ENVIRONMENTAL CHANGE AND HUMAN CULTURE
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UNTIL THE SECOND MILLENNIUM B.C.
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# Plant macrofossils from the archaeological sites of Uan Muhuggiag and Ti-n-Torha, Southwestern Libya

Archaeological investigations in the Tadrart Acacus range led to the discovery of very rich and interesting remains of Epipalaeolithic and Neolithic habitation. Studies of the environmental conditions included the geology of the area, the remains of wild and domestic animals, pollen and macroscopic plant remains. The results show the great importance of these sites for understanding the subsistence patterns of pastoral tribes which inhabited the Sahara in the Early and Middle Holocene (Barich 1987).

The Ti-n-Torha and Uan Muhuggiag rock shelters contained deposits rich in plant material. Pollen analyses were made of the settlement layers at both sites (Pasa and Pasa-Durante 1962; Schulz 1987). Macrofossils were reported only from the Uan Muhuggiag shelter in which the following species were found: *Acacia albida, Balanites aegyptiaca, Artemisia campestris, Zilla spinosa, Aristida sp.* and *Citrullus vulgaris* (Pasa and Pasa-Durante 1962). Further studies on plant macrofossils from Uan Muhuggiag and Ti-n-Torha/Two Caves were undertaken by the present author in order to supplement the information about the natural environment provided by pollen analysis and to contribute to the discussion on the use of wild plants by prehistoric populations of the Acacus area. Preliminary results are reported here.

## Present-day climate and vegetation

Tadrart Acacus is a low mountain range, with the highest elevations of about 900 m a.s.l. in the middle part, situated on the north-east edge of the central Saharan mountains, in the rain shadow of the Tassili-n-Ajjer. The area belongs

to the zone of subtropical dry desert climate with extremely irregular precipitation and maximum rainfall in summer. The nearest meteorological data are available from Ghat on the west side of the range, at an elevation of 561 m a.s.l. Mean annual precipitation is 10 mm, and mean annual temperature is 25.3°C (Walter *et al.* 1975). Deeply cut wadis have perennial vegetation in the form of desert savanna with *Acacia-Maerua-Panicum* or *Tamarix-Stipagrostis* communities. Diffuse vegetation is limited to annual herbs which develop only after rain (Schulz 1987). Geological structure and topography of the range enable the ground-water accumulation during the rain season and subsequent slow discharge in the dry season, thus reducing the influence of climatic aridity on vegetation and creating specific microclimates favorable for human habitation (Marcolongo 1987).

## Archaeological setting

The oldest occupation levels were found in the northern part of the Tadrart Acacus, in rock shelter located in the Wadi Ti-n-Torha (Fig. 1). Three sites were excavated there, namely East Shelter, North Shelter and the Two Caves Shelter, with the oldest occupation traces with ages between 9,350 ± 110 and 7,990 ± 70 b.p. found in the East and Two Caves shelters (Barich 1987; Barich *et al.* 1984). According to Barich (1987), the earliest habitation had a semi-permanent character, with subsistence based on fishing, hunting and gathering of wild plants; domestic animals were not found. The lithic industry was of typical Epipalaeolithic character but the use of pottery was suggested by the presence of potsherds in the layer dated to 8640 ± 70 b.p. in the East Shelter. Faunal remains from the Two Caves indicated that the shelters were occupied probably in the dry season, *i.e.* during the late autumn, winter or early spring (Gautier 1987). Occupation levels in the Ti-n-Torha North Shelter were of younger age, their C-14 dates ranged between 7,070 ± 60 and 5,260 ± 130 b.p.

More or less at the same time Neolithic population appeared in the central part of the Tadrart Acacus (Fig. 1), where traces of frequent stays of pastoral tribes were found in several shelters in the Wadi Teshuinat. The most interesting of them was Uan Muhuggiag shelter were rock paintings were discovered illustrating, among other things, hunting and pastoral scenes. Two Neolithic horizons were distinguished in this shelter (Barich 1987). The older one started before 6,035 ± 100 b.p. and had the youngest date of 5,350 ± 200 b.p. It represented a non-residential site which was used by pastoral groups several times but for short periods only. Pottery already played an important role, and the lithic industry continued a local tradition. Domestic animals (cattle, sheep, goat) were more important in the diet than the wild game, over 92% of the bones belonged to domestic types (Gautier 1987). According to Barich (1987), grass-seed gathering was probably reduced compared to Ti-n-Torha, because the number of grinding implements was very small. The younger horizon was connected with

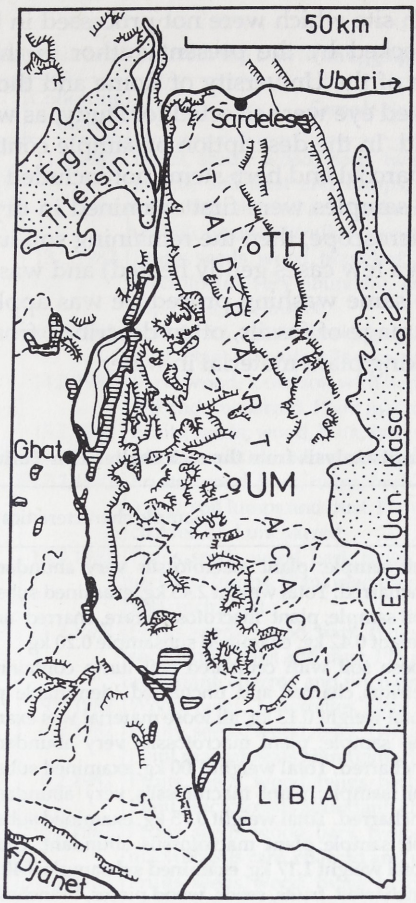



Fig. 1. Location of the Tin-n-Torha (TH) and Uan Muhuggiag (UM) rock shelters (after Schulz 1987).

the dates ranging from 4,730 ± 310 to 2,220 ± 220 b.p. It contained quite different archaeological material and indicated slighter habitation compared to the older phase. Rock paincings were connected with this horizon.

## Material and methods

All samples for macrofossil analysis were collected by Barbara Barich during the excavation seasons of 1978 in Ti-n-Torha/Two Caves and 1982 in Uan Muhuggiag. Most of them were small samples composed of isolated large fruits or seeds, lumps of soil, stems of herbaceous plants, leaves, twigs, wood and charcoals. They were picked up in the field either directly from the exposed level or from the sieved portions of earth. In addition, six large soil samples

were collected from each site which were not processed in the field. In 1986 all small samples were checked by the present author in the laboratory of the Instituto di Paletnologia of the University of Rome and those containing fruits or seeds visible with naked eye were selected for study, as were the soil samples not processed in the field. In the description of sample content (Tables 1 and 2) the presence of wood, charcoal and herb stems not included in this study is indicated. In Cracow, small samples were first examined in dry condition under a low-power binocular microscope, then the remaining soil lumps and dust were soaked in pure water (in a few cases gently heated) and washed through a sieve with 0.2 mm mesh. The same washing procedure was applied to the large soil samples. No signs of damage of fossils, often described from other desert sites, were observed after soaking plant material in water.

Table 1

**List of samples for seed and fruit analysis from the rock shelter Ti-n-Torha/Two Caves.**

| Sample number | Sector | Layer | Sample characteristics |
|---|---|---|---|
| 1 | | I | Soil sample; plant macrofossils very abundant, charred and uncharred. Total weight 2.45 kg, examined subsample 0.80 kg |
| 2 | West | III | Soil sample; plant macrofossils rare, charred and uncharred. Total weight 0.42 kg, examined subsample 0.20 kg |
| 3 | Test trench | I | Loose soil with cemented soil lump containing abundant plant detritus, charred and uncharred. Identifiable plant macrofossils rare. Total weight 0.13 kg, all loose material was examined |
| 4 | West | I | Soil sample; plant macrofossils very abundant, charred and uncharred. Total weight 1.00 kg, examined subsample 0.20 kg |
| 5 | East | IIa | Soil sample; plant macrofossils very abundant, charred and uncharred. Total weight 0.75 kg, examined subsample 0.37 kg |
| 6 | mostly Central | surface | Soil sample; plant macrofossils abundant, charred and uncharred. Total weight 1.17 kg, examined subsample 0.40 kg |
| 7 | West | I | Uncharred fruits, seeds, wood pieces, branches, herb stems, coprolites, soil lumps |
| 8 | East | III | Accumulation of uncharred herb stems, few charcoals (nest?) |
| 9 | Central | surface | Twigs, one coprolite, one cocoon, uncharred |
| 10 | Central | II | One twig with fruits, fresh in appearance |
| 11 | West | II | Few fruits, twigs, one twig with fruits fresh in appearance. All uncharred |
| 12 | East | IIa | Twigs with fruits fresh in appearance, one coprolite, uncharred |
| 13 | East | II | Twigs with fruits fresh in appearance, one charcoal |
| 14 | Central | III | Fragments of herbaceous plant, fresh in appearance |
| 15 | West | III | Few uncharred twigs and herb stems, one charred twig, one coprolite |
| 16 | East | IIa | Soil sample; plant macrofossils very abundant, charred and uncharred |

Due to the procedure of sample collecting, each sample can be ascribed to a definite layer but neither the stratigraphic sequence within a layer nor the position of sample on a horizontal plan are known (Figs. 2 and 3). In the case of a few samples from an individual layer we have only an indication that plant remnants were picked up several times, *i.e.* from different places in the excavated layer. Macrofossil samples were given arbitrary numbers by the present author.

Table 2

**List of samples for seed and fruit analysis from the Uan Muhuggiag rock shelter.**

| Sample number | Sector | Layer | Collecting date | Sample characteristics |
|---|---|---|---|---|
| 1 | B | 1 | 11.2.1982 | Fruits, seeds, wood, bark, twigs, herb stems, coprolites, insects, soil dust and lumps, plant macrofossils very abundant, charred and uncharred. Lumps of cemented soil with dung and *Citrullus colocynthis* seeds |
| 2 | B | 1a | 13.2.1982 | Fruits, seeds, wood, branches, herb stems, loose soil, plant macrofossils very abundant, charred and uncharred, coprolites, one insect |
| 3 | B | 2d | 18.2.1982 | Few fruits, wood, bark, twigs, herb stems, coprolite, soil dust. Plant macrofossils rare, uncharred only |
| 4 | B | 2 | 14.2.1982 | Bark, wood, loose soil with herbacous plant fragments, charred and uncharred. Plant macrofossils very abundant |
| 4a | B | 2 | 15.2.1982 | Fruits, seeds, wood, bark, twigs, coprolites, loose soil. Plant macrofossils abundant, charred and uncharred |
| 5 | B | 2b | 17.2.1982 | Fruits, wood, bark, twigs, herb stems, bones, coprolites, one insect, soil lumps and dust. Plant macrofossils very abundant, charred and uncharred |
| 6 | B | 2a | 15.2.1982 | Fruits, seeds, wood, bark, twigs, charcoals, coprolites, one insect, soil lumps. Plant macrofossils very abundant, charred and uncharred |
| 7 | B | 2 | 14.2.1982 | Fruits, seeds, wood, bark, twigs, herb stems, coprolites, insects, soil lumps and dust. Plant macrofossils very abundant, charred and uncharred |
| 8 | A | 3 | 9.2.1982 | Wood, twigs, 3 coprolites, plant macrofossils rare, uncharred |
| 9 | A | 2 | 7.2.1982 | Fruits, seeds, wood, bark, twigs, herb stems, coprolites. Plant macrofossils abundant, charred and uncharred |
| 10 | A | 2c | 9.2.1982 | Fruits, seeds, wood, twigs, herb stems, coprolites, soil dust. Plant macrofossils abundant, charred and uncharred |
| 11 | A | 2b | 8.2.1982 | Fruits, seeds, wood, bark, twigs, charcoals, coprolites. Plant macrofossils rare, charred and uncharred |
| 12 | A | 2a | 8.2.1982 | Fruits, seeds, wood, twigs, herbaceous stems, charcoals, coprolites, one snail. Plant macrofossils abundant, charred and uncharred |
| 13 | A | 1a | 7.2.1982 | Fruits, wood, bark, herbaceous stems, coprolites, one insect, soil lumps. Plant macrofossils rare, uncharred |
| 14 | A | 1 | 6.2.1982 | Fruits, seeds, coprolites, insects. Plant macrofossils rare, charred and uncharred |
| 15 | A | 1a | 7.2.1982 | Fruits, leaves fresh in appearance, coprolites. Plant macrofossils rare, uncharred |
| 16 | A | 2 | 7.2.1982 | Fruits, seeds, coprolites. Plant macrofossils rare, charred and uncharred |
| 17 | A | 2a | 8.2.1982 | Lumps of sediment with "roasted" *Acacia sp.* seeds, coprolites |
| 18 | A | 2a | 8.2.1982 | Few seeds |
| 19 | A | 2c | 9.2.1982 | Lump of soil with straw and *Urochloa* type spikelets, uncharred |
| 20 | A | 2 | | A fragment of uncharred *Balanites* fruit – stone |
| 21 | A | 1 | | A fragment of uncharred *Balanites* fruit – stone, charcoals |
| 25 | A | 2 –143 cm | 8.2.1982 | Soil sample with charcoal, plant macrofossils very abundant, charred and uncharred |
| 26 | A | surface | 5.2.1982 | A fragment of charred *Balanites* fruit – stone |
| 27 | A | 2a –160 cm | | Soil sample with charred lumps of deposit composed mostly of plant detritus. Plant macrofossils very abundant, charred and uncharred |

Table 2 (continued)

| Sample number | Sector | Layer | Collecting date | Sample characteristics |
|---|---|---|---|---|
| 28 | A | 1 –75 cm | 6.2.1982 | Soil sample plant macrofossils very abundant, charred and uncharred |
| 29 | A | 2a | 7.2.1982 | One uncharred large coprolite |
| 30 | A | 2 | 7.2.1982 | Lumps of cemented deposit from the top of the layer, composed of sand and very abundant plant detritus, mostly uncharred; few charcoals. A small portion of disintegrated deposit was examined |
| 31 | A | 1 –80/90 cm | | Partly charred lumps of soil from the hearth, charcoals, bones. Plant macrofossils rare, charred and uncharred |
| 32 | A+B | surface | 4.2.1982 | Few pieces of cemented soil from the hardened level (crust) on top of the excavated deposit. Uncharred and less numerous charred plant detritus visible on the surface, coprolites |

Plant remains were preserved in charred and uncharred (dessicated) conditions, both types of fossils being mixed in one layer. About half of the taxa were represented by charred and uncharred specimens, the other half by uncharred only. On the basis of field observations it was assumed by the excavator that charred and uncharred fossils were of the same age. This assumption was confirmed by C-14 dating of the two kinds of fossils from the layers 1a in sector A and 2b in sector B at Uan Muhuggiag. The discrepancy between charred and uncharred material occurred in the layer 2, sector A. In sector B three samples from the layer 1 gave three different dates pointing to the heterogeneity of plant material in the top layer (Table 3).

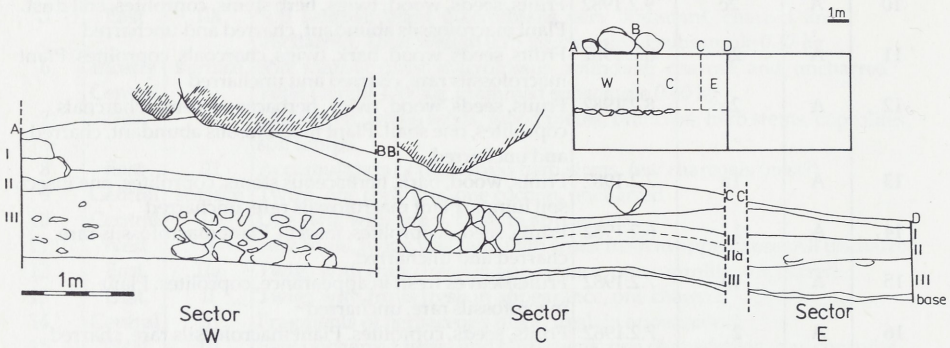



Fig. 2. Tin-n-Torha. Schematic profiles of the West, Central and East sectors (after Barich 1987, simplified);
I - III: archaeological layers.

It should be stressed that in both sites the archaeological layers were numbered by the excavator in each sector independently and the same layer number does not necessarily mean the same age (Tables 3 and 4). Thus, in Uan Muhuggiag layers 1 and 1a in sector A and the layer 1 ( but not 1a) in sector B belong to the younger habitation horizon, while the layer 1a in sector B and layers 2 - 2d in both sectors belong to the older one (Fig. 3).

Table 3

**$^{14}C$ dates for individual layers in the Ti-n-Torha/Two Caves shelter and numbers of samples available for seed-and-fruit analysis.**

| Sector | Layer | $^{14}C$ b.p. | Lab. No. | Material | Botanical samples |
|---|---|---|---|---|---|
| West | I | 8840 ± 60 | R-1405 | charcoal | 4, 7 |
| | | 8520 ± 60 | R-1407 | charcoal | |
| | | 5210 ± 90 | Gd-2855 | uncharred plant detritus from sample 4 | |
| West | II | 8450 ± 60 | R-1408 | charcoal | 11 |
| West | III | 8630 ± 50 | R-1404 | charcoal | 2, 15 |
| | | 8400 ± 90 | R-1404 | bis charcoal | |
| Central | Surface | | | | 6 |
| Central | II | | | | 10 |
| Central | III | | | | 14 |
| East | I | 6230 ± 50 | R-1403 | charcoal | |
| East | II | 8620 ± 50 | R-1406 | charcoal | 13 |
| | | 8650 ± 105 | R-1409 | charcoal | |
| East | IIa | | | | 5, 12, 16 |
| East | III | 9350 ± 110 | R-1402 | charcoal | 8 |
| Test trench | I | | | | 3 |

R – datings from Barich *et al.* 1984; Gd – from Pazdur, this volume.

Table 4

**$^{14}C$ dates for individual layers in Uan Muhuggiag shelter and numbers of samples available for seed-and-fruit analysis.**

| Sector | Layer | $^{14}C$ b.p. | Lab. No. | Material | Botanical samples |
|---|---|---|---|---|---|
| A | Surface | | | | 26 |
| A | 1 | | | | 14, 21, 28, 31 |
| A | 1a | 3770 ± 200 | Ud-224 | charcoal | 13, 15 |
| | | 3800 ± 140 | Gd-4363 | uncharred *Balanites* fruits, two | |
| | | 3720 ± 90 | Gd-2962 | measurements of one sample | |
| A | 2 | 6035 ± 100 | Ud-225 | charcoal | 9, 16, 20, 25, 30 |
| | | 5290 ± 110 | Gd-4362 | uncharred *Balanites* fruits | |
| A | 2a | 6030 ± 80 | Gd-2853 | uncharred coprolites | 12, 17, 18, 27, 29 |
| A | 2b | | | | 11 |
| A | 2c | 5780 ± 80 | Gd-4358 | uncharred *Balanites* fruits | 10, 19 |
| A | 3 | | | | 8 |
| A+B | Surface | | | | 32 |
| B | 1 | 2220 ± 220 | Gd-4290 | uncharred *Citrullus colocynthis* seeds | 1 |
| | | 2770 ± 80 | Gd-4288 | uncharred coprolites | |
| | | 3810 ± 80 | Gd-2854 | uncharred *Balanites* fruits | |
| B | 1a | 4980 ± 70 | Gd-2958 | uncharred *Balanites* | 2 |
| | | 4980 ± 110 | Gd-4357 | fruits, two measurements of one sample | |
| B | 2 | 5340 ± 120 | Gd-2959 | uncharred *Balanites* fruits | 4, 4a, 7 |
| B | 2a | 5420 ± 100 | Gd-2960 | uncharred *Balanites* fruits | 6 |
| B | 2b | 5350 ± 200 | Ud-226 | charcoal | 5 |
| | | 5420 ± 50 | Gd-5337 | uncharred *Balanites* fruits | |
| B | 2d | | | | 3 |

Ud – datings from Barich 1987; Gd – from Pazdur, this volume.

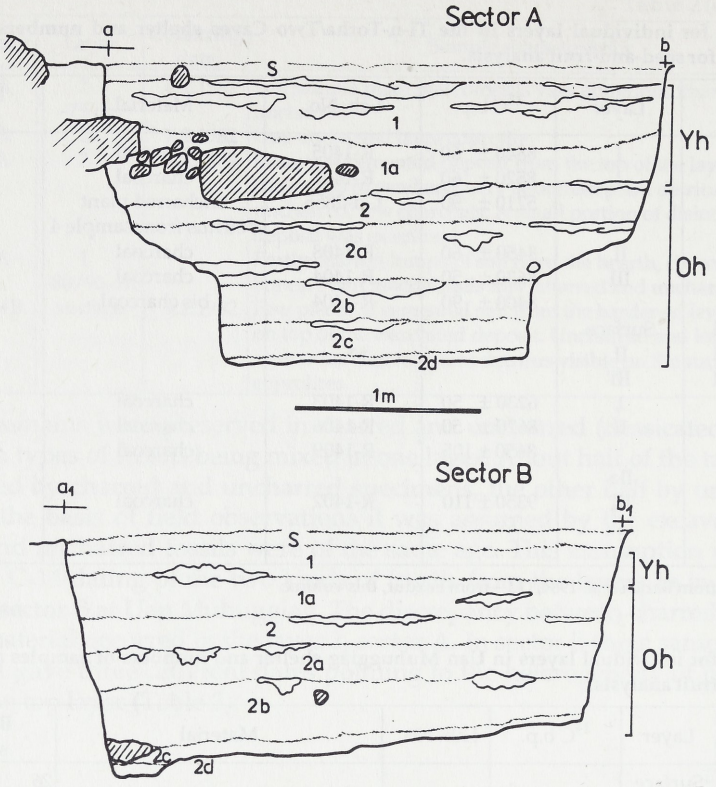


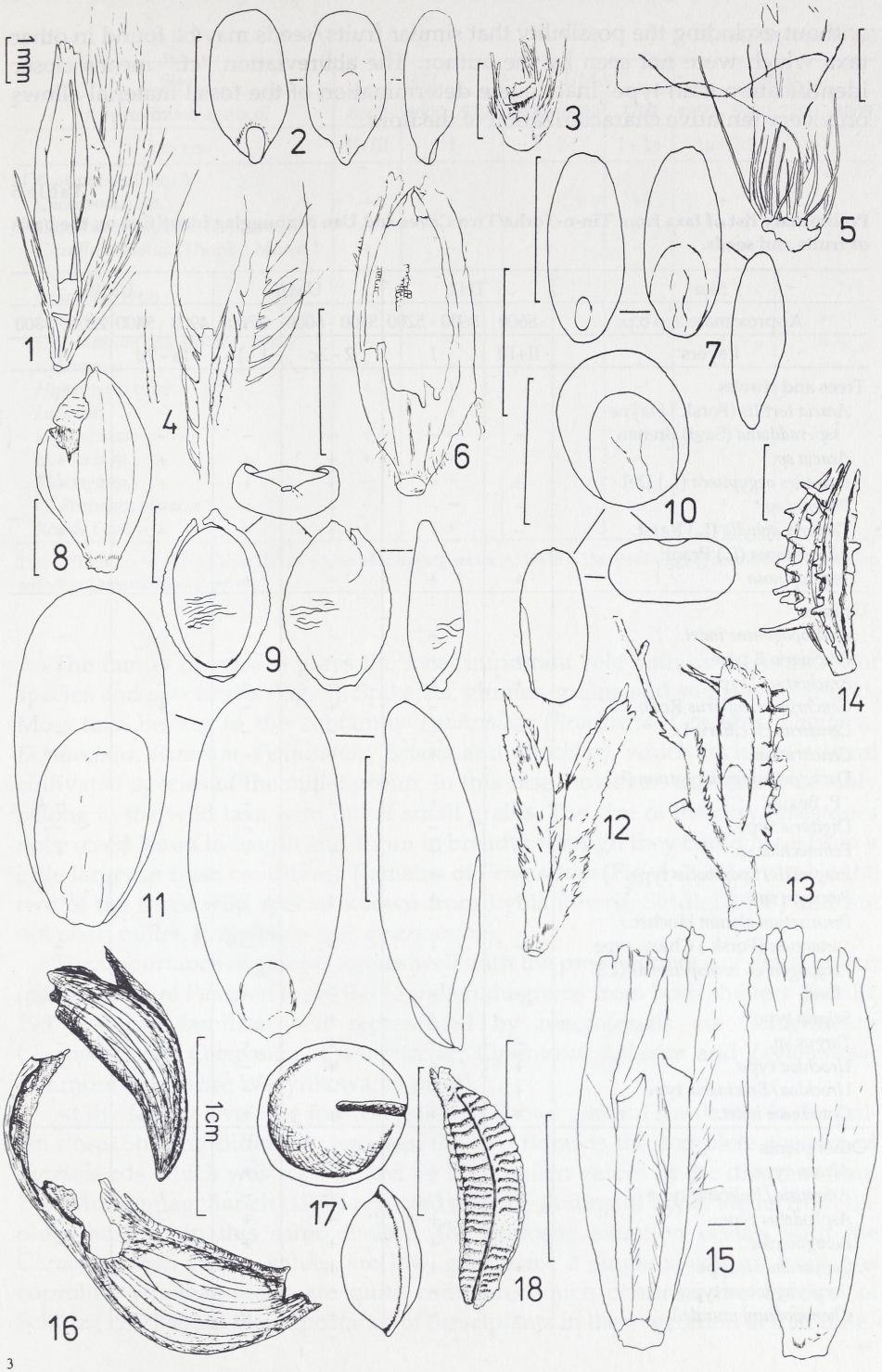

Fig. 3. Uan Muhuggiag. Schematic profiles from the sectors A and B (after Barich 1987, simplified); S and 1 - 2d: archaeological layers; Yh: younger settlement horizon; Oh: older settlement horizon.

## Taxonomic composition of the flora

Morphological differentiation of the carpological flora indicates that over 65 taxa are present. About 40 of them could be identified to taxonomic groups of various ranks and only those are listed in Table 5. The qualification "type" following plant name means morphological resemblance to a taxon named but

Fig. 4. Selected plant remains from Uan Muhuggiag (UM) and Tin-n-Torha (TH);

1 - 4: *Pennisetum elatum/setaceum* type, UM sector B, layer 2b, uncharred: 1: spikelet with one fertile floret and bristles; 2: one grain; 3: spikelet base with bristles and pedicel; 4: outer (scabrous) and inner (plumose) bristles; 5: *Cenchrus* cf. *ciliaris*, spikelet base, TH West sector, layer I, uncharred. 6 - 7. *Digitaria* type: 6: uncharred spikelet, UM sector B, layer 2b, 7: one charred grain, UM sector B, layer 2. 8 - 9: *Urochloa* type, TH layer I, uncharred. 8: spikelet with long outer glume, dorsal view; 9: one spikelet without outer and inner glumes. 10: *Echinochloa sp.*, one charred grain, UM sector B, layer 2. 11: *Panicoideae indet.*, one uncharred grain, UM sector B, layer 2. 12: *Polypogon* cf. *monspeliensis*, uncharred spikelet, UM sector B, layer 2b. 13 - 14: *Tragus sp.*, two damaged spikelets, uncharred, TH layer I. 15: *Andropogoneae indet.*, one spikelet, uncharred, TH surface layer. 16: *Acacia tortilis ssp. raddiana*, two odd fragments, uncharred, UM sector B, layer 1. 17: *Chenopodium murale*, one uncharred seed, UM sector B, layer 2. 18: cf. *Picris sp.*, uncharred fruit, UM sector B, layer 2b. Scale lines equal 1 mm except for No. 16.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without excluding the possibility that similar fruits/seeds may be found in other taxa which were not seen by the author. The abbreviation "cf." means closer identification than type. Inadequate determination of the fossil material allows only very tentative characterization of the flora.

Table 5

**Preliminary list of taxa from Tin-n-Torha/Two Caves and Uan Muhuggiag identified on the basis of fruits and seeds.**

| Site | TH2 | | UMA | | UMB | |
|---|---|---|---|---|---|---|
| Approximate age b.p. | 8600 | 8600 - 5200 | 5200 - 6000 | 3700 | 4900 - 5400 | 2200 - 3800 |
| Layers | II+III | I | 2 - 2c | 1 - 1a | 1a - 2d | 1 |
| Trees and shrubs | | | | | | |
| *Acacia tortilis* (Forsk.) Hayne *ssp. raddiana* (Savi) Brenan | – | – | – | – | – | + |
| *Acacia sp.* | | | + | + | + | + |
| *Balanites aegyptiaca* (L.) Del. | + | – | + | + | + | + |
| *Phoenix sp.** | – | – | – | – | – | + |
| *Tamarix aphylla* (L.) Karst. | – | + | + | + | + | + |
| *Zilla spinosa* (L.) Prantl. *ssp. spinosa* | + | + | + | + | – | + |
| Grasses | | | | | | |
| *Andropogoneae indet.* | – | + | – | – | + | – |
| *Brachiaria* B type | + | + | – | – | – | – |
| *Brachiaria* C type | + | + | – | – | – | – |
| *Cenchrus* cf. *biflorus* Roxb. | – | – | + | – | + | – |
| *Cenchrus* cf. *ciliaris* L. | – | + | – | – | – | – |
| *Cenchrus sp.* | + | + | + | – | + | – |
| *Dactyloctenium aegyptium* (L.) P. Beauv. | – | + | + | – | + | – |
| *Digitaria* type | – | – | + | – | + | – |
| *Echinochloa sp.* | + | + | + | + | + | + |
| *Eragrostis/Sporobolus* type | – | + | – | – | | – |
| *Panicum sp.* | + | + | + | + | – | – |
| *Pennisetum elatum* Hochst./ *setaceum* (Forsk.) Chiov. type | – | + | + | – | + | – |
| *Polypogon* cf. *monspeliensis* (L.) Desf. | – | – | – | – | + | – |
| *Setaria* type | + | + | + | – | + | – |
| *Targus sp.* | – | + | + | + | + | – |
| *Urochloa* type | + | + | + | – | + | – |
| *Urochloa/Brachiaria* type | + | + | – | – | – | – |
| *Gramineae indet.* | + | + | + | + | + | – |
| Other plants | | | | | | |
| *Aizoon* type | + | + | – | + | – | – |
| *Artemisia/Pulicaria* type | + | – | + | – | + | – |
| *Asphodelus* type | + | + | – | + | – | – |
| *Boraginaceae* | + | + | + | + | – | – |
| *Capparidaceae* type | + | + | + | + | – | – |
| *Caryophyllaceae* type | + | – | – | – | – | – |
| *Chenopodium murale* L. | – | – | + | – | + | – |

Table 5 (continued)

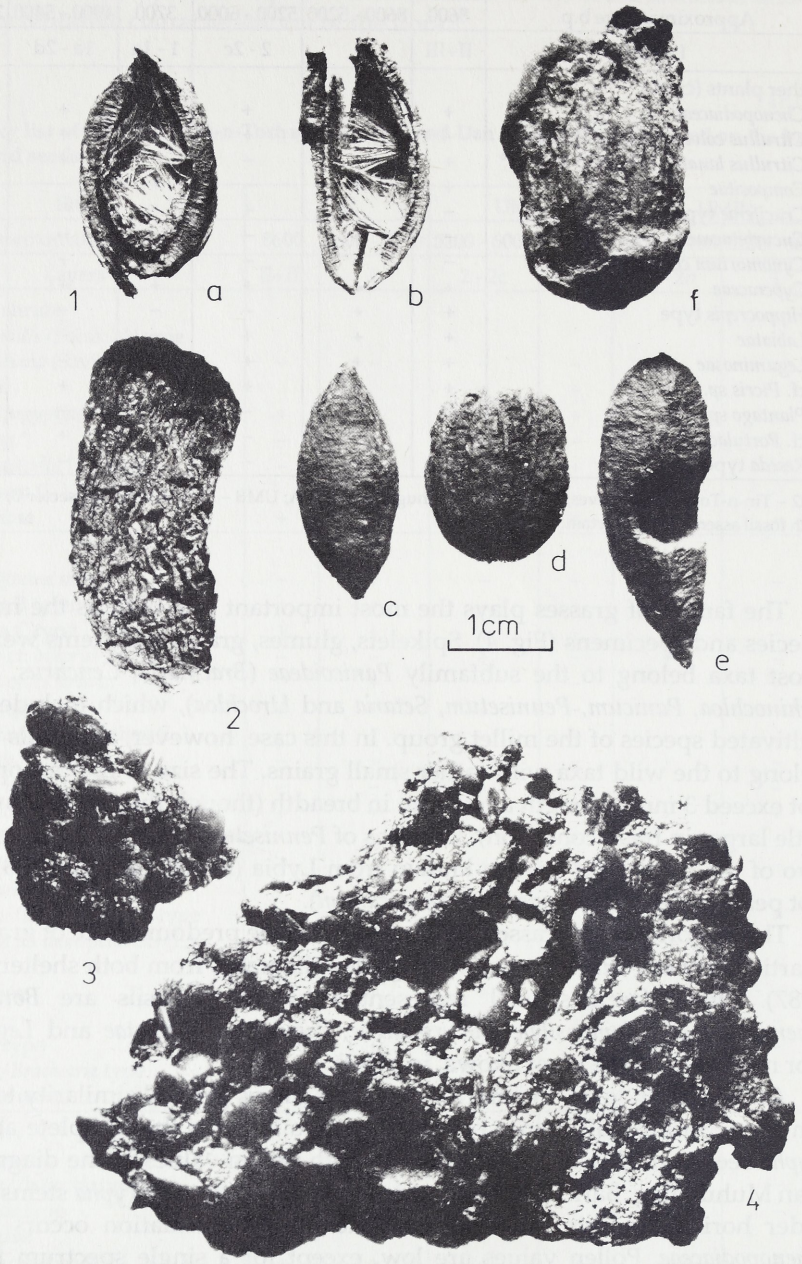
| Site | TH2 | | UMA | | UMB | |
|---|---|---|---|---|---|---|
| Approximate age b.p. | 8600 | 8600 - 5200 | 5200 - 6000 | 3700 | 4900 - 5400 | 2200 - 3800 |
| Layers | II+III | I | 2 - 2c | 1 - 1a | 1a - 2d | 1 |
| Other plants (cntd.) | | | | | | |
| *Chenopodiaceae* | + | + | + | + | + | + |
| *Citrullus colocynthis* (L.) Schrad. | – | + | + | + | + | + |
| *Citrullus lanatus* (Thunb.) Mansf.* | + | – | – | – | + | – |
| *Compositae* | + | + | – | + | – | + |
| *Cruciferae* type | – | – | + | – | – | – |
| *Cucurbitaceae* | – | + | – | – | – | – |
| *Cynomorium coccineum* L. type? | – | – | – | – | + | + |
| *Cyperaceae* | + | + | + | + | + | – |
| *Hippocrepis* type | + | + | – | – | – | – |
| *Labiatae* | + | + | + | – | – | – |
| *Leguminosae* | + | + | + | – | – | + |
| cf. *Picris sp.* | + | + | + | – | + | – |
| *Plantago sp.* | – | – | – | + | – | – |
| cf. *Portulaca oleracea* L. | – | – | – | – | + | – |
| *Reseda* type | + | + | – | – | – | – |

TH2 – Tin-n-Torha/Two Caves; UMA – Uan Muhuggiag sector A; UMB – Uan Muhuggiag sector B; * – affiliation with fossil assemblage uncertain.

The family of grasses plays the most important role both as the number of species and specimens (Fig. 4). Spikelets, glumes, grains and stems were found. Most taxa belong to the subfamily *Panicoideae* (*Brachiaria, Cenchrus, Digitaria, Echinochloa, Panicum, Pennisetum, Setaria* and *Urochloa*), which includes several cultivated species of the millet group. In this case, however, all fossils probably belong to the wild taxa with rather small grains. The size of the caryopses does not exceed 3 mm in length and 1 mm in breadth (though they could have been a little larger in fresh condition). Remains of *Pennisetum* (Fig. 4: 1 - 4) resemble the two of the three wild species known from Lybia (Sherif, Siddiqi 1988) and are not pearl millet, *P. typhoides* (=*P. americanum*).

The importance of grasses agrees well with the predominance of grass pollen (particularly of *Panicum* type) in the pollen diagrams from both shelters (Schulz 1987). Other families well represented by macrofossils are *Boraginaceae, Chenopodiaceae, Compositae, Cucurbitaceae, Cyperaceae, Labiatae* and *Leguminosae* (for more details see Wasylikowa, in print).

At the family level, the macrofossil flora shows general similarity to the pollen flora. Striking difference between the two floras is the complete absence of *Typha* seeds which was represented by high pollen values in the diagram from Uan Muhuggiag. Barich (1987) reported also the finding of *Typha* stems from the older horizon in this same shelter. The opposite situation occurs with the *Chenopodiaceae*. Pollen values are low, except for a single spectrum from one coprolite, whereas seeds are quite common, which confirms the opinion of Schulz (1987) about the importance of these plants in the vegetation at that time.


1
a
b
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2
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d
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1cm
3
4

**Remarks on the possible use of wild plants**

Few taxa found in the fossil material represent wild plants which are collected for various uses by the inhabitants of the Sahara today. Most interesting is the desert date *Balanites aegyptiaca* (L.) Del. (Fig. 5: 4). It is a small tree or shrub which grows in the *Acacia-Panicum* communities along the wadis in the desert zone (Ozenda 1958) and in the dry savanna zone (Knapp 1973). Its ripe fruits may be eaten raw, its oil is extracted from the seeds, and its fruit pulp has medicinal properties. Due to the saponine content, fruits may be used for cleaning silk and cotton. Different articles of home-use are made of its very hard wood which is also used in fires (Gast 1968; Tubiana and Tubiana 1977). Many fruit-stones were found in all layers from Uan Muhuggiag and only two fragments appeared in one sample from Ti-n-Torha/Two Caves. Most of the very hard fruit-stones were broken, usually split longitudinally, and uncharred; a few were charred or partly charred, many of them filled with fragments of herbs, mainly grass spikelets. It seems probable that the endocarps were crushed by people in order to obtain seeds. The work could have been done inside or outside the shelter. The utilization of *Balanites* fruits is here suggested only for the Neolithic period (and younger times) in Uan Muhuggiag where the stones were abundant (particularly so in the sector B). Two fruit stone-wall pieces of the age of about 8,600 b.p. (layer IIa) found in the Ti-n-Torha/Two Caves may represent quite accidental admixture.

Several other plants could have been gathered for food by the nomads inhabiting the Acacus Mountains but there is no direct evidence. In several samples from Uan Muhuggiag seeds of colocynth *Citrullus colocynthis* (L.) Schrad. were found. This common Saharan species has very bitter fruits but its seeds can be eaten after boiling and drying them (Nicolaisen 1963). A few seeds of water melon, *Citrullus lanatus* (Thunb.) Mansf. were present in one sample from Uan Muhuggiag and one from Ti-n-Torha. They had a badly damaged surface (digested?) and did not look fresh. This widely cultivated plant has also wild races which occur in tropical Africa. Those without a bitter taste are collected as food for humans and animals (Nowiński 1977). The species is not included in the present-day flora of Sahara by Ozenda (1958) and its occurrence in our material might indicate a change of its former range, but contamination by modern seeds of a cultivated form is more likely.

*Cynomorium coccineum* L., a parasitic plant growing in salt mashes, has an underground stem that can be dried and ground into flour (Nicolaisen 1963). Two possible fragments of the stem of this plant were found in both horizons of Uan

Fig. 5. Uan Muhuggiag. 1: *Balanites aegyptiaca* from sector B, layer 2b: a - e: fruit-stones; f: fruit with epi- and mesocarpium preserved; a, b: filled with *Pennisetum* spikelets, all uncharred. 2: *Cynomorium coccineum* type?, uncharred specimen resembling stem fragment of this plant, sector B, layer 1. 3: *Acacia sp.*, "roasted" seeds, sector A, layer 2a. 4: *Citrullus colocynthis*, uncharred seeds, sector B layer 1. (Photo A. Pachoński).

Muhuggiag shelter (Fig. 5: 3). Various grasses, having grains slightly smaller than the present-day cultivated millet, were available in the wadis and were found in the shelter deposits. They were certainly collected but we have no clear evidence whether the grains were gathered for food or stems (with grains attached) for bedding, or both. It should be stressed here that Ti-n-Torha and Uan Muhuggiag do not differ much in the number of grass remains. This means that plant material does not support the opinion of Barich (1987) that the gathering of grasses was more important in Ti-n-Torha than in Uan Muhuggiag.

The finding of three stones of a palm from the genus *Phoenix* in the uppermost level of Uan Muhuggiag requires comment. The endocarps are relatively short and broad (15 × 7 mm and 17 × 8.5 mm), with rounded ends, and resemble the stone described by Hadidi (1980: Fig. A5.3) from Nabta Playa and dated to 7,000 - 6,500 b.p. According to Hadidi this stone is similar in size to endocarps of a wild tropical palm *Phoenix reclinata* Jacq. and to the stones of a dwarf form of date palm *P. dactylifera* L. which grows wild. This dwarf form, in his opinion, may be regarded as one of the prototypes of the date palm and with this form the stone from Nabta Playa is compared. For the time being the stones from Uan Muhuggiag were not identified to the species level because no reference material was available. Their precise age is not known since they were found in the sample No. 1 (layer 1, sector B) which contained uncharred plant remains of various ages (Table 4).

The list of taxa identified from the Acacus by their seeds, fruits and pollen includes some other plants which are gathered for food in various parts of the Sahara today (*e.g. Aizoon* type, *Chenopodium sp.* div., *Maerua*). It should be stressed, however, that the fact that some plants are collected from the wild state today does not prove their utilization at every place and every time in the past. This has to be confirmed by additional observations, such as the frequency or abundance of findings, evidence for special treatment *etc.*, as is the case with *Balanites* stones from Uan Muhuggiag.

Plants known presently only in cultivated forms are represented by *Ceratonia siliqua* L.?, St. John's Bread. A fragment of a legume most probably from this species was found in layer 2a in Uan Muhuggiag. The species has been cultivated in the Mediterranean basin at least since the 1st millennium b.c. (Duran, Baratte 1910; Nowiński 1977) and its presence in the Acacus is difficult to explain. The easiest explanation would be contamination by much younger or modern material but this possibility requires more evidence.

## Vegetation of the habitation periods

Plant material found in settlement layers may not have accumulated in the rock shelters in a natural way, except possibly for a few pollen grains blown in. It was partly gathered by people for special purposes outside of the shelters and stored inside and partly brought in unconsciously by people and animals (*e.g.* pollen, seeds and fruits attached to animal hair, or sticking to the other plants

which were collected or included in the dung). This mean that the fossil flora reflects surrounding vegetation in a very specific way. It shows which plants were present in the area at the time of habitation but gives no direct information about the quantitative relations between different species. Plants which were of some use to humans and their animals are overrepresented. Taking these reservations into account Schulz (1987) presented an attempt at reconstructing the vegetation in the Acacus Mountains during the time between about nine and five thousand years ago. On the basis of pollen spectra from the shelters Ti-n-Torha North and East and Uan Muhuggiag he concluded that woodlands similar to the present-day communities of *Acacia-Panicum* or *Tamarix-Stipagrostis* type occurred along the wadis. They were probably richer in floral composition and extended farther towards the surrounding plains than today. Probably also the herbaceous vegetation covered these plains with denser populations of perennial and annual species. Places with high ground-water level or more persistent water pools were surrounded by belts of *Phragmites, Cyperaceae* and *Typha*. The vegetation was sufficently rich to provide good pastures. Schulz has stressed the importance of Sahelian elements in the past flora of the Acacus and pointed out the area of Aïr Mountains, about 800 km to the southeast, as a possible modern analogue for the reconstructed fossil vegetation. Pollen spectra indicated also the presence of the Mediterranean/montane pre-Sahara species which could grow in the upper part of the mountains (*Artemisia, Ephedra, Olea*). The presence of these elements, however, was not considered by Schulz as an evidence for the displacement of Sahelian and Mediterranean zones. In his opinion, the rare occurrence of several species representing the Sahelian element in the Tassili-n-Ajjir and the destruction of modern vegetation by overgrazing and by the drought of the last decades demand great caution in the interpretation of the vegetational changes in the Acacus during the Holocene.

Macrofossil analysis has confirmed the presence of several desert savanna elements, such as *Acacia tortilis ssp. raddiana, A. sp., Balanites aegyptiaca, Zilla spinosa ssp. spinosa, Tamarix aphylla, Citrullus colocynthis, Asphodelus* type, *Aizoon* type, *Panicus sp. div., Pennisetum sp. div.* and another grasses (Quezel 1965). We may expect that a more detailed phytogeographical analysis of the macrofossil flora will be possible when more specific determinations are available. Even then, however, it will not be easy to estimate the significance of the savanna element in the fossil flora because many plants can grow in the wadi woodlands within the desert zone as well as in the typical dry savanna zone.

Climatic oscillations described by Pasa (Pasa and Pasa-Durante 1963; Barich 1987) from Uan Muhuggiag on the basis of lithological changes and pollen analysis were not confirmed by much more detailed pollen diagrams presented by Schulz (1987). At the present stage of investigation, macrofossil spectra also do not permit any stratigraphic differentiation of the fossil flora. Instead, they confirm the difference between Ti-n-Torha and Uan Muhuggiag as far as the representation of arboreal flora is concerned. The almost complete absence of trees and shrubs among the identified diaspores from Ti-n-Torha/Two Caves agrees well with the smaller number of arboreal pollen in Ti-n-Torha East and

North compared with Uan Muhuggiag. It was explained by Schulz (1987) as the reflection of a real difference in vegetation between the northern and central parts of the Acacus Mountains because higher climatic dryness of the northern part, caused probably by more peripheral position within the mountain range, resulted in more open vegetation around Ti-n-Torha. A fairly abundant occurrence, in settlement layers, of plant detritus with an admixture of fruits and seeds indicates that local wadi vegetation must have been quite rich during the short seasons when the rock shelters were inhabited.

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