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The Halaf Environment and Human Activities in the Khabur Drainage, Syria

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Archaeobotanical studies frequently focus on single site economies; as a result, relatively few such studies in the Near East use plant remains to develop regional perspectives. By comparing farming practices and evidence for plant resources in the vicinities of two contemporary Halaf sites in different environments, this paper offers a first attempt to examine how peoples of the 5th millennium B.C., *linked by their material culture, differed in their adaptation to local environments.*

Introduction

In the late 6th millennium B.C., a distinctive, painted ceramic ware began to appear in the northern Jezireh (between the Euphrates and Tigris Rivers) of Syria and Iraq (FIG. 1, inset). Named for the site where it was first identified (von Oppenheim and Schmidt 1943), the Halaf ceramic period spans 800–1000 years (Watkins and Campbell 1987: 451–453; Hours and Copeland 1987: 421; Davidson 1977: 350–353; Watson 1983: 238), during which this handsome pottery became widely distributed (LeBlanc and Watson 1973: 117). Archaeologists have determined that most Halaf settlements were small (ca. 1 ha) (Watson 1983: 239, after Davidson 1977; Hijara 1980: 252, 272) and typically were occupied only intermittently. By the Late Halaf period (ca. 5000–4500 B.C.) painted Halaf ceramics were extensively exchanged or otherwise regionally distributed (Davidson and McKerrell 1976: 53). At most excavated Halaf sites are "tholoi," structures that probably were domed, and some of which may have been employed for crop storage (Akkermans 1987: 26, 1989: 59–66; Seeden 1982: 74, 91). Although Halaf sites are usually identified as villages (Hijara 1980: 251–258, 272; Mellaart 1975: 161, 169), we understand little about the respective roles of farmers, pastoralists, seasonality, or full-time occupation during the period or whether differences in settlement sizes reflect different political or economic functions. In the patterns of exchange of materials such as obsidian (Renfrew, Dixon, and Cann 1966) and ceramics (Davidson and McKerrell 1976), some authors see evidence of ranked societies (Watson 1983: 241), but while the Halaf culture has been characterized as an agricultural society raising dry-farmed crops and domesticated animals (Watson 1983: 238–239), there has been little research directed at determining how the Halafians lived and why they settled in the upper Jezireh.

Problems in Late Halaf Period Economies

In attempting to redress this situation by reconstructing site economies and their regional integration, specific questions arise: 1) What were local environments like during the Halaf period? 2) How did people adapt to them? 3) Were site occupations seasonal or permanent? 4) Did farmers throughout the Halaf cultural region use the same techniques? 5) What was the role of herding? 6) Were perishable materials such as agricultural products also widely distributed in the manner of Halaf ceramics? 7) What ecological and environmental changes induced by human or natural agents can be detected that were related to Halaf resource uses?

To address these questions, this paper presents an analysis of plant remains from two Late Halaf sites situated in quite different environments in the Syrian Jezireh, and attempts to reconstruct aspects of each site's economy. The methods borrow heavily from the work of other archaeobotanists (Fasham and Monk 1978; Hillman 1984a, 1984b, 1985; Hubbard 1975, 1976; Jones 1984, 1987; Miller 1984a, 1984b, 1988; Miller and Smart 1984; Popper 1988; Willcox 1974). In order to build on their work, applying botanical models for comparative purposes, emphasis must be placed on controlling for variation in contexts and on sampling designs to ensure that real differences between sites can be observed.

The two sites, Tell Aqab and Umm Qseir (FIG. 1), lie in the Khabur River drainage. Excavations produced closely comparable ceramic assemblages (suggesting contemporaneity) and uncovered tholos foundations buried in ashy debris; despite their similar stratigraphy and cul-

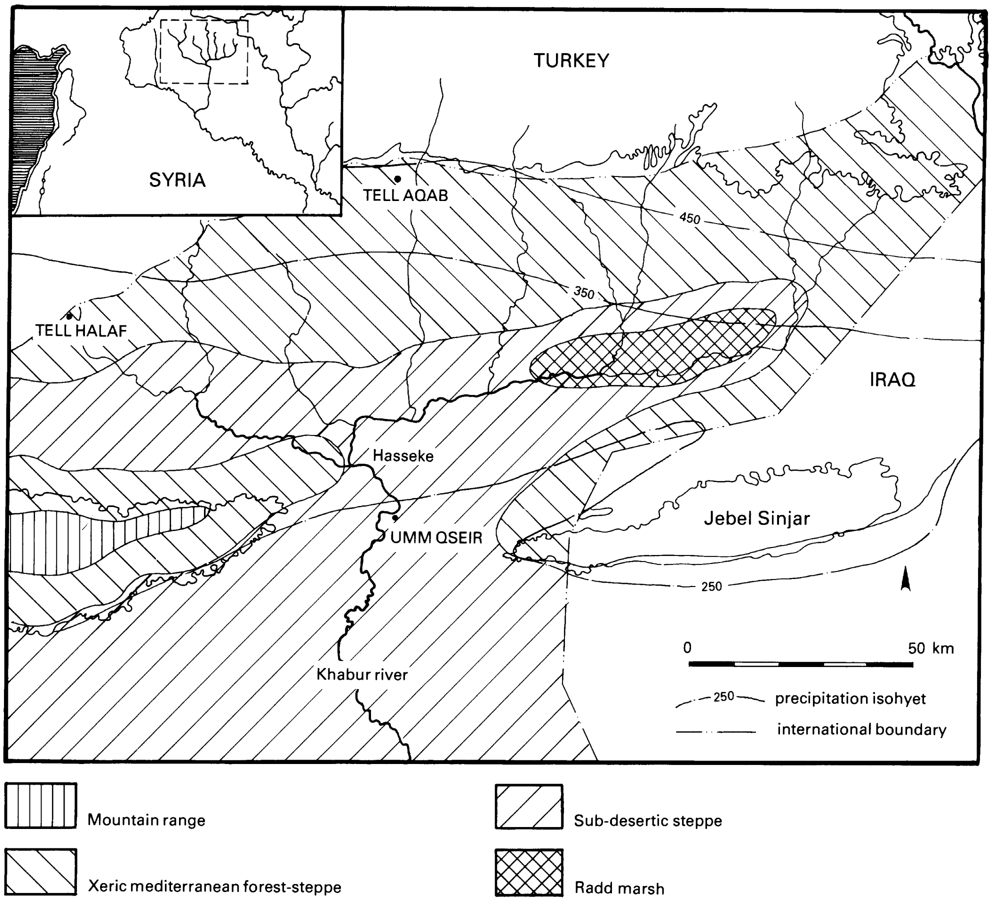


Figure 1. Location of sites discussed in the text and modern precipitation isohyets and vegetation zones in the Khabur drainage, Syria.

tural assemblages, however, Tell Aqab and Umm Qseir occupy what are today two contrasting settings that one might characterize as representing opposite ends of a continuum of resources and environments. This paper explores the nature of local environments during the 5th millennium B.C., and through interpretation of the Late Halaf plant remains, begins to reconstruct economic adaptations and subsequent environmental changes in the Khabur area 7000 years ago.

The Sites

Umm Qseir and Tell Aqab were selected for archaeobotanical study to provide potentially contrasting contemporary pictures of the Halaf culture, on the assumption that there would have been environmental differences between the sites comparable to what we see today. These modern differences are reflected principally in rainfall, vegetation, and soil types (FIGS. 1, 2). While all these may have changed somewhat over 7000 years, the two sites lie in distinctly different bioclimatic zones (UNESCO-FAO 1963), and the environmental differential between the sites is unlikely to have altered substantially over time.

Tell Aqab, excavated in the late 1970s by a team from Edinburgh University, produced only a limited exposure of the Late Halaf phase (8 × 10 m), which appears at the base of a step trench. The only architectural feature in this exposure was a tholos wall, over which spilled an extensive ashy midden (Davidson and Watkins 1981: 5). Since no other structures were fully excavated, and none of the midden material can be clearly associated with the function of the tholos itself, no architectural evidence exists to suggest how the site and surrounding resources might have been used. Tholoi have been interpreted as storage structures at other Halaf sites (Seeden 1982: 74, 91; Akkermans 1989: 59–66), but this does not answer the question of how often and how long people occupied the site.

The excavated architecture of Umm Qseir greatly resembles that of Tell Aqab. In a 7 × 10 m trench, a single

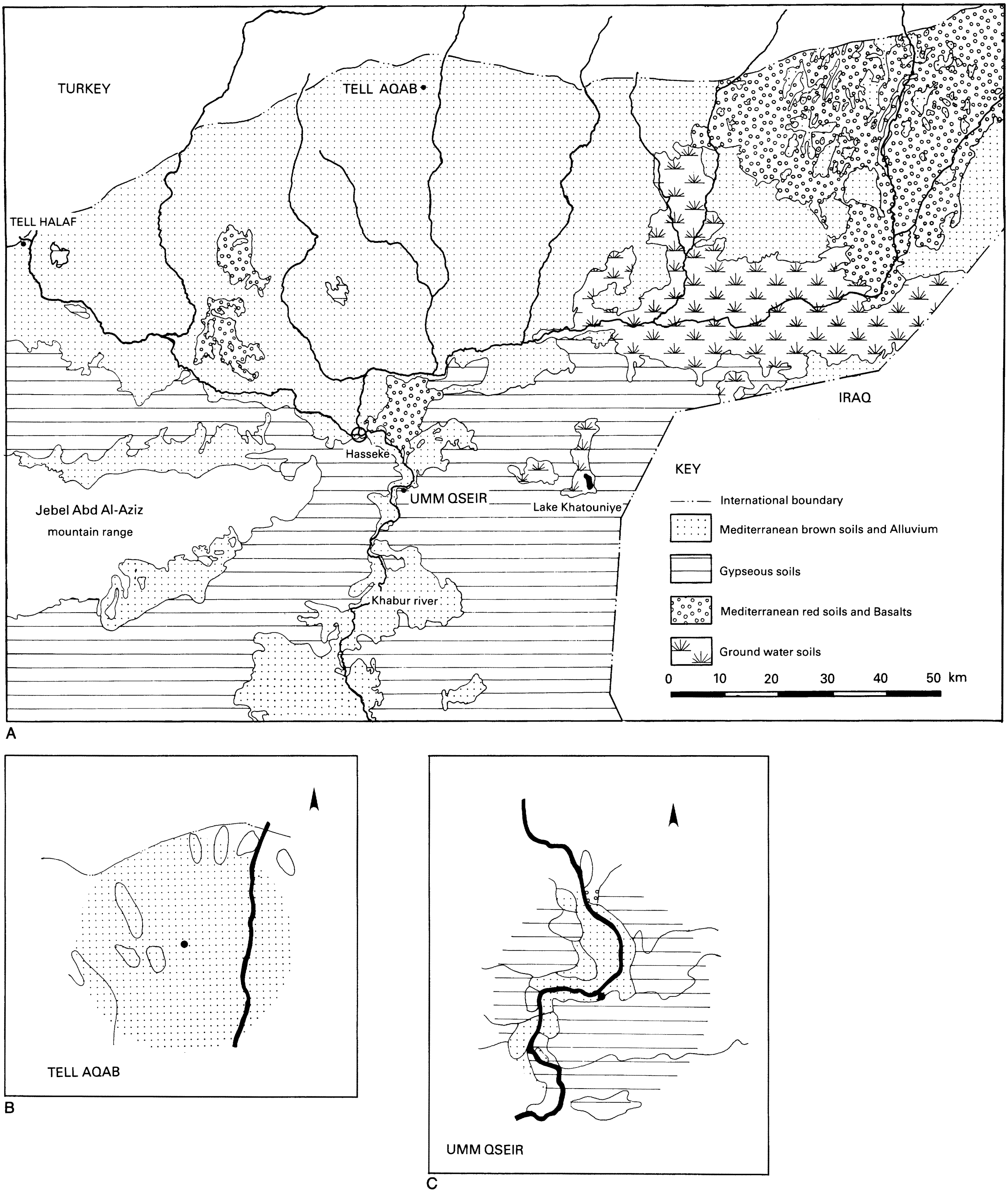


Figure 2. Major soil groups in the Khabur drainage (after van Liere 1964). A) Map of Khabur drainage; B) Detail of 5 km radius around Tell Aqab showing soil types within major groups; C) Detail of 5 km radius around Umm Qseir showing soil types within major groups.

Figure 3. Cultivation on Mediterranean brown soils in the Khabur drainage.

tholos was discovered during a Yale University excavation in 1986. Like the deposit at Tell Aqab, the eroded tholos wall was covered by several meters of ashy midden. Since Umm Qseir also lacked clear evidence of households, reconstructing settlement from the tholos and midden is equally problematic without studying plant remains and animal bones.

Most Late Halaf sites are within the dry periphery of the Mediterranean zone, which here means a climatic belt at the edge of tropical deserts (Raven 1973: 214) that includes characteristic rainfall patterns (winter only), soils, and vegetation. While Tell Aqab, like most Halaf sites (Davidson 1977: 11–13; Hijara 1980: 234–235), lies at this Mediterranean periphery in the Near East, Umm Qseir is in a more southerly subdesertic zone (UNESCO-FAO 1963) that experiences greater aridity and greater winter cold.

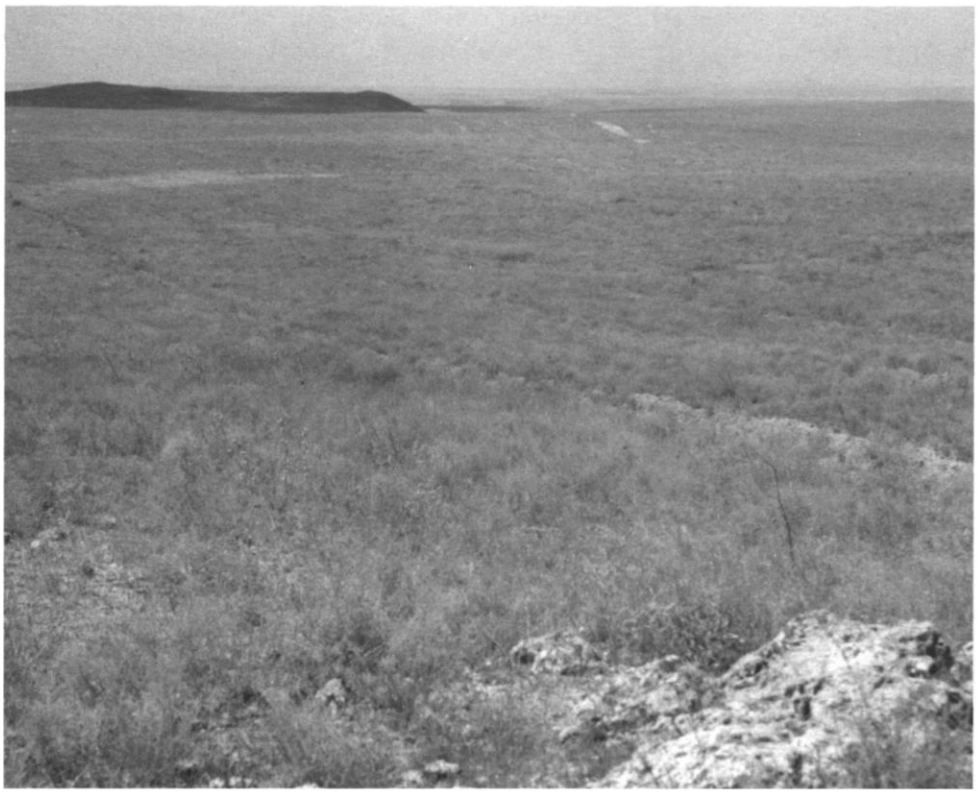
Tell Aqab is about 8 km SW of 'Amouda and lies well within the modern 400 mm isohyet (Syrian Meteorological Department 1977), which ensures ample annual rainfall for agriculture. Dry-farming is reliable and productive on the rich Mediterranean-steppe brown soils adjacent to the site (Muir 1951: 172, 174; Reifenberg 1952: 76) (FIG. 3). These soils are alluvial (Reifenberg 1952) and largely of Quaternary montane origin (van Liere 1960–1961: 41–45). It is unclear how many of these soils represent recent deposits; there has clearly been some deposition since Tell Aqab was occupied, resulting from ancient deforestation of the foothills of Anatolia (Rowton 1967: 275–277; Miller 1986: 89; Wilkinson 1990: 100). While the Taurus Range within sight of Tell Aqab would have provided a rich source of timber in antiquity, present-day soils adjacent to the site could also support a pistachio-oak (*Pistacia atlantica* L., *Quercus persica* Jaub. et Sp.) steppe forest (Pabot 1957: 64, 80; UNESCO-FAO 1969: 64; Zohary 1973: 585–586). Because the climate is somewhat continental, with cold winters, other deciduous trees may also have been present in wetter areas where they could survive summer drought.

Quite different from the location of Tell Aqab is that of Umm Qseir, about 10 km south of Hasseke and the montane alignment of Jebel Abd al Aziz and Jebel Sinjar, and 20 km south of the nearest Halaf site (Hole and Johnson 1986–1987: 172). Umm Qseir is in the valley of the Khabur River but beyond the 250 mm rainfall isohyet, which is today regarded as a rule-of-thumb boundary for the limits of dry farming, where crop failure is a common experience (Davies 1957: 127) (FIG. 1). The soils around the site also make dry farming unproductive since, with the exception of the alluvium in a very narrow river valley, all those within and well beyond a radius of 10 km are of gypseous parent materials (Muir 1951: 171; van Liere 1964) (FIG. 2) and tend toward high salinity values. The climax vegetation of the Mesopotamian steppe adjacent to Umm Qseir would doubtless be quite different from the northern xerothermic (UNESCO-FAO 1969: 78) Mediterranean forest-steppe adjacent to Tell Aqab. With cold winters and searing summer heat and aridity, the subdesert climate south of Hasseke prohibits most tree growth, and a wormwood (*Artemisia herba-alba* Asso.) dominated steppe, with dwarfed woody vegetation, is most likely (Pabot 1957: 76, 80; Zohary 1973: 473, 478–480) (FIG. 4).

In comparing soil maps of the two regions, one notes the patchiness of different soil types around Umm Qseir, contrasting with undifferentiated, rich soils at Aqab (van Liere 1964) (FIG. 2). The homogeneity of soil types at Aqab (and thus the potential for homogeneous plant cover) is corroborated by studies of clay sources in the adjacent Wadi Dara system. These studies afford a closer examination of regional soil chemistry (Davidson 1981: 71). The samples from near Tell Aqab clustered closely in trace-element composition (Davidson 1981: 70), a pattern that could suggest soil homogeneity throughout the system studied, although for differentiation in flora and vegetation, the physical properties of soil are far more important than chemical ones (Sankary 1971: 115–121; Zohary 1981: 39). This point is of some relevance at Umm Qseir where gypseous soils, patchy on soil maps, do not preclude a rich vegetation cover, albeit differentiated into distinct communities, under optimum conditions.

The differences between the environments at Tell Aqab and Umm Qseir today doubtless reflect an equally broad contrast at the beginning of the 5th millennium B.C. From the locations of the sites one might reasonably expect the Halaf inhabitants at Tell Aqab to have practiced dry-farming (Davidson 1977: 11–12; Davidson and Watkins 1981: 1–3), while Umm Qseir, poorly situated to sustain an agricultural economy, might have served as a camp for pastoralists or herders exploiting the steppic forage (Hole and Johnson 1986–1987: 172–173; Melinda Zeder and Elizabeth Myler, personal communication, 1989). While the excavated architecture yielded little information about site economies, a study of the plant remains will enhance our understanding of the sites.

Figure 4. Modern climax vegetation in the *Artemisia herba-alba* Asso. steppe south of the Jebel Abd al Aziz.



Sampling Charred Plant Remains

If a comparison of plant remains from Tell Aqab and Umm Qseir is to be used to provide economic and environmental data for the Late Halaf period, one of the first concerns is whether differences in sampling or preservation have created spuriously divergent results. In order to study differences due to the environment and economy, one must examine variables affecting the composition of an archaeobotanical sample, such as context and recovery of charred plant remains.

Recovery

The plant remains examined in this article were recovered from Late Halaf levels sampled at the two sites described above. The material from Umm Qseir was recovered and floated in 1986: the excavators used the finest mesh available locally (about 350 μ), retaining all recovered charred material from relatively small samples (2–4 liters) of ash lenses containing animal bone and diagnostic pottery. As the flots were small (143 cc total), all fragments greater than 500 μ (0.5 mm) diameter were sorted under low magnification (7×–10×) in the laboratory. Fragments smaller than this are usually parts of plant structures (seeds, bracts, glumes, capsules, etc.) represented largely intact in the >500 μ fraction. As very few intact seeds smaller than 500 μ in diameter can be identified under low magnification, this flot fraction was extensively scanned for identifiable fragments rather than intensively sorted (removal of all identifiable fragments). Wood charcoal fragments were recovered from the fraction >1 mm, but almost none reached 2 mm in diameter, and very few have the full growth ring necessary for ready identification. From a total of 2211 plant fragments, 949 proved identifiable and formed the basis of the analysis.

The plant remains from Tell Aqab were recovered when the site was excavated in the early 1970s. The excavators floated the entire Late Halaf ashy deposits overlying the tholos walls in Trench 2, and although the volume was not recorded it was said to be "large" (Davidson and Watkins 1981: 5; Thomas E. Davidson, personal communication, 1988). (Other "large" samples from the site consisted of five level wheelbarrows of earth. Since a wheelbarrow holds about 30 liters, the samples approached 150 liters in size.) The soil was processed with a Cambridge Mark III froth flotation machine (Thomas E. Davidson, personal communication, 1988), which generated a total of 407 cc of flot, a volume much greater than that recovered from the deposits at Umm Qseir. Only 73 cc (18%), however, were sorted in the laboratory using an incremental subsampling technique to ensure that all frequent taxa are recorded (Fasham and Monk 1978). As with Umm Qseir samples, charred items less than 500 μ in diameter were scanned, while larger fractions were intensively sorted. While the volume of charred plant remains recovered from excavations at Tell Aqab was thus much greater than that from Umm Qseir, only a portion of Tell Aqab flot was sorted. By using this method of subsampling in the lab, a sample estimated to be comparable to that from Umm Qseir was isolated for further study. Thus the Umm Qseir deposit was subsampled in the field while that from Tell Aqab was subsampled in the lab. As will be discussed later, rather than introducing variance in the samples, this difference in method instead provided a check that both sites had been adequately sampled to record some of the rarer taxa.

Context

In selecting such similar archaeological deposits for analysis, I assumed that many similarities later evident in the composition of plant remains were the result of similar taphonomic processes rather than convergent results of very different deposition and preservation processes. The soil samples from which charred plant remains were extracted at Umm Qseir and Tell Aqab were from very similar stratigraphic contexts, suggesting closely comparable taphonomic histories—an interpretation corroborated by internal evidence, namely a) the physical condition and preservation of the charred remains, and b) the composition of taxa and plant parts in the samples.

The stratigraphic contexts of the ashy deposits sampled are likewise homologous. At both sites the excavators chose samples from around the wall stumps of circular Halafian tholoi. At Umm Qseir, ashy deposits over 2 m deep underlay and overlay a very eroded Halaf tholos, and appeared to be midden debris unassociated with the primary function of the structure (Hole and Johnson 1986–1987: 174).

At Tell Aqab a large ashy deposit partially filled a collapsed Halaf tholos and extended over the stump of the tholos wall. Stratigraphically the deposit represents a midden infill over a disused structure. Like the middens at Umm Qseir, it is at best a secondary cultural context representing the mixing of hearth ashes from many events of food preparation, cooking, and fuel use, and the plant remains must be regarded as an aggregate of the range of activities that exposed plants to hearth fires on the site.

As midden material in secondary, if not even more distantly derived, cultural contexts the plant remains offer the greatest amount of information if interpreted as an

Table 1. Sample sizes and counts from Halaf sites.

	Umm Qseir	*Tell Aqab*
Sample size (ml)	143	407
Volume sorted (ml)	143	73
Number of archaeological deposits sampled	3	3
Raw Counts:		
Grains		
Emmer wheat (*Triticum dicoccum* Schrank.)	76	22
Barley (6 row) (*Hordeum vulgare*)	45	0
Barley (2 row) (*Hordeum vulgare*)	30	31
Flax seed (*Linum usitatissimum*)	0	1
Legumes		
Lentil (*Lens culinaris* Medik.)	87	3
Bitter vetch (*Vicia ervilia* [L.] Willd.)	9	1
Chickpea (*Cicer arietinum*)	2	0
Pea (*Pisum* sp.)	1	0
Chaff		
Emmer rachis and glume fragments	535	143
Barley rachis and glume fragments	8	0
Cereal straw	20	4
Weeds		
Wild barley (*Hordeum spontaneum* C. Koch)	8	0
Maygrass (*Phalaris* sp.)	4	0
Brome grass (*Bromus* sp.)	2	0
Goat-faced grass seed (*Aegilops* sp.)	2	3
Goat-faced grass chaff (cf. *Aegilops crassa* Boiss.)	69	0
Polypogon type	0	7
Bellevalia sp.	7	0
Hypecoum sp.	1	0
Vaccaria pyramidata Medik.	0	4
Catchfly (*Silene* sp.)	0	4
Astragalus type	20	181
Scorpiurus muricatus	0	1
Scorpion vetch (*Coronilla scorpioides* [L.] Koch.)	1	0
Trigonella sp.	1	4
Medicago type	0	10
Trefoil (*Trifolium* type)	0	2
Lathyrus type	0	1
Bugloss (*Buglossoides arvensis* I. M. Johnson)	9	0
Wild plants		
Purselane (*Portulaca oleracea*)	2	0
Wild blackberry (*Rubus sanctus* Schreb.)	2	0
Wild pistachio (*Pistacia khinjuk* Stokes.)	1	0
Woods and dung fuel		
Willow/poplar type (*Salix/Populus*)	3	0
Almond (*Amygdalus* sp.)	4	0
Ash (*Fraxinus* sp.)	0	1
Juniper (*Juniperus* sp.)	0	2
Number of identifiable items	949	425
Number of taxa (identifiable)	26	19
Total number of seeds sorted	1494	605
Total number of chaff fragments sorted	717	147
Total number of items	2211	752

averaged set of burning activities on the site. These activities are better and more extensively identified and discussed elsewhere (Hillman 1984a, 1984b, 1985) but it is relevant to repeat here that they reflect a mixture of agricultural processing, collection of wild plants, and fuel use on the site (Miller 1988: 80).

The two samples of plant remains discussed are from closely comparable archaeological deposits and were sampled in such a way that at each site rarer taxa (e.g., flax, pistachio, and catchfly—known to be in relatively low numbers at other sites in the Near East) were recovered (TABLE 1). As mixed deposits consisting of many burned residues, these middens would be expected to have very similar diversity, for while yielding different taxa they should reflect similarly mixed residues of burned material.

To compare diversity of the samples statistically would require simulation studies such as proposed by McCartney and Glass (1990: 533). Both richness (number of taxa) and evenness (distribution of items among taxa) are sensitive to sample size but richness less so (McCartney and Glass 1990: 525, 533; Magurran 1988: 72–73). Richness is greater at Umm Qseir with 26 taxa (compared with 19 at Tell Aqab) where small samples precluded using incremental subsampling to be certain that rarer taxa are represented in the counts.

It is most likely that a combination of different regional environments and economic activities can account for most variations in the associations of taxa represented by the samples. That is, if no differences can be observed between the charred plant remains from Umm Qseir and Tell Aqab, then in the Late Halaf the two sites had similar environments and their inhabitants practiced similar plant food procurement strategies.

Analytical Methods Using Modern Activity and Vegetation Models

Assuming that prehistoric regional environments and economic activities were the critical variables determining composition of charred plant remains recovered from the two sites, analysis must seek to identify 1) differences in sample composition, and 2) the contributions of each activity to these differences.

Fortunately, both vegetation types and agricultural activities have been studied in the Near East and described with the use of environmental models and activity models. Based on the modern observed associations of plant taxa with specific environments or human activities, these models identify plant taxa (indicator species) with a) physical properties that suggest they derive from a particular activ-

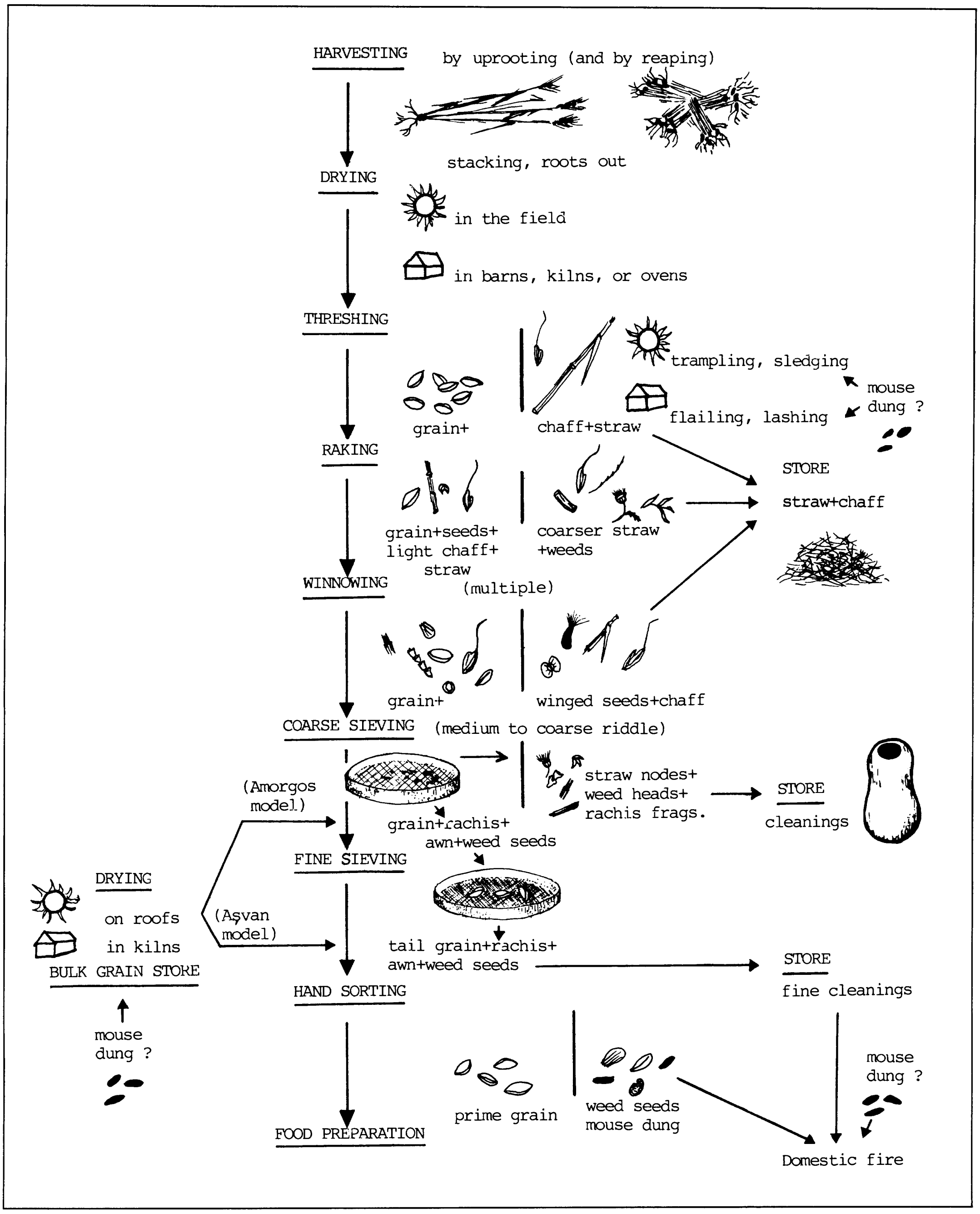


Figure 5. Ethnographic model of the stages of crop processing (after Hillman 1984a, 1984b; Jones 1984).

ity (activity models[1]), or b) narrow ecological requirements that identify a niche found particularly frequently in one type of vegetation (environmental models[2]). Indicator species in archaeological contexts then suggest that

1. An early stage of analysis must determine the contributions of different activities to the composition of the different samples (Hillman 1984a). With the use of models like the crop processing example, it is possible to suggest how a particular plant specimen arrived on a site and how it was charred and incorporated in a midden deposit. Archaeobotanists have proposed detailed crop processing models for various regions of the Near East (Hillman 1984a, 1984b, 1985; Jones 1984; Al Azm 1985), but no formal models exist for the Khabur drainage. In this analysis, results of fieldwork (see TABLE 2) provided the taxa to substitute for those in Turkish and Greek models. Information was also gathered from local informants from a recently-settled Bedouin tribe on the food, medicinal, and fuel uses of wild plants native to the Khabur region.

2. The second stage of analysis moves from identifying human activ-

these activities or ecological requirements were operative in the past. For example, to apply models of an agricultural activity such as crop processing (e.g., Hillman 1984a, 1984b, 1985; Jones 1984) (FIG. 5), one first identifies indicator taxa and plant tissues in the archaeological sample. Next, the modern models are consulted to identify both the specific activity (modern parameters) that contributed to the archaeological deposit and other taxa associated with the same activity, including taxa that may not have been preserved archaeologically. The application of these models in a presence analysis depends on species richness, or number of taxa present, rather than species evenness, or distribution of plant remains among taxa.

In analyzing differences between the two sites, I considered both presence/absence of taxa and ratios of taxa to sample volumes (Miller 1988: 73–76). Application of models relies on presence of indicator taxa or plant tissues (Hillman 1984a: 7–8, 14; Hubbard 1975: 198, 1976: 160; Jones 1987: 314–315). Presence analysis has proven a useful tool in making comparisons between sites (e.g., Hubbard 1975, 1976; Willcox 1974; Popper 1988: 60–64) and clearly constitutes a first step in developing a method to examine sites in their regional economic and environmental contexts. In certain cases ratios provided a particularly useful way to illustrate differences between the two sites where the activities are clearly similar.

Results of Archaeobotanical Analysis at Tell Aqab and Umm Qseir

Given that 1) archaeological context and samples are very similar and 2) only the most frequent taxa are considered, the samples should contain the same taxa if Tell Aqab and Umm Qseir were in the same environment in the past and the same activities were carried out on both sites. There are, however, notable differences in the plant remains represented at Tell Aqab and Umm Qseir, suggesting that activities and environments were different at the two sites in the Late Halaf period (TABLE 1).

Both sites contained small fragments of chaff and a range of field weeds that suggest the waste fraction from final stages of crop processing (FIG. 6) as well as other plants derived from non-agricultural activities. The charred plant evidence from the hearths documented the use of fuels and (in the case of Umm Qseir) of wild resources, while it preserved only the final stages of fine sieving and the hand-picking of cereal and pulse crops.

From the taxa listed in Table 1 and the activities shown in Figure 6, it is evident that, while plant remains from the two sites are similar, there are some significant differences in both species and activities represented. Both grain and chaff from emmer wheat and barley crops, lentils, field peas, and bitter vetch appear at both sites; however, at Umm Qseir the crop inventory is augmented by chickpea and six-row barley, while cultivated flax appears at Tell Aqab. From both sites a range of field weeds associated with cultivation was also identified. Only Umm Qseir, however, produced evidence of collecting wild plants for food. Detailed examination of the plant inventories of the two sites shows the differences in farming regimes.

Tell Aqab is located in a prime dry-farming region at the edge of today's xeric Mediterranean climatic zone, and there are few surprises in the prehistoric plant inventory. All the crops are easily dry-farmed, with pulse harvest in the spring and cereals in the early summer. Lentils are harvested in April, bitter vetch in early or mid May, and field pea in late May or June. The cereals, especially barley, may stand after ripening, but are certainly harvested by July. Two-row barley is typical of traditional dry-farming in Mediterranean climates throughout the Fertile Crescent.

Table 2 lists some models I have compiled from which certain weeds can be tentatively associated with farming regimes and soil types.[3] At Tell Aqab the weed flora, while

ities to reconstructing a local environment for the time in which a site was occupied. Usually other plant remains such as pollen and phytoliths are employed in environmental reconstruction (Dimbleby 1967: 112–120; Pearsall 1989: 245, 294–295, 338; Piperno 1988: 200–201), but the evidence from charred plant remains is often complementary to such studies. In the upper Khabur drainage, pollen analyses have proved unfruitful because there are no appropriate deposits from which to core a long sequence (Gremmen and Bottema, in press; Bottema 1989: 7); moreover, no phytolith analyses have been attempted, perhaps because of the lengthy investment in building a reference slide collection.

Almost all charred plant remains represent plants selected by humans from the ancient environment. By arguing that they are culturally filtered (Godwin and Tansley 1941: 117–118) and cannot provide an unbiased sample of diversity in the surrounding plant community, some botanists have rejected them in environmental reconstruction. But activity models are employed to reconstruct the cultural filters; when we know how plants were selected for use the plant taxa may then be compared with environmental models in the manner employed in phytolith and pollen analysis.

Unfortunately, not all the necessary environmental models can be inferred from existing formal botanical studies. Pabot (1957: 76) and Le Houérou (1981: 497) offer generalized models of degraded communities, but these are not specific to the Khabur region. Frey and Kurschner (in press) estimate climax and describe actual vegetation in the lower Khabur drainage today, but what archaeobotanists most need are additional studies of ruderal (waste places) and segetal (agricultural fields) communities, critical to understanding the effects of agriculture and grazing. To redress this situation, Youssef Barkoudah of Damascus University and the author collected more than 200 species and recorded frequency and density of species in severely degraded areas in 1988. In the absence of published models that identify species most likely to turn up in archaeological sites, the author again relied on her fieldwork in the Upper Khabur.

3. Although plant associations doubtless have changed since the Halaf period in response to severe environmental and possible climatic changes,

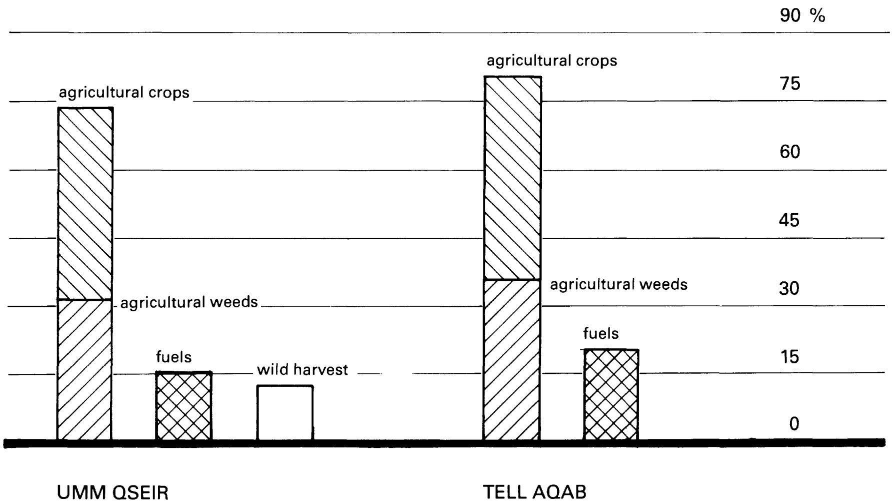


Figure 6. Distribution of plant taxa and types assigned to activity models at Tell Aqab and at Umm Qseir. The percentages indicate the proportion of taxa and types belonging to the activity. (Numbers of plant fragments are not considered.)

less rich than that from Umm Qseir, includes *Vaccaria pyramidata,* a widespread weed typical of dry-farmed cereal crops in continental to sub-Mediterranean climates (Bischof 1978: 28). A number of species of *Silene* are also weeds associated with dry-farmed cereals (Bischof 1978: 24–27; Sauerborn and Sauerborn 1988: 142–149).

The presence of linseed (from ripened flax plants) at Tell Aqab, although not well represented from the Halaf level, may partially explain the paucity of weed types: flax grows best in tilled soil and has very low tolerance for weed competition. Successful flax growers weed their fields (Gill and Vear 1980: 198), and if this was done at Tell Aqab, fewer weeds may have become incorporated in hearth deposits. Even if flax was a minor crop, crop rotation might result in cereals grown on land weeded in previous years and on which a weed crop might have been impoverished.

Linseed is a high protein (20%) food source and oil crop, but must be heated before consumption to release toxic prussic acid. This requirement might account for the incorporation of linseed in hearth debris: the crop may not have been grown for flax fibers because this use requires harvesting green plants (with immature seed capsules), rotting the stems, and washing away pith from fiber. Instead, the plants were allowed to mature and produce oil-bearing seeds. The harvest of legumes, cereals, and flax at Tell Aqab indicates an occupation during the spring, and assuming that the crops were grown in the immediate vicinity, the inhabitants probably were on site throughout the winter and early spring to tend their crops.

At Umm Qseir the plant assemblage indicates a slightly different farming style, with two strategies operative. From the crops and weeds represented, it is clear that both dry farming and some supplementally-watered crops were featured in the site economy. In this instance crop requirements are important considerations in distinguishing those plants cultivated adjacent to the site from those grown farther afield. When water requirements are taken into consideration along with local soil types, there emerges an interesting pattern of farming and collecting that is quite different from the pattern of dry-farming at Tell Aqab.

By referring to local models of agricultural field weeds (TABLE 2), fruiting date and soil requirements of crops can be used to suggest their association with some of the weeds represented at Umm Qseir. Associated with such spring-fruiting weeds as *Bellevalia* sp. and *Buglossoides* sp. is the cultivation of spring crops (lentil, bitter vetch, field pea, and chickpea). The harvest of emmer wheat in late spring would also involve reaping weeds that fruit late, including the wild grasses and *Hypecoum* sp. Six-row spring barley is likewise harvested in June in subdesertic to xeric Mediterranean climates, but its presence at Umm Qseir strongly suggests some kind of irrigation since, in producing three times the seed per tiller than two-row varieties, it is better suited to irrigated fields where water

the model associations in Table 2 (checked against observations by Pabot 1957; Mouterde 1966–1983; Guest, Townsend, and Al-Rawi 1966–1985; palynological studies; and conversations with Youssef Barkoudah [see also Bottema and Barkoudah 1979]) provide a first attempt to discriminate among the weeds associated with different farming practices in the Khabur Basin.

Table 2. Vegetation (weedy) associations in the Khabur Basin. These lists of taxa are compiled from field studies carried out by the author during late spring, summer, and autumn in the Khabur Basin in 1985, 1988, and 1990. (Each list combines observations from multiple locations). The taxa with asterisks are those recorded growing only in the ecological conditions indicated.

Soil type	*Fruiting date*
Gypseous Dry-Farmed soils (west and east of the Khabur River south of Hasseke)	
Gypsophila linearifolia (Fisch et Mey) Boiss.	May
Hypecoum pendulum L.*	May-June
Sinapis alba L.	May-June
Chorispora tenella (Pall.) D.C.*	May
Astragalus tribuloides Del.*	May
Hymenocarpus circinnatus (L.) Savi.*	May
Trigonella monantha C.A. Mey	May
Erodium near *subtrilobum* Jord.	April-May
Andrachne telephioides L.	May-August
Chrozophora tinctoria (L.) Raf.	June-September
Malva aegyptia L.*	May
Arnebia decumbens (Vent.) Coss. et Kralik	May-June
Verbascum alepense Benth.	May-June
Thymelaea passerina Coss. et Germ.	June-August
Scabiosa olivieri Coulter	May-June
Filago pyramidata L.	May-June
Centaurea bruguieriana (D.C.) Hand.-Mazz.	July
Picris kotshchyi Boiss.	May-June
Bellevalia glauca (Lindl.) Kunth*	April-June
Lolium rigidum Gaud.	June-July
Bromus sp.	spring, summer
Dry-Farmed Mediterranean soils (north of Hasseke and Jebel Abd al-Aziz)	
Gypsophila pilosa Huds.	May
Vaccaria pyramidata Medik.*	May
Sisymbrium irio L.	May
Brassica deflexa Boiss.*	May-June
Sinapis alba L.	May-June
Euclidium syriacum (L.) Rb.*	April-May
Erodium ciconium (L.) L'Hér*	April-May
Chrozophora tinctoria (L.) Raf.	June-September
Eryngium c.f. *campestre* L.	July-September
Bupleurum lancifolium Hornem. var. *heterophyllum* (Link.) Wolff	May
Heterocaryum szovitsianum (Fisch et Mey) A.D.C.*	May
Anchusa aegyptiaca L.	May-July
Verbascum alepense Benth.	May-June
Cephalaria setosa Boiss. et Hohen*	July
Anthemis sp.	spring, summer
Centaurea hyalolepis Boiss.	July
Centaurea cf. rigida Banks et Sol.*	June-July
C. bruguieriana (D.C.) Hand.-Mazz.	July
Cousinia chaborasica Bornm. et Hand.-Mazz.	June-August
Picnomon acarna (L.) Cass.*	July-August
Taeniatherum crinitum (Schreb.) Nevski	June-July
Prosopis farcta (Banks et Sol.) Macbride	August-September
Irrigated and alluvial soils (spring crops including cereals; many of these weeds are modern introductions)	
Polygonum argyrocoleum Steud.*	May
Rumex pulcher L.	April-May
Sinapis alba L.	May-June
Hirchfeldia incana (L.) Lagrèze-Fossat	May
Cardaria draba (L.) Desv.*	May
Lepidium latifolium L.	May-June
Melilotus indicus (L.) All.*	spring
Ammi visnaga (L.) Lam.*	June-July
Cuscuta campestris Yuncker	summer, autumn
Galium incanum Sibth. et Sm.*	June-July
Cephalaria syriaca (L.) Schrader*	June-July
Xanthium spinosum L.	spring-autumn
Centaurea iberica Trev. ex Sprengel	June
C. pallescens Delile	June-July
Carduus australis L.	June
Notobasis syriaca (L.) Cass.	May-June
Cicorium pumilum Jacq.	June-July
Phalaris minor Retz.*	June
Bromus scoparius L.	June
Bromus squarrosus L.	June-July
Avena wiestii Steud.	May-June
Lolium rigidum Gaud.	June-July
Prosopis farcta (Banks et Sol.) Macbride	August-September
Alhagi maurorum Medik.	summer
Glycyrrhiza glabra L.	summer
Irrigated and alluvial soils (modern summer crops; many weeds are also modern arrivals in the Khabur)	
Portulaca oleracea L.*	August-October
Hibiscus trionum L.	August-September
Malva parviflora L.*	June-July
Corchorus olitorius L.*	summer
Convolulus arvensis L.	June-August
Cuscuta campestris Yuncker	summer, autumn
Daturia stramonium L.*	summer, autumn
Physalis alkekengi L.*	summer, autumn
Xanthium strumarium L.*	summer, autumn
Sorghum halepense (L.) Pers.*	July-October
Cyperus rotundus L.*	autumn
Echinochloa colona (L.) Link.*	summer, autumn

can supply requisite nutrients longer than in dry-farmed plots (Helbaek 1970: 222–223; Charles 1984: 30). This pattern is evident today in traditional farming, a fact volunteered by both botanists and farmers interviewed.

Thus the crops represented at Umm Qseir were perhaps farmed in several quite different locations. Six-row barley likely grew on the alluvial soils of the Khabur River Valley with supplemental watering, probably from spring flooding, but the weeds from the site are from dry-farmed contexts, and thus must be associated with the final processing of dry-farmed emmer and pulses. It is difficult to ascertain exactly where this dry-farming took place. If we reconstruct the Jezireh steppe as a climax or near-climax biotope in the Halaf period, it is possible that emmer and chickpeas were occasionally dry farmed adjacent to the site in exceptionally wet years. The soils around Umm Qseir are low in fertility and require long fallowing to replenish nutrients (c.f. Charles 1988: 25; Wilkinson 1990: 89–

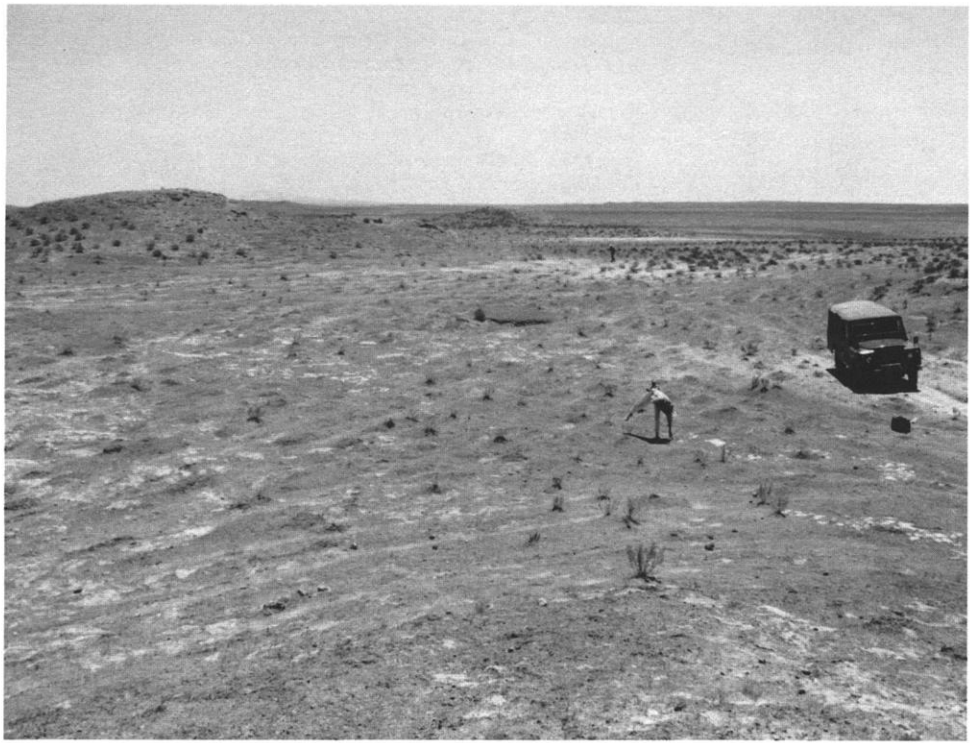


Figure 7. View of steppe today south of Umm Qseir showing the degradation of grazing land and erosion of soils from gypseous bedrock.

Figure 8. View of the northern slopes of the Jebel Abd al Aziz showing the extent of deforestation in modern times. Plantation of pines for reforestation project visible in foreground.

Figure 9. Abandoned terraces once used for dry-farming in the Jebel Abd al Aziz. (Principal crop undetermined.)

91). Dry-farming of emmer, chickpeas, and small lentils like the Halaf type is impossible today, and has been so in living memory, in the heavily eroded and saline gypseous soils adjacent to the site.

Bitter vetch is known today primarily as a fodder crop, but it may also occasionally have served in prehistory as a human food (Helbaek 1961) and as an additive or flavoring to other staple foods. Hillman (1985: 22) cites its use in barley bread, perhaps as a fermented leavening agent; it is equally possible that it might have been added to beer. It is doubtful that it was ever grown near Umm Qseir since in contemporary agricultural regimes of the northern Fertile Crescent it thrives only at altitudes greater than 500–800 m and has considerably lower tolerance to drought and salinity than any of the other crops from the site. It is quite unknown in the Khabur drainage and upper Jezireh today (see also Charles 1985: 56–57), but it could have been cultivated in the nearby low mountain range of the Jebel Abd al Aziz where rainfall is higher (FIG. 1).

Environmental degradation in the fragile steppe (FIG. 7) and nearby mountain ranges (FIG. 8), much of it doubtless occurring since the Halaf period, has wrought incredible destruction of forest and rangeland vegetation and soils. The remains of agricultural terraces, perhaps Roman or Islamic in date, are witness to the lost agricultural potential of the Jebel Abd al Aziz, which has suffered significant deforestation and desiccation in recent years (FIG. 9). The Halaf people of Umm Qseir probably farmed bitter vetch elsewhere during the spring or were importing it, already cleaned of weeds, through an exchange system. The weeds from fine cleanings of the other dry-farmed crops suggest spring farming on the steppe soils adjacent to the site, indicating locally better conditions than those that prevail today.

Evidence for wild plant resources at Umm Qseir gives us an indication of other seasons when the Halafians were present and helps us test the hypothesis that some people moved elsewhere during parts of the year. Late summer use of the site may account for the presence of seeds from purselane (*Portulaca oleracea*), which begins fruiting in August and continues through October, and for the shells of wild pistachio (*Pistacia khinjuk*), which once probably extended along the wadis at low elevations to within easy walking distance of the site. In the early autumn, occupants of the site could harvest wild blackberry (*Rubus sanctus*) which, although no longer frequent along the Khabur today, must have grown along the river course during the Halaf period when its pips were charred at Umm Qseir. Fresh berries neither store nor travel well, and the nutritional return for drying blackberries would be relatively low. Thus their presence strongly suggests that they were consumed immediately and locally. It is possible that the site was occupied throughout the winter, although there is no plant evidence to prove this. Very few plants seed during the winter months, and their absence from archaeological sites cannot be used to infer an absence of people. Winter is a season of hardship on the steppe, and in the recent past Bedouin camped along the Khabur at sites like Umm Qseir where water, food, and fuel were available until the advent of spring rains.

Fuel types also support occupation of both sites in the spring. The plant remains from the ashy middens in each instance suggest that the fires were for the same purpose, namely cooking. Furthermore, *Astragalus* seeds are present at both sites in the Late Halaf. I interpret the presence of these seeds, which livestock would consume while grazing, as evidence of the use of dung fuels (Miller 1984a, 1984b: 73–77). As these seeds would only seasonally become ripe and be consumed by animals, their presence at both sites suggests that both sites were occupied during summer months.

Nevertheless, one difference between the two sites is in the fuel sources represented. Watkins and Campbell (1987: 453) comment on the lack of charcoal at Halaf sites in general. This is also true of these sites, where no large chunks of wood charcoal suitable for conventional radiocarbon dating were recovered. The proportions of wood charcoal fragments to overall flot volume vary between the two sites, however; and, in conjunction with different proportions of seeds probably derived from the burning of dung fuels (Miller 1984a; Miller and Smart 1984), these figures may indicate different cooking fuels. Samples from Tell Aqab yielded less than 0.25 cc volume of charcoal fragments (less than 0.3% of sorted, charred plant remains), while in the samples from Umm Qseir the proportion of charcoal to flot volume is 20 times greater. Fragments of wood charcoal comprise an estimated 6% of the Umm Qseir flot volume.

Likewise, the density of seeds to flot volume differs at the two sites. At Tell Aqab that of *Astragalus* seeds is much greater (2.5 seeds/cc flot) than at Umm Qseir (0.14 seeds/cc flot). Furthermore, this difference cannot be fully explained by differences in the environment, for at Umm Qseir these seeds occur in abundance from the post-Halaf occupation (not discussed in this paper); clearly the plants from which they derived could grow in the vicinity of both sites. Therefore, it appears possible that the inhabitants of Tell Aqab were heavily reliant on dung fuels during the Halaf period, accounting for both the greater density of *Astragalus* seeds and the lower proportion of wood charcoal at this site. While in theory other weed seeds, cereal chaff, and grains may also have been burned in dung fuels, their ratios differ from that of *Astragalus* at Tell Aqab (0.30 other items/cc flot), but not at Umm Qseir (0.15 other items/cc flot), suggesting that their presence is influenced by factors other than those accounting for the incorporation of *Astragalus* in the plant remains.

The wood charcoal fragments from both sites were almost all minute (<1 mm in diameter) and lacked the full growth ring needed for ready identification. While a full list of genera represented is thus impossible at this stage, several tentative suggestions may be offered. The steppe-forest species at Tell Aqab differed from the woody genera available near Umm Qseir. *Fraxinus* and a softwood, perhaps a juniper like those growing in the low altitude *Juniperus-Pistacia* steppe-scrub described by Zohary (1973: 583), were identified among the wood charcoals. A deciduous species requiring water in the summer, *Fraxinus* may have survived in an intermittent riparian gallery forest near the site. One species, *F. syriaca* Boiss., occurs in the low forest of Kurdistan in Iraq (Guest, Townsend, and al-Rawi 1966–1985), thrives in the bioclimatic region in Turkey just to the north of Tell Aqab, and perhaps has been reported as *F. excelsior* L. along the Syrian-Turkish border (Mouterde 1966–1983: 21), although it has since disappeared from the region.

At Umm Qseir the wood charcoals represent different genera and a different environment. From the riparian forest adjacent to the site the inhabitants collected and burned Salicaceous species—willow (*Salix*) or poplar (*Populus*). From the steppe they gathered almond (*Amygdalus*), a tree absent near the site today, but one that might previously have survived in association with the nut-bearing wild pistachio in finger wadis extending off the southern slopes of the Jebel Abd al-Aziz to the west of Umm Qseir.

Interpretations

Throughout the analysis it was assumed that Tell Aqab was in the richer of the two environments during the Late Halaf period, principally because the region appears richer today in the potential biomass it can support. Tell Aqab lies in what archaeologists consider to be the heartland of the Halaf culture (Davidson 1977: 9–10; Watson 1983: 232–238). In the Khabur drainage, the adjacent Balikh drainage, and the Iraqi Jezireh, the distribution of Halaf sites is similar, with clusters of small, perhaps semi-permanent sites near a larger one (Davidson and McKerrell 1976: 48, 53; Akkermans 1987: 25; Hijara 1980: 252). If the greater densities of sites in the heartland of the Halafian region are associated with larger populations than in peripheral areas such as at Umm Qseir, this may imply a larger resource base.

Nevertheless the results from analysis of Tell Aqab plant remains show little evidence of a richer resource base. The lack of wild types from the site and few identifiable wood charcoals makes environmental interpretation very difficult. Greater representation of dung fuel suggests that fewer woody resources may have been locally available. This pattern may reflect a broader trend in the Halaf heartland (Watkins and Campbell 1987: 453). At other Halaf sites low occurrence of wild types has been interpreted as evidence of low availability (van Zeist and Waterbolk-van Rooijen 1989: 329–330), but most wild plants arrive on archaeological sites through human selection of useful species from the environment: thus it is difficult to know whether the absence of wild types at Tell Aqab reflects an economic preference or an ecosystem degraded through intensive human use. A combination of these factors is most probable given the higher population densities evident in the northern Khabur drainage during the Halaf period. Lower tree densities might reduce populations of large wild mammals and increase those of smaller lagomorphs and rodents (De Vos 1969: 158–160). This prediction could be addressed through study of the faunal assemblage, which still awaits analysis.

Dry farming of flax, which requires about 400 mm annual rainfall, and other crops suggests that rainfall approximated its modern levels and that agricultural settlement could have continued uninterrupted at Tell Aqab. By contrast, the low rainfall at Umm Qseir would preclude dry farming in all but exceptional years. Agriculture and perhaps human settlements in this environment would only have been sporadic. In spite of possible environmental degradation in the Halaf heartland, charred plant remains at Umm Qseir suggest that local resources were largely undepleted during this period. There was wood to burn, as suggested by proportions of dung fuel remains and charcoal fragments. Some crops, especially bitter vetch, may have been farmed within a distance of 25 km to the north, or west (in the recent past Bedouin migrated about 40 km annually), but others were grown at the site. In wet years, uneroded soils adjacent to the site could have supported the lentils, chickpeas, and emmer recovered archaeologically, while six-row barley may have thrived on the seasonally flooded alluvium. Berries grew wild along the river. The wild fauna (Melinda Zeder and Elizabeth Myler, personal communication, 1989; Hole and Johnson 1986–1987: 177–179) attest to a rich vegetation on the adjacent steppe, which probably supported perennial grasses and scattered trees—pistachio (*Pistacia khinjuk*) and wild fig (*Ficus carica* L. var. *rupestris* Hausskn. ex Boiss.)—in the wadis, and thickets of woody shrubs such as the chenopods, wormwood (*Artemisia*), and wild caper (*Capparis spinosa* L.). Wild roseaceous shrubs (wild almond, hawthorn, cherry) probably grew on the foothills of Jebel Abd al Aziz and Jebel Kaokab. In diversity of species, perennial vegetation, microenvironments on different soils, wild flora, and perhaps in wild fauna, Umm Qseir appears to have been a richer site in the Late Halaf period than today: only in its more recent past has its environment been ravaged.

This is an important conclusion because it indicates that differences between prehistoric and modern environments are the result of human activities. Climatic changes in the Near East also account for environmental change, but in the case of the Late Halaf period in the Jezireh it would have affected both biotopes. Today the Lower Khabur is rapidly becoming a desert while the environs of Tell Aqab now constitute the breadbasket of modern Syria. Yet the situation today had its origins in the environment of the Halaf culture. Subsequent developments are beyond the scope of this paper, but Umm Qseir and Tell Aqab offer some tantalizing clues in their later occupational phases. By the Uruq phase at Umm Qseir, the plant remains suggest heavy use of dung fuels, perhaps reflecting an increasing scarcity of wood fuels at the site. If hunting was indeed a major activity in the steppe, as the Uruq faunal assemblage suggests (Melinda Zeder and Elizabeth Myler, personal communication, 1989; Hole and Johnson 1986–1987: 178), fire may have been employed to drive game and to attract animals to the subsequent new growth. This would have had a profound and permanent effect on rangeland (Daubenmire 1968: 249, 256–257; Naveh 1975: 199, 206). Soil erosion quickly sets in with the annualization of perennial cover (Young 1943: 836), and the shallow soils adjacent to the site are much more fragile than those around Tell Aqab (Muir 1951: 172–174). With the loss of forests, local precipitation may have diminished, and evapotranspiration may have increased, especially if the albedo (radiation reflected from the ground surface) was raised by removal of vegetative cover (Kaul and Thalen 1979: 258; Sagan, Toon, and Pollack 1979: 1367). If fire was less intensively used than at Tell Aqab, the environment of Umm Qseir could have remained a richer one during the Late Halaf period, but it has always been the more fragile.

Nevertheless, Umm Qseir's resources attracted Late Halaf inhabitants. We expected to find evidence of semi-sedentary people, perhaps pastoralists, who camped along the river to graze their flocks (Hole and Johnson 1986–1987: 172, 184). The interpretation of faunal remains doubtless provides the best evidence of pastoral activities at Umm Qseir (Melinda Zeder and Elizabeth Myler, personal communication, 1989), but the environmental setting reconstructed from plant remains suggests that seminomadic pastoralists could have gathered along the banks of the Khabur river in summer, autumn, and winter as they did in recent times when winter rainfall on the steppe ensured rich pasture and water only in the spring. The evidence for dry-farming and six-row barley (which required supplemental watering) in the vicinity suggests that at least part of the population occupied the site during the spring while crops ripened. This poses an additional question: Why were the Late Halafians farming at Umm Qseir in a season when the rain-fed steppe offered rich pasturage? Soil infertility and unpredictable rainfall suggest that farming was opportunistic and sporadic; thus the answer to the Halafian presence must in part reflect resources available at Umm Qseir that differed from those at northern sites like Tell Aqab. Good hunting and grazing were probably available; trees provided fuel and construction materials for ephemeral shelters; and the site's occupants probably could have exchanged local products for crops from the north along much the same networks through which ceramics and obsidian flowed (Davidson 1981: 76–77; Davidson and McKerrell 1976: 53, 1980: 163; James Blackman, personal communication, 1989).

Conclusions

Examining plant remains in the framework of ecological models can help us generate hypotheses concerning how humans produced, collected, and processed food. In turn, reconstructions of the environmental conditions and human adaptations to them in the Halaf period will serve as a baseline for future studies of the Khabur. The 5th millennium B.C. marks an archaeological datum: until recently no prior occupation of the Khabur drainage had been archaeologically investigated, and this study is the first attempt to develop a regional understanding of resource use in different environments. By the 5th millennium agricultural populations appeared for the first time to exploit the steppe in the south. That they were using resources no longer abundant in the north can be tested through further fieldwork in the Khabur drainage.

We now realize how little we have previously understood about the Halaf economies. Some have suggested mechanisms by which the characteristic painted pottery was distributed among sites across a 600 km latitude, on occasion at some distance from the origin of its manufacture, but our understanding of ceramic and obsidian distributions must now also accommodate dispersals of organic commodities—plant foods, animals and animal products, oils, fibers, hides, fodder, even dyes and medicines. Patty Jo Watson suggests a "developed chiefdom" social organization among the Halafians (1983: 243), but it will be impossible to improve our understanding of their social organization without a much better understanding of the environmental constraints and economic structure in which the social patterns were founded. From this point of view, it is critical that we understand the range of variability in Halafian economic adaptation—in this case, how the Halaf was economically structured both in the dry-farming optimum at Tell Aqab and at its geographical periphery at Umm Qseir.

Research continues into these problems. The study of plant remains will eventually benefit from quantitative analyses of the variability in the middens and differences between Halaf levels and later occupations at both sites. The ubiquitous presence of middens on Near Eastern archaeological sites affords a great potential for future work both in the Khabur and other regions, for midden deposits combine plant remains from many households within a single site. Comparing middens allows us to compare site economies across a transect of environmental and temporal change. We need to strengthen the analysis outlined in this paper with additional studies of the environment today: the interrelationships of plants, fauna, soils, precipitation, consumption, and regeneration. Additional archaeological and environmental data from all periods in the Khabur must be acquired to understand the dynamics of environmental change and concomitant human adaptions and pressures. Above all, we need to understand the cultural history of the Khabur as interactive with its dramatic environmental history.

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