

The Near East

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ABSTRACT: The archaeobotanical record of the Near East is more than 12,000 years long. Within this time period it is possible to define three broad eras of crop introduction: cereals and pulses from about 9000 BC, orchard crops from about 4000 BC, and crops exotic to the Near East after 2000 BC. Plant remains also enable one to trace the impact of human activity on the landscape from earliest times.

1 DEVELOPMENT OF RESEARCH DURING THE LAST TWO DECADES

Until the late 1960s, archaeobotanical research in the Near East depended primarily on chance finds of plant remains. As scholars increasingly focussed on the economic basis of ancient societies, they began actively seeking plant remains. Spurred by interest in agricultural and village origins, American, British, and French excavators included archaeobotanists in multidisciplinary research programs. Hans Helbaek, and later Willem van Zeist, began using flotation to concentrate plant remains from soil samples. David French encouraged the use of machine-assisted flotation systems that permit more soil to be processed. Systematic sampling of archaeological sites for plant remains has become common practice, although even today many sites are not served by an archaeobotanist.

Near Eastern archaeobotanical laboratory work is conducted at facilities on three continents, but research centers specializing in the region are few. Willem van Zeist at the Biologisch-Archaeologisch Instituut in Groningen, and Gordon Hillman at the Institute of Archaeology in London have both been actively running laboratories and training students who have gone on to work independently at those laboratories and at other universities. Lorenzo Costantini at the Italian Institute for the Middle and Far East (IsMEO) and Maria Hopf in Mainz have active research programs as well. In the Near East, the British Institute of

Archaeology in Ankara has an archaeobotanical library and collections developed by Gordon Hillman and Mark Nesbitt. Mordechai Kislev at Bar-Ilan University in Israel, too, has an ongoing research program. There are a number of archaeobotanical laboratories in North America, but mostly these focus on New World materials. Two exceptions are housed in the Department of Archaeology at Boston University and at The University Museum of the University of Pennsylvania.

One result of the international and multidisciplinary nature of most Near Eastern archaeological research is that archaeobotanists working there come from several academic traditions. The pioneering scholars of the 1960s and early 1970s were primarily botanists. The current generation is more likely to have formal archaeological training, through graduate programs in anthropology in the United States or through archaeology programs in Europe.

In 1982 the Sumerian Agriculture Group was organized. Yearly meetings on particular themes bring together botanists, archaeobotanists, epigraphers, and archaeologists. The papers from each session are published as the "Bulletin on Sumerian Agriculture" (Postgate & Powell 1984).

1.1 Nature of the data

Some sites are excavated to answer specific questions, and others because they are very large or historically important. Salvage archae-

ology has played an increasing role in recent years, especially in the Tigris-Euphrates drainage. In the 1960s and 1970s, several dam projects on the Euphrates river prompted major international efforts to extract as much information as possible before rising waters flooded the site-filled river valley. Fortunately, this research included archaeobotanical studies. Reports from the Tabqa (Syria), Keban (Turkey), and Karababa (Turkey) projects are still being produced. Sites on the Tigris threatened with inundation have also been excavated; it is too soon to know how much attention will be paid to plant remains.

When one considers archaeobotanical reports published since 1970, it is clear that there is a significant lag between excavation and botanical analysis. Often, studies do not see final publication until 10 or 15 years after excavation. On many sites, especially those excavated before the 1980s, seed recovery was limited to clearly visible concentrations, for routine flotation and sieving were rarely practiced. Sites with extensive burning yielded a substantial amount of the material available for study, and much of the rest came from occasional special interest samples (e.g., funerary offerings (Ellison et al. 1978; Müller 1981a)). In some cases it has been possible to retrieve plant materials from older excavations by systematically taking sediment samples from the baulks of old excavations (e.g., van Zeist & Bakker-Heeres 1982(1985)).

This chapter concentrates on seed remains formally reported since 1969. Analysts of other classes of botanical materials, too, are expanding our knowledge of ancient human-land relationships in the Near East with wood charcoal, pollen, and phytolith evidence.

The typical site in the Near East is a mound ("tell," "tepe," or "hüyük"), formed by the accumulated effects of mudbrick construction and decay. Under these circumstances, the bulk of the excavated material is construction collapse, which ordinarily has only sparse and scattered plant remains. Other structures and trashy deposits may also have a low density of charred material. For example, at the pre-agricultural site of Abu Hureyra, Hillman reports an average of about four seeds per bucket of floated soil (Hillman et al. 1989); similar numbers characterize one phase at Malyan, where many deposits were sampled despite the low density of charred material (Miller 1982).

Archaeologists commonly test charred, organically rich deposits for seeds. If one restricts sampling to obvious concentrations, however, there may not be enough material to show patterning in the distribution of plant materials

through space and time. An extensive sampling strategy does not guarantee rich returns, but may nonetheless be critical for understanding patterns of ancient plant use. As more is learned about the role of plants in ancient society, systematic sampling of sites during excavation has become increasingly important to archaeologists and archaeobotanists working in the Near East.

What makes a find or an archaeobotanical assemblage important? In a few cases, a timely preliminary report has made a great impact even though the final report did not appear until some years later. So little work has been completed in the Near East that even minor results augment the picture of the role of plants in ancient life. The mere presence of a type can document early use or cultivation. Its unexpected occurrence outside its climatic or phytogeographical range may provide evidence for trade or contact, which in turn has economic and social implications.

Once a plant has been introduced into a region, further occurrences may represent either continuing trade, or, if environmental conditions permit, spread of the new plant as a crop or weed. For example, the occurrence of emmer at Ali Kosh in southwestern Iran as early as the eighth millennium BC strongly suggests at least "down-the-line" contact with the Levant soon after plant domestication. Botanical evidence available in the early 1970s pointed to cultural contact between Hacilar and regions to the west (Helbaek 1970) and between Çayönü and regions to the east (van Zeist 1972). Other more recent archaeological findings at Çayönü, Gritille, and elsewhere confirm early connections between eastern Turkey and the Levant (Cauvin 1988). Presence of an apparently exotic taxon can also be used in arguments comparing climatic and anthropogenic vegetation and landscape changes (cf. discussions about significance of einkorn at Mureybit, section 2.2). Even if a limited sampling procedure documents only the presence of certain taxa, it may be enough to demonstrate to the sometimes skeptical archaeologist that flotation may indeed yield seeds, and thereby act as a spur to further research and financial support.

This chapter covers the prehistoric and historic periods, and calibrated radiocarbon dates BC are used throughout. For that reason, the dates for the earlier periods will seem about 1000 years older than those commonly reported as radiocarbon years BC. Dates preceding 7000 BC (ca 8000 BP) have been interpolated based on the calibration diagram of Stuiver et al.

(1986: Fig. 7).

1.2 A Major Research The Origins of Agriculture

The primary impetus oriented archaeobotany in the Near East was Robert Braidwood's work in the 1950s at Jarmo and the development of his interdisciplinary approach. Danish botanist, Hjalmar Holm, was the first to look for plant remains in archaeological questions (Helbaek 1960; Braidwood et al. 1958). Archaeologists invited botanists to work on early farming societies, as they went on to work at Jarmo and Neely, where rural societies in the Near East (et al. 1969); van Zeist (Mureybit (Cauvin 1988) Çayönü (Braidwood 1958) whom stressed the importance of also worked with the Taurus Basin and elsewhere (Heeres (1982(1985) Academy Major R. History of Agriculture worked at Can F. took an approach to archaeobotany (French). The reports on Agriculture at Mureybit (van Zeist 1970) turned out to be an important contribution to the 1960s and 1970s literature in the Near East.

Braidwood's work led to theories of increasing aridity, where "such evidence" might imply that sort of beast implied in (Childe 1952: 25) the significance of climate changes to people to begin (1960).

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1.2 A Major Research Focus: The Origins of Agriculture

The primary impetus to modern problem-oriented archaeobotanical research in the Near East was Robert Braidwood's work in the 1950s at Jarmo on the origins of agriculture and the development of early farming villages. His interdisciplinary research team included the Danish botanist, Hans Helbaek. Their collaboration was the first explicit effort in the Near East to look for plant remains to answer an archaeological question with botanical materials (Helbaek 1960; Braidwood & Howe 1960; Braidwood et al. 1983). Thereafter, other archaeologists invited archaeobotanists into their projects, as they continued to focus on the early farming societies. For example, Helbaek went on to work at Ali Kosh with Hole, Flannery and Neely, who examined early agricultural societies in terms of human ecology (Hole et al. 1969); van Zeist worked with Cauvin at Mureybit (Cauvin 1978) and Braidwood at Çayönü (Braidwood & Çambel 1982), both of whom stressed the origins of village life; he also worked with de Contenson in the Damascus Basin and elsewhere (van Zeist & Bakker-Heeres (1982(1985)); associated with the British Academy Major Research Project in the Early History of Agriculture, Renfrew and Hillman worked at Can Hasan III with French, who took an approach more related to human geography (French et al. 1972; Renfrew 1968). The reports on Ali Kosh (Helbaek 1969) and Mureybit (van Zeist & Casparie 1968; van Zeist 1970) turned out to be among the most important contributions to the discussions of the 1960s and 1970s on the origins of agriculture in the Near East.

Braidwood's work was influenced by earlier theories. V. Gordon Childe had suggested that increasing aridity in the Near East brought people, animals, and plants together in oases, where "such enforced juxtaposition might promote that sort of symbiosis between man and beast implied in the word 'domestication'" (Childe 1952: 25). Braidwood set out to assess the significance of climate change; he and his colleagues concluded that post-Pleistocene climate changes were too minor to have forced people to begin farming (Braidwood & Howe 1960).

By the late 1960s, hunter-gatherer studies suggested that the foraging life was not nasty, brutish, and short (cf. Lee 1969). With climate

apparently not an issue, the question became why did people abandon the supposedly easy life of a forager for one of toil and risk. A popular explanation was population pressure. Basing his discussion on virtually no data, Binford argued that overpopulation forced people to move to environmentally marginal zones, where food scarcity necessitated a new adaptation: cultivation (Binford 1968). At Mureybit, extraordinary finds of morphologically wild einkorn well outside its present day range suggested to some that here indeed was evidence for pre-agricultural cultivation or trade, since the nearest stands of wild einkorn are over 100 km away (van Zeist & Casparie 1968; van Zeist 1970).

As the most fully studied archaeobotanical assemblage in the Near East available at the time, the Ali Kosh plant materials played an important role in the debate. In particular, Flannery (1969) interpreted the remains as evidence for a "broad spectrum" diet, which consisted of a variety of reliable, but hard to process, second choice foods. Why would people have come to rely on these foods? Presumably because they had depleted higher quality, though riskier resources (namely, game). Although the earliest levels at Ali Kosh had domesticated plants, Flannery extrapolated the broad-spectrum adaptation back to pre-agricultural populations. He suggested that sedentary villagers would have responded to reduced resources by food producing. Research continues to address this issue (Miller, forthcoming).

Work on early agriculture intensified in the 1970s and 1980s, and new questions were asked. As Helbaek (1969: 403) had pointed out, the morphological changes of the domestication process, generally associated with loss of the wild seed dispersal mechanism, would have occurred after cultivation had already begun. In the absence of morphological change, however, an ancient seed cannot provide direct evidence for cultivation. New approaches therefore consider entire assemblages of plant remains, not just domesticated cereals and pulses, to identify the systemic changes (both ecological and subsistence) associated with cultivation. Research continues to expand our knowledge of foraging adaptations through excavations that focus on early sites (e.g., Wadi Hammeh 27 (Edwards et al. 1988) and 'Ain Ruhab (Muheisen et al. 1988)).

Other current research looks forward from the beginnings of cultivation to the development of agricultural systems, food producing economies that involve massive disruptions of

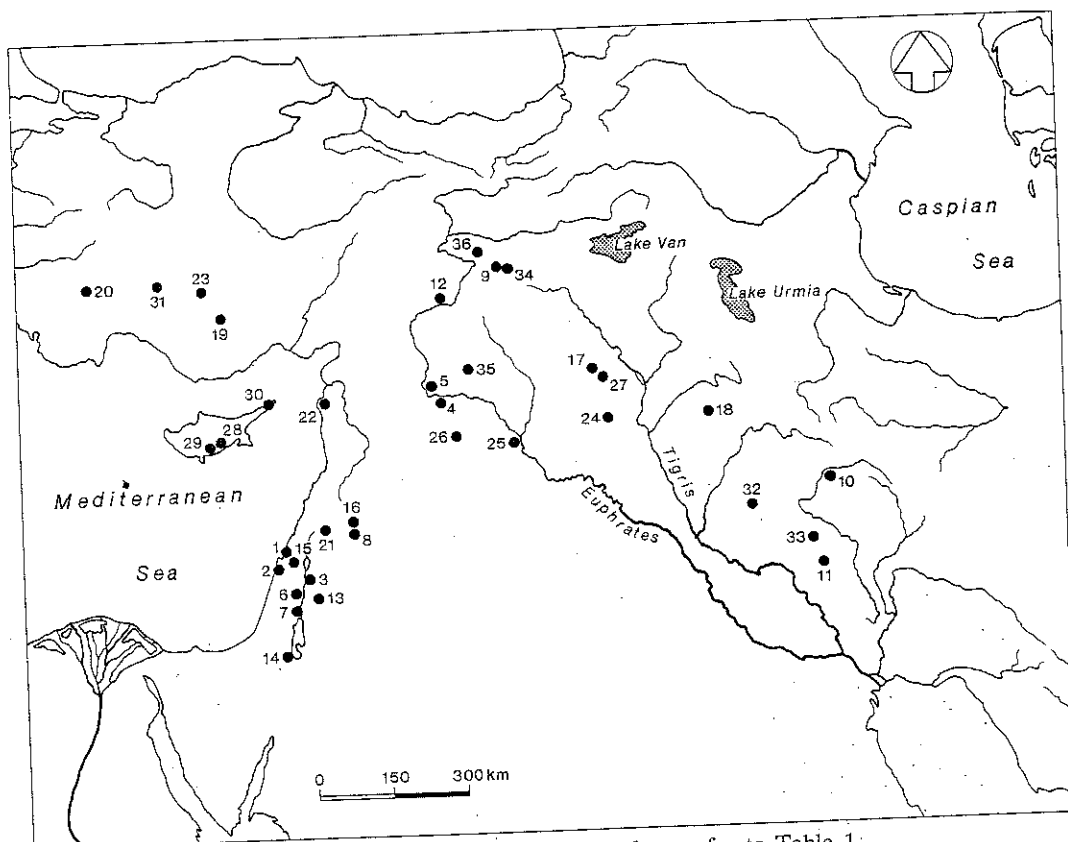


Fig. 1. Near Eastern sites before 6000 BC. The site numbers refer to Table 1.

"natural" ecosystems through the cultivation of plants and the introduction of domestic animals (van Zeist 1986a; cf. Sherratt 1980; Köhler-Rollefson 1988). Archaeobotanical studies document people's impact on the land and trace the introduction and spread of new crops.

Van Zeist (1986a) summarizes the current state of our knowledge of the spread of farming and domesticated plants. It now appears that plants were first domesticated in the southern Levant in the zones where wild emmer and barley grew naturally. Agricultural practices then spread in an arc along the northern edge of the fertile crescent - the first domesticated emmer identified to date comes from Aswad, dating to about 9000 BC; by the middle of the ninth millennium BC, it had appeared at Çayönü. The sites with the earliest evidence for domestication do not all share the same species, and plant use seems to include both domesticated cereals and morphologically wild cereals and pulses, as well as plants that were subsequently domesticated.

Excavation continues to uncover more evi-

dence for the introduction and spread of particular plants. Detailed archaeobotanical reports and taxonomically oriented surveys deal with three gross eras of domestication. The first, during which the cereals and legumes were domesticated, started about 9000 BC. Although the timing of domestication of particular plants varies, as does the spread of agriculture from community to community, the major Near Eastern cereals (einkorn (*Triticum monococcum*), emmer (*T. dicoccum*), hard wheat (*T. durum*), bread wheat (*T. aestivum*), barley (*Hordeum distichum* and *H. vulgare*)) and pulses (lentil (*Lens esculentum*), pea (*Pisum sativum*), and chickpea (*Cicer arietinum*)) were widely available to the farmers by 6000 BC. Fava bean (*Vicia faba*), bitter vetch (*Vicia ervilia*), and grass pea (*Lathyrus sativus*) also came into cultivation. As this crop complex became established, flax (definitely for its fiber, perhaps as an oil plant) and domesticated animals were integrated into the agricultural economy. Vine and orchard production characterize the second era of domestication, begin-

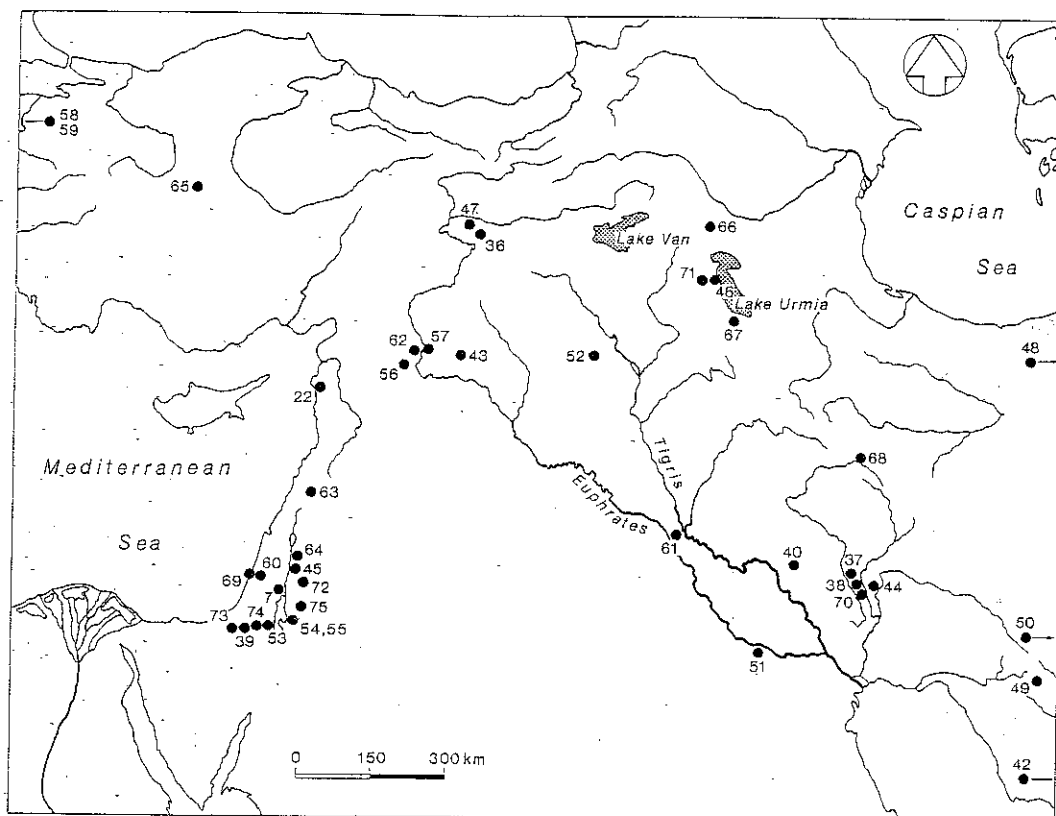


Fig. 2. Near Eastern sites after 6000 BC. The site numbers refer to Table 1.

ning about 4000 BC. Zohary and Spiegel-Roy's (1975) discussion of grape (*Vitis vinifera*), date (*Phoenix dactylifera*), olive (*Olea europaea*), fig (*Ficus carica*) has not been superseded, though new archaeological finds provide additional evidence for the continuing development of fruit production and use (e.g., Costantini (1985) on the date). The third era is characterized by the spread of new crops from distant areas long after agriculture had been established in the Near East (e.g., rice (*Oryza sativa*), millet (*Setaria italica* and *Panicum miliaceum*), and sesame (*Sesamum indicum*)). A current summary of plant domestication arranged by taxon is Zohary and Hopf (1988).

The origins of agriculture and village life inspired much archaeobotanical research in the Near East. Originally focussed on finding the earliest domesticated plants and transitional forms, archaeobotanical studies soon broadened to consider other questions about agricultural practices, plant use, and people's impact on the environment. Studies of early farming now lead in both directions from the "moment" of do-

mestication - either to preagricultural foraging adaptations and the beginnings of cultivation, or to the subsequent development and spread of agriculture. Our knowledge of the later periods (Chalcolithic, Bronze Age, and beyond) is spottier, for relatively few sites have been systematically studied (Tables 1 and 2, Figs. 1 and 2).

2 EVIDENCE FOR PLANT USE IN THE LATE EPIPALEOLITHIC (ca 11,000-9000 BC)

Foraging populations of the Near East began to settle in permanent or semi-permanent villages by the end the Epipaleolithic (termed "Natufian" in the Levant). Though dependent on wild plants and animals for food, these societies were the direct precursors of the later farming groups. Unfortunately, very few sites have yielded botanical remains from this period. Preservation is frequently poor and reports of recently excavated sites are not yet ready.

Table 1. Chronology.

Years BC:	Epipaleolithic			Aceramic		Neo/Chalcolithic			Bronze		Iron	Byz./Islam.
	11000	10000	8500	8000	7000	6000	5000	4000	3000	2000	1000	BC/AD
1 Hayonim	x	.	.	.	.	.	.	.	.	.	.	.
2 Nahal Oren	x	.	.	.	.	.	.	.	.	.	.	.
3 Wadi Hammeh 27	x	.	.	.	.	.	.	.	.	.	.	.
4 Abu Hureyra	x	.	.	.	.	.	.	.	.	.	.	.
5 Mureybit	.	x	.	.	.	.	.	.	.	.	.	.
6 Netiv Hagdud	.	.	x	x	.	(x)	.	.	.	x	x	.
7 Jericho
8 Aswad	.	.	.	x	x	.	.	.	.	.	.	.
9 Çayönü	.	.	.	x	x	.	.	.	.	.	.	.
10 Ganj Dareh	.	.	.	x?	x	.	.	.	.	.	.	.
11 Ali Kosh	x	x	.	.	.	.	.	.
12 Gritille	x	x	.	.	.	.	.	.
13 'Ain Ghazal	x	x	.	.	.	.	.	.
14 Nahal Hemar	x	x	.	.	.	.	.	.
15 Yiftah'el	x	x	.	.	.	.	.	.
16 Ghoraifé	x	.	.	.	.	.	.
17 Magzaliya	x	.	.	.	.	.	.
18 Jarmo	x	.	.	.	.	.	.
19 Can Hasan III	x	.	.	.	.	.	.
20 Hacilar	x	x	.	.	.	.	.
21 Ramad	x	x	x	.	.	.	.
22 Ras Shamra	x	.	.	.	.	.	.
23 Çatal Hüyük	x	.	.	.	.	.	.
24 Umm Dabaghiyah	x	.	.	.	.	.	.
25 Bouqras	x	.	.	.	.	.	.
26 el Kowm	x	.	.	.	.	.	.
27 Yarim I & II	x	.	.	.	.	.
28 Khirakitia	x	.	.	.	.	.
29 Tenta Kalavassos	x	.	.	.	.	.
30 Cap Andreas-Kastros	x	.	.	.	.	.
31 Erbaba	x	.	.	.	.	.
32 Chogha Mami	x	.	.	.	.	.
33 Sabz	x	.	.	.	.	.
34 Girikihaciyan	x	.	.	.	.	.
35 Sabi Abyad	x	x	x	x	x	.
36 Korucutepe	x	.	.	.	.
37 Bende bal	x	.	.	.	.
38 Jaffarabad	x	x	.	.	.
39 Shiqmim

Furthermore, advances in radiocarbon dating have shown some controversial finds to be intrusive (Gowlett Hedges 1987). Despite its scarcity, however, the Epipaleolithic evidence is very important. Sites from which at least some remains have been reported include Mureybit and Abu Hureyra in Syria, Nahal Oren and Hayonim in Israel, and a few sites in Jordan.

2.1 Abu Hureyra

Abu Hureyra is an Epipaleolithic and Neolithic site on the Euphrates river at the edge of the Syrian desert (Moore et al. 1975; Hillman et al. 1989). The final report (Moore et al., in press)

was unavailable for review, but Hillman et al. (1989) discuss the Epipaleolithic plant gathering economy and include some reference to the later period. Abu Hureyra is a significant site both because it is early and because it was successfully and extensively sampled for plant remains. Hillman and his colleagues use a vast array of archaeobotanical, botanical, ecological, ethnographic, and nutritional evidence and arguments in a stimulating discussion of the pre-agricultural subsistence system.

Hillman et al. (1989) consider three basic questions about Epipaleolithic Abu Hureyra's subsistence system: whether or not people cultivated food plants, how diverse their diet was, and whether or not the site was occupied

Table 1 (Continued).

Years BC:	Epipaleolithic			Aceramic		Neo/Chalcolithic			Bronze		Iron	Byz./Islam.	
	11000	10000	8500	8000	7000	6000	5000	4000	3000	2000	1000	BC/AD	
40 Farukhabad	x	x	x	.	.	.	.
41 Kurban Höyük	x	x	x	.	.	.	.
42 Yahya	x	x	x	x	.	.	.
43 Hammam
et-Turkman	x	x	x	x	x	x	.
44 Sharafabad	x	.	.	.	.	.
45 Abu Hamid	x	.	.	.	.	.
46 Gijlar	x	x	.	.	.	.
47 Tepecik	x	x	x	.	.	.
48 Hissar	x	x	.	.	.	.
49 Malyan	x	x	x	.	.	.
50 Shahr-i Sokhta	x	.	.	.	.
51 Ur	x	.	.	.	.
52 Tell Taya	x	.	.	.	.
53 Arad	x	.	.	.	.
54 Bab 'edh Dra	x	.	.	.	.
55 Numeira	x	.	.	.	.
56 Selenkahiye	x	.	.	.	.
57 Sweyhat	x	.	.	.	.
58 Demircihüyük	x	.	.	.	.
59 Troy	x	.	.	.	.
60 Ifshar	x	x	.	.	.
61 ed-Der	x	.	.	.
62 Hadidi	x	x	.	.
63 Kamid el-Loz	x	x	.	.
64 Deir 'Alla	x	x	.	.
65 Gordion	x	x	.	.
66 Bastam	x	.	.
67 Hasanlu	x	.	.
68 Nush-i Jan	x	.	.
69 Qasile	x	.	.
70 Susa,	x	.	.
Ville Royale II	x	.	.
71 Qal'eh Ismail Aqa	x	.	.
72 Heshbon	x	.	.
73 Beersheba	x	.	.
74 Nahal Yattir	x	.	.
75 Leijun	x	.	.

year round. Morphologically changed plants by themselves cannot help us identify the earliest farming societies (unless, of course domestication rates were too fast to be archaeologically visible (cf. Hillman & Davies, in press). Hillman and his colleagues present a new argument that addresses this question by looking at within-sample variation. By assuming the seed remains represent human food, they note an "apparent association" among the wild einkorn, wild annual rye and wild perennial rye (*Secale montanum*) that "suggests that *S. montanum* was harvested together with the other two cereals." Furthermore, as *S. montanum* grows in clumps and does not persist in disturbed ground, these grains "were probably gathered

from wild stands rather than cultivated" (Hillman et al. 1989: 252-253).

Turning their attention to dietary diversity, they argue that most of the seeds in the assemblage had been intentionally collected for food or other non-fuel economic uses, and were charred accidentally in the course of processing. Interpreting the Abu Hureyra assemblage as food remains is in keeping with Flannery's (1969) view that late Epipaleolithic peoples ate a "broad spectrum" of foods. This would also explain why there are no pure seed deposits readily interpretable as food remains. Rather, the samples have mixtures of large and small seeded grasses, legumes, chenopods, sedges, *Polygonum*, and many other types. The variety

of habitats from which these plants come is impressive, suggesting the Abu Hureyran were utilizing much of the territory around their settlement. Unfortunately seed and charcoal densities are not high on average. Out of 24 deposits reported, only four have a seed density greater than ten per bucket, and the deposits average less than 2 ml of material per bucket (Hillman et al. 1989: Fig. 14.1). The identified charcoal is limited to riverine types, which is a good indication that other types of wood were not readily available.

Finally, Hillman et al. (1989) discuss seasonality. The presence of fairly substantial pit houses had originally argued for at least semi-permanent habitation (Moore et al. 1975: 56), and the river is the major year-round water source. Taken as a group, the plant remains suggest a minimal habitation from spring to early summer and the fall. Plant products that would have been available at other times of the year are not easily preserved, so there is no positive botanical evidence for winter and late summer occupation. Year-round occupation is nevertheless likely.

2.2 Mureybit

Mureybit is a Natufian-related site just upstream from Abu Hureyra dating to the early ninth millennium BC (van Zeist & Bakker-Heeres 1984(1986)b). The earlier levels have roasting pits that contained concentrations of morphologically wild einkorn. There is little doubt that these grains represent food remains, but Mureybit lies outside the modern range of wild einkorn. As a result, the finds have been adduced either as evidence for early cultivation or as evidence that the Syrian desert was moister than it is now. Sherratt (1980) suggests people could have farmed the relatively moist river flood plain in this otherwise marginal environment. Based on the presence of *Cerealia* pollen from the archaeological deposits, Leroi-Gourhan (1974) concludes that there were cultivated fields at the base of the site, presumably einkorn. An alternative explanation for cereal pollen on the site is that it arrived adhering to the harvested, wild grains (cf. Robinson & Hubbard 1977). Van Zeist and Woldring's (1980) palynological study strongly supports the view that the climate was moister then than today, so the einkorn finds might have been collected from the wild.

Judging from a nearly pure sample of *Polygonum*, the Epipaleolithic people ate wild seeds that later dropped out of the diet when more

productive plants (wheat and barley) came under cultivation. An analogy can be made with prehistoric eastern North America, whose inhabitants ate small starchy seeded plants like *Iva annua*, *Chenopodium berlandieri* (both domesticated) and *Polygonum erectum* (possibly domesticated) only to abandon these crops after the introduction of maize from Mesoamerica (cf. Cowan 1985).

2.3 Nahal Oren

Nahal Oren, a cave and talus slope site dating to the Epipaleolithic and Pre-Pottery Neolithic periods, is at Mt. Carmel in a valley that meets the Mediterranean coastal plain (Noy et al. 1973). Unfortunately, flotation yielded few seeds. In contrast to the Syrian Epipaleolithic assemblages, these are primarily large-seeded legumes. Some apparently domesticated emmer that was mentioned in the original report has since been accelerator dated as intrusive (Gowlett & Hedges 1987: 134). For these reasons, no firm conclusions can be reached about plant use at this site.

2.4 Hayonim

Hayonim is another cave and terrace site in Israel located in a valley leading to the coastal plain. A high proportion of *Lupinus pilosus* L. characterizes its Natufian assemblage (Hopf & Bar-Yosef 1987). These and other archaeobotanical examples of early legume use by foragers and the earliest farmers led Kislev and Bar-Yosef (1988) to conclude that the earliest domesticates in the Near East were probably pulses. A more recent article by the same authors, however, considers barley to be the earliest domesticate (Bar-Yosef & Kislev 1989). In addition to lupine, there were two grains of *Hordeum spontaneum* (the wild ancestor of domesticated barley) and a few fragments of almond shell.

2.5 Other Epipaleolithic Sites

Recent work by Susan Colledge and Reinder Neef in Jordan may soon allow us to fill in some of the gaps in our knowledge of the Epipaleolithic. So far only seed lists are published, but they show species which "suggest a steppic environment, with some water in the vicinity" in the Azraq basin; a Pre-pottery Neolithic B site in the same area has similar finds

(Garrard et al. 1988). Wadi Hammeh 27 (Edwards et al. 1988) is another Early Natufian site in Jordan currently under investigation by Colledge, and Neef is analyzing material from the late Natufian site of 'Ain Ruhab (Muheisen et al. 1988). Unfortunately, seed recovery was poor at both sites.

3 EVIDENCE OF PLANT USE DURING THE ACERAMIC NEOLITHIC (ca 9000-6000 BC)

Sites of the Aceramic Neolithic period have domesticated plants and/or animals and generally lack pottery. In the Levant, a very early phase (Pre-Pottery Neolithic A - PPNA) is distinguished from the PPNB; many PPNB sites have evidence of animal domestication. Elsewhere in the Near East, sites are categorized simply as "Aceramic." Archaeologists have been much more successful in retrieving remains from PPNB and other late Aceramic sites of the seventh millennium BC than from earlier sites.

Permanent human settlement, with its great potential for environmental disturbance, began in the Epipaleolithic, but the Aceramic Neolithic saw the development of the irreversible changes in plant use and landscape associated with dependence on agriculture and pastoralism. Plant domestication apparently started in the Levant and spread across southern Turkey, northern Syria and Iraq, south along the Zagros flanks, and down onto the Mesopotamian plain (van Zeist 1986a). The occurrence of PPNB-related sites in northern Mesopotamia and southern Anatolia suggests that farming societies of the Levant expanded into areas to the north and east, spreading along the northern edge of the fertile crescent. From a botanical point of view, these early sites show significant similarities and differences with Epipaleolithic sites.

Although the earliest evidence for plant domestication comes from the Levant, people living in different physiographic zones applied the "idea" of cultivation to the local wild plants available to them. No single early site has all the early domesticates or their wild ancestors. Unfortunately, the transition to domestication is difficult to trace archaeobotanically, possibly because it happened very rapidly. Morphologically transitional cereal grains and rachis fragments are exceedingly rare, although some assemblages show a mix of wild and domesticated types (Zohary & Hopf 1988: 60). Even though pulses seem to be an important compo-

nent of many assemblages, the morphological distinctions between the wild and domesticated forms are not always visible on delicate archaeological specimens (cf. Butler 1989; section 3.12).

3.1 Netiv Hagdud

Located in the Jordan valley not far from Jericho, Netiv Hagdud is one of the early PPNA sites from which botanical remains were retrieved by flotation (Kislev et al. 1986). Domesticated barley has been accelerator dated to ca 9000 BC (9700-150 BP, OxA-744; Gowlett & Hedges 1987: 136). Only the barley is published in detail so far. The finds are very interesting because they are early, numerous, and include rachis internodes attributable to wild (*Hordeum spontaneum*) and domestic (*H. distichum*) types. Mention is also made of a few wild emmer spikelet forks and a single internode of domestic emmer. Based on these finds, Bar-Yosef and Kislev (1989) compare the characteristics of several possible candidates for early domestication, and conclude that barley would have been the most advantageous.

3.2 Jericho

Jericho is in the Jordan valley, just north of the Dead Sea. The region is very arid, but there is a perennial spring at the base of the mound. The archaeobotanical material from Jericho is not directly comparable to most of the assemblages mentioned here, because it was retrieved by hand rather than through flotation (Hopf 1983). The charred remains come primarily from stored crops of the Early and Middle Bronze Age. But there are a few grains and impressions of domesticated emmer and barley and rachis fragments of domesticated einkorn, emmer, and two-row barley from PPNA levels. There is also a substantial amount of domesticated emmer, einkorn, two-row barley, lentil, pea, and some fava bean and flax capsules from the PPNB.

3.3 Aswad, Ghoraifé, and Ramad

Aswad, a site in the Damascus basin first occupied at about 9000 BC, is one of several investigated by van Zeist and his colleagues that together document the development of agriculture in western Syria (van Zeist & Bakker-Heeres 1982(1985)). Perhaps most significant

are the earliest known domesticated emmer grains, which date to the early occupation of the site. Wild emmer does not grow in the area today, nor would it have grown there in the past. Rather, it is a plant of the southern Levant. Emmer cultivation is therefore likely to have originated to the south and southwest, only later spreading to Aswad. One suspects it is only a matter of time before earlier domesticated emmer is found in the Levant.

Flax (*Linum*) is present as well. The size of flax seeds from the Damascus basin sites increases through time. Though the earliest ones are small, they are larger than Near Eastern wild flax (*Linum bienne*), which was found, for example, at Çayönü. Van Zeist cautiously proposes the Aswad flax may have been cultivated as early as the first half of the eighth millennium BC.

As is true of many sites where flotation was carried out, the samples are quite mixed; although most have large numbers of cereal grains, especially emmer, they are generally in samples containing even greater numbers of spikelet forks, small-seeded grasses, sedges, legumes and other types.

Occupied primarily during the eighth millennium BC, Ghoraife and Ramad are later than Aswad, but geographically close (van Zeist & Bakker-Heeres 1982(1985)). Based on relatively large size, flax from Ramad is considered to be the domestic type, *Linum usitatissimum*.

3.4 'Ain Ghazal

'Ain Ghazal is a large PPNB site in Jordan located at the edge of the steppe on the outskirts of Amman (Rollefson et al. 1985). Grazing by herds of domestic animals, and to a lesser extent continuous cultivation, may have promoted progressive deforestation during the occupation of the site (Köhler-Rollefson 1988). The primary archaeobotanical evidence so far has come from analysis of the poles used in construction; their diameter decreases through time, suggesting a loss of primary forest (ibid.). The assemblage has high proportions of domesticated pea and lentil (Rollefson et al. 1985; section 3.12 below).

3.5 Nahal Hemar

Nahal Hemar is a PPNB cave site in the southern Judaean desert that yielded desiccated organic remains, including seeds and linen textile fragments (Kislev 1988; Schick 1986).

There are several edible species: domesticated emmer, barley, and lentil, as well as pistachio, acorn and other fruits. There are also seeds of wild, non-edible types. Many seem to have been accumulated by rodents; gnawed pistachio nuts are the most common find. It is likely that unlike today, pistachio grew close to the site.

The fragments of linen thread are especially important, because they are several hundred years earlier than the finds from Çatal Hüyük in Turkey, the oldest known up to now (Ryder 1965). Though both of these sites lack flax seeds, we know from other aceramic sites that flax was grown (section 3.3).

3.6 Çayönü

Located in the oak forest region of southeastern Anatolia, between the headwaters of the Tigris and Euphrates rivers, Çayönü was first occupied in the first half of the ninth millennium BC. The site yielded pistachio nutshell and the charred wood was of forest rather than riverine species. Van Zeist (1972) proposed early contact between Çayönü and sites to the west, because the domesticated einkorn was the single-grained type, that would not have evolved from the local twin-grained wild type. Although the earliest levels had both wild and domestic einkorn and wild emmer, cereals are not common. Nor are there many weed seeds, especially compared to earlier and contemporary sites of steppic environments, such as Abu Hureyra, Aswad, and Ali Kosh. Rather, the samples have relatively large amounts of pulses - bitter vetch, other vetches, pea, and lentil. There are no domestic animals in the early levels.

3.7 Magzaliya

Magzaliya is a PPNB-related site on the northern Mesopotamian steppe within the rainfall agriculture zone (Lisicyna 1983). The assemblage resembles that of roughly contemporary levels of Jarmo, as well as those of later sites such as Umm Dabaghiyah and Yarim Tepe I. The crop plants include einkorn, emmer, possibly club wheat (*Triticum compactum*), six-row barley, lentil, and flax.

3.8 Ganj Dareh

Ganj Dareh is a small mound in the Zagros mountains of Iran; local vegetation was prob-

ably oak-dominated forest-steppe (van Zeist et al. 1984(1986)). Like Mureybit, the earliest level has firepits but no structures. The assemblage includes mostly wild herbaceous plants, and pistachio occurs in virtually every sample. No one type predominates in any of the samples. Of great interest is the domesticated barley, present from the beginning of the occupation. Although the dating is problematic, these seeds may date as early as the ninth millennium BC. Forest and riverine wood was available, for the charcoal assemblage consists primarily of pistachio and hackberry (perhaps used as firewood); poplar/willow was used in construction.

3.9 Ali Kosh

Ali Kosh is a small mound located in the lowland steppe of southwestern Iran (Helbaek 1969). The excavators identified two Aceramic Neolithic phases (Bus Mordeh and Ali Kosh) and a later pottery phase (Mohammed Jaffar). All levels had domesticated plants and animals. The presence of domesticated emmer at this early date shows there was some cultural contact with upland regions. There is no suggestion of in situ domestication from the wild type; rather, fully domesticated emmer must have somehow traveled from the Levant and spread along the arc of the Fertile Crescent (section 3 above). Ali Kosh yielded other unexpected finds. Massive quantities of wild, small seeded legumes (*Astragalus*, *Medicago*, and *Trigonella*) are particularly prominent in the Bus Mordeh deposits (92%). The larger seeded *Prosopis* is prominent in the Ali Kosh phase, which also has the highest proportion of cultigens (40%) and lowest proportion of legumes (20%). Small-seeded legumes once again dominate the Mohammed Jaffar phase deposits (59%). Interpreted by Helbaek as food remains, the dominance of wild legumes suggested that despite access to high yielding crops and domestic animals, people were making great efforts to get plant protein.

In many respects, the Bus Mordeh and Mohammed Jaffar components at Ali Kosh are more similar to each other than they are to that of the middle (Ali Kosh) phase, especially in the high proportion of small-seeded legumes relative to cultigens.

3.10 Can Hasan III

Can Hasan III is a late Aceramic site on the

Konya plain in southern Anatolia (French et al. 1972). It was the first Near Eastern site at which flotation was used extensively. Several notes on the plant remains are available (Renfrew 1968; French et al. 1972; Hillman 1978). Based primarily on the discovery of domestic-type rachises, Hillman (1978) concludes that domesticated rye (*Secale cereale*) grew in fields as early as the mid-seventh millennium BC. The rye finds are sparsely distributed in the flotation samples, however, so the rye may be an "obligate 'weed' of other cereals or ... a maslin or separate crop in its own right" (Hillman 1978: 172).

3.11 Cyprus

The Aceramic Neolithic also saw the settlement of Cyprus (Kroll, this volume; Le Brun et al. 1987; Hansen in press). The colonists brought domesticated animals and plants, including sheep, goat, einkorn, emmer and barley. The major crop at Khirokitia and Tenta Kalavassos is einkorn (Waines & Stanley-Price 1975/77; Miller 1984b; Hansen, forthcoming a,b). At Cape Andreas-Kastros, emmer seems to be of somewhat greater importance, though einkorn is a significant presence (van Zeist 1981). Van Zeist suggests this could mean that either the settlers came from an einkorn-growing region or that local conditions encouraged the use of einkorn. Given the distribution of einkorn cultivation and the location of Cyprus, Anatolia is a likely source of colonizers (see below, section 4.1; Table 2); where the Neolithic settlers came from is still an open question, however (Le Brun et al. 1987). Cypriot sites are among the earliest with olive pits, but there is no reason to assume the fruits were other than wild. In the Ceramic Neolithic, bread wheat/hard wheat enters the assemblage.

3.12 The emerging pattern of pulse exploitation

Genetic and morphological differences between the wild and domesticated cereals of the Near East are relatively well known. The history of the major Near Eastern pulse crops is less clear. The archaeobotanical record of lentil, pea, chickpea, bitter vetch, grass pea, and fava bean is long, and these crops are coming under increasing scrutiny (Zohary 1989; Zohary & Hopf 1988).

Legume domestication is harder to document than cereal domestication. The main morpho-

logical change is to an indehiscent (non-shattering) seed pod, rarely present in archaeological assemblages. Microscopic anatomical features of pulses, especially surface texture, have some potential as distinguishing characteristics (Butler 1989). Though seed size increased during the domestication process, the change was a gradual one, so intermediate forms cannot be unambiguously classified. Cultivation, if not domestication, is sometimes inferred on ecological or archaeological grounds. For example, Zohary and Hopf (1988) point out that pulses accompany domesticated wheat and barley even before they are independently recognizable as domesticates.

Unlike the wild cereals, wild legumes do not form dense stands, nor can large quantities of seeds be collected easily. Ladizinsky (1989) notes it would take about 10,000 wild lentil plants to collect 1 kg of clean seed. Seed dormancy in wild plants would also have made cultivation difficult (*ibid.*). The earliest occurrences of pulses tend to be scattered finds in mixed samples (an exception is the lupine from Natufian Hayonim), and the extent to which pulses represent early cultivation and/or food is not clear. It is during the seventh millennium BC, however, especially in sites of the PPNB and related cultures, that concentrations of pulses begin to occur consistently. For example, Garfinkel et al. (1988) report a large hoard of lentils (7.4 kg, charred) from the PPNB site of Yiftah'el. They persuasively argue that the quantity found is unlikely to have been collected in the wild; furthermore, the dominant weed impurity is *Galium*, which does not grow with wild lentil (Garfinkel et al. 1988).

Yiftah'el also yielded the earliest known domesticated broad beans, found in a silo (Kislev 1985). M. Donaldson and R. Neef's work on the PPNB site of 'Ain Ghazal suggests that "domesticated peas and lentils appear to have constituted the primary staple in the diet ... with supplements provided by domestic wheat and barley as well as fig, chickpea, almond, and pistachio" (Rollefson & Simmons 1985: 17). A flotation sample from the upper Neolithic level at Gritille, a final PPNB site on the Euphrates in southeastern Turkey, yielded over 800 *Lathyrus* seeds (personal observation) dating to 6500 BC (Voigt 1988 and personal communication). Kislev (1989b: 265) suggests *Lathyrus* was originally domesticated in the Balkans at "the beginning of the sixth millennium BCE" (ca 7000 calib. BC), based on a hoard found at Podromos in Greece; if that is so, it did not take more than a few hundred years for the crop to reach southeastern Anatolia. Regardless of

what one thinks of the earliest pulse finds, only the most skeptical would consider the PPNB and later finds gathered from the wild.

Examined in biocultural context, one may wonder that pulses were domesticated at all. First, consider the well known nutritional complementarity between legumes and cereals. For example, maize and beans in the prehistoric North American diet provided complete protein even though the Native Americans lacked major sources of meat from domesticated animals. The dietary significance of pulses in the ancient Near East is less obvious, however, because the best evidence for fairly widespread legume cultivation occurs exactly among the cultures that had the first domesticated animals! In fact, Ladizinsky suggests that

"The low seed set per plant and the open nature of wild stands indicate, therefore, that in pre-agricultural times lentils, and other pulses as well, are unlikely to have constituted a major portion of human diet. It can, therefore, be suggested that collection of wild lentils was not primarily for their seeds but for some other purpose, such as fodder. This may support Bohrer's (1972) contention that plant gathering by man in Southwest Asia in pre-agricultural times was undertaken mainly to provide captive animals with fodder" (Ladizinsky 1989: 383).

Second, pulses were domesticated even though many of the wild forms are inedible due to certain chemical compounds in the seeds. For example, a genetic blood disorder called G6PD deficiency is found in circum-Mediterranean populations. Fava beans are toxic to those who suffer from the disease, but heterozygotes have increased resistance to malaria. Thus, fava beans have come to enjoy an important role in Mediterranean cuisine (Katz 1987). Grass pea provides another example of toxicity. It is a hardy plant high in protein, but without proper processing, the seed is toxic when eaten in large quantities (Kislev & Hopf 1985). Nevertheless, grass pea occurs on Near Eastern sites; it is sometimes found in jars or other concentrations, which suggests it was a food source despite its unpleasant side effects.

4 AGRICULTURE ESTABLISHED

The ecological effects of the new subsistence system were far-reaching, and botanical evidence has documented changing patterns of land use and abuse. By about 6000 BC, domesticated animals, notably sheep, goat and cattle, had joined the familiar crop complex of Near Eastern cereals and pulses, forming the econ-

omic basis of later Neolithic society and the first civilizations. Up until that time, there is a pattern of seemingly opportunistic use of non-local domesticates and the domestication of locally available types (van Zeist 1986a).

There are several developments in the sixth millennium BC. Free-threshing wheat (*Triticum aestivum* or *T. durum*) becomes a more common crop at this time, as does six-row barley (Zohary & Hopf 1988). Flax cultivation began in the Aceramic Neolithic. Now it spread throughout the Near East (van Zeist & Bakker-Heeres 1975a). Helbaek (1970: 212) suggested that widespread cultivation of these three crops was associated with a major technological change identifiable in the archaeobotanical record - the introduction of irrigation agriculture. Although water control systems, such as check dams and terraces, are likely to have been built as early as the pre-Pottery Neolithic, more extensive, possibly river-based systems are later (Sherratt 1980; see also Hopf 1983). The significance of these developments cannot be overemphasized, for the economic basis of the later Mesopotamian civilizations depended on very productive agricultural systems.

Our knowledge of the period is based on relatively little material, much of which was reported in the 1960s and 1970s. There is a group of Anatolian sites (Hacilar, Çatal Hüyük, and the more recent Erbaba); Levantine and Syrian sites include Bouqras, el Kowm and Ras Shamra; there are several sites on the edge of Mesopotamia (e.g., Umm Dabaghiyah, Yarim Tepe I, and Chogha Mami).

4.1 Anatolia

Hacilar (Helbaek 1970), Çatal Hüyük (Helbaek 1964), and Erbaba (van Zeist & Buitenhuis 1983) are all located in central Anatolia. Einkorn and naked barley are the major cereals of the three assemblages, though varying proportions of emmer, two- and six-row barley occur as well. This contrasts with contemporary sites mentioned below, where einkorn is a minor component. Pulses such as lentil, pea, and bitter vetch also occur, and tree crops include acorn, hackberry, almond, and pistachio.

4.2 Syria

Bouqras (van Zeist & Waterbolk-van Rooijen 1985) is located on a bluff at the edge of the Euphrates valley in a low rainfall zone (about 125 mm/year). The average weights of hard

wheat/bread wheat and naked barley at Bouqras compare favorably with those at Erbaba, a site near the 500 mm rainfall isohyet; this suggests that water was available, possibly through the higher water table or wadi check dams. The authors do not consider river irrigation possible, for high water comes just before the harvest. If one only considers the grain supplies burned in situ in two of the buildings, one might think free-threshing wheat and barley were the primary food plants, but a ubiquity analysis that includes trashy deposits shows high percentages of the glumed wheats, especially emmer (ibid.: 142).

El Kowm (van Zeist 1986b) is located in an oasis in the Syrian desert. The assemblage is small. Irrigation may be assumed, for the crop plants (emmer and hard wheat, and hulled two- and six-row barley and naked barley) would have required it. There are many fig seeds, presumed wild.

Ras Shamra (van Zeist & Bakker-Heeres 1984(1986a)) is located near the Mediterranean coast of northwest Syria. Its lowest levels are contemporary with aceramic Ramad, and the occupation continued into ceramic Neolithic and Halaf times. Van Zeist and Bakker-Heeres note several trends. First, the aceramic levels are poor in plant remains, and the absolute numbers and proportions of weed seeds increase through time. In addition, even as weed seeds increase, the pulse crops decline. A similar pulse crop decline was reported at Aswad and Ghoraifé (ibid.: 166). Olive is relatively common, and there is some fig and pistachio as well; all are presumed wild.

4.3 The edge of Mesopotamia - Rainfall agriculture and irrigation

There are several sites dating to the late seventh and sixth millennia BC that lie on the steppe at the edge of the Mesopotamian plain. The northern ones belong to the Hassunan (Umm Dabaghiyah and Yarim Tepe I) and later Halaf cultures (Girikihaciyan, Yarim Tepe II and Sabi Abyad), and the southern ones are Samarran (Tell es-Sawwan and Chogha Mami). There are almost no materials from the subsequent Ubaid period in southern or northern Mesopotamia; two exceptions are from Sabz in the south and Hammam et-Turkman in the north. The assemblages reported are all meager, but they are the only ones available for the period preceding the rise of the great irrigation-based civilizations of the Mesopotamian plain.

Table 2. Some plant remains from selected Near Eastern sites.

SITE	millennium BC	CEREAL					PULSE					FRUIT				FIBER	
		einkorn	emmer wheat	naked wheat	2-row barley	6-row barley	lentil	pea	bitter vetch	fava	chick-pea	grass pea	grape	olive	fig	date	flax
Hayonim	11	.	.	.	w	.	.	.	.	.	.	(+)	.	.	.	.	.
Abu Hureyra	11,10	w	.	.	w	.	.	+	+	.	.	+	.	.	+	.	+
Mureybit	10	w	.	.	w	.	.	+	+	.	.	.	.	.	+	.	+
Jericho	9,8,7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aswad	9,8,7	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Abu Hureyra	8	.	?	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Çayönü	8,7	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ganj Dareh	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ali Kosh	8,7	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
'Ain Ghazal	8,7,6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nahal Hemar	7	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Yiftah'el	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ghorraifé	7	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Hacılar	7	w?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ramad	7	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Ras Shamra	7	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Bouqras	7	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
el Kowm	7	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Yarim I & II	7,6	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Erbaba	6	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Jericho	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ramad	6	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Ras Shamra	6	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Girihaciyan	6	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Sabi Abyad	6	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.

Table 2 (Continued).

SITE	millennium BC	CEREAL					PULSE					FRUIT				FIBER		
		einkorn	emmer wheat	naked wheat	2-row barley	6-row barley	lentil	pea	bitter vetch	fava	chick-pea	grass	pea	grape	olive	fig	date	flax
Hacilar	6	●	●	●	●	●	●	●	+	+	+		●	●	●	●	●	●
Ali Kosh	6	(+)	●	●	●	+	+	●	●	●	●	●	●	●	●	●	●	+
Sabz	6	●	●	●	●	+	●	●	●	●	●	●	●	●	●	●	●	●
Korucutepe	5,4	+	●	●	●	●	●	●	+	●	●	●	+	●	●	●	●	●
Shiqmum	5,4	●	●	+	●	+	●	●	●	●	●	●	●	●	●	+	●	●
Ras Shamra	5	+	●	+	+	●	+	●	●	●	●	●	●	+	●	+	●	+
Jaffarabad	5	+	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Farukhabad	5,4,3	+	+	+	●	+	+	●	●	●	●	●	●	●	●	●	●	●
Kurban Höyük	5,4	●	●	●	●	●	+	●	●	●	●	●	+	●	●	●	●	+
Sharafabad	4	●	●	●	●	●	+	●	●	●	●	●	●	●	●	●	●	●
Abu Hamid	4	●	●	●	●	●	●	●	●	●	●	●	●	●	●	+	●	●
Gijlar	4,3	●	●	●	+	●	+	●	●	●	●	●	+	●	●	●	●	+
Malyan	4,3	+	●	●	●	●	●	●	●	●	●	●	●	●	●	+	●	●
Shahr-i Sokhta	3	+	+	+	+	+	+	+	●	●	●	●	●	●	●	●	●	+
Ur	3	●	●	+	●	●	●	●	●	+	●	●	●	●	●	●	●	●
Tell Taya	3	●	+	●	●	●	+	●	+	●	+	+	+	+	●	●	●	●
Arad	3	●	+	+	●	+	●	●	+	●	+	+	+	+	●	●	●	+
Jericho	3,2	●	●	●	●	●	●	●	●	●	+	+	+	+	+	+	+	+
Bab 'edh Dra	3	(+)	+	(+)	+	●	+	+	●	●	●	●	●	●	+	●	●	+
Numeira	3	(+)	+	(+)	●	●	●	●	●	●	●	●	●	●	+	+	+	+
Selenkahiye	3	+	+	+	●	●	+	+	+	+	+	+	+	+	+	+	+	+
Sweyhat	3	●	●	●	●	●	+	+	●	+	+	+	+	+	+	+	+	+
Demircihüyük	3	●	●	●	●	●	●	+	●	+	+	+	+	+	+	+	+	+
Korucutepe	3	●	●	●	●	●	+	+	●	+	+	+	+	+	+	+	+	+
Tepecik	3	+	+	●	●	●	+	+	+	+	+	+	+	+	+	+	+	+

Table 2 (Continued).

SITE	millennium BC	CEREAL					PULSE				FRUIT				FIBER		
		einkorn	emmer wheat	naked wheat	2-row barley	6-row barley	lentil	pea	bitter vetch	fava	chick-pea	grass pea	grape	olive	fig	date	flax
Kurban Höyük	3	.	(•)	.	(•)	.	•	+	•	.	+	•	•	.	.	.	+
ed-Der	2	.	+	+	(+)	(•)	+	+	.	.	+	•	+	+	•	.	.
Hadidi	2	.	.	+	•	•	+	+	.	.	+	•	+	.	.	.	.
Kamid 'el Loz	2	.	.	+	.	.	+	•	.	.	.	.	+	+	.	.	•
Deir 'Alla	2	.	.	•	•	.	+	+	.	.	.	.	+	.	.	.	.
Koncutepe	2	.	+	•	•	.	+	.	.	.	.	.	+	.	.	.	.
Tepecik	2	.	+	•	•	.	+	+	.	.	.	+	.	+	.	.	.
Hadidi	1	.	.	+	.	•	+	.	.	•	+	+	•	•	.	+	•
Kamid 'el Loz	1	.	.	+	•	.	+	+	+	.	.	•	+	.	.	.	.
Deir 'Alla	1	.	+	•	.	+	+	+	.	+	.	+	.	.	.	.	•
Bastam	1	.	+	•	.	•	+	+	+	.	.	+	+	.	.	.	.
Qasile	1	.	.	.	.	•	+	+	.	.	.	+	+	+	.	.	.
Heshbon	1	.	.	•	.	•	+	+	.	.	.	.	•	.	.	+	.
Nahal Yatir	1	.	+	+	•	•	+	+	.	.	.	+	.	.	.	.	.
Lejjun	1	.	.	.	.	.	.	•	.	.	.	.	.	.	.	•	.
Susa, Ville Royale	1	.	.	•	•	.	.	+	.	.	.	.	.	.	.	.	.
Qal'eh Ismail Aga	1	.	+	+	.	•	+	.	.	.	.	•	•	.	.	.	+
Heshbon	AD	.	.	•	.	•	.	.	.	.	.	.	.	•	.	.	•
Qal'eh Ismail Aga	AD	.	+	+	+	.	+	.	.	.	.	•	•	•	.	.	.
Lejjun	AD	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.

• major component

+ minor component

w wild (cereals only)

() species determination in question

The relative importance indicated is the author's subjective assessment

Only a few impressions and charred grains and rachis fragments of emmer and barley were retrieved from Umm Dabaghiyah. Given the inhospitable nature of the area today, Helbaek (1972a) suggests their primary significance is in demonstrating that such plants were available. In contrast, there are thousands of tentatively identified *Chenopodiaceae* seeds in the earliest levels from plants that may have been burned for fuel or other reasons. There is no arboreal charcoal, consistent with the treeless nature of the environment.

Yarim Tepe I and II (Bakhteyev & Yanushevich 1980) yielded several deposits of cereals. The bulk of the finds consists of hulled six-row barley, though some naked barley, emmer, bread wheat/hard wheat, and tentatively identified spelt are also reported.

The culture area defined by Halafian pottery extends from the Mediterranean to eastern Iraq (Watson 1983). Even so, plant remains from Halafian sites are few and they come from sites covering a varied territory. As of this writing, no synthesis of Halaf material is possible. Differences between sites may be the result of small sample sizes, or they may be truly representative of local variability. For example, Ras Shamra, at the western limit of Halaf cultural influence, has olives, characteristic of the Mediterranean agricultural system. At Ras Shamra and Girikihaciyan (one of the northernmost available sites), emmer seems to be the major cereal (van Zeist 1979/1980). Emmer also predominates at Sabi Abyad, a Syrian site on a major Euphrates tributary (van Zeist & Waterbolk-van Rooijen 1989). [By the Ubaid period, at the nearby Hammam et-Turkman, two-row barley began to rise in importance (van Zeist et al. 1988).] Finally, Yarim Tepe II, one of the eastern Halafian sites, seems to have a large proportion of six-row barley (Bakhteyev & Yanushevich 1980).

One of the questions about Halafian agriculture concerns irrigation; Halafian sites lie within the rainfall agriculture zone of the Near East, but contemporary cultures to the south did practice irrigation (Watson 1983; see below, this section). A comparison of material from Tell Aqab and Umm O'seir in Syria shows that the latter, more southerly site has crops (six-row barley) that would have required supplemental watering or a high water table, but final results are not yet available (McCorriston 1989). Such practices would be a continuation of Neolithic water control and field management.

Partially overlapping the Hassunan period in time, Samarran wares found on the eastern

edge of the Mesopotamian plain define the culture that probably had the first canal irrigation. Indeed, at Chogha Mami, traces of an irrigation canal were uncovered (Oates & Oates 1976). Though recovery was meager, several sites from this period yielded plant remains. Along with remains identified earlier from Tell es-Sawwan (Helbaek 1965), material from Chogha Mami in Iraq (Helbaek 1972b) provides early botanical evidence for irrigation. In particular, Helbaek points to several consistently occurring indicators of irrigation in this arid zone: the large size of the flax seed, and the presence of six-row hulled barley and bread wheat and, at the somewhat later Tepe Sabz, large seeded lentil. A technique that may soon add to our ability to identify different water regimes is phytolith analysis; for example, based on modern experimental analogy, the practice of irrigation at the Chalcolithic site of Shiqmim may be inferred from the presence of multicelled phytoliths (Rosen 1987).

Remarkably little material is available from sites of the late fifth and fourth millennia BC. A group of samples from several sites in southwestern Iran give some insight into crop choice and plant use on Susiana and the neighboring Deh Luran plain. Comparisons between sites are difficult because the sampling procedures were not uniform. Two of the earlier sites in Susiana, Jaffarabad and Bendebal (Miller 1983), had concentrations of wheat, barley and lentil; lentil seems less common on the Deh Luran plain, at least in the earlier period.

Although not an archaeobotanist himself, Henry Wright, who excavated Sharafabad and Farukhabad in the late 1960s, may be the first person who routinely recorded the volume of flotation samples in the Near East. At Sharafabad, Wright took soil samples at stratigraphically significant intervals from a large Middle Uruk pit (Wright et al. 1981). Despite conscientious sampling, there was a very low density of charred material. Examined in isolation, the Sharafabad samples do not give much information about ancient plant use. However, since density of charred seeds per liter can be calculated, the material can be used to support Wright's seasonal interpretation of the strata in the pit. That is, more charred seeds thought to have come from dung fuel occurred in the levels assigned on independent grounds to "winter" deposition (see section 7.1). Farukhabad is a fourth millennium BC site on the Deh Luran plain, not far from Ali Kosh. The samples come primarily from occupation debris, and the deposits contained little charred material. The assemblage includes some cultigens,

but most of the material consists of weed seeds and rachis fragments (Miller 1981b; Radford 1980). An overview of archaeobotanical research in southwestern Iran appears in Miller (1985a).

Emmer wheat and hulled two- and six-row barley seem to be the cereal staples in the Chalcolithic of the Levant (fifth and fourth millennia BC), and lentil is the most common pulse (Kislev 1987: Table 9.3). As Zohary and Spiegel-Roy (1973) proposed, olive becomes a more common element in Levantine assemblages, and is probably domesticated. Tell Abu Hamid, in Jordan, yielded emmer, six-row hulled barley, and grass pea (*Lathyrus*), as well as lentil and a chickpea (Neef 1988). Based on numerous small pit fragments, Neef suggests that the Abu Hamid olives are among the earliest cultivated found to date; fig may or may not have been cultivated (*ibid.*). At Shiqmim (Kislev 1987), samples tended to be mixed, with cereals (mainly hulled barley and emmer), rachis fragments and weed seeds.

4.4 The vine

The Euphrates dam projects have yielded archaeobotanical remains of seeds and charcoal. Excavated as part of the Keban project, Korucutepe and Tepecik span the Chalcolithic to Middle Bronze Age (van Zeist & Bakker-Heeres 1975b). The main excavation areas at Kurban Hüyük, in the Karababa region, date to the Chalcolithic and Early Bronze Ages; only a preliminary report is available (Miller 1986). Though these sites are far inland, they are all within the range of wild grape (Zohary & Spiegel-Roy 1973). The Keban sequence has grape from the beginning. Decrease in the breadth: length ratio suggest that the earlier material is wild and the later material is cultivated (van Zeist & Bakker-Heeres 1975b). At Kurban Hüyük, the amount of grape increased (grape occurs in 5% of the samples from the late Chalcolithic, in 10% from the Early Early Bronze Age, and in 66% from the Mid-Late Early Bronze Age). One Mid-Late EB deposit was filled with charred grape seeds, peduncles, and fruits as well as nutshell, but contained little other botanical debris. One is tempted to interpret the sample as refuse from wine production. Although the site is within the natural range of wild grape, the Kurban Hüyük grape is late enough so that it probably represents a cultivated type.

Although not numerous until about 1900 BC, a few morphologically wild grape seeds were

recovered from Tepe Hissar in northeastern Iran in mid-fourth millennium BC levels (Costantini & Dyson, in prep.). Shahr-i Sokhta, in Seistan province of eastern Iran also produced large numbers of grape seeds (Costantini n.d.). The mid-third millennium BC specimens have average breadth: length ratios over 60, whereas those from the late third millennium BC are under 60. According to the Zohary & Spiegel-Roy (1973) distribution map, Shahr-i Sokhta is outside the range of wild grape, so the entire series probably comes from cultivated varieties.

Direct evidence for late fourth millennium BC wine production comes from recently analyzed wine residues on a potsherd from Godin Tepe (Badler et al., in prep.). The vessel was probably locally produced, but this central Zagros mountain site lies outside the modern range of wild grape. Flotation samples were taken, so it may be possible some day to determine whether the local grapes used in wine production were wild or domesticated.

5 PLANT USE OF THE EARLY CIVILIZATIONS

The third millennium BC (Early Bronze Age - EB) saw the development of urban civilizations in Mesopotamia and peripheral regions. An overview is particularly difficult, not only because there is little material, but because one would not expect the full range of plants and plant use to occur uniformly within and between the functionally differentiated settlements that characterize urban systems. Although we do not have archaeobotanical evidence from the earliest settlements on the Mesopotamian plain and there are few exhaustive studies from anywhere in the Near East, archaeobotanists have paid more attention to the Early Bronze Age than to any of the periods after Aceramic times. Grape became widespread at this time.

It is unfortunate that excavators in Mesopotamia proper have not sought plant remains more often. Funerary offerings at Ur (Ellison et al. 1978) include crabapples on strings, a fruit which is well attested in Akkadian sources (cf. Gelb 1982). There are a few cereals, pulses and fruit pits from Early Dynastic and Akkadian levels at Tell Taya (Waines 1973). From the second millennium BC, Tell ed-Der has produced a variety of condiments and herbs, including the seeds of cumin and coriander (*Coriandrum sativum*), garlic cloves (*Allium sativum*), and tubers of *Cyperus tuberosus* (van Zeist 1984). Michael Charles is working on

systematically collected samples from several sites in Mesopotamia (Postgate & Killick 1983).

5.1 North Syria and the Euphrates valley

Van Zeist and Bakker-Heeres (1985(1988)) examined a group of Bronze Age sites on the north Syrian Euphrates: Selenkahiye, Hadidi and Sweyhat. Two-row barley, free-threshing wheat, lentil and grass pea were the major crops. The barley of the late EB is hulled; naked barley, more common in the Neolithic, is no longer in evidence in this region. Emmer, too, seems to disappear by the end of the EB. The increase in barley at the expense of emmer is evident in the similarly situated Hammam et-Turkman (van Zeist et al. 1988). Selenkahiye had several spatially separated barley deposits. Although they are on floor of same room, the weed proportions of the deposits are not uniform. Furthermore, grain dimensions in four of the samples varied. It therefore seems that the barley samples come from different sources, perhaps supplies stored by a merchant for sale as a commodity (ibid.: 279 ff.). [There is a good analogy with present-day village grain storage practices: like the Selenkahiye barley, samples of threshed, stored grain from two modern farmers and from a small store near Malyan, Iran showed between-sample variability in terms of both purity and grain size (Miller 1982: 108 ff., 386 ff.)]

Two-rowed hulled barley also predominates in the assemblage from third millennium BC levels at Tell Leilan, an urban center in northern Syria. Emmer and durum wheat are also present, and the most common pulse is lentil (Wetterstrom, in press).

5.2 Anatolia

In addition to the Chalcolithic remains mentioned above, Kurban Hüyük also yielded material from the Early Bronze Age (Miller 1986). Barley and wheat are the major crops, but wheat seems to predominate. This contrasts with comparable sites in areas of lower rainfall (e.g., Tell Taya in Mesopotamia and Malyan in highland Iran), where barley seems to be more important (Waines 1973; Miller 1982).

Plant remains from several other third millennium BC sites have been reported from Turkey. At Demircihüyük, preliminary results suggest a preference for wheat, especially wild and domestic einkorn (Schlichtherle 1977/1978). This site also has the first *Camelina sativa*

known from the Near East, though it is scattered in the ash levels and may just be a weed. [By the Late Bronze Age, the Syrian site of Hadidi has a concentration of *Camelina sativa*.] A single sample of emmer mixed with a few barley grains is reported from Troy (Shay et al. 1982).

5.3 Iran

Malyan (ancient Anshan), a primarily third millennium BC city in southern Iran, was extensively sampled for plant remains (Miller 1982, 1984a, 1985b). Density of charred material is low, but the early and late third millennium BC deposits show consistent differences both in wood species and seed densities. The site lies in a wide valley near the border between the Zagros oak forest to the north and pistachio-almond forest to the south, though the modern vegetation is very degraded. Charcoal analysis suggests that in the third millennium BC, as wood close to the site was being depleted, oak from the hillsides came into wider use. The scattered seed remains are typical of many Near Eastern assemblages, consisting of mixtures of cultigens (primarily barley, but also wheat, lentil and grape) and weed seeds. Proportions of barley to wheat are consistent through time, about 13:1. There is, however, an unexpected but dramatic increase in the proportion of seeds relative to charcoal that requires explanation. Since most of the remains are charred, an ethnographic model was developed to evaluate the likelihood of various activities that could lead to charring. Not surprisingly, in the absence of accidental burning of whole structures, fuel burning and trash disposal are the most probable sources of charred remains. Since third millennium BC Malyan depended on sheep and goat, and also had cows, dung could be a source of seeds (Miller & Smart 1984). Interpreted thus, the Malyan seed assemblage is readily explained as the residue of dung fuel; deforestation initially suggested by the charcoal analysis is accompanied by an increase in seeds from dung. Further support for this conclusion lies in a single latrine deposit from about 2000 BC, which has more wheat, ordinarily favored for human food, than barley, in proportions of 2:1 (see section 7.1 below).

Shahr-i Sokhta is a late third millennium BC site in eastern Iran (Costantini n.d.). Dry preservation was exceptionally good, though there are some charred remains. Much of the material consists of food offerings from graves:

grape seeds, wheat, and barley predominate. In addition to the more traditional food remains, *Chenopodium* seeds were found in some pots. Indian dwarf wheat (*Triticum sphaerococcum*) seems to have been introduced from Harappan societies to the east. The distribution of identifiable insects and insect parts follows the interpretation of archaeological context; for example, larval exuviae of dermestid beetles, a common pest of stored grain, were found in food storage jars (Costantini et al. 1975/76/77: 254).

5.4 The Levant

In the Levant little information about Early and Middle Bronze Age plant remains is available. Jericho (Hopf 1983) and Arad (Hopf 1978) are both in arid locations. The former sees an increase in barley over wheat after the Early Bronze-Middle Bronze transition, whereas barley predominates in the archaeobotanical material from Arad. Both sites have relatively few samples (some of which are, however, quite large), so it is not easy to detect trends. Two sites in Jordan, Bab 'edh Dhra and Numeira, have a number of cultigens, primarily six-row barley and grape. Cemetery deposits from Bab 'edh Dhra yielded a hoard of grape, as well as almond (*Prunus dulcis*; McCreery 1981). A recent study at Tel Ifshar in southern Israel concentrates on Middle Bronze Age levels, and there is a handful of samples from other periods (Chernoff 1988). The study uses a modified version of the crop processing model developed by Hillman (1981) and Jones (1984) to interpret the charred remains.

6 THE END OF THE SECOND MILLENNIUM BC AND BEYOND

The Late Bronze Age, Iron Age, and later periods are poorly represented by archaeobotanical finds. Plant remains from only a few sites are reported.

In Jordan, Deir 'Alla yielded concentrations of bread wheat/hard wheat, though two-row barley, flax, bitter vetch (*Vicia ervilia*), cumin (*Cuminum cyminum*), and fenugreek (*Trigonella foenum-graecum*) also show up in large numbers (van Zeist & Heeres 1973; Neef 1989). Iron Age sesame from the site is particularly important (Neef 1989; see section 7.5).

A few Levantine sites have produced plant remains, but the assemblages are small. Kamid el-Loz provides a rare glimpse of agriculture in

Late Bronze and Early Iron Age Lebanon: three large concentrations of six-row barley, a large sample of bitter vetch, and another of chickpea (Behre 1970). Beer-Sheba yielded date and olive pits (Liphschitz & Waisel 1973). Kislev (1986) reports a nearly pure hoard of two-row barley from the Roman period site of Nahal Yattir, and Gilliland (1986) reports a series of mixed seed samples from an Iron Age to Islamic period sequence at Heshbon in Jordan. The Roman outpost at Lejjun, also in Jordan, yielded a wide variety of food plants (Crawford 1987). Barley is the most common grain, and lentil the most common pulse. Fruits include olive, grape, date, and (Byzantine) peach. Since some olive and grape wood was found, local production is likely. In contrast, the date and peach may have been imports. Located in an arid area that has been devoid of any appreciable number of trees for at least a century, Lejjun's primary fuel source was dung supplemented with a small amount of wood; Crawford considers dung a probable source of weed seeds in domestic contexts.

Several Iranian sites yielded plant remains from the second and first millennia BC. Barley predominates in stored grain samples from Bastam, an Urartian fortress (ca 9th-7th century BC) in northwestern Iran, and there is a variety of pulses (pea, lentil, chickpea, grass pea) and fruits (almond, apricot, grape) in lesser numbers (Hopf & Willerding 1989). Six-row barley is the major cereal preserved at roughly contemporary sites such as Hasanlu (Costantini 1988) and Nush-i Jan (Kyilo & Hubbard 1981). Broomcorn millet, which first appeared in the mid-second millennium BC, becomes a more common element in archaeobotanical assemblages in the lands surrounding Mesopotamia.

6.1 New crops (rice, millet, and sesame)

There are written references to plants and to agriculture from the earliest clay texts of the Sumerians. The ancients did not write down every aspect of plant use, however, and tracing the introduction and spread of plants remains an important concern of archaeobotany. For example, even before the Assyrian kings expressed a strong interest in horticulture by bringing plants home from their military forays into foreign lands (Wiseman 1983), the archaeobotanical record shows increasing importation and adoption of exotic crops, not just in Assyrian lands, but all around the ancient Near East.

Rice (*Oryza sativa*), millet (*Setaria italica* and *Panicum miliaceum*), and sesame (*Sesamum indicum*) were cultivated in south Asia by the late third millennium BC, in Harappan times (see Weber (1989) for millets; Zohary & Hopf (1988) for rice and sesame); in central Europe, the use of millet was widespread even earlier (Nesbitt & Summers 1988; Kroll, this volume). Near Eastern finds of these plants are all later.

Hellenistic writers report rice cultivation in the Near East (Zohary & Hopf:1988:82). The earliest archaeological rice that I know of from the region was found in a burnt room of the Parthian period (1st century AD) at Susa, in southwestern Iran (Miller 1981a). There are also a few rice grains from a deposit which is dated either to the Hellenistic or Islamic period at Gordion, central Anatolia (unpublished data).

It is not yet known how millet arrived in the Near East (Nesbitt & Summers 1988). The earliest foxtail millet (*Setaria italica*) found to date in the Near East comes from seventh century BC deposits at Tille Hüyük in southeastern Turkey (Nesbitt & Summers 1988). In northwestern Iran, broomcorn millet (*Panicum miliaceum*) is found at Haftavan in a level dated 1900-1500 BC (Nesbitt & Summers 1988); it is a minor component in levels dating to about 1300 BC at Hasanlu, and an important one by ca 1000 BC (Costantini 1988). Even earlier finds come from fourth millennium BC levels at Tepe Yahya, in eastern Iran (Lamberg-Karlovsky & Tosi 1989). Iranian sites with plant remains from Urartian and later times all have broomcorn millet (Bastam, Hasanlu, and Nush-i Jan; Hopf & Willerding 1989; Kylo & Hubbard 1981), as does the Iron Age site of Deir 'Alla in Jordan (Neef 1989). Nesbitt and Summers (ibid.) also report a "large deposit" of uncharred broomcorn millet from Phrygian levels at Gordion. They consider it "odd" that sesame and millet, two "summer crops," are not found together more often; recent excavations at Gordion have begun to justify their expectations (see below).

* Ancient texts mention the "oil-plant," etymologically related to "sesame," long before evidence of sesame itself occurs in the archaeological record. Helbaek (1966) pointed out that Nimrud, an Iron Age Assyrian site, had a significant amount of flax but no sesame. Yet the word for sesame, but not flax, occurs in Sumerian and Akkadian texts. He proposed that this word originally applied to flax, and only later came to refer to another small oil seed, namely sesame. The controversy has not abated, and several papers in the 1985 Bulletin

of Sumerian Agriculture deal with "the oil-plant" (Bedigian 1985; Stol 1985; Renfrew 1985; Postgate 1985). Those favoring a translation of sesame point to Mesopotamian contacts with Harappan civilization of the Indus valley. But the "oil-plant" referred to in Sumerian and Akkadian texts of the third millennium BC antedates the first actual sesame seeds in the Near East by over a thousand years. Extensive evidence of sesame oil pressing occurs in the early Urartian (Iron Age) site of Karmir Blur (Zohary & Hopf 1988:127); roughly contemporary are six sesame seeds from early Urartian Bastam (Hopf & Willerding 1988:295), a small jar of sesame from early Phrygian Gordion (Miller, unpublished data from the 1989 excavation), and a number of finds from Iron Age levels at Deir 'Alla (Neef 1989:36). Thus, despite possible early textual references to sesame, the first certain Near Eastern finds come from Iron Age sites in regions peripheral to Mesopotamia. If borne out by future work, the apparent pattern of sesame distribution suggests that sesame (and perhaps broomcorn millet as well) arrived in the Near East by the seventh century BC. The introduction of these two crops suggests trade and cultural influence across northern Iran (perhaps by way of central Asia) that may have involved other communication and the trade in non-agricultural products as well.

7 NEW APPROACHES TO INTERPRETING ARCHAEOBOTANICAL ASSEMBLAGES

Archaeobotanical work in the Near East has generally emphasized the major food crops, and since earlier excavators only saved large and obvious seed concentrations, most archaeological evidence until recently consisted of food remains. With the coming of widespread flotation, the archaeological contexts of plant remains available for study has become much more varied, as have the assemblages themselves. Hoards of stored food remains are still found in situ, but more often than not, flotation samples contain mixed collections of cultigens, weed seeds, rachis fragments and wood charcoal. No longer do archaeobotanists simply assume that all seeds thus found are food.

Consideration of archaeological context allows for a more sophisticated appreciation of the meaning of an archaeobotanical assemblage. In asking "how did these seeds arrive on the site?" and "how did they become charred?" one can go beyond the strictly botanical questions about

* GORDION: No Sesame;
it was flax

domestication. Hillman's (1981) work on crop processing has inspired an appreciation for the complexities of archaeobotanical interpretation.

7.1 Food, fodder, or fuel?

Distinguishing food remains from crop residues and other debris depends on archaeological context. For example, Malyan latrine deposits produced a virtually certain example of human food remains: mineralized grape seeds and cereal grains (Miller 1982). The clean hoard of barley found at Roman Nahal Yattir is also most likely a food store (Kislev 1986). Even hoards of mixed cultigens may be food remains that were either grown together or combined after the harvest (cf. Kislev 1989a). In contrast, charred barley dispersed in the archaeological deposits at Malyan seems to be ultimately from animal fodder that was incorporated in dung used as fuel; van Zeist & Bakker-Heeres (1985 (1988)), too, find this to be the most satisfactory interpretation of the high proportions of barley at Early Bronze Age Selenkahiye.

Wild plants may be food remains as well. Such interpretations are most secure when the seeds are found in jars or other concentrated deposits. There are many examples of this from the Near East: *Prosopis* at Nimrud (Helbaek 1966), *Polygonum* and einkorn at Mureybit (van Zeist & Bakker-Heeres 1984(1986)b), *Chenopodium* at Shahr-i Sokhta (Costantini n.d.). Some archaeobotanists have interpreted even mixed samples of weeds as food remains, but these interpretations are more problematic. Hillman's (1981) crop processing model may explain some samples with disproportionately high numbers of weed seeds relative to cultigens or other obvious food plants.

Near Eastern archaeobotanists routinely consider a variety of economic and chance factors that shape charred seed assemblages. Few, however, feel as strongly as I that one should consider why the material is not a fuel residue before attempting other explanations. For example, there may be clear evidence that burning was unrelated to fuel use: charred beams, concentrations of seeds, and other non-fuel debris from a burned building. Distinguishing scattered burnt trash from scattered burnt fuel residue is more difficult, however, and if remains come from a variety of sources, it may well be impossible to ascertain what those sources were.

Without denying the complexity of the archaeobotanical record, one may still consider broad patterns of ancient plant use that might

have affected archaeobotanical preservation across the Near East. Ethnographic models focus attention on how people process, use, discard, and burn plant materials. If charred remains are primarily fuel residues, they would reflect differences in fuel sources across time and space. If, on the other hand, the assemblages consist primarily of burned trash residues from crop and food processing, differences between samples would reflect those activities. An explanatory model should be able to account for archaeologically comparable assemblages in both forest and steppe zones.

Fuel use by ancient peoples contributed greatly to the preservation of botanical materials. The least ambiguous fuel residues are wood charcoal. Frequently omitted from archaeobotanical reports, charcoal provides important supplementary information about the availability of wood fuel. In natural steppe and deforested regions of the Near East, arboreal vegetation is largely restricted to permanent water sources; typical species are poplar, willow, and tamarisk. In such environments, riverine vegetation may not supply enough wood, and alternative fuel sources will be found. Some Near Eastern sites have burnt dung, though it is not always interpreted as fuel. Not as well appreciated is the fact that charred seeds may have come from dung, even if none or little of the fragile substance has itself survived (Miller 1984a; Bottema 1984).

Patterns of fuel use are reflected in several key characteristics of sites: their location, seed assemblages, and charcoal (if reported). In the forest and steppe-forest zone, the number and variety of weedy types tends to be low, dung is likely to be absent, and charcoal usually comes from forest types (e.g., Çayönü, Ganj Dareh, and Malyan at 3000 BC). In deforested or unforested areas, the number and variety of weedy types is high, there may well be fragments of burnt dung, and wood fuel is restricted to riverine types like poplar, willow, and tamarisk (e.g., Abu Hureyra, Ali Kosh, Umm Dabaghiyah, Selenkahiye). In some cases, especially on sites that antedate animal domestication, a varied seed assemblage may come from shrubby and weedy types burned for fuel (e.g., Hillman 1975: 73; van Zeist & Bakker-Heeres 1982(1985): 234); by later times, many of the weed seeds may have originated in dung fuel.

Several assemblages from early sites located in steppe environments have high proportions of small-seeded legume and other wild plants. For example, at Ali Kosh, in addition to cultivated wheat and barley, Helbaek found phe-

nomenal numbers of *Medicago*, *Astragalus*, and *Trigoneilla*. He remarks that samples rich in legumes tend to have large numbers of indigestible wheat glume bases as well (Helbaek 1969: 400). Furthermore, he reports charred sheep/goat dung, though he saw no seeds in it. Helbaek suggests the seeds could have come from plants burned as fuel, but considers them to have most likely been collected for food. In the absence of a sample-by-sample seed inventory, one cannot evaluate sample purity, but, for reasons cited above, the seeds are more likely to be the residue of a brush or dung fueled fire.

Unlike Ali Kosh, there are several steppe sites that lack domestic animals as a possible source of dung, but have similar mixed assemblages of cultigens and/or large numbers of other plants of no obvious economic importance. Van Zeist and Bakker-Heeres (1982 (1985): 234) remark that "the anomalously great number of *Astragalus* seeds in Ramad M4 2.80 could point (but not necessarily!) to the use of this plant as fuel." In contrast, Hillman et al. (1989) consider the mixed samples of charred wild seeds at Abu Hureyra to have been intentionally collected for food.

7.2 Borages and other uncharred seeds

A number of investigators have reported occasional or significant numbers of uncharred seeds in otherwise ordinary flotation samples. Occurring in relatively pure deposits or singly in mixed charred botanical assemblages, deciding whether they are ancient or modern is a problem noted by many. Uncharred, silicified seeds of Boraginaceae (e.g., *Lithospermum* and *Echium*) are especially common on archaeological sites in the Near East. Van Zeist and Buitenhuis (1983) point out that the nutlets turn gray or white when burned due to the presence of silica, and even uncharred they may persist in the soil.

In some archaeological levels, borages are the most common taxon reported or they represent a significant proportion of weed seeds. For example, at Can Hasan III, three of the four samples analyzed had thousands of *Lithospermum* but fewer than 20 cereal grains each (French et al. 1972: 187). At Kamid el-Loz, a vessel dating to 1300-1200 BC yielded millions of *Echium* achenes; Baas (1980) considers possible nutritional, medicinal, fabric coloring uses of this plant, but reaches no conclusion about their actual use.

Other commonly occurring uncharred seeds

include hackberry (*Celtis*), which like borages tends to turn white on burning, and sedges. Insects and other burrowing animals may leave caches of seeds. [I once noticed an insect chamber filled with modern *Fumaria* seeds in a baulk about a meter and a half below the modern surface.] Uncharred and partly charred *Capparis* seeds from Neolithic deposits at Ras Shamra are thought to be recent, despite the fact that one of them was found 14.2 meters below the modern surface (van Zeist & Bakker-Heeres 1984(1986)a: 161).

Rodent-gnawed desiccated seeds from Nahal Hemar include types not common in the area today, notably pistachio (Kislev 1988). If the rodent in question has a small home range, this would be further evidence for a nearby source of pistachio (cf. Miller 1989). Most of the time, however, archaeological significance of uncharred seeds remains a puzzle.

7.3 Assessing human impact on the land

Humans have radically altered the vegetation of the Near East during thousands of years of fuel collecting, agriculture, pastoralism, and other activities. Forest regeneration may be possible, but cycles of tree loss and erosion have lead to permanent landscape changes. The modern environmental context of a site helps one evaluate an archaeobotanical assemblage. Based on phytogeographical studies, rather than palynological or archaeobotanical reconstructions, Zohary's (1973) "Geobotanical Foundations of the Middle East" is a useful survey of vegetation patterns in the Near East that provides a modern baseline for interpreting archaeobotanical remains.

Environmental degradation caused by human activities is apparent as early as PPNB times at 'Ain Ghazal (Köhler-Rollefson 1988). In some areas, deforestation has been traced through changing patterns of fuel use. For example, the third millennium BC assemblages from Malyan and Kurban Hüyük both show increasing use of dung fuel at the expense of wood. In the Keban area of eastern Turkey, too, changing fuel use patterns are documented after the Early Bronze Age (Willcox 1974). Climate change accounts for some vegetation change in the Near East, especially at the end of the Pleistocene. More recent changes are largely anthropogenic, and plant remains from archaeological sites are therefore very useful indicators of human-land relationships.

Botanizing in the modern Near East, the archaeobotanist is struck by the lack of con-

gruity between the archaeobotanical taxa and the modern weed and waste vegetation. Ethnobotanical studies at Malyan show there is no necessary relationship between common modern field weeds and weed seed contaminants of stored grain, and the most common weeds of today may represent only a small proportion of archaeobotanical samples (Miller 1982). Similarly, wild rue (*Peganum harmala*) and camelthorn (*Alhagi spec.*), which cover vast areas of degraded pasture and steppe, occur only rarely in the archaeobotanical record. There are some third millennium BC *Peganum* from Selenkahiye on the Euphrates (van Zeist & Bakker-Heeres 1985(1988)) and some *Alhagi* from the northern Iranian sites of Gijlar (Costantini & Costantini-Biasini 1984) and Hissar (Costantini & Dyson in prep.).

Weeds resistant to grazing and other disturbances (such as cultivation!) have surely become more common over the millennia. Van Zeist & Bakker-Heeres (1985(1988)) suggest that the differences between the charred seed assemblages of Early Bronze Age Selenkahiye and Epipaleolithic Mureybit may be due to the development of the agricultural ecosystem. The Abu Hureyra weed assemblage may hint at the beginning of this change (Hillman 1975); the Neolithic samples have toxic seeds lacking in the Epipaleolithic assemblage. To be sure, Hillman and his colleagues (1989) argue that the Epipaleolithic seeds represent human food, and that the Neolithic seeds are crop weeds. Nevertheless, it is clear that the weed flora of the Near East has undergone tremendous modification.

Weed seeds also give information about local environmental conditions. Helbaek points to the sedges from Ali Kosh as evidence that the fields were close to high water table. Even if these sedges do not represent field weeds harvested with the crops, they suggest a nearby source of moist ground. The Ali Kosh assemblage is similar to that of other archaeobotanically investigated sites similarly situated (e.g., Aswad). At Umm Dabaghiyah, Helbaek (1972: 18) reports one sample with "thousands of seeds most of which seem to come from a humid, saline or highly brackish station such as the edge of a water course or a salt swamp or lake," which he tentatively identifies as members of the Goosefoot family (*Chenopodiaceae*). He mentions possible use of the stems as fuel or thatch. Whether fuel or fodder, such examples show that weed seeds from archaeological sites can be used to identify microhabitats close to an archaeological site: marshy or dry, irrigated or unirrigated.

8 CONCLUSION

Twenty years ago, Near Eastern archaeobotany was an obscure specialty employed primarily to deal with serendipitous finds. Methodologies and research problems that evolved through the interplay of archaeobotanical and more traditional archaeological concerns have resulted in an almost weed-like growth in our knowledge of ancient human-plant interactions. Routine use of flotation has been essential in this process, as has the application of many of the approaches discussed elsewhere in this volume, (e.g., ethnographic modelling and more systematic sampling). But we need not worry about running out of work! Our understanding of the origin and development of agriculture, the most systematically addressed research problem in the Near East, is far from complete, and we have barely begun to study the archaeobotanical evidence of other time periods.

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REFERENCES

- Baas, J. 1980. Ein bedeutsamer botanischer Fund der Gattung *Echium* Linné aus Kamid el-Loz. In R. Hachmann (Hrsg.), Bericht über die Ergebnisse in Kamid el-Loz in den Jahren 1968 bis 1970, p.111-115. Bonn, Saarbrücker Beiträge zur Altertumskunde.
- Badler, V., P. McGovern & R.H. Michel, in prep. Drink and be merry!: infrared spectroscopy and ancient Near Eastern wine. In W.R. Biers & P.E. McGovern (eds.), Organic contents of ancient vessels: materials analysis and archaeological investigation. Philadelphia, MASCA research papers in science and archaeology.
- Bakhteyev, F.K. & Z.V. Yanushevich 1980. Discoveries of cultivated plants in the early farming settlements of Yarym-Tepe I and Yarym-Tepe II in northern Iraq. *Journal of Archaeological Science* 7:167-178.
- Bar-Yosef, O. & M. Kislev 1989. Early farming communities in the Jordan Valley. In D.R. Harris & G.C. Hillman (eds.), Foraging and Farming. The Evolution of

- Plant Exploitation, p.632-642. London, Unwin Hyman.
- Bedigian, D. 1985. Is se-gis-i sesame or flax? *Bulletin of Sumerian Agriculture* 2:159-178.
- Behre, K.-E. 1970. Kulturpflanzenreste aus Kamid el-Loz. In R.Hachmann (Hrsg.), *Bericht über die Ergebnisse der Ausgrabungen in Kamid el-Loz (Libanon) in den Jahren 1966 und 1967*, p.59-69. Bonn, Saarbrücker Beiträge zur Altertumskunde.
- Binford, L.R. 1968. Post-Pleistocene Adaptations. In S.R.Binford & L.R.Binford (eds.), *New perspectives in archaeology*, p.313-341. Chicago, Aldine.
- Bottema, S. 1984. The composition of modern charred seed assemblages. In W.van Zeist & W.A.Casparie (eds.), *Plants and Ancient Man*, p.207-212. Rotterdam, Balkema.
- Braidwood, R.J. & H.Cambel 1982. The Çayönü excavations: overview through 1981. In L.S.Braidwood & R.J.Braidwood (eds.), *Prehistoric village archaeology in south-eastern Turkey*. British Archaeological Reports, International Series 138:1-15.
- Braidwood, R.J. & B.Howe 1960. Prehistoric investigations in Iraqi Kurdistan. *Studies in Oriental Civilization* 31. Chicago: Oriental Institute.
- Braidwood, L.S., R.J.Braidwood, C.A.Reed & P.J.Watson 1983. Prehistoric archaeology along the Zagros flanks. *Studies in Ancient Oriental Civilization* 31. Chicago: Oriental Institute.
- Butler, A. 1989. Cryptic anatomical characters as evidence of early cultivation in the grain legumes (pulses). In D.R.Harris & G.C.Hillman (eds.), *Foraging and Farming. The Evolution of Plant Exploitation*, p.390-407. London, Unwin Hyman.
- Cauvin, J. 1978. Les premiers villages de Syrie-Palestine du IX^{ème} siècle au VII^{ème} millénaire avant J.C. *Collection de la Maison de l'Orient Méditerranéen* no. 4, Série archéologique 3. Lyon.
- Cauvin, J. 1988. La néolithisation de la Turquie du sud-est dans son contexte proche-oriental. *Anatolica* 15:69-80.
- Chernoff, M.C. 1988. The archaeobotanical material from Tel el Ifshar, Israel. Ph.D. Dissertation, Brandeis University. Ann Arbor, University Microfilms.
- Childe, V.G. 1952. *New light on the most ancient East*. (1969 ed.). New York: Norton.
- Costantini, L. n.d. Le piante. In Basaglia et al. (eds.), *La città bruciata del deserto salato*, p.159-228. Venice, Erizzo Editrice.
- Costantini, L. & L.Costantini-Biasini 1984. I resti vegetali dei saggi a Qa'eh Ismail Aqa e Tappeh Gijlar. In P.E.Pecorella et al. (eds.), *Tro lo Zagros e l'Urmia, ricerche storiche ed archeologiche nell' Azerbaigian iraniano*, p.397-402. Rome, Edizioni dell'Ateneo.
- Costantini, L. 1985. Considerazioni su alcuni reperti di palma da dattero e sul centro di origine e l'area di coltivazione della Phoenix dactylifera L. *Orientalia Iosephi Tucci Memoriae Dicata* 56:209-217.
- Costantini, L. 1988. Seed list, Hasanlu archive. Philadelphia, University Museum.
- Costantini, L. & R.H.Dyson Jr., in prep. The ancient agriculture of the Damghan valley: the archaeobotanical evidence from Tepe Hissar. MASCA research reports in science and archaeology.
- Costantini, L., M.Tosi & A.Vigna Taglianti 1975/1976/1977. Typology and socioeconomical implications of entomological finds from some ancient Near Eastern sites. *Paléorient* 3:247-258.
- Cowan, C.W. 1985. Understanding the evolution of plant husbandry in eastern North America: lessons from botany, ethnography, and archaeology. In R.I.Ford (ed.), *Prehistoric food production in North America*, p.205-243. Anthropological paper 75. Ann Arbor, University of Michigan Museum of Anthropology.
- Crawford, P. 1987. Food for a Roman legion: the plant remains from el-Lejjun. In S.T.Parker (ed.), *The Roman frontier in central Jordan, interim report on the Limes Arabicus Project, 1980-1985*. British Archaeological Reports, International Series 340(ii):691-704.
- Edwards, P.C., S.J.Bourke, S.M.Colledge, J.Head, & P.G.Macumber 1988. Late Pleistocene prehistory in Wadi al-Hammeh, Jordan Valley. In A.N.Gebel & H.G.Garrard (eds.), *The prehistory of Jordan: the state of research in 1986*. British Archaeological Reports, International Series 396:525-565.
- Elison, R., J.Renfrew, D.Brothwell & N.Seeley 1978. Some food offerings from Ur, excavated by Sir Leonard Woolley, and previously unpublished. *Journal of Archaeological Science* 5:167-177.
- Flannery, K.V. 1969. Origins and ecological effects of early domestication in Iran and the Near East. In P.J.Ucko & G.W.Dimbleby (eds.), *The Domestication and Exploitation of Plants and Animals*, p.73-100. Chicago, Aldine.
- French, D.H. (with G.C.Hillman, S.Payne & R.J.Payne) 1972. Excavations at Can Hasan III 1969-1970. In E.S.Higgs (ed.), *Papers in economic prehistory*, p.181-190. Cambridge, The University Press.
- Garfinkel, Y., M.E.Kislev & D.Zohary 1988. Lentil in Pre-Pottery Neolithic B Yiftah'el: additional evidence of its early domestication. *Israel Journal of Botany* 37:49-51.
- Garrard, A.N., A.Betts, B.Byrd, S.Colledge & C.Hunt 1988. Summary of palaeoenvironmental and prehistoric investigations in the Azraq Basin. In A.N.Garrard & H.G.Gebel (eds.), *The prehistory of Jordan: the state of research in 1986*. British Archaeological Reports, International Series 396:311-337.
- Geib, I.J. 1982. Sumerian and Akkadian Words for "String of Fruit." In *Festschrift für Andreas Kraus zum 60. Geburtstag*. Abteilung bayerische Geschichte 10:67-82, 484.
- Gilliland, D. 1986. Paleoethnobotany and paleoenvironment. In Ø.S.LaBianca & L.Lacelle (eds.), *Hesban 2: Environmental Foundations*, p.123-142. Berrien Springs, Michigan, Andrews University Press.
- Gowlett, J.A.J. & R.E.M.Hedges 1987. Radiocarbon dating by accelerator mass spectrometry: applications to archaeology in the Near East. In O.Aurenche, J.Evin & F.Hours (eds.), *Chronologies du Proche Orient*. British Archaeological Reports, International Series 379:121-144.
- Hansen, J., in press. Palaeoethnobotany in Cyprus: recent research. In J.Renfrew (ed.), *New light on early farming: recent developments in palaeoethnobotany*. Edinburgh, The University Press.
- Hansen, J., forthcoming a. Khirrokita plant remains. In A.Le Brun, *Fouilles récentes à Khirrokita (Chypre) 1977-1981*. Editions Recherches sur les Civilisations. Paris, A.D.P.F.
- Hansen, J., forthcoming b. Flora. Chapter XI in I.A.Todd (ed.), *Vasilikos Valley Project 7: Excavations at Kalavassos-Tenta II. Studies in Mediterranean Archaeology* 85. Göteborg, Paul Åström.
- Helbaek, H. 1960. The palaeoethnobotany of the Near East and Europe. In R.J.Braidwood & B.Howe, *Prehistoric investigations in Iraqi Kurdistan*, p.99-118. *Studies in Oriental Civilization* 31. Chicago, Oriental

- Institute.
- Helbaek, H. 1964. First impressions of the Çatal Hüyük plant husbandry. *Anatolian Studies* 14:121-123.
- Helbaek, H. 1965. Early Hassunan vegetable remains at es-Sawwan near Samarra. *Sumer* 20:45-48.
- Helbaek, H. 1966. The plant remains from Nimrud. In M.E.L. Mallowan, *Nimrud and its remains*, vol. 2, p.613-620. London.
- Helbaek, H. 1969. Plant-collecting, dry-farming, and irrigation agriculture in prehistoric Deh Luran. In F.Hole, K.V.Flannery & J.A.Neely (eds.), *Prehistory and human ecology of the Deh Luran Plain*, p.383-426. Memoir 1. Ann Arbor, University of Michigan Museum of Anthropology.
- Helbaek, H. 1970. The plant husbandry of Hacilar. In J.Mellaart, *Excavations at Hacilar*, p.189-244. Edinburgh, University Press.
- Helbaek, H. 1972a. Traces of plant remains in the early ceramic site of Umm Dabaghiyah. *Iraq* 34:17-19.
- Helbaek, H. 1972b. Samarran irrigation agriculture at Chogha Mami in Iraq. *Iraq* 34:35-48.
- Hillman, G. 1978. On the origins of domestic rye - *Secale cereale*: the finds from aceramic Can Hasan III in Turkey. *Anatolian Studies* 28:157-174.
- Hillman, G.C. 1981. Reconstructing crop husbandry practices from charred remains of plants. In R.Mercer (ed.), *Farming practice in British prehistory*, p.123-162. Edinburgh, The University Press.
- Hillman, G.C., S.M.Collidge & D.R.Harris 1989. Plant food economy during the Epipaleolithic period at Tell Abu Hureyra, Syria: dietary diversity, seasonality, and modes of exploitation. In D.R.Harris & G.C.Hillman (eds.), *Foraging and Farming. The Evolution of Plant Exploitation*, p.240-268. London, Unwin Hyman.
- Hillman, G.C. & S.M.Davies, in press. Experimental measurements of domestication rates in populations of wild einkorn (*Triticum boeoticum*) under primitive systems of cultivation. *Botanical Journal of the Linnean Society*.
- Hole, F., K.V.Flannery & J.A.Neely 1969. Prehistory and human ecology of the Deh Luran Plain. Memoir 1. Ann Arbor: University of Michigan Museum of Anthropology.
- Hopf, M. 1978. Plant remains, Strata V-I. In R.Amiran, *Early Arad*, p.64-82. Jerusalem, Israel Exploration Society.
- Hopf, M. 1983. Jericho plant remains. In K.M.Kenyon & T.A.Holland (eds.), *Excavations at Jericho*, p.576-621. London, British School of Archaeology in Jerusalem.
- Hopf, M. & O.Bar-Yosef 1987. Plant remains from Hayonim Cave, western Galilee. *Paléorient* 13(1):117-120.
- Hopf, M. & U.Willerding 1988. Pflanzenresten. In W.Kleiss, *Bastam II. Teheraner Forschungen* 5:263-318. Tehran, Deutsches Archäologisches Institut.
- Jones, G.E.M. 1984. Interpretation of archaeological plant remains: ethnographic models from Greece. In W.van Zeist & W.A.Casparie (eds.), *Plants and Ancient Man*, p.43-61. Rotterdam, Balkema.
- Katz, S.H. 1987. Food and biocultural evolution: a model for the investigation of modern nutritional problems. In F.E.Johnston (ed.), *Nutritional Anthropology*, p.41-63. New York, Alan R. Liss.
- Kislev, M.E. 1985. Early Neolithic horsebean from Yiftah'el, Israel. *Science* 228:319-320.
- Kislev, M.E. 1986. A barley store of the Bar-Kochba rebels (Roman period). *Israel Journal of Botany* 35:183-196.
- Kislev, M.E. 1987. Chalcolithic plant husbandry and ancient vegetation at Shiqmim. In T.E.Levy (ed.), *Shiqmim I, Studies concerning Chalcolithic societies in the northern Negev Desert, Israel (1982-1984)*. British Archaeological Reports, International Series 356:251-279, 548-563.
- Kislev, M.E. 1988. Nahal Hemar Cave, desiccated plant remains: an interim report. *'Atiqot* 18:76-81.
- Kislev, M.E. 1989a. Multiformity in barley from an Iron Age store in Sinai. In U.Körber-Grohne & H.Küster (Hrsg.), *Archäobotanik. Dissertationes Botanicae* 133:67-80.
- Kislev, M.E. 1989b. Origins of the cultivation of *Lathyrus sativus* and *L. cicera* (Fabaceae). *Economic Botany* 43:262-270.
- Kislev, M.E. & O.Bar-Yosef 1988. The legumes: the earliest domesticated plants in the Near East? *Current Anthropology* 29:175-179.
- Kislev, M.E., O.Bar-Yosef & A.Gopher 1986. Early Neolithic domesticated and wild barley from the Netiv Haqduq region in the Jordan Valley. *Israel Journal of Botany* 35:197-201.
- Kislev, M.E. & M.Hopf 1985. Food remains from Tell Qasile, with special reference to *Lathyrus sativus/cicera*. In A.Mazar, *Excavations at Tell Qasile*, part 2, p.140-147. Qedem 20. Jerusalem.
- Köhler-Rollefson, I. 1988. The aftermath of the Levantine Neolithic revolution in the light of ecological and ethnographic evidence. *Paléorient* 14(1):87-93.
- Kroll, H. 1991. Südsteuropa. In W.van Zeist, K.Wasylikowa & K.-E.Behre (eds.), *Progress in Old World Palaeoethnobotany*. Rotterdam, Balkema.
- Kyllo, M.A. & R.N.L.B.Hubbard 1981. Median and Parthian plant remains from Tepe Nush-i Jan. *Iran* 19:91-100.
- Ladizinsky, G. 1989. Origin and domestication of the southwest Asian grain legumes. In D.R.Harris & G.C.Hillman (eds.), *Foraging and Farming. The Evolution of Plant Exploitation*, p.374-389. London, Unwin Hyman.
- Lamberg-Karlovsky, C.C. & M.Tosi 1989. The Proto-Elamite community at Tepe Yahya: tools of administration and social order. In K.Frifer & P.Sørensen (eds.), *South Asian Archaeology 1985*, p.104-113. Curzon Press.
- Le Brun, A., S.Cluzan, S.J.M.Davis, J.Hansen & J. Renault-Miskovsky 1987. Le Néolithique précéramique de Chypre. *L'Anthropologie* 1:283-316.
- Lee, R.B. 1969. What Hunters Do for a Living, or How to Make Out on Scarce Resources. In R.B.Lee & I.DeVore (eds.), *Man, the Hunter*, p.30-48. Chicago, Aldine.
- Leroi-Gourhan, A. 1974. Études palynologiques des derniers 11.000 ans en Syrie semi-désertiques. *Paléorient* 2:443-451.
- Lipshchitz, N. & Y.Waisel 1973. Analysis of the botanical material of the 1969/70 seasons and the climatic history of the Beer-Sheva region. In Y.Aharoni, Beer-Sheva I, p.97-105. Tel Aviv, Tel Aviv University.
- Lisicyna, G. 1983. Die ältesten paläoethnobotanischen Funde in Nordmesopotamien. *Zeitschrift für Archäologie* 17:31-38.
- McCorriston, J. 1989. The Halaf environment and human activities in the Khabur drainage. Paper presented at the Society for American Archaeology Annual Meeting, Atlanta.
- McCreery, D. 1979. Flotation of the Bab edh-Dhra and Numeira plant remains. *Annual of the American Schools of Oriental Research* 46:165-169.

- Miller, N.F. 1981a. Plant remains from Ville Royale II, Susa. *Cahiers de la Délégation Archéologique Française en Iran* 12:137-142.
- Miller, N.F. 1981b. The plant remains. In H.T. Wright, An early town on the Deh Luran Plain, excavations at Tepe Farukhabad, p.227-232, 427-430. *Memoir 13*. Ann Arbor, University of Michigan, Museum of Anthropology.
- Miller, N.F. 1982. Economy and environment of Malayan, a third millennium B.C. urban center in southern Iran. Ph.D. Dissertation, University of Michigan. Ann Arbor, University Microfilms.
- Miller, N.F. 1983. Paleoethnobotanical results from Bendebal and Jaffarabad. *Cahiers de la Délégation Archéologique Française en Iran* 13:277-284.
- Miller, N.F. 1984a. The use of dung as fuel: an ethnographic example and an archaeological application. *Paléorient* 10(2):71-79.
- Miller, N.F. 1984b. Some plant remains from Khirakitia, Cyprus: 1977 and 1978 Excavations. In A.Le Brun, *Fouilles récentes à Khirakitia (Chypre) 1977-1981*, vol. 1, p.183-188. *Éditions Recherches sur les Civilisations, mémoire 41*. Paris, A.D.P.F.
- Miller, N.F. 1985a. Paleoethnobotanical research in Khuzestan. *Paléorient* 11(2):125-137.
- Miller, N.F. 1985b. Paleoethnobotanical evidence for deforestation in ancient Iran: a case study of urban Malayan. *Journal of Ethnobiology* 5:1-19.
- Miller, N.F. 1986. Vegetation and land use. *Anatolica* 13:85-89, 119-120.
- Miller, N.F. 1989. What mean these seeds: a comparative approach to archaeological seed analysis. *Historical Archaeology* 23:50-59.
- Miller, N.F., forthcoming. Origins of plant cultivation in the Near East. In P.J.Watson & C.W.Cowan (eds.), *Origins of agriculture in world perspective*. Washington D.C., Smithsonian Institution.
- Miller, N.F. & T.L.Smart 1984. Intentional burning of dung as fuel: a mechanism for the incorporation of charred seeds into the archeological record. *Journal of Ethnobiology* 4:15-28.
- Moore, A.M.T. (with G.C.Hillman & A.J.Legge) 1975. The excavation of Tell Abu Hureyra in Syria: a preliminary report. *Proceedings of the Prehistoric Society* 41:50-77.
- Moore, A.M.T., G.C.Hillman & A.J.Legge, in press. The Epipaleolithic and Neolithic occupations at Abu Hureyra, Syria: the people, their economy, settlement, technology, and environment. New Haven: Yale University Press.
- Muhsen, M.S., H.G.Gebel, C.Hannss, R.Neef 1988. 'Ain Ruhab, a new Final Natufian and Yarmoukian site near Irbid. In A.N.Garrard & H.G.Gebel (eds.), *The prehistory of Jordan: the state of research in 1986*. *British Archaeological Reports, International Series* 396:472-502.
- Neef, R. 1988. Les activités agricoles et horticoles. In Abu Hamid, village du 4e millénaire de la vallée du Jourdain, p.29-30. *Centre Culturel Français et Département des Antiquités de Jordanie*.
- Neef, R. 1989/1990. Planten. In *Een Verhaal voor het Oprapen, Opgravingen te Deir Alla in de Jordaan Vallei*, p.30-37. Leiden, Rijksmuseum van Oudheden.
- Nesbitt, M., in prep. Site gazetteer of archaeobotanical reports from the Near East and Greece. Appendix 1 in M.Nesbitt, *Archaeobotany of the Asvan Project*.
- Nesbitt, M. & G.D.Summers 1988. Some recent discoveries of millet (*Panicum miliaceum* and *Setaria italica*) at excavations in Turkey and Iran. *Anatolian Studies* 38:85-97.
- Noy, T., A.J.Legge & E.S.Higgs (with R.W.Dennell) 1973. Recent excavations at Nahal Oren, Israel. *Proceedings of the Prehistoric Society* 39:75-99.
- Oates, D. & J.Oates 1976. Early irrigation agriculture in Mesopotamia. In G.Sieveking, I.Longworth & K.Wilson (eds.), *Problems in economic and social archaeology*, p.109-136. London, Duckworth.
- Postgate, J.N. 1985. The "oil-plant" in Assyria. *Bulletin of Sumerian Agriculture* 2:145-152.
- Postgate, J.N. & J.A.Killick 1983. *British Archaeological Expedition to Abu Essalabikh, final field report on the eighth season, 1983*. *Sumer* 39:95-99.
- Postgate, J.N. & M.A.Powell 1984. Preface. *Bulletin on Sumerian Agriculture* 1:v.
- Radford, D.S. 1980. The study of ancient plant material from Tepe Farukhabad. Masters' thesis, University of Southampton, Southampton.
- Renfrew, J. 1968. A note on the Neolithic grain from Can Hasan. *Anatolian Studies* 18:55-56.
- Renfrew, J.M. 1985. Finds of sesame and linseed in ancient Iraq. *Bulletin of Sumerian Agriculture* 2:63-66.
- Robinson, M. & R.N.L.B.Hubbard 1977. The transport of pollen in the bracts of hulled cereals. *Journal of Archaeological Science* 4:197-199.
- Rollefson, G.O. & A.H.Simmons 1985. Excavation at 'Ain Ghazal 1984: preliminary report. *Annual of the Department of Antiquities of Jordan* 29:11-30.
- Rollefson, G.O., A.H.Simmons, M.L.Donaldson, W. Gillespie, Z.Kafafi, I.Köhler-Rollefson, E.McAdam, S.L. Rolston & M.K.Tubb 1985. Excavation at the Pre-Pottery Neolithic B village of 'Ain Ghazal (Jordan), 1983. *Mitteilungen der Deutschen Orient-Gesellschaft zu Berlin* 117:69-116.
- Rosen, A. 1987. Phytolith studies at Shiqmim. In T.E. Levy (ed.), *Shiqmim I, Studies concerning Chalcolithic societies in the northern Negev Desert, Israel (1982-1984)*. *British Archaeological Reports, International Series* 356:243-250.
- Ryder, M.L. 1965. Report of textiles from Çatal Hüyük. *Anatolian Studies* 15:175-176.
- Schick, T. 1986. Perishable remains from the Nahal Hemar cave. *Journal of the Israel Prehistoric Society* 19:95-97.
- Schlichterle, H. 1977/1978. Vorläufiger Bericht über die archäobotanischen Untersuchungen am Demircihüyük (Nordwestanatolien). In M.Korfmann, *Demircihüyük*, p.45-53. Istanbul, *Istanbul Mitteilungen*. Deutsches Archäologisches Institut.
- Shay, J.M., S.M.Anderson & C.T.Shay 1982. Carbonized seeds and wood. In G.F.Rapp & J.A.Gifford (eds.), *Troy: the archaeological geology*, p.189-193. Princeton, Princeton University Press.
- Sherratt, A. 1980. Water, soil, and seasonality in early cereal cultivation. *World Archaeology* 11:313-330.
- Stewart, R.B. 1981. Floral remains. In R.J.Braidwood, H.Çambel & W.Schirmer, *Beginnings of village-farming communities in southeastern Turkey: Çayönü Tepesi, 1978 and 1979*. *Journal of Field Archaeology* 8:249-258.
- Stol, M. 1985. Remarks on the cultivation of sesame and the extraction of its oil. *Bulletin of Sumerian Agriculture* 2:119-126.
- Struiver, M., B.Kromer, B.Becker, & C.W.Ferguson 1986. Radiocarbon age calibration back to 13,300 years BP and the 14C age matching of the German oak and US bristlecone pine chronologies. *Radiocarbon* 28(2B):969-979.

- Voigt, M.M. 1988. Excavations at Neolithic Gritille. *Anatolica* 15:215-232.
- Waines, J.G. 1973. Plant remains from Tell Taya, Iraq. *Iraq* 35:185-187.
- Waines, J.G. & N.P. Stanley Price 1975/77. Plant remains from Khirrokita in Cyprus. *Paléorient* 3:281-284.
- Watson, P.J. 1983. The Halafian culture: a review and synthesis. In T.C. Young Jr., P.E.L. Smith, & P. Mortensen (eds.), *The hilly flanks: essays on the prehistory of south western Asia*, p.231-249. *Studies in Ancient Oriental Civilization* 36. Chicago, Oriental Institute, University of Chicago.
- Wetterstrom, W., in press. Ninevite 5 Period Agriculture at Tell Leilan: preliminary results. In H. Weiss (ed.), *The Origins of North Mesopotamian Civilization: Ninevite 5 Chronology, Economy, Society*. New Haven, Yale University Press.
- Weber, S.A. 1989. Plants and Harappan subsistence: an example of stability and change from Rojdi. Ph.D. Dissertation, University of Pennsylvania. Philadelphia.
- Willcox, G.H. 1974. A history of deforestation as indicated by charcoal analysis of four sites in eastern Anatolia. *Anatolian Studies* 24:117-133.
- Wiseman, D.J. 1983. Mesopotamian gardens. *Anatolian Studies* 33:137-144.
- Wright, H.T., N.F. Miller & R.W. Redding 1978. Time and process in an Uruk rural center. In *L'archéologie de l'Iraq: perspectives et limites de l'interprétation anthropologique des documents. Colloques internationaux du CNRS* 580:265-282.
- Zeist, W. van 1970. The Oriental Institute excavations at Mureybit, Syria: preliminary report on the 1965 campaign. Part III: the palaeobotany. *Journal of Near Eastern Studies* 29:167-176.
- Zeist, W. van 1972. Palaeobotanical results of the 1970 season at Çayönü, Turkey. *Helinium* 12(1):3-19.
- Zeist, W. van 1979/1980. Plant remains from Girikihaçyan, Turkey. *Anatolica* 7:75-89.
- Zeist, W. van 1981. Plant remains from Cape Andreas-Kastros (Cyprus). In A. LeBrun, *Un site néolithique précéramique en Chypre: Cap Andreas-Kastros*, p.95-99. *Recherche sur les grandes civilisations, mémoire* 5. Paris, Éditions A.D.P.F.
- Zeist, W. van 1986a. Some aspects of early Neolithic plant husbandry in the Near East. *Anatolica* 15:49-67.
- Zeist, W. van 1986b. Plant remains from Neolithic El Kowm, central Syria. Appendix in R.H. Dornemann, *A Neolithic village at Tell El Kowm in the Syrian Desert*, p.65-68. *Studies in Ancient Oriental Civilization* 43. Chicago, Oriental Institute, University of Chicago.
- Zeist, W. van & J.A.H. Bakker-Heeres 1975a. Evidence for linseed cultivation before 6000 bc. *Journal of Archaeological Science* 2:215-219.
- Zeist, W. van & J.A.H. Bakker-Heeres 1975b. Prehistoric and early historic plant husbandry in the Altınova Plain, southeastern Turkey. In M.N. van Loon (ed.), *Korucutepe. Final Report on the Excavations of the Universities of Chicago, California (Los Angeles) and Amsterdam in the Keban Reservoir, Eastern Anatolia, 1968-1970. Vol. 1*, p.225-257. Amsterdam/Oxford, North Holland Publishing Company.
- Zeist, W. van & J.A.H. Bakker-Heeres 1982(1985). Archaeobotanical studies in the Levant. 1. Neolithic sites in the Damascus Basin: Aswad, Ghoraife, Ramad. *Palaeohistoria* 24:165-256.
- Zeist, W. van & J.A.H. Bakker-Heeres 1984(1986)a. Archaeobotanical studies in the Levant. 2. Neolithic and Halaf levels at Ras Shamra. *Palaeohistoria* 26:151-170.
- Zeist, W. van & J.A.H. Bakker-Heeres 1984(1986)b. Archaeobotanical studies in the Levant. 3. Late-Paleolithic Mureybit. *Palaeohistoria* 26:171-199.
- Zeist, W. van & J.A.H. Bakker-Heeres 1985(1988). Archaeobotanical studies in the Levant. 4. Bronze Age sites on the north Syrian Euphrates. *Palaeohistoria* 27:247-316.
- Zeist, W. van & H. Buitenhuis 1983. Palaeobotanical studies of Neolithic Er Baba, Turkey. *Anatolica* 10:47-89.
- Zeist, W. van & W.A. Casparie 1968. Wild einkorn wheat and barley from Tell Mureybit in northern Syria. *Acta Botanica Neerlandica* 17:44-53.
- Zeist, W. van & J.A.H. Heeres 1973. Paleobotanical studies of Deir 'Alla, Jordan. *Paléorient* 1:21-37.
- Zeist, W. van, P.E.L. Smith, R.M. Palfenier-Vegter, M. Suwijn & W.A. Casparie 1984(1986). An archaeobotanical study of Ganj Dareh Tepe, Iran. *Palaeohistoria* 26:201-224.
- Zeist, W. van (with J. Vynckier) 1984. Palaeobotanical investigations of Tell ed-Der. In L. de Meyer (ed.), *Tell ed-Der IV*, p.119-143. Leuven, Uitgeverij Peeters.
- Zeist, W. van & W. Waterbolk-van Rooijen 1985. The palaeobotany of Tell Bouqras, eastern Syria. *Paléorient* 11(2):131-147.
- Zeist, W. van & W. Waterbolk-van Rooijen 1989. Plant remains from Tell Sabi Abyad, prehistoric investigations in the Balikh Valley, northern Syria. In P.M.M.G. Akkermans (ed.), *Excavations at Tell Sabi Abyad. British Archaeological Reports, International Series* 468:325-335.
- Zeist, W. van, W. Waterbolk-van Rooijen & S. Bottema 1989. Some notes on the plant husbandry of Tell Hammam et-Turkman. Appendix 2 in M.N. van Loon (ed.), *Hammam et-Turkman I. Report on the University of Amsterdam's 1981-84 excavations in Syria*, p.705-715. Istanbul.
- Zeist, W. van & H. Woldring 1980. Holocene vegetation and climate of northwestern Syria. *Palaeohistoria* 22:111-125.
- Zohary, D. 1989. Domestication of the southwest Asian Neolithic crop assemblage of cereals, pulses, and flax: The evidence from the living plants. In D.R. Harris & G.C. Hillman (eds.), *Foraging and Farming. The Evolution of Plant Exploitation*, p.358-373. London, Unwin Hyman.
- Zohary, D. & M. Hopf 1988. Domestication of plants in the Old World. Oxford: Clarendon Press.
- Zohary, D. & P. Spiegel-Roy 1975. Beginnings of fruit growing in the Old World. *Science* 187:319-327.
- Zohary, M. 1973. *Geobotanical Foundations of the Middle East*. Stuttgart: Gustav Fischer.