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## Seed Eaters of the Ancient Near East: Human or Herbivore?<sup>1</sup>

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In 1969, Kent Flannery hypothesized that at the end of the Pleistocene human populations grew in the Near East and people began to eat a broader range of animals and plants. It was clear from faunal remains that relatively few ungulate taxa provided most of the meat supply. Botanical remains extracted by the new technique of flotation, however, pointed to a previously unimagined range of plant foods—not only obviously nutritious cereals and nuts but small-seeded wild plants such as clover. Although these resources would have been second-choice foods in terms of processing costs, Flannery said that they were more reliable and would have permitted more people to occupy the same territory. This dietary reconstruction has therefore been used to support the theory that food production began in southwestern Asia because of population pressure (Smith and Young 1972, 1983; Cohen and Armelagos 1984).

A number of new discoveries have begun to make an impact on our thinking about preagricultural subsistence. When Flannery formulated the “broad-spectrum-revolution” model, he had to extrapolate from the early agricultural site of Ali Kosh, which had the most complete archaeobotanical assemblage then available. We now know of several sites in the Syrian steppe, in Anatolia, and along the northern Zagros arc that were year-round or nearly year-round settlements and that are contemporary or nearly contemporary with earlier Natufian and Pre-Pottery Neolithic A sites in the Levant (notable Abu Hureyra, Hallan Çemi, and two “Neolithic” sites, Nemrik 9 and Qermez Dere [fig. 1]). Archaeobotanists working on these sites have found no evidence of *morphologically domesticated* plants or even of cultivated ones (Hillman, Colledge, and Harris 1989; Rosenberg

1993:3; Kozłowski 1989:30; Watkins, Baird, and Betts 1989:21).<sup>2</sup>

Despite rapid advances in research, at least a few generalizations about the economic base of the early agricultural societies and their predecessors are likely to hold up:

1. Plant cultivation began in the Jordan Valley during the 9th millennium b.c. and spread along the hilly-flanks/Zagros arc (van Zeist 1986, Bar-Yosef and Kislev 1989).

2. Plant domestication followed permanent settled village life not just in the Natufian Levant but also in Anatolia and Iraq (Rosenberg 1993, Watkins, Baird, and Betts 1989, Kozłowski 1989).

3. Domestication of ungulates for meat probably began in the 9th millennium b.c. in the hilly-flanks/Zagros uplands and spread to the west (Hole 1984). New discoveries, however, suggest that the first such domesticate may well have been pig (Rosenberg, Nesbitt, and Redding n.d.).

Still unresolved is the nature of the dietary adaptation implied by the material culture and settlement changes that occurred between about 12,000 and 9000 b.c. in the Levant and, as recently recognized, in Anatolia and the Iraqi Jezira. Ambiguities in the evidence of postglacial vegetation change inspire some of the questions: Did the natural habitat of the wild wheats and barleys expand or did it not? If the answer is yes, do the social and economic changes visible in the archaeological record reflect people's responses to the richness of new resources, and does dependence on these plant foods represent a decision to seek out plentiful, reliable resources? If the answer is no, were the grasses famine foods at best, and was it population pressure that forced people to resort to labor-intensive, second-choice resources? Without recapitulating all the arguments here, there are those who propose that late Natufian and related sedentary groups increasingly concentrated on only a few plant and animal resources (mainly the wild wheats and barleys and gazelle in the Levant, though some stress the importance of acorns) (e.g., Edwards 1989, Henry 1989, Olshewski 1993) and others who would agree with Flannery's original proposal that the preagricultural “hunter-gatherers may well have specifically adapted their harvesting methods to maximize the spectrum of edible seeds” (Hillman, Colledge, and Harris 1989:260).

### ALI KOSH: THE BROAD-SPECTRUM REVOLUTION RECONSIDERED

Helbaek (1969) analyzed a series of archaeobotanical samples from Ali Kosh and provided summary counts of seeds and rachis fragments dating to the Bus Mordeh (7500–6750 b.c.), Ali Kosh (6750–6000 b.c.), and Mohammad Jaffar (6000–5600 b.c.) phases. His work had two long-lasting results. First, he documented the pres-

2. The Nemrik 9 faunal remains may include pig, cattle, and goat transitional to the domesticated forms (Lasota-Moskalewska 1990).

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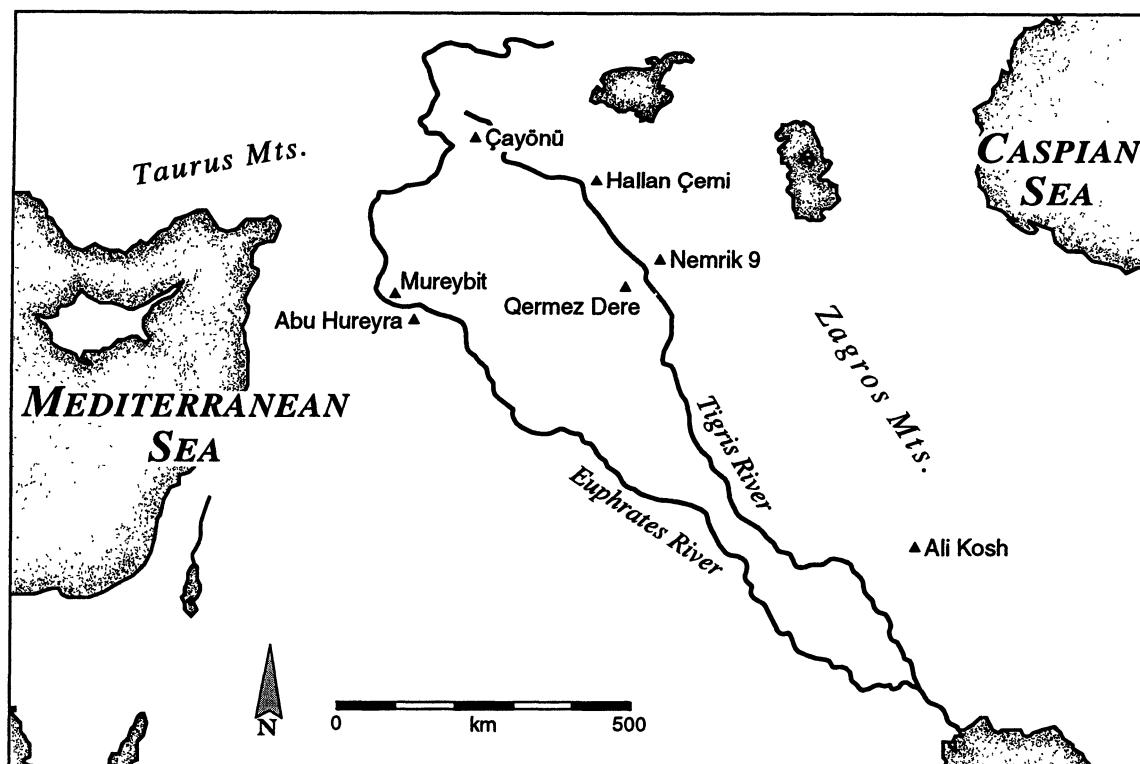


FIG. 1. Epipaleolithic and early Neolithic sites mentioned in text.

ence of early agricultural communities far from the natural habitat zones of the wild cereals. Second, he established a descriptive economic and environmental base line against which new data could be compared. He noted that the absence of wood charcoal and the presence of seeds of steppe plants at Ali Kosh suggests that the climate has not changed appreciably over the past eight millennia; the natural vegetation is and was steppe, with trees such as poplar, willow, and tamarisk

largely restricted to riverbanks and marshes. Agriculture was based on the cultivation of emmer wheat and barley, possibly in such naturally moist areas.

Helbaek traced economic and environmental change at Ali Kosh. Changes in the proportions of the seeds of various ecologically sensitive wild and domestic plants demonstrate shifts in the agricultural system. For example, domesticates make up a small percentage of the seeds from Bus Mordeh phase deposits (table 1, fig. 2, *a*).

TABLE 1  
*Plant Remains from Ali Kosh*

	Bus Mordeh	Ali Kosh	Mohammad Jaffar
No. samples	21	13	13
Seed count			
Cultivated plants	1,072	369	278
Introduced weeds	71	130	39
Indigenous grasses	277	40	1,253
Indigenous legumes	29,421	171	4,771
Swamp plants	53	1	0
Other wild plants	410	18	1,359
Tree, shrub fruits	6	188	403
Wheat spikelet forks <sup>a</sup>	2,812	905	957
Total	31,310	917	8,103

SOURCE: Helbaek (1969:391).

<sup>a</sup>Not included in sum.

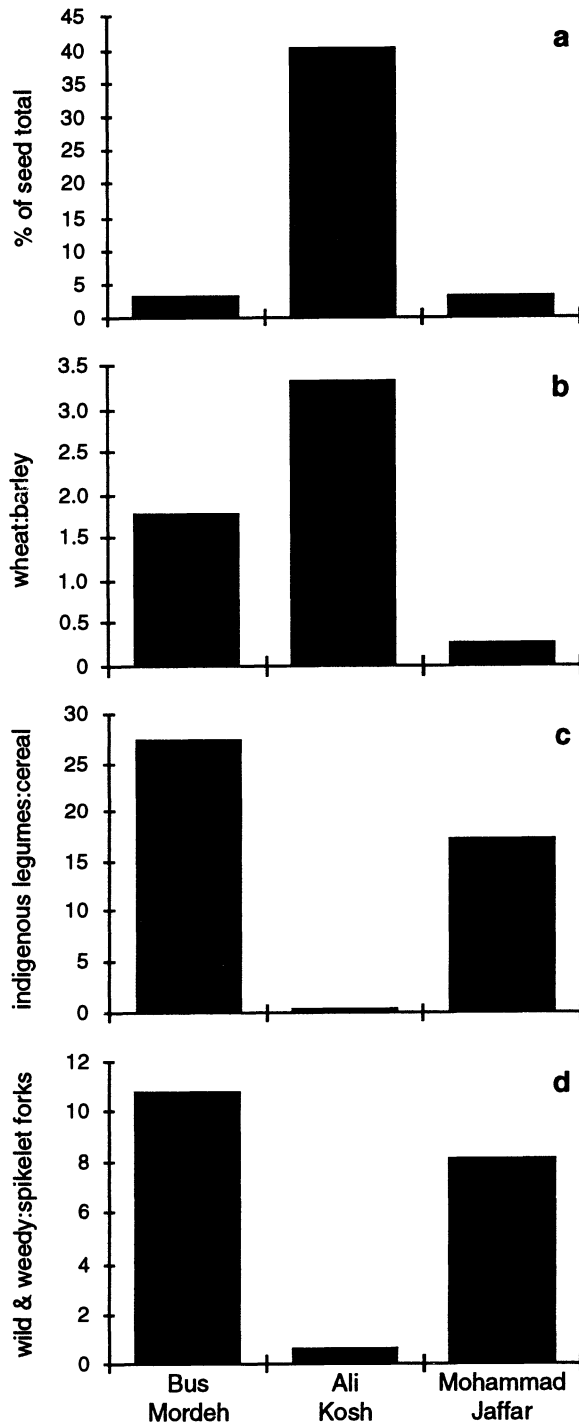


FIG. 2. Ali Kosh plant remains. a, seeds of cultivated plants; b, wheat:barley; c, indigenous legumes:cereal; d, wild and weedy seeds:wheat spikelet forks (seed and spikelet fork counts from Helbaek 1969:391).

During the Ali Kosh phase, the proportion of cultigens increases, which suggests that agricultural production expanded, perhaps as a result of increasing sedentism (cf. Hole, Flannery, and Neely 1969:347), and there is a corresponding decline in the proportion of indigenous legumes of the steppe. Seeds and pollen of *Prosopis*, probably an introduced perennial field weed, become more numerous over time (Helbaek 1969, Woosley and Hole 1978). An economic change with ecological implications can be seen in the ratio of wheat to barley, which increases between the Bus Mordeh and Ali Kosh phases but undergoes a steep decline in the Mohammad Jaffar phase (fig. 2, b). Helbaek considered this to be evidence for an increase in soil salinization near Ali Kosh, since barley is the more salt-tolerant crop. An increase in the percentage of the pollen of the usually halophytic family Chenopodiaceae supports this interpretation (Woosley and Hole 1978). Finally, swamp plants disappear. This result is in accord with the pollen (Woosley and Hole 1978) and geomorphological (Kirkby 1977) data, both of which suggest a drying of the central marsh and consequent diminution of suitable habitat for marsh plants. Since 1969, developments in archaeological theory, experimental archaeology, and ethnoarchaeology have changed the way archaeologists view archaeological deposits as evidence of past human behavior (e.g., Schiffer 1976, Watson 1979, Kramer 1979). Paleoethnobotanists have not been unaffected by this growing concern with archaeological context and site formation processes (e.g., Dennell 1976, Minnis 1981, Hillman 1981, Miller 1984, Miller and Smart 1984, Miksicek 1987). In particular, we now recognize that any assessment of charred archaeobotanical material should account for the cultural practices or natural processes under which that material became carbonized. It is therefore useful to consider the archaeological contexts in which the seeds are found and the circumstances of charring that may account for the seed assemblage.

Helbaek considered most of the seeds to be the remains of human food, particularly cultivated emmer and barley and small- and large-seeded wild legumes (clover, medick, trigonel, and *Prosopis*). He thought that people even ate cereal rachis fragments.

Most of the plant material from Ali Kosh originated in refuse deposits associated with structures and post-abandonment fill (Hole, Flannery, and Neely 1969). Although two concentrations of relatively pure *Prosopis* (p. 46) and barley (p. 62) are specifically mentioned, Helbaek (1969:385) notes that "no concentrated deposit was in fact found during the 1963 campaign." Therefore, although he reports only counts of the seeds by phase, the samples seem to represent mixed collections of seeds from cultural fill.

How then do we account for the carbonization of the seeds? Ali Kosh was not burned in antiquity, so it is unlikely that plant material was charred accidentally. Controlled or not, fires need fuel, yet no wood charcoal was found at Ali Kosh. Using ethnographic analogy, Helbaek considers the reeds and club rushes found in the archaeobotanical samples to be the most likely fuel ma-

terial (1969:387). Burned dung was found in numerous deposits as well (Hole, Flannery, and Neely 1969:36, 55, 61, 62), although Helbaek specifically states that seeds were not found in the dung (1969:396). He does note, however, "a correlation between the number of excess spikelet fragments and the seeds of small legumes" (1969:400), exactly what one would expect if straw from threshed grain supplemented the forage from the steppe and both were incorporated in dung burned as fuel.

Intentional burning of dung as fuel can account for both the absence of wood charcoal and the presence of numerous seeds of fodder plants. In fact, the Ali Kosh materials fit all the criteria for the use of dung fuel suggested by Miller and Smart (1984): (1) Alternative sources of fuel are rare in this semiarid region. (2) There were suitable herbivores (goats and sheep). (3) Actual burned dung is found throughout the sequence, as are numerous seeds of plants eaten by herbivores. (4) The mixed and charred character of the seed assemblages and its appearance in refuse rather than storage or use contexts supports identification as spent fuel rather than food remains.<sup>3</sup> (5) Dung is commonly used for fuel in Iran to this day.

Reconsideration of the Ali Kosh materials in light of the dung hypothesis entails a major revision of the human dietary interpretations (i.e., the broad-spectrum revolution), since the remains represent fodder, not food. Helbaek's environmental interpretations, however, are remarkably robust, probably because domestic animals ate a more environmentally representative group of plants than people did.

The materials also speak to questions of seasonality. Hole, Flannery, and Neely (1969:347) cite the relatively substantial architecture and lack of internal hearths as evidence for year-round (including summer) occupation during the Ali Kosh phase. Certainly from a botanical point of view, the earlier Bus Mordeh and later Mohammad Jaffar phases are more similar to each other than either is to the middle, Ali Kosh, phase.<sup>4</sup> Mud-brick structures in the Ali Kosh phase account for some of the distinctive characteristics of those deposits (see Dennell 1972). After all, people generally do not live in their own trash, and unburned structures tend to have a low density of charred remains in deposits that archaeologists commonly call "fill."

3. People undoubtedly ate some of these taxa, particularly the cultigens but also the wild plants (see Woosley and Hole 1978). For example, an upturned basket containing some *Prosopis* seeds was found in a room at Ali Kosh (Hole, Flannery, and Neely 1969:46). There are also any number of ethnographic examples of people who subsist on what to a Euro-American appear to be unlikely food sources (e.g., Doubly 1984). I only suggest here that most of the actual specimens of these taxa became charred through the burning of dung as fuel.

4. Dennell (1972) observed this pattern and attributed it to functional/depositional differences. He felt that material from indoor hearths in the Ali Kosh phase would contain more concentrated cultigen remains than the open-air midden deposits of the later and earlier phases. It is not clear to me that most of the Ali Kosh-phase seeds came directly from hearths or, even if they did, the hearths would contain more food remains.

Beyond density of charred remains, one can see that introduced weeds (perhaps associated with grain fields) and grain occur in relatively high numbers during Ali Kosh times, and the indigenous legume and grass categories are high during both the Bus Mordeh and the Mohammad Jaffar phase (table 1, fig. 2 a). The ratio of indigenous legumes to cereals shows a similar distribution (fig. 2, c).

The number of wheat spikelet forks compared with the number of seeds from presumed forage plants strengthens the impression that the Bus Mordeh and Mohammad Jaffar assemblages are more similar to each other than either is to the Ali Kosh-phase material (fig. 2, d). During the Ali Kosh phase, steppe plants (i.e., grazed fodder) make up a smaller component of the charred-seed assemblage relative to spikelet forks and cereal (probable stored fodder).

Thus, the diet of the Ali Kosh-phase herds is distinctive and emphasizes cultivated cereals and associated field weeds. On the Deh Luran plain, winter pastures are plentiful; it is during the summer months that forage is inadequate and stored grain might be fed to the animals. Dung produced in the summer and stored for winter use could account for the relatively high proportion of crop and weed seeds. The botanical evidence therefore supports Hole, Flannery, and Neely's (1969) idea that Ali Kosh-phase deposits represent a less transhumant lifestyle than those of the Bus Mordeh and Mohammad Jaffar phases.

Does this mean that there was no long-term change in the agricultural system? Even though the trends do not reflect simple growth, the data cited above for salinization and the drying of the central marsh are still valid evidence of permanent changes.

Do other types of material, such as the faunal remains, support this analysis? One would expect an increased proportion of sheep relative to goat during Ali Kosh times, if woolly sheep were available, because they are better adapted to the hot, dry Khuzestan summers than goats or nonwoolly sheep (Flannery 1969). This test implication is not borne out; there is an increase in the sheep:goat ratio through time (Hole, Flannery, and Neely 1969:270). Considering that sheep may not yet have evolved their woolly coats, perhaps a more relevant test implication is that wild ungulates that use the lowland winter pasture (namely, onager and gazelle) would make up a lower proportion of the Ali Kosh-phase ungulates. Unfortunately for the hypothesis, there is gradual increase in the use of onager and gazelle through time and a corresponding decline in the percentage of goats and/or sheep (table 2, fig. 3). The Mohammad Jaffar-phase emphasis on hunting does, however, conform nicely to a general Near Eastern pattern: the proportion of wild mammals increases in faunal assemblages at the same time that many settlements seem to have been abandoned (about 6000 B.C.), perhaps replaced by transhumant herding camps (Akkermans 1987, Buitenhuis 1990; cf. Zeder 1994). The reason is not clear, but it may sometimes be a result of local environmental degradation (Köhler-Rollefson and Rollefson 1990). As

TABLE 2  
*Ungulate Remains from Ali Kosh*

Species	Percentage of Identified Ungulate Bones		
	Bus Mordeh (n = 1,851)	Ali Kosh (n = 4,406)	Mohammad Jaffar (n = 1,305)
Goat and/or sheep	72	61	54
Gazelle	24	29	32
Onager	3	6	11
Aurochs	1	4	2
Pig	+	+	+
Total	100	100	99

SOURCE: Hole, Flannery, and Neely (1969:264).

evidence of soil salinization, the decline in the wheat: barley ratio at Ali Kosh may be an instance of this phenomenon.

I have tried to demonstrate that knowledge of the archaeological context of charred material is critical for paleoethnobotanical interpretations (see Wright, Miller, and Redding 1981; Miller 1991:153–55). Deposit-by-deposit reporting of context and content could help settle the question of whether an item was found unmixed and therefore probably collected as food or whether it was mixed with other plants, burned as fuel, and deposited on a midden.

By reanalyzing Helbaek's important contribution, I have been able to resolve some of the inconsistencies born of the attempt to identify a developmental sequence among taphonomically different archaeobotanical assemblages. Helbaek's broad conclusions about agricultural development in the early village period still stand, but the new interpretation sheds light on pastoral strategies that were previously invisible.

The remains of dung on archaeological sites can be very helpful in recognizing ancient fields (Miller and Gleason 1994) or identifying areas where animals were kept (Hecker 1982). However, dung need not be col-

lected from penned or stabled animals (Makal 1954:12; Watson 1979:122; Smithsonian Institution 1981). As Kurdish villagers insisted to the surprised ethnographer, the most important product of their animals was dung for fuel (Kramer 1982:45, 47). It is less obvious that people in nonagricultural circumstances would go to the trouble of picking up after animals. Nevertheless, in many parts of the world the dung of wild and domesticated animals is collected from their grazing lands. Out on the Great Plains of the United States, the Native Americans collected buffalo chips. Up on the treeless puna of Peru, wild camellids defecate in convenient, territory-marking piles, and camellid dung fires readily explain some seed assemblages found there (Pearsall 1989:320). And Doughty noted, "Wandering in all the waste Arabia . . . [t]here is almost no parcel of soil where fuel may not be found, of old camel dung . . . bleaching in the sun" (1921:304–5). It is clear that where fuel is scarce but herbivores are not, dung is a highly valued fuel.

#### DUNG OR DIET AT ABU HUREYRA?

Having neither domesticated plants nor animals, the Epipaleolithic settlement at Abu Hureyra provides a better test of the original broad-spectrum-revolution hypothesis than Ali Kosh. Abu Hureyra is large, and its semisubterranean round houses were occupied year-round or virtually year-round (Moore 1975, 1979; Hillman, Colledge, and Harris 1989). The settlement seems to have been culturally related to the contemporary Natufian societies of the Levant. At that time conditions were somewhat more favorable for vegetation than they are today, for the steppe was a little moister (van Zeist and Woldring 1980; van Zeist and Bottema 1991; Wright 1993). The primary meat source was gazelle, which accounted for about 80% of the bones (Legge 1975). Riparian forest along the Euphrates provided wood fuel and probably harbored some game as well. The seed assemblage is very varied, and in a preliminary analysis Hillman, Colledge, and Harris (1989) propose that most of the 150 edible types of seeds are food remains. This posi-

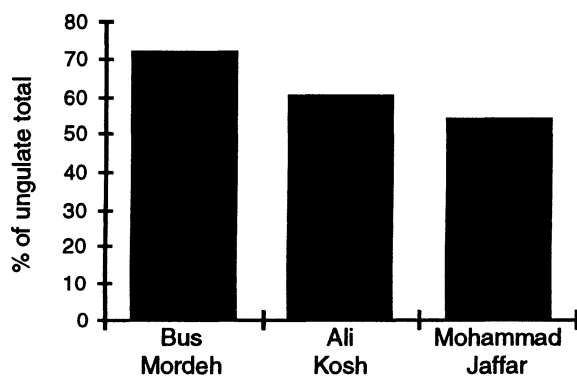


FIG. 3. Goats and/or sheep (% of ungulate total bone count) at Ali Kosh (Hole, Flannery, and Neely 1969:264).

tion is argued very cogently, but even so, two questions remain: Could this assemblage reflect the burning of dung fuel? If so, what are the implications for Late Epipaleolithic dietary reconstructions, insofar as they are based on plant remains?

Archaeobotanists commonly observe that it is difficult to compare the data generated by different researchers because recovery, laboratory, and reporting procedures are not uniform. This situation is unavoidable; over the duration of a single project even one's own standards may change. Nevertheless, at least for the better-documented periods of the Neolithic and beyond, several generalizations seem valid for archaeobotanical samples that come from cultural fill (see references in Miller 1991).<sup>5</sup> First, if charcoal is reported, the woods found in sites of forested areas tend to be forest woods, whereas those found on the steppe tend to be from riparian forest or shrubs. Second, charred-seed assemblages from forested areas tend to be less diverse than those from the steppe, and the number and density of charred-seed remains tend to be lower (this is true of wild and weedy seeds; it also generally holds for density of cereal remains).<sup>6</sup> Third, when comparable procedures are followed, the proportion of seeds to wood charcoal tends to be higher in areas with little or no arboreal vegetation (Miller 1990 and unpublished laboratory notes). Fourth, at agricultural sites in all zones, the number of crop seeds in cultural fill is generally low compared with the number of seeds of wild and weedy plants.

Hillman's (1981, 1984) observations about crop processing could easily account for the fourth observation. In fact, Hillman's and Dennell's (1972, 1976) work was extremely important in getting people to realize that charred seeds are not all food remains. The crop-processing model does not, however, account for the other three observations. Furthermore, it does not account for the differences between environmental zones; it is unlikely that processing technology for wheat, barley, and legumes was so different in the Zagros from that in northern Syria or southern Iraq. Charred-seed assemblages from all sites and time periods share one trait, however; they were burned. This holds the key to understanding; intentionally burned materials were more likely to have been put in a fire than accidentally burned ones, and fuel is one of the few things routinely and necessarily put in fires. In rural areas of low population density, organic trash such as crop-processing debris is

more likely to be fed to animals, used as fertilizer, or left to rot than it is to be burned. Thus, probability alone would suggest that most *charred* remains come from fuel.

Hillman, Colledge, and Harris (1989:259) explicitly consider alternatives to their hypothesis that the Abu Hureyra remains come from food. They consider dung an unlikely source of seeds for two reasons. First, although charred fragments of infant feces were recognized, animal dung fragments were not found. This argument from absence of data is not incontrovertible.<sup>7</sup> As has been demonstrated elsewhere, many if not most seeds from cultural fill on some Near Eastern sites can be best explained as coming from dung fuel (e.g., Miller 1984, Miller and Smart 1984; cf. van Zeist and Bakker-Heeres 1985:275); it is not a requirement that dung fragments be found.

A second comment is more to the point: "all the bone remains identified from Epipaleolithic levels . . . were from wild species (mainly gazelle), and dispersed gazelle pellets are unlikely to have been collected for burning when there was plenty of wood available in the local riverine forest" (Hillman, Colledge, and Harris 1989:259). As quantitative results of the charcoal analysis are not yet available and comparisons of the number or amount of charred seeds relative to wood charcoal have not been reported, it is impossible to evaluate the assertion that "plenty" of wood fuel was available. However, Abu Hureyra was probably occupied year-round, so it is likely that riverine wood resources were under continuous stress. Certainly, along the Euphrates today one comes across riparian vegetation that is managed for firewood by periodic lopping of branches, but such patches do not provide a year's worth of fuel.

With regard to the economic feasibility of collecting gazelle dung, several points may be made. First, dung is a highly desirable fuel source where wood is scarce; all one needs is a rake and a basket, technology that would not have been beyond the residents of Abu Hureyra. It is estimated that hundreds of thousands of gazelle lived in the Syrian desert, at least some of them near Abu Hureyra (see Legge and Rowley-Conwy 1987). Individual gazelle herds can number up to a hundred (Simmons and Ilany 1977:271), and male gazelles maintain territories by marking them with piles of dung. Indeed, *Gazella subguttarosa* leave "very pronounced and/or frequent dung piles in their territories" (Walther, Mungall, and Grau 1983:194), and for gazelle in general the piles tend to be deposited along territorial boundaries and trails (p. 86). That is, dung piles occur in predictable spots and would have been easily collected.

Van Zeist noted some time ago that the archaeobotanical record from northern Syria documents changes in the vegetation brought on by farming and herding. He suggested that the differences between the seed assemblages of Epipaleolithic Mureybit and Bronze Age Selen-

5. I specifically exclude samples of pure or virtually pure seed and other crop remains found in burned structures and features (most probably food) and fruit pits and nutshells (most probably direct waste products of food consumption or processing).

6. Seed assemblages in more forested regions would have higher proportions of food-processing debris than those from the steppe, because the contribution made by dung fuel contents would be lower. The contrast between Ali Kosh and Çayönü, located in the oak-juniper forest zone, is instructive. At Çayönü, levels with domesticated plants but without domesticated herbivores have seeds that are most probably food and food-processing debris (pulses, cereals, rachises, and nutshells) (van Zeist and de Roller 1994:94). Where dung was an important fuel, however, seeds from dung fuel would far outnumber those of other sources.

7. At the site of Jeitun, Turkmenistan, where substantial amounts of dung have been found, Hillman and Charles (n.d.) think it unlikely that most of the charred seeds originated in dung fuel.

kahiye may be explained as an artifact of cultivation (van Zeist and Bakker-Heeres 1985). That is, as cultivation progressed over the millennia, disturbed ground habitats expanded. The Abu Hureyra material fits this framework too; the pasture quality of steppe vegetation declined with the onset of agriculture and animal husbandry, and the population of toxic and unpalatable plants increased (Hillman, Colledge, and Harris 1989:254). As noted for Ali Kosh, environmental reconstructions based on plant remains seem to be more stable than dietary ones.

#### IMPLICATIONS FOR PREHISTORY

If the charred-seed assemblages from Ali Kosh and Abu Hureyra are primarily remnants of dung-fueled fires, a number of our ideas about ancient plant use and wild or domestic herd management must be revised. The vast majority of seed remains were not destined for human consumption and burned accidentally, nor were they direct by-products of food processing. In short, the archaeobotanical evidence from cultural fill does not support the broad-spectrum hypothesis; it does not speak directly to it at all. Thus, the conclusions presented here eliminate one argument that has been used to support population-pressure theories of agricultural origins.

The recognition that charred plant remains from cultural fill are *primarily* fuel remains enhances understanding of some assemblages and permits new questions to be asked of the data. For example, low numbers of seeds from some sites may be due to the ready availability of wood in the forested zones rather than to any lack of interest in plant foods on the part of ancient people. Where it is possible to compare material from a single time period and samples from the same depth below the modern surface, one would expect flotation samples from sites in forested regions to have smaller amounts of seed material relative to wood charcoal. In order to test this expectation, we need archaeobotanical reports which include wood charcoal quantities for each sample (see Miller 1990, 1994, and several unpublished reports).

Acknowledging that charred seeds may be dung fuel remains does not mean that archaeobotanical evidence is irrelevant for diet reconstructions. First, primary or nearly pure deposits of food are routinely found in burned storage or cooking contexts and, more directly, mineralized in cess deposits. Second, many of the charred seeds we find are from plants also gathered or cultivated for food; it is just the burned specimens that were never eaten. Third, just as material culture studies (e.g., of grinding stones, sickle blades), settlement data, and human osteological analysis provide insight into early Holocene society and economy, environmental reconstructions are very important in setting the scene and establishing the constraints within which these societies lived. By taking into account archaeological context, not only do environmental reconstructions become more plausible but the plant remains also shed light on the relation between people and animals. Thus, we can

begin to integrate the study of land and herd management and to trace the impact of humans and other animals on the landscape.

#### References Cited

- AKKERMANS, P. M. M. G. 1987. A Late Neolithic and Early Halaf village at Sabi Abyad, North Syria. *Paléorient* 13(1):23–40.
- BAR-YOSEF, OFER, AND MORDECHAI KISLEV. 1989. "Early farming communities in the Jordan Valley," in *Foraging and farming: The evolution of plant exploitation*. Edited by D. R. Harris and G. C. Hillman, pp. 632–42. London: Unwin Hyman.
- BUITENHUIS, HIJLKE. 1990. "Archaeozoological aspects of Late Holocene economy and environment in the Near East," in *Man's role in the shaping of the eastern Mediterranean landscape*. Edited by S. Bottema, J. Entje-Neiborg, and W. van Zeist, pp. 195–205. Rotterdam: A. A. Balkema.
- COHEN, MARK N., AND GEORGE J. ARMELAGOS. 1984. "Paleopathology at the origins of agriculture: Editors' summation," in *Paleopathology at the origins of agriculture*. Edited by M. N. Cohen and G. J. Armelagos, pp. 585–601. Orlando: Academic Press.
- DENNELL, ROBIN W. 1972. "The interpretation of plant remains: Bulgaria," in *Papers in economic prehistory*. Edited by E. S. Higgs, pp. 149–59. Cambridge: Cambridge University Press.
- . 1976. The economic importance of plant resources represented on archaeological sites. *Journal of Archaeological Science* 3:229–47.
- DOUBLEY, J. F. 1984. "Seeds" of wild grasses: A major food of Southwestern Indians. *Economic Botany* 38:52–64.
- DOUGHTY, CHARLES M. 1921. 2d edition. *Travels in Arabia Deserta*. Vol. 1. London: Philip Lee Warner.
- EDWARDS, P. C. 1989. Revising the broad spectrum revolution and its role in the origins of southwest Asian agriculture. *Antiquity* 63:225–46.
- FLANNERY, KENT V. 1969. "Origins and ecological effects of early domestication in Iran and the Near East," in *The domestication and exploitation of plants and animals*. Edited by P. J. Ucko and G. W. Dimbleby, pp. 73–100. Chicago: Aldine.
- HECKER, HOWARD M. 1982. Domestication revisited: Its implications for faunal analysis. *Journal of Field Archaeology* 9:217–36.
- HELBAEK, HANS. 1969. "Plant collecting, dry-farming, and irrigation in prehistoric Deh Luran," in *Prehistory and human ecology of the Deh Luran plain*, by F. Hole, K. V. Flannery, and J. A. Neely, pp. 383–426. University of Michigan Museum of Anthropology Memoir 1.
- HENRY, DONALD O. 1989. *From foraging to agriculture*. Philadelphia: University of Pennsylvania Press.
- HILLMAN, GORDON C. 1989. "Reconstructing crop husbandry practices from charred remains of crops," in *Farming practice in British prehistory*. Edited by R. Mercer, pp. 123–62. Edinburgh: Edinburgh University Press.
- . 1984. "Interpretation of archaeological plant remains: The application of ethnographic models from Turkey," in *Plants and ancient man*. Edited by W. van Zeist and W. A. Casparie, pp. 1–41. Rotterdam: A. A. Balkema.
- HILLMAN, GORDON C., SUSAN M. COLLEDGE, AND DAVID R. HARRIS. 1989. "Plant-food economy during the Epipaleolithic period at Tell Abu Hureyra, Syria: Dietary diversity, seasonality, and modes of exploitation," in *Foraging and farming: The evolution of plant exploitation*. Edited by D. R. Harris and G. C. Hillman, pp. 240–68. London: Unwin Hyman.
- HILLMAN, GORDON C., AND MICHAEL CHARLES. n.d. Crop husbandry in a desert environment: Evidence from the charred plant macro-remains from Jeitun 1989–90. MS.
- HOLE, FRANK. 1984. A reassessment of the Neolithic revolution. *Paléorient* 10(2):49–60.
- HOLE, FRANK, KENT V. FLANNERY, AND JAMES A. NEELEY.



1969. *Prehistory and human ecology on the Deh Luran plain*. University of Michigan Museum of Anthropology Memoir 1.
- KIRKBY, MICHAEL J. 1977. "Land and water resources of the Deh Luran and Khuzistan plains," in *Studies in the archaeological history of the Deh Luran plain: The excavation of Chagha Sefid*, by F. Hole, pp. 251–88. University of Michigan Museum of Anthropology Memoir 9.
- KÖHLER-ROLLEFSON, ILSE, AND GARY O. ROLLEFSON. 1990. "The impact of Neolithic subsistence strategies on the environment: The case of 'Ain Ghazal, Jordan," in *Man's role in the shaping of the eastern Mediterranean landscape*. Edited by S. Bottema, J. Entje-Neiborg, and W. van Zeist, pp. 3–14. Rotterdam: A. A. Balkema.
- KOZŁOWSKI, STEFAN K. 1989. Nemrik 9: A PPN Neolithic site in northern Iraq. *Paléorient* 15(1):25–31.
- KRAMER, CAROL. 1979. *Ethnoarchaeology*. New York: Columbia University Press.
- . 1982. *Village ethnoarchaeology: Rural Iran in archaeological perspective*. New York: Academic Press.
- LASOTA-MOSKALEWSKA, ALICJA. 1990. "Preliminary archaeological investigation of animal remains from site Nemrik 9 in Iraq," in *Nemrik 9: Pre-Pottery Neolithic site in Iraq*. Edited by S. K. Kozłowski, pp. 185–208. Warsaw: Wydawnictwa Uniwersytetu Warszawskiego.
- LEGGE, ANTHONY J. 1975. The fauna of Tell Abu Hureyra: Preliminary analysis. *Proceedings of the Prehistoric Society* 41:74–77.
- LEGGE, ANTHONY J., AND PETER ROWLEY-CONWY. 1987. Gazelle killing in Stone Age Syria. *Scientific American* 277(2):88–95.
- MAKAL, MAHMUT. 1954. *A village in Anatolia*. London: Mitchell.
- MIKSICEK, CHARLES. 1987. Formation processes of the archaeological record. *Advances in Archaeological Method and Theory* 10:211–47.
- MILLER, NAOMI F. 1984. The use of dung as fuel: An ethnographic example and an archaeological application. *Paléorient* 10(2):71–79.
- . 1990. Clearing land for farmland and fuel: Archaeobotanical studies of the ancient Near East. *MASCA Research Papers in Science and Archaeology* 7(suppl.):71–78.
- . 1991. "The Near East," in *Progress in Old World palaeoethnobotany*. Edited by W. van Zeist, K.-E. Behre, and K. Wasylikowa, pp. 133–60. Rotterdam: A. A. Balkema.
- . 1994. Archaeobotanical report, appendix to Mesopotamian-Anatolian interaction at Hacinebi Tepe, Turkey: Preliminary report on the 1992 excavations, by G. Stein and A. Misir. *Anatolica* 20:168–72.
- MILLER, NAOMI F., AND KATHRYN L. GLEASON. 1994. "Fertilizer in the identification and analysis of cultivated soil," in *The archaeology of garden and field*. Edited by N. F. Miller and K. L. Gleason, pp. 25–43. Philadelphia: University of Pennsylvania Press.
- MILLER, NAOMI F., AND TRISTINE L. SMART. 1984. Intentional burning of dung as fuel: A mechanism for the incorporation of charred seeds into the archaeological record. *Journal of Ethnobiology* 4:15–28.
- MINNIS, PAUL E. 1981. Seeds in archaeological sites: Sources and some interpretive problems. *American Antiquity* 46:143–52.
- MOORE, ANDREW M. T. 1975. The excavation of Tell Abu Hureyra in Syria: A preliminary report. *Proceedings of the Prehistoric Society* 41:50–77.
- . 1979. A pre-Neolithic farmers' village on the Euphrates. *Scientific American* 241(2):62–70.
- OLSZEWSKI, DEBORAH I. 1993. Subsistence ecology in the Mediterranean forest: Implications for the origins of cultivation in the Epipaleolithic southern Levant. *American Anthropologist* 95:420–35.
- PEARSALL, DEBORAH M. 1989. "Adaptation of prehistoric hunter-gatherers to the High Andes: The changing role of plant resources," in *Foraging and farming: The evolution of plant exploitation*. Edited by D. R. Harris and G. C. Hillman, pp. 318–32. London: Unwin Hyman.
- ROSENBERG, MICHAEL. 1993. Hallan Çemi and early settled village life in eastern Anatolia. *Mar Şipri* 6(2):1–4.
- ROSENBERG, M., M. NESBITT, AND R. W. REDDING. n.d. Hallan Çemi, pig husbandry, and post-Pleistocene adaptations along the Taurus-Zagros arc. *Paléorient*. In press.
- SCHIFFER, MICHAEL B.. 1976. *Behavioral archaeology*. New York: Academic Press.
- SIMONS, A. H., AND G. ILANY. 1977. What mean these bones? *Paléorient* 3:269–74.
- SMITH, PHILIP E. L., AND T. CUYLER YOUNG JR. 1972. "The evolution of early agriculture and culture in Greater Mesopotamia: A trial model," in *Population growth*. Edited by B. Spooner, pp. 1–59. Cambridge: MIT Press.
- . 1983. "The force of numbers: Population pressure in the central western Zagros 12,000–4500 B.C.," in *The hilly flanks and beyond*. Edited by T. C. Young Jr., P. E. L. Smith, and P. Mortensen, pp. 141–61. Chicago: Oriental Institute, University of Chicago.
- SMITHSONIAN INSTITUTION.. 1981. Reverend Glessner's footage of Iraq c. 1934–1956, with annotation. 81.3.1-2RV, part 1 (minute 5:30–minute 5:50). Washington, D.C.: Smithsonian Institution.
- VAN ZEIST, WILLEM. 1986. Some aspects of early Neolithic plant husbandry in the Near East. *Anatolica* 15:49–67.
- VAN ZEIST, WILLEM, AND J. A. H. BAKKER-HEERES. 1985. Archaeobotanical studies in the Levant 4: Bronze Age sites on the North Syrian Euphrates. *Palaeohistoria* 27:247–316.
- VAN ZEIST, WILLEM, AND SYTZE BOTTEMA. 1991. *Late Quaternary vegetation of the Near East*. Beihefte zum Tübinger Atlas des vorderen Orients A 18.
- VAN ZEIST, WILLEM, AND GERRIT JAN DE ROLLER. 1994. The plant husbandry of aceramic Çayönü, SE Turkey. *Palaeohistoria* 33/34:65–96.
- VAN ZEIST, WILLEM, AND H. WOLDRING. 1980. Holocene vegetation and climate of northwestern Syria. *Palaeohistoria* 22:11–125.
- WALTHER, FRITZ R., ELIZABETH CARY MUNGALL, AND GERALD A. GRAU. 1983. *Gazelles and their relatives, a study in territorial behavior*. Park Ridge, N.J.: Noyes.
- WATKINS, T., D. BAIRD, AND A. BETTS. 1989. Qermez Dere and the early Aceramic Neolithic of N. Iraq. *Paléorient* 15(1):19–24.
- WATSON, PATTY JO. 1979. *Archaeological ethnography in western Iran*. Tucson: University of Arizona Press.
- WOOSLEY, ANNE I., AND FRANK HOLE. 1978. Pollen evidence of subsistence and environment in ancient Iran. *Paléorient* 4:59–70.
- WRIGHT, HENRY T., NAOMI F. MILLER, AND RICHARD W. REDDING. 1981. "Time and process in an Uruk rural center," in *L'archéologie de l'Iraq: Perspectives et limites d'interprétation anthropologique des documents: Colloques Internationaux du C.N.R.S.*, vol. 580, pp. 265–82.
- WRIGHT, HERBERT E. 1993. Environmental determinism in Near Eastern prehistory. *CURRENT ANTHROPOLOGY* 34:458–69.
- ZEDER, MELINDA A. 1994. After the revolution: Post-Neolithic subsistence in northern Mesopotamia. *American Anthropologist* 96:97–126.