	13.41			8	0.06	386	8
<i>Tamarix aphylla</i> vegetative	122	5.61	48	1.70	540	65.85	10940	75.27	11650	80
<i>Tamarix</i> cf. <i>nilotica</i> vegetative			18	0.64			16	0.11	34	8
<i>Tamarix</i> sp. vegetative	28	1.29	48	1.70	60	7.32	97	0.67	233	36
<i>Arnebia hispidissima/tinctoria</i>	8	0.37	135	4.79					143	8
Boraginaceae/Lamiaceae							1	0.01	1	4
Asteraceae	8	0.37	25	0.89			13	0.09	46	12
Paniceae rachis fragment	6	0.28							6	4
Poaceae	3	0.14	16	0.57	1	0.12			20	12
<i>Scirpus maritimus</i>			486	17.25	23	2.80			509	4
Cyperaceae	55	2.53	422	14.98			8	0.06	485	16
Type 22	152	6.99	280	9.94	8	0.98	1295	8.91	1735	60
Indet. flower/bud			4				10		14	
Indet. testa/pericarp	8		4						12	
Indet.	132		145		124		193		594	
Total	2315		2971		944		14738		20968	

Table 19.2. Plant macro-remains from Masara sites (A = Abundance; N = Number; U = Ubiquity (see text for definitions)).

in the area; the autecology of the species and the plant communities are relatively stable over time; the modern preferred habitats of species indicate the type of former environments and plant communities (Smart and Hoffman 1988).

Most of the recovered arboreal taxa exhibit considerable ecological flexibility (e.g. Ozenda 1991; Zahran and Willis 1992; Boulos 1999, 2000, 2002, 2005; Abd El-Ghani 2000). Today they occupy a variety of habitats ranging from deep, moist wadis (*Tamarix aphylla*) and desert wadis (*Acacia tortilis* ssp. *raddiana*) to sandy plains (*Capparis decidua*, *Leptadenia pyrotechnica*). Many species have roots penetrating deeply into the ground (*Acacia nilotica*, *A. tortilis* ssp. *raddiana*, *Faidherbia albida*, *Balanites aegyptiaca*, *Tamarix aphylla*, *T. nilotica*) where they can reach water and are therefore quasi independent from surface water. On the other hand *Acacia nilotica* and *Salvadora persica* can also survive inundation for an extended period. Only *Calotropis procera* requires a permanent water supply. The trees and

shrubs could have grown in wadis and runnels where occasional or periodic run-off from the escarpment augmented the ground water supply. An oscillating water supply may be indicated by wood anatomy. A characteristic feature observed in the charcoal from Masara sites is the occurrence of growth rings. They are clearly visible macroscopically, and microscopically their boundaries are very distinct. They are found most frequently in *Acacia* species and are also present in other taxa, but never in *Tamarix*. They are made up of bands of small thick-walled fibre and parenchyma cells alternating with bands of larger, thin-walled cells. The fibres in the thick-walled sections are gelatinous. Vessel diameter is more or less constant, but vessels are more numerous in the thin-walled bands. Gourlay (1995) has attributed growth rings in arid regions to seasonally changing precipitation and/or minimum temperature. *Acacia tortilis* ssp. *raddiana*, *Balanites aegyptiaca*, *Capparis decidua*, *Leptadenia pyrotechnica* and *Salvadora persica* are Sahelian elements. The

only other site where some of them occur, Site 83/39 in Abu Ballas/Mudpans, lies well to the south and is somewhat younger than Masara C. Here Neumann (1989a, b) identified as locally growing trees *Acacia* sp. and *Tamarix* sp., plus the possible imports *Maerua crassifolia* and *Leptadenia pyrotechnica* from deposits dating to about 8200 BP.

An interesting feature is the occurrence in high numbers (almost 11,000) of tiny *Tamarix aphylla* twig fragments in all samples from locus 308. These are also present in other Masara localities in smaller numbers, but they fade out in later periods. *T. aphylla* is by and large adapted to the same habitats as *T. nilotica*, but since it requires a great deal of moisture it rapidly exhausts underground water resources in its vicinity. Today the occurrence of *T. aphylla* is restricted to the better-watered western part of the oasis where it is usually found associated with *Acacia nilotica*, *Balanites aegyptiaca*, *Capparis aegyptia*, *Citrullus colocynthis*, *Ziziphus spina-christi*, etc. Its declining presence in archaeobotanical assemblages might serve as an indication of a continuously diminishing groundwater supply in the eastern part of the palaeooasis already occurring in prehistoric times.

Some species are salt tolerant (e. g. *Cornulaca monacantha*, *Salvadora persica*, *Tamarix* spp., *Scirpus maritimus*) and can grow in halophytic communities. That soil salinity must have been high in some areas is clearly visible in the charcoal of *Tamarix* sp., where salt crystals within cells are abundant. These crystals must have formed during the lifetime of the plant and are clearly distinguishable from post-mortem salt accumulations. Today, *Tamarix nilotica* grows on sandy plains, saline sandy soils, at the edges of salt marshes and colonises freshly exposed wet habitats. The plants do well on semi-mobile sand.

The herbaceous plants indicate various types of habitat, differing in the amount of water and soluble salts present in the soil. Pools of (periodically) standing (brackish) water, swamps or wet soils would support the growth of *Scirpus maritimus* and other Cyperaceae, probably together with *Tamarix* species. Open, moist habitats are required by *Portulaca oleracea*. Although well adapted to hot climates, it needs a good water supply at least during germination and in its vegetative stage. Under favourable conditions it is fast-growing and can complete its life cycle within two weeks. Less moisture is demanded by the desert annuals *Schouwia purpurea*, *Astragalus vogelii* and *Arnebia hispidissima*, which can develop abundantly after (seasonal) rains.

In Masara times the vegetation of the palaeo-oasis appears to have been mosaic-like with small groves or single trees in wadis, near springs and in other areas where groundwater was in reachable depth for the roots; wet soils or pools of (periodically) standing water with hydrophytic or halophytic vegetation existed around springs and in low-lying areas and after seasonal or periodical rains in the oasis itself or on top of the plateau, the area flourished with desert annuals.

During the early Holocene north-eastern Africa witnessed several pluvial and arid phases. Wet periods resulted in an

accumulation of lacustrine sediments while arid ones led to aeolian erosion. Sedimentological evidence from the southern Western Desert at Nabta Playa points to a humid phase between 9500 and 8200 BP punctuated by an arid one before 8560 BP (Schild and Wendorf 2001). Unfortunately no such detailed sedimentological studies exist for the Dakhleh area. Based on the evidence from Nabta Playa, some 300km south of Dakhleh, occupation of the four Masara sites discussed here falls into a transitional period.

Palaeobotanical evidence of the vegetation in the ninth millennium BP in the Eastern Sahara is scanty. It includes pollen from a fossil lake at Selima Oasis in north-western Sudan (Haynes *et al.* 1989), charcoal from Abu Ballas/Mudpans (Neumann 1989a, b), charcoal, fruits and seeds from the El Gebal El Beid Playa Site E-77-7 (Barakat 1996, 2001; Wasylukowa *et al.* 2001) and fruits and seeds from Abu-Darbein, Sudan (Abdel-Magid 1989, 1995). For the mid-ninth millennium BP the collection of charcoal, fruits and seeds from Dakhleh Oasis is by far the largest and richest one; both El Gebal El Beid and Abu-Darbein unfortunately yielded only a few propagules. As for charcoal, Abu Ballas produced as locally growing plants *Tamarix* sp., *Acacia* sp. and Chenopodiaceae, El Gebal El Beid only *Tamarix* sp., indicating a contracted desert vegetation.

Although the plant assemblage from Masara sites in Dakhleh is rich compared with other roughly contemporaneous sites in the Western Desert, it does not provide a sound basis for the reconstruction of past climate and the position of vegetation zones. Almost all recovered taxa still occur in the area today and many of them exhibit a wide ecological range. Long-term changes in the amount of annual rainfall and its distribution throughout the year and changes in average temperature will eventually result in a shift of vegetation zones. (Wickens 1975, Hoelzmann *et al.* 2004). That at least changes in the amount of rainfall took place in the Western Desert during the life-time of the four Masara sites is indicated by sedimentological studies; the beginning and end of the cultural unit seem to coincide with humid phases, separated by an arid one. The effects of a decrease in rainfall, however, might be ameliorated by topography, runoff from the escarpment in Dakhleh, and by soil micro-morphology. Furthermore, deep-rooted species are independent of precipitation until the underground water resources are depleted. A change in vegetation is therefore likely to lag behind a change in climate.

Economic significance of the flora

The possible utilisation of plants in the Masara period is summarised in Table 19.3. It is based on ethnographic reports and should serve as an indication of the economic potential of the flora. The subfossil assemblage of macro-remains can be characterised by the occurrence of high numbers of small fruits and seeds of only a few taxa. The dominant ones – *Portulaca oleracea*, *Schouwia purpurea*, Viciaeae, *Scirpus maritimus*, and Cyperaceae – have several characteristics in

	A	B	C	D	E	F	G	H	I
<i>Boerhavia</i> sp.	•		•		•				
<i>Portulaca oleracea</i>	◊		•		•				
Caryophyllaceae					◊				
<i>Cornulaca monacantha</i>									•
<i>Salsola imbricata</i>					•	♦			•
Chenopodiaceae	◊		◊						•
<i>Capparis decidua</i>	•				•	•			•
<i>Brassica nigra</i>	•				•				
<i>Malcolmia aegyptiaca</i>			•						•
<i>Schouwia purpurea</i>	?		•		•				
<i>Astragalus vogelii</i>	•		•						
Trifolieae	◊	◊		◊	•				
Vicieae	•								
Fabaceae	•								
<i>Acacia nilotica</i>	•	•			•		•	♦	•
<i>Acacia tortilis</i> ssp. <i>raddiana</i>					•			♦	•
<i>Acacia</i> sp.									•
<i>Faidherbia albida</i>					•			♦	•
<i>Balanites aegyptiaca</i>	•	•	•		•		•		•
<i>Salvadora persica</i>		◊			•	•			•
<i>Tamarix aphylla</i>					•	♦			•
<i>Tamarix nilotica</i>					•				•
<i>Tamarix</i> sp.									•
<i>Calotropis procera</i>					•				•
<i>Leptadenia pyrotechnica</i>		•	•		•				•
<i>Arnebia hispidissima</i> / <i>tinctoria</i>								•	
Boraginaceae / Lamiaceae					•				
Asteraceae	•	◊	•	•	•		•		
Paniceae		♦							?
Poaceae		♦		•					?
<i>Scirpus maritimus</i>	•			•					
Cyperaceae	•		•	•					

Table 19.3. Potential economic use of plants based on ethnographic accounts. Legend: A = seeds, B = fruits and wild cereals, C = green parts, D = rhizomes or tubers, E = medicinal, F = salt or sugar, G = gum or sap, H = dye or tannin, I = fuel; full symbols = use ethnographically well documented; empty symbols = ethnographic reports scanty and/or not from the region.

common; under favourable conditions they occur in massive stands, they produce abundant but small seeds or fruits, there is hardly any ethnographic reference to the utilisation of these propagules. In contrast to that, other parts of these plants – mainly leaf but tuber, rhizome and pith as well – are widely used. The taxa are present mainly in the Masara period and rare or missing in later phases in Dakhleh.

Today, *Portulaca oleracea* is eaten raw as a salad plant and cooked as a pot herb (Bebawi and Neugebohrn 1991, Peters *et al.* 1992, Burkill 1997) and it is assumed that it was already used this way in Pharaonic Egypt (Germer 1985, Fahmy 2001). Substantial archaeological finds, however,

are missing. The plant is rich in ascorbic and oxalic acids, in calcium and iron and has a wide range of medical uses (Bebawi and Neugebohrn 1991, Burkill 1997, Neuwinger 2000). Ethnographic reports on the utilisation of seeds are scarce. Australian aborigines eat them roasted (Burkill 1997). The leaves of *Schouwia purpurea* can be eaten either cooked or dried and young leaves add an agreeable flavour to a salad (Nicolaisen 1963). Available ethnographic records mention only the use of leaves, not of seeds. Small-seeded legumes such as Vicieae and Trifolieae are often present in large numbers in archaeobotanical assemblages (Thanheiser 1987; Moens and Wetterstrom 1988; Wasylikowa 1997, 2001). In agrarian contexts this can be attributed to the fact that several taxa grow as weeds on arable land or are cultivated as fodder. In pre-agrarian contexts the interpretation of their presence is conjectural. The pods and seeds are often (very) small and develop on the same plant over an extended period. A selective collection would therefore be rather difficult and correspondingly ethnographic references are scarce. They mainly refer to the consumption of roots (e.g. *Indigofera*, *Lotus*, *Rhynchosia*, *Tephrosia*), leaves (e.g. *Crotalaria*, *Indigofera*, *Sesbania*) and flowers (e.g. *Crotalaria*, *Dolichos*, *Vigna*, *Trifolium*), and rarely to whole pods or seeds (Peters *et al.* 1992; Butler 1995; Butler 2001). Several *Scirpus* species have edible fruits, rhizomes and tubers and their consumption seems to have had a long tradition in Africa as well as in other parts of the world (Hillman *et al.* 1989). In late palaeolithic Wadi Kubbaniya, nutlets of *S. cf. maritimus/tuberosus* were found incorporated in human faeces. The fruits might have been roasted prior to consumption, while tubers were ground or pounded to a mush (Hillman 1989; Hillman *et al.* 1989). Fruits and tubers of *S. maritimus*, as well as other Cyperaceae, have also been recovered from Nabta Playa but there the small number of remains renders their use questionable (Wasylikowa 1997, 2001). Reports on the collection of sedges are poorly represented in the ethnographic literature, but the cultivation of *Cyperus esculentus* L. for its aromatic tubers has a long tradition in Egypt (Germer 1985). The haulms of several taxa are grazed by domestic stock, while the pith can be eaten either raw or cooked (Burkill 1985).

The occurrence of high numbers of small fruits and seeds with questionable use in archaeobotanical assemblages, like the ones recovered in Masara sites, is a matter of conjecture. Some general harvesting of small propagules in mixed pastures described as the *lawn-mower system* (Hillman 1989) might be possible, but one would then expect to recover a large variety of species and not samples consisting of only a few taxa. Alternatively, the diaspores could have arrived at the sites as by-products of the harvesting of vegetative plant parts. Ethnographic studies and contemporary practice, however, indicate that leaves destined for human consumption are often collected before the plant blooms. Seeds would then appear in archaeological deposits in small numbers only. Another potential source of seeds would be the burning of the withered plant itself or of animal dung (see Hillman *et al.*

1997; Butler 2001; Wasylikowa 2001). Seeds and fruits with hard shells especially can pass through the gut of the animal undamaged, and by burning dung these propagules become incorporated in the archaeobotanical record (Bottema 1984, Miller 1984, Murray 2000). Easily collected, dung provides fuel of high caloric value even in areas where fuel-wood is abundant (Charles 1998). What role the collecting of dung from wild ruminants might have played in prehistoric times in Dakhleh is a matter of speculation. So far no dung fragments have been recovered. Whether wild ruminants were present in the area in sufficient numbers to produce an amount of dung worth collecting is a matter of debate. With the exception of hartebeest and gazelle, no larger animals have been recovered to date. Charred dung was only found in Old Kingdom contexts. Its absence in earlier periods, however, does not necessarily indicate that it was not used, as dung often burns to fine grey ash and is therefore lost for later recovery (Charles 1998).

The use of tubers has not been shown by finds in Dakhleh. The few fragments of parenchymatous tissue found in samples from the Masara and the subsequent Bashendi A period have not yet been identified. It can only be assumed that the potential of the tubers as a possible food stuff cannot have escaped the observant minds of the previous inhabitants of Dakhleh Oasis.

The recovered taxa provided fuel, fodder and food; carbohydrates and proteins plus fibre, vitamins and trace elements. The human demand for lipids must have been met by the consumption of meat.

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