

**MASCA Research Papers**  
**in Science and Archaeology**

Supplement to Volume 7, 1990

**ECONOMY AND SETTLEMENT IN THE NEAR EAST:**  
**Analyses of Ancient Sites and Materials**

---

edited by

Naomi F. Miller

MASCA, The University Museum of Archaeology and Anthropology  
University of Pennsylvania, Philadelphia  
1990

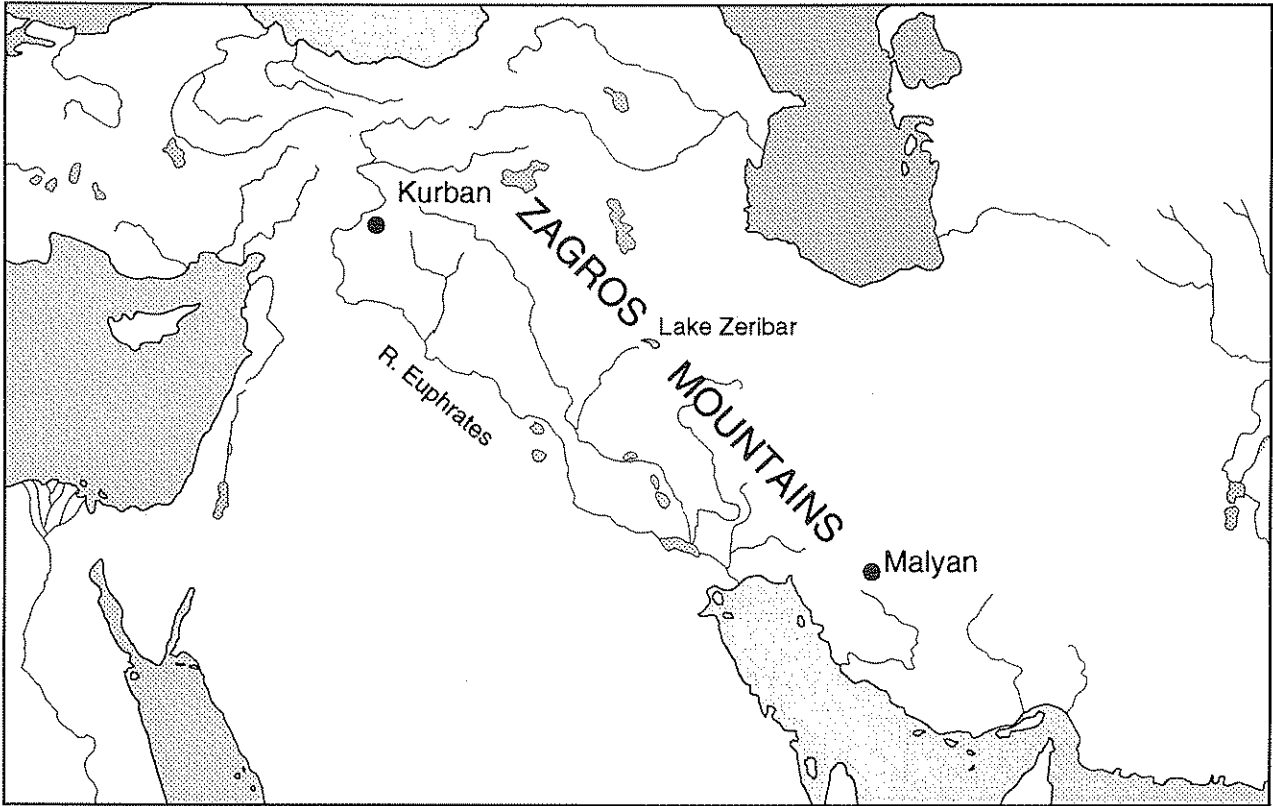


Fig. 1:  
Map of Near East showing sites mentioned in text.

# CLEARING LAND FOR FARMLAND AND FUEL: ARCHAEOBOTANICAL STUDIES OF THE ANCIENT NEAR EAST

Naomi F. Miller

*MASCA, The University Museum of Archaeology and Anthropology, University of Pennsylvania,  
Philadelphia, PA 19104*

In a wooded region, clearing land of trees is probably the simplest way to expand farmland and provide fuel for a growing population. As long as there is sufficient wooded land people will be able to collect fuel. As land clearance proceeds, it will take more effort to collect fuel. Vegetation loss may lead to a permanent drop in the water table, increased runoff and wind erosion, and loss of seed sources for vegetation renewal. Such processes ultimately transform the landscape. Continued disturbance may eventually necessitate changes in settlement, agricultural production, and fuel procurement. These forces are clearly at work in today's world, but dramatic changes in the landscape are by no means restricted to modern times. For example, a recent study of environmental change in the southwestern United States showed that periodic abandonment of Anasazi villages resulted from the depletion of fuel resources near settlements, and that local changes induced by tree cutting, along with population growth, may eventually have led to agricultural intensification (Köhler and Matthews 1988). Land clearance can have a variety of effects, many of which leave traces in the archaeological record.

In the Near East, people have been actively modifying the vegetation for millennia (Köhler-Rollefson 1988; Miller 1991). The pace of change probably quickened during times of population expansion in areas of intensive settlement, and the third millennium B.C. was such a time. Although it is difficult to date episodes of land clearance, we can use several lines of evidence to trace landscape change, including texts (Rowton 1967; Hansman 1976) and sedimentology (Diester-Haass 1973; Nützel 1976). Although Diester-Haass attributes increased sedimentation in the Gulf to climate changes, one can easily imagine that deforestation in the Tigris-Euphrates drainage caused increased runoff and erosion. Archaeological and pollen evidence discussed below yields further evidence of deforestation. Wood was cut primarily to create agricultural fields and to provide fuel for domestic and industrial

purposes. As trees were cut down near settlements, the composition of the woodlands changed, and alternative fuel sources were used more frequently. Detailed paleoethnobotanical analysis at Malyan, an urban center in the highlands of southern Iran, illustrates the environmental implications of an increased demand for fuel. Preliminary paleoethnobotanical results from Kurban Höyük, a small town in southeastern Turkey, suggest a similar pattern of tree cutting (Fig. 1). Since fuel remains from archaeological sites reflect *local* vegetation and plant use, one can assess the degree of environmental disturbance caused by people. In conjunction with the evidence of craft production, the magnitude of land clearance inferred from the archaeobotanical record allows one to monitor and interpret aspects of economic and social change.

## **Plaster and metal production**

The people of the ancient Near East developed a number of fire-using technologies: lime and gypsum plaster production, ceramic manufacture, and copper metallurgy (cf. Wertime 1983). Floors, bowls, statues, and other artifacts made of lime plaster have been documented from the Epipaleolithic on (Kingery et al. 1988). Metal use first appeared in Anatolia during the Aceramic Neolithic (Muhly et al. 1987). Small quantities of pure native copper appear first, and early smiths may also have experimented with the more plentiful, colorful copper-bearing minerals, such as malachite (Kingery et al. 1988; Rostoker et al. 1988).

Although many ceramics can be produced with relatively low quality fuels, the manufacture of both lime plaster and metals requires high temperatures and large amounts of fuel. For each ton of lime plaster produced, about two tons of limestone must be burned with two tons of fuel wood. Oxidic and sulfidic ores may be smelted down to copper with relatively simple techniques that use wood fuel (Rostoker et al. 1988); however, to smelt complex, weathered copper-iron sulfide ores it is critical that

the ore come into contact with charcoal for the chemical reduction to pure copper to take place (Rostoker et al. 1988). Wood, dung, and straw are not adequate for this process. The use of charcoal for fuel is relatively inefficient, as much of the heat value is expended by burning during its manufacture (Horne 1982). But even if the simpler technology employing only wood fuel was practiced, it would have taken more fuel to produce metal tools and vessels than comparable items made of clay, basketry, wood, or stone.

Local population increase in parts of the Near East during the third millennium can account for some forest clearance, since more people require more land to farm and more wood for cooking and heating. In many regions, *per capita* rates of fuel use probably also increased due to continuing use of plaster and pottery and the introduction of new metal technologies.

### Malyan

One such area is the Kur river basin, located on one of the main land routes between Mesopotamia and the Iranian plateau. Malyan was a major highland center at the northwest end of the valley. The extant vegetation suggests that the site lies at the southeastern limit of the Zagrosian oak park

forest zone, near the pistachio-almond steppe forest of southern Iran (Fig. 2). The region is semi-arid. Rainfall agriculture is possible, but irrigation considerably reduces the risk of crop failure.

Sedentary population in the valley seems to have declined drastically between the beginning and end of the third millennium. Malyan itself was virtually abandoned (Sumner 1989). The valley was resettled in the late third millennium (Kaftari period), and social complexity seems to have increased at that time as well. Population distribution and size changed, as suggested by an increase in the number of levels in the settlement hierarchy from two to four, and a dramatic increase in the total area covered by settlements (Fig. 3). At the beginning of the third millennium B.C. (Banesh period) Malyan was about 40 ha. At the beginning of the second millennium (Kaftari period), it was much larger, 130 ha. Population estimates based on archaeological survey data for the settled population of the Kur basin are about 9600 during the Banesh period and 45,000 in Kaftari times (Sumner 1986, 1989). It is likely that relatively high population in the valley and at Malyan itself led to forest clearance for both fuel and agricultural land.

Paleoethnobotanical work at the site established the

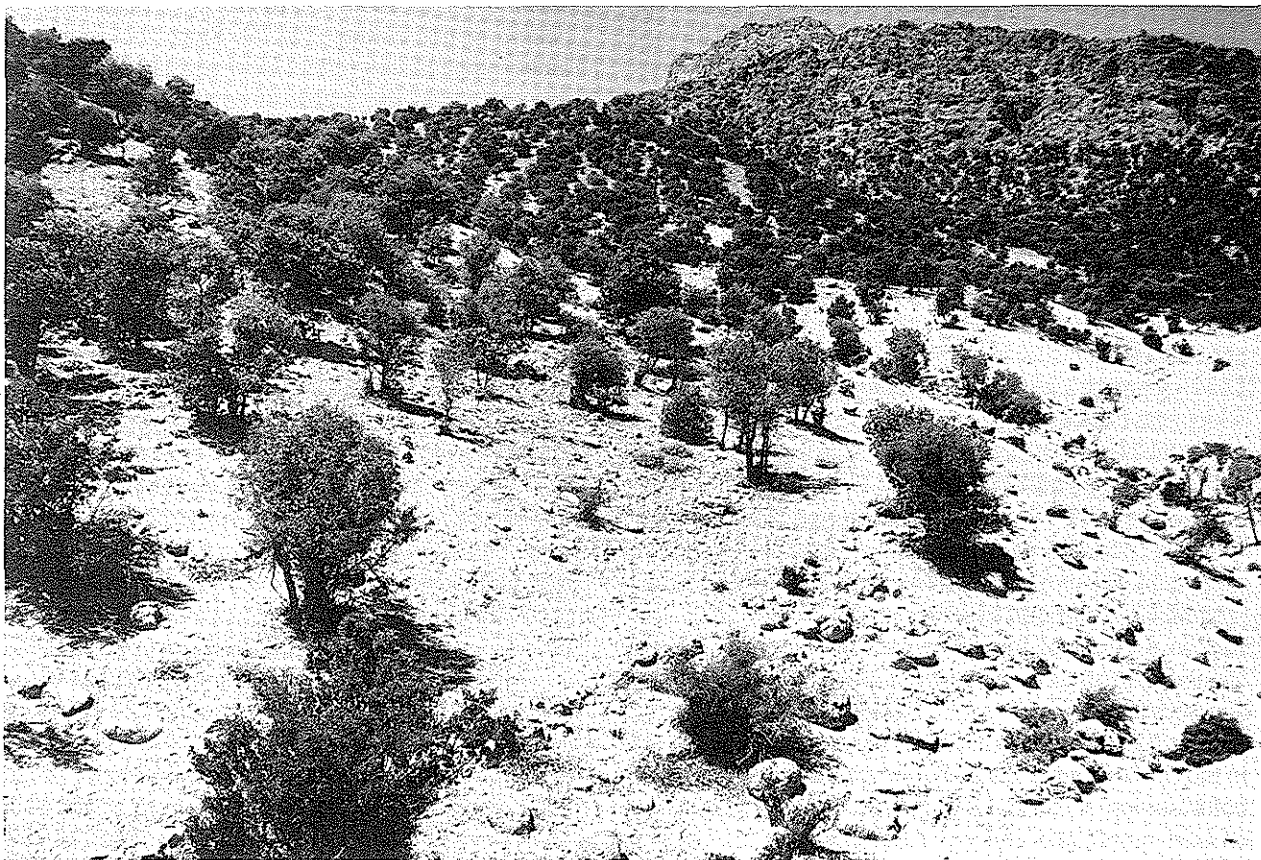


Fig. 2:  
Oak forest at northwest end of Kur river basin.

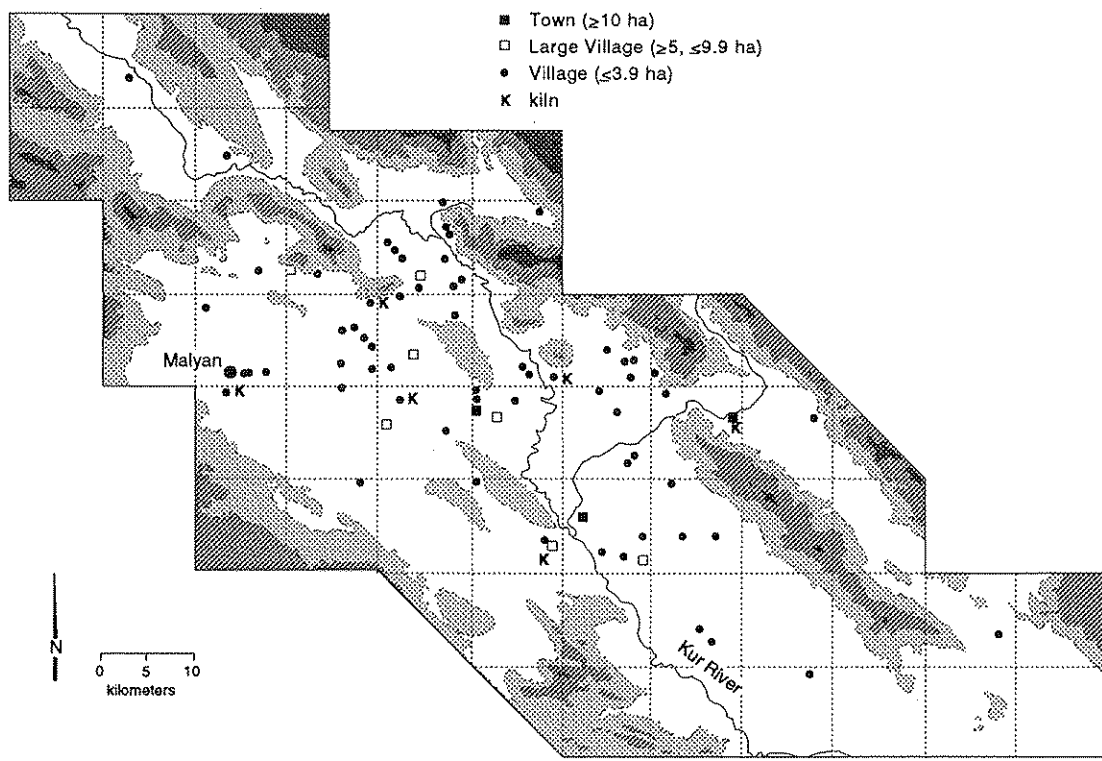
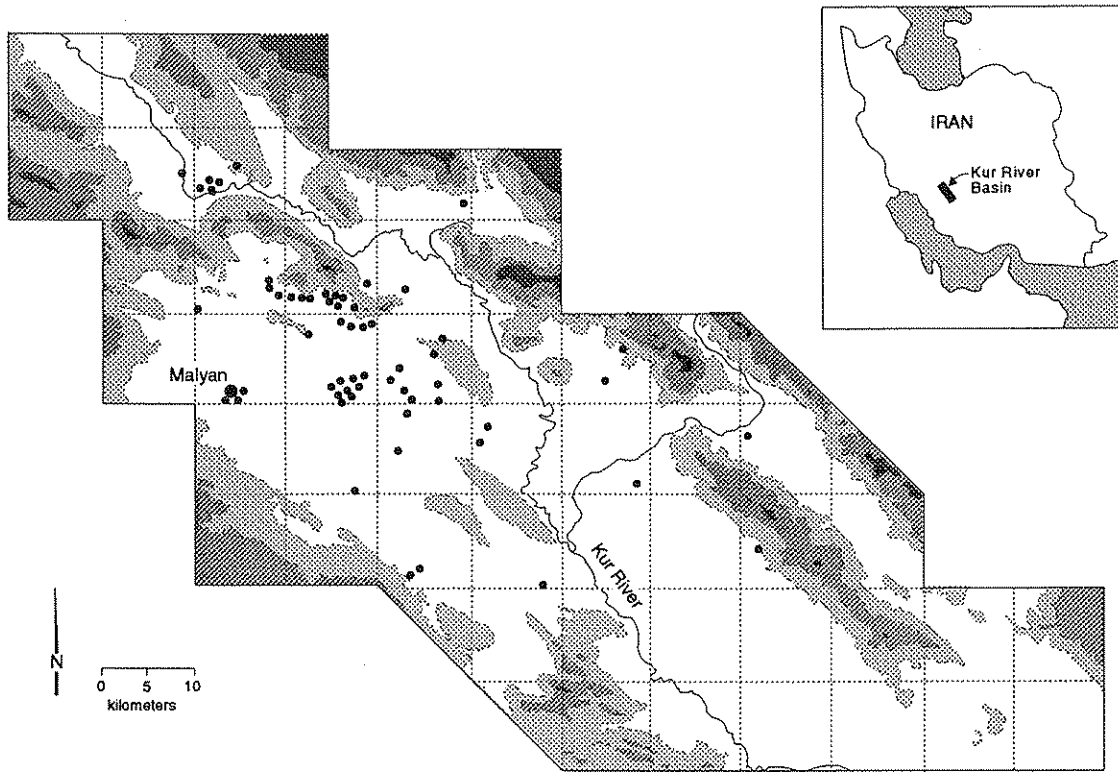


Fig. 3:  
 Maps of Kur river basin: Banesh (above), and Kaftari (below) settlement systems. Population estimates of 110-210 people per ha of settlement are based on ethnographic analogy. Malyan is estimated to have housed about 6400 people, or two thirds of the valley's population at the beginning of the third millennium, and 19,800, or nearly half of the valley's population at the beginning of the second millennium (see Sumner 1986, 1989).

basic character of the ancient environment and subsistence (Miller 1982). Ancient forest composition is inferred from modern distribution studies and analysis of archaeological charcoal. The charcoal is not a direct reflection of the ancient vegetation, but rather a reflection of fuel choice. Juniper, almond, pistachio and poplar were most often chosen for fuel, probably because they grew near the site (Miller 1985). A decrease in juniper and poplar, wood types thought to have grown on the valley floor, and an increase in oak charcoal suggest that the distance travelled to procure fuel was greater in Kaftari than in Banesh times.<sup>1</sup> The charred seed assemblage provides further support for forest clearance.

A charred seed assemblage is the outcome of intentional and accidental events (Minnis 1981). Not all seeds found on archaeological sites come from intentionally collected food plants, so interpretations must consider how seeds are deposited and preserved. At third millennium Malyan, most of the plant remains were concentrated in hearths or dispersed in occupational debris; there were no burned structures. In addition to food plants such as barley, wheat, nuts, and grape, the charred seed assemblage included many weed seeds. Ethnographic analogy suggests that plant materials are most commonly burned intentionally for fuel; only rarely does food fall into a fire. Furthermore, a likely source of fuel in animal herding societies in semi-arid lands is dung, which frequently contains weed seeds (e.g., Schröder and Baart 1982). At Malyan, an increase through time in the proportion of weed seeds relative to wood charcoal suggests that dung had replaced increasingly scarce wood as a source of fuel (Miller and Smart 1984). The natural spread of oak during the Holocene (van Zeist and Bottema 1977) cannot be ruled out as a factor in the increased use of oak, but the relative decline in wood fuel relative to dung supports the view that humans had a strong influence on the vegetation.

Although most of the archaeological charcoal from Malyan originated in domestic fires, wood and wood charcoal fueled industrial production as well. Blackman (1982) has documented extensive use of lime plaster at Malyan during the third millennium. Large-scale production would have required vast quantities of fuel, though lime plaster manufacture would have occurred off-site, near wood supplies. Smelting occurred at Malyan itself, and there is widespread evidence for the use of metals throughout the occupation (Nickerson 1983). Even if *per capita* metal use was constant, the absolute quantity of metal used increased, given valley-wide population growth. If people smelted ore with wood charcoal, which consumes fuel wood inefficiently, the rate of tree loss would have accelerated even more. The demand for fuel could have been met by land clearance, and population growth in the valley probably encouraged the replacement of woodland by agricultural fields.

### Kurban Höyük

Malyan is one of few third millennium sites for which an extensive paleoethnobotanical record exists. Contemporary levels at Kurban Höyük in southeastern Turkey are presently under investigation (see Algaze et al. 1986). Kurban Höyük is located on the Euphrates river in the northern reaches of the Mesopotamian steppe, a more arid region than Malyan.

Like Malyan, the early third millennium occupation was relatively small at first, and there is a stratigraphic break between the deposits of the first and second half of the third millennium. The settlement seems to have prospered and grown during the latter half of this period (mid/late Early Bronze Age). Although the site is only 6 ha, compared to Malyan's 130 ha, it is thought to have functioned as a small local center. Not only is it the largest site within its immediate catchment (radius 5 km), but intra-site differences in faunal remains that could reflect status-based dietary differences suggest the site was more than just a simple farming community (Wattenmaker 1987). The total area of contemporary sites in the catchment reaches a peak not surpassed until Roman/Early Byzantine times (Wilkinson 1990). Kurban Höyük may have been involved in regional exchange as a result of its location along major overland trade routes between lower Mesopotamia and Anatolia (Algaze et al. 1986).

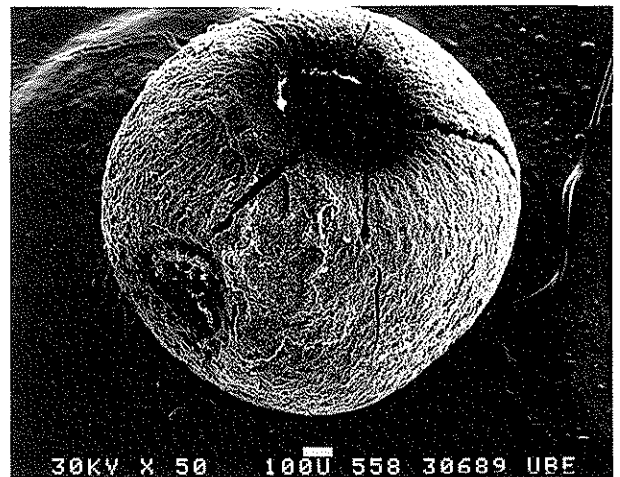
One result of population expansion and economic development is intensified agriculture and increased demand for fuel. Attendant stress on the vegetation can lead to more permanent disturbance. Wilkinson (1990) suggests that population may have approached the maximum possible before intensive manuring and annual cropping would have become necessary. Furthermore, he found evidence for a major erosional episode near Kurban Höyük (Wilkinson 1990:23). Based on sherds found at the interface between the underlying red soil and the eroded limestone debris, he has dated the onset of erosion to the late third millennium. The botanical analysis is not yet complete, but evidence for deforestation is consistent with this dating, and comparisons can also be made with the Malyan assemblage.

The natural vegetation around Kurban Höyük would be an open canopy oak woodland (Zohary 1973). Today, there are only two relict oak trees and some hawthorn and a few other types on the bluffs (Fig. 4). The major trees along the river are willow, tamarisk, and fig. Most charcoal from Kurban Höyük is too fragmentary to identify, but there are a number of identifiable seeds. Many of the weed seeds are the same types occurring at Malyan (e.g., *Lolium*, *Astragalus*, *Medicago*, *Galium*; Fig. 5). As mentioned earlier, seed to charcoal ratios shed some light on fuel use. The proportion of seeds relative to charcoal is substantially higher at Kurban Höyük, presumably due to greater reliance on dung fuel in this arid area (Fig. 6). As was the case at Malyan, the relative quantities of weed seeds increase



Fig. 4:  
Oak tree on bluff of Euphrates river near Kurban Höyük.

Fig. 5:  
Scanning electron micrograph of weed seeds from Kurban Höyük: a. (left) *Lolium*, b. (right) *Galium*.



dramatically between the early and later half of the third millennium, supporting the proposition that the number of trees declined.

### How widespread was land clearance?

The paleoethnobotanical evidence from both of these widely separated sites suggests land clearance was an important factor in human-land relationships in the third millennium Near East. Other studies have had similar results. For example, to the south of Kurban Höyük, van Zeist and Woldring (1980) noted a decline in tree pollen in the third millennium in northwestern Syria. In the Keban region, upriver from Kurban Höyük, Willcox (1974) found evidence for deforestation sometime between the end of the Early Bronze Age and Hellenistic times. Unfortunately, he did not have a continuous sequence of charcoals, so more precise dating of forest decline in that region is not possible.

The extent of land clearance in this period cannot be deduced from a few archaeological or palynological studies. Despite the examples just presented, there is no reason *a priori* to suppose that uniform processes of population growth, agricultural expansion, and metallurgical advances operated throughout the Near East. Certainly in historic times the severity of environmental disturbance fluctuated. In the Kur basin, for example, travelers' accounts from the seventeenth to nineteenth centuries show that the degree of environmental degradation and human influence on the landscape is a function of political control, and even severely abused woodlands are able to regenerate to some extent if left alone for long enough (Kortum 1976). As for more distant times, the first evidence for human disturbance in the pollen record of Lake Zeribar in the central Zagros oak forest does not occur until a little over two thousand years ago (van Zeist and Bottema 1977). At Lake Van, in eastern Turkey, human activity first shows up only five hundred years ago (van Zeist and Woldring 1978). These areas, where population densities and technological advance were not great enough to make as visible an impact on the vegetation, were remote from the mainstream of trade and contact with the urban civilizations of Mesopotamia.

### Conclusions

Local, site-specific studies of fuel use provide important information about the intensity of land use in a region and the ability of the human population to maintain its lifestyle at a given level of technology. Both Malyan and Kurban Höyük were on major trade routes in antiquity. They saw population growth during the third millennium, and were occupied at a time when bronze metallurgy became more important. And both settlements witnessed land clearance in their vicinity. Social and technological developments do not occur uniformly, however, and paleoethnobotany provides one way to assess the impact of human activities

on the landscape.

### Acknowledgments

The Malyan excavation (1974-1978) was sponsored by The University Museum of the University of Pennsylvania, and the Kurban Höyük excavation (1980-1984) was sponsored by the Oriental Institute of the University of Chicago. I would like to thank R. Neef of the Biologisch-Archaeologisch Instituut, Groningen, for telling me about and translating sections of a Dutch study on seeds in dung (Schröder and Baart 1982). William M. Sumner, Paul Minnis, and an anonymous reviewer provided many useful comments on an earlier draft of this paper.

### Note

1. Forest decline was probably not continuous, for in the middle of the third millennium the valley was either depopulated or only seasonally occupied by nomads.

### References

- Algaze, G., K. Ataman, M. Ingraham, L. Marfoe, M. McDonald, N. Miller, C. Snow, G. Stein, B. Verhaaren, P. Wattenmaker, T. Wilkinson, and A. Yener. 1986. The Chicago Euphrates Archaeological Project 1980-1984: An Interim Report. *Anatolica* 13:37-148.
- Blackman, M.J. 1982. The Manufacture and Use of Burned Lime Plaster at Proto-Elamite Anshan (Iran). In *Early Pyrotechnology*, ed. T.A. Wertime and S.A. Wertime, pp. 107-115. Smithsonian Institution Press, Washington DC.
- Diester-Haass, L. 1973. Holocene Climate in the Persian Gulf as Deduced from Grain-Size and Pteropod Distribution. *Marine Geology* 14:207-223.
- Hansman, J. 1976. Gilgamesh, Humbaba and the Land of the ERIN-Trees. *Iraq* 38:23-35.
- Horne, L. 1982. Fuel for the Metal-Worker. *Expedition* 25(1):6-13.
- Kingery, W.D., P.B. Vandiver, and M. Prickett. 1988. The Beginnings of Pyrotechnology, Part II: Production and Use of Lime and Gypsum Plaster in the Pre-Pottery Neolithic Near East. *Journal of Field Archaeology* 15:219-244.
- Kohler, T.A., and M.H. Matthews. 1988. Long-Term Anasazi Land Use and Forest Reduction: A Case Study from Southwest Colorado. *American Antiquity* 53:537-564.
- Köhler-Rollefson, I. 1988. The Aftermath of the Levantine Neolithic Revolution in Light of Ecological and Ethnographic Evidence. *Paléorient* 14(1):87-93.
- Kortum, G. 1976. Die Marv-Dasht Ebene in Fars. *Kieler Geographische Schriften* 44. Geographisch Institut der Universität Kiel, Kiel.



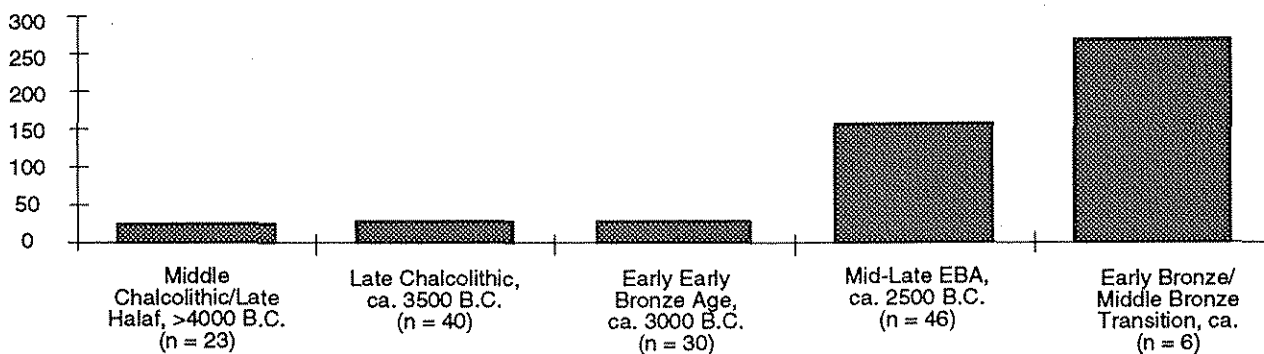
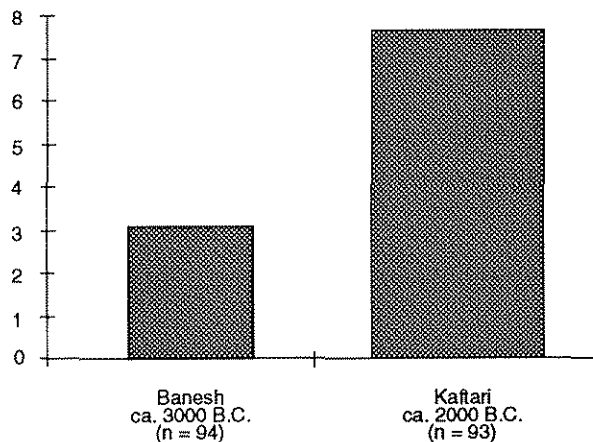


Fig. 6:  
Number of weed seeds per gram of charcoal in flotation samples: a. (above) Kurban Höyük, b. (right) Malyan.  
Note: The ratios in Fig. 6a and b are not directly comparable because the size of the charcoal fragments weighed is not the same for Malyan (>0.84 mm) and Kurban Höyük (>1.00 mm).



- Miller, N.F. 1982. *Economy and Environment of Malyan, a Third Millennium B.C. Urban Center in Southern Iran*. Ph.D. dissertation, University of Michigan, Ann Arbor.
- \_\_\_\_\_. 1985. Paleobotanical Evidence for Deforestation in Ancient Iran: A Case Study of Urban Malyan. *Journal of Ethnobiology* 5:1-19.
- \_\_\_\_\_. 1991. The Near East. In *Progress in Old World Palaeobotany*, ed. W. van Zeist, K. Wasylikowa, and K.-E. Behre, pp. 133-160. A.A. Balkema, Rotterdam.
- Miller, N.F., and 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.
- Minnis, P.E. 1981. Seeds in Archaeological Sites: Sources and Some Interpretive Problems. *American Antiquity* 46:143-152.
- Muhly, J.D., T. Stech, and R. Maddin. 1987. Çayönü and the Beginnings of Metallurgy in Anatolia and Mesopotamia. In *Proceedings of the Rencontre Assyriologique, Istanbul*, in press.
- Nickerson, J.A. 1983. *Intrasite Variability During the Kaftari Period at Tal-e Malyan (Anshan), Iran*. Ph.D. dissertation, Ohio State University, Columbus.
- Nützel, W. 1976. The Climatic Changes of Mesopotamia and Bordering Areas. *Sumer* 32:11-24.
- Rostoker, W., V.C. Pigott, and J. Dvorak. 1988. Direct Reduction to Copper Metal by Oxide-Sulfide Mineral Interaction. *Archeomaterials* 3, in press.
- Rowton, M.B. 1967. The Woodlands of Ancient Western Asia. *Journal of Near Eastern Studies* 26:261-277.
- Schröder, J., and E.A.D. Baart. 1982. Draagt drijfmest bij an de verspreiding van *Echinochloa crus-galli*? *Med. Fac. Landbouww. Rijksuniv. Gent* 47(1):27-35.
- Sumner, W.M. 1986. Proto-Elamite Civilization in Fars. In *Gamdat Nasr, Period or Regional Style?* ed. U. Finkelbeiner and W. Röllig, pp. 199-211. Dr. Ludwig Reichert Verlag, Wiesbaden.
- \_\_\_\_\_. 1989. Anshan in the Kaftari Phase: Patterns of Settlement and Land Use. In *Archaeologia Iranica et Orientalis: Miscellanea in Honorem Louis Vanden Berghe*, ed. L. de Meyer and E. Haerinck. Peeters Press, Ghent.
- Van Zeist, W., and S. Bottema. 1977. Palynological Investigations in Western Iran. *Palaeohistoria* 19:19-84.

- Van Zeist, W., and H. Woldring. 1978. A Postglacial Pollen Diagram from Lake Van in East Anatolia. *Review of Palaeobotany and Palynology* 26:249-276.
- \_\_\_\_\_. 1980. Holocene Vegetation and Climate of Northwestern Syria. *Palaeohistoria* 22:112-125.
- Wattenmaker, P.A. 1987. Town and Village Economies in an Early State Society. *Paléorient* 13(2):113-122.
- Wertime, T.A. 1983. The Furnace versus the Goat: The Pyrotechnologic Industries and Mediterranean Deforestation in Antiquity. *Journal of Field Archaeology* 10:445-452.
- Wilkinson, T.J. 1990. *Town and Country in Southeastern Anatolia*. Vol. 1: *Settlement and Land Use at Kurban Höyük and Other Sites in the Lower Karababa Basin*. Oriental Institute Publications 109. Oriental Institute, Chicago.
- Willcox, G.H. 1974. A History of Deforestation as Indicated by Charcoal Analysis of Four Sites in Eastern Anatolia. *Anatolian Studies* 24:117-133.
- Zohary, M. 1973. *Geobotanical Foundations of the Middle East*. Gustav Fischer, Stuttgart.