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Abstract

Vegetation during the glacial period, post-glacial warming and the Younger Dryas does not seem to have been affected by human activities to any appreciable extent. Forest expansion at the beginning of the Holocene occurred independently of human agency, though early Neolithic farmers were able to take advantage of improved climatic conditions. Absence of macrobotanical remains precludes discussion of possible drought from 6,000 to 5,500 BC. By farming, herding, and fuel-cutting, human populations began to have an impact on the landscape at different times and places. Deleterious effects of these activities became evident in the Tigris-Euphrates drainage during the third millennium BC based on macrobotanical evidence from archaeological sites. Even more widespread, permanent deforestation did not occur until the Iron Age.

Keywords

Vegetation, archaeobotany, macroremains, Epipaleolithic, Neolithic

Disciplines

Near Eastern Languages and Societies

THE MACROBOTANICAL EVIDENCE FOR VEGETATION IN THE NEAR EAST, c. 18 000/16 000 BC TO 4 000 BC

N. MILLER

Abstract : *Vegetation during the glacial period, post-glacial warming and the Younger Dryas does not seem to have been affected by human activities to any appreciable extent. Forest expansion at the beginning of the Holocene occurred independently of human agency, though early Neolithic farmers were able to take advantage of improved climatic conditions. Absence of macrobotanical remains precludes discussion of possible drought from 6,000 to 5,500 BC. By farming, herding, and fuel-cutting, human populations began to have an impact on the landscape at different times and places. Deleterious effects of these activities became evident in the Tigris-Euphrates drainage during the third millennium BC based on macrobotanical evidence from archaeological sites. Even more widespread, permanent deforestation did not occur until the Iron Age.*

Résumé : *Pendant la période glaciaire, le réchauffement post-glaciaire et le Dryas Récent, la végétation ne semble pas avoir été affectée de façon sensible par les activités humaines. L'expansion de la forêt au début de l'Holocène s'est produite sans intervention humaine, bien que les agriculteurs néolithiques aient été capables de mettre à profit des conditions climatiques meilleures. L'absence de macro-restes végétaux exclut toute discussion concernant une période de sécheresse possible entre 6 000 et 5 500 av. J.-C. Par l'agriculture, l'élevage et l'abattage des arbres, les populations ont commencé à modifier le paysage à différentes époques et en différentes régions. Les effets néfastes de ces activités sont évidents dans le bassin du Tigre et de l'Euphrate dès le 3^e millénaire av. J.-C. grâce à l'étude des macro-restes botaniques de sites archéologiques. Bien plus étendue, la déforestation permanente n'est manifeste qu'à partir de l'Âge du Fer.*

Key-words : *Vegetation, archaeobotany, macroremains, Epipaleolithic, Neolithic.*

Mots clefs : *Végétation, archéobotanique, macrorestes, Epipaléolithique, Néolithique.*

The forces of climate and human actions have both shaped the vegetation in the Near East. The present-day distribution of relict vegetation provides clues about the inherent capacity of the land and climate to support different vegetation formations, and pollen studies help extend the picture back to the past. Where, when, and how people first had an impact on plant life can be tracked more directly in the seeds and charcoal from archaeological sites. By altering the vegetation cover, people also can affect climate indirectly. In the period considered here, however, the major anthropogenic forces that shape the modern landscape, agricultural land clearance, de-

forestation, and overgrazing, had not yet had a significant effect.

Before trying to infer the history of vegetation it is useful to imagine patterns of modern plant cover limited only by present-day climate conditions, not people (fig. 1). The major phytogeographical regions in the Near East as defined by Zohary¹ are (1) the Mediterranean (characterized by a relatively mild climate), which includes the forests and woodlands of the Levant, Jordan valley, and coastal Anatolia to the

1. ZOHARY, 1973.

Fig. 1 : Modern vegetation zones (Zohary, 1973; adapted by N.F. Miller and M.A. Pouls).

highlands (2), Kurdo-Zagrosian and Indo-Turanian (with a more continental climate; forest to steppe and desert), which includes the northern Taurus-Zagros oak forest, southern Zagros pistachio-almond forest, the central Anatolian and Iranian steppes, and the northern Mesopotamian steppe, and (3) Nubio-Sindian (more tropical), which includes lower Mesopotamia and the Gulf coast. Vegetation of rivers, marshes, salty areas, fields, and disturbed ground cross-cuts these major zones.

The primary continuous record of vegetation history in the Near East is written in pollen cores². They document extensive Indo-Turanian steppe under the cold dry conditions of the glacial period, the expansion of Mediterranean and Indo-Turanian woodland from about 13,000 BC following post-glacial warming, a relatively short-lived (500-1,000 years) retreat of arboreal vegetation caused by cool dry conditions

of the Younger Dryas and its subsequent re-advance³. Since only a small number of pollen spectra within a core are dated, we can only approximate the time frame within which region-wide shifts occurred. The drought years of 6,000-5,500 BC proposed by Sanlaville⁴ cannot be evaluated by macroremain evidence, as there are almost no archaeobotanical assemblages or groups of assemblages that date to that time. In any case, vegetation changes lag behind climate changes (e.g., it takes time for trees to colonize a new area; neither do they die in the first drought or cold snap).

As evidence for ancient vegetation, macroremain assemblages complement the pollen record, and depending on one's questions, can be more or less useful. Pollen catchments extend for many kilometers. An archaeological site's catchment is reasonably thought of as no more than a day's walk:

2. Van ZEIST and BOTTEMA, 1991; ROSSIGNOL-STRIK, 1993.

3. HILLMAN, 1996; MOORE and HILLMAN, 1992.

4. SANLAVILLE, 1996.

macroremains reflect resources used directly by people and their animals, so they tend to originate in local plant cover. In contrast to pollen, most of the extant remains are preserved in charred form. This suggests the primary nature of the cultural filter: fuel. In addition, some food processing remains, like nutshell, would be readily preserved, and occasional burnt buildings have yielded *in situ* stored crop remains and wood from construction. Seeds of wild plants are more problematic: are they from food, crop-processing debris, or dung burned as fuel? Fortunately for vegetation reconstructions, presence of a type strongly suggests it grew in the area, though absence has less meaning.

Coming from archaeological sites with higher densities of charcoal, macroremain assemblages tend to be more tightly dated than pollen cores, but of much shorter duration. The useful archaeobotanical record is shorter, too, with the best documented periods being the aceramic Neolithic and the Bronze age⁵. Finally, depending on the type, seeds, charcoal, and pollen of any plant may be identified to different taxonomic levels. For example, seeds but not pollen of many members of the *Chenopodiaceae* can be identified to genus, whereas pollen of some types is readily preserved but the seeds are not (e.g., *Salix* [willow] or *Fraxinus* [ash]).

Thanks to the local sources of plant remains on archaeological sites and the relatively few sites from which full assemblages have been reported, the following discussion will deal with several aspects of vegetation, but within the broader context established by pollen and other evidence (fig. 2).

THE GLACIAL PERIOD

Very few sites from the end of the glacial period have been excavated, and even fewer have yielded interpretable quantities of plant remains. Sites were occupied seasonally, so human impact on the vegetation in their immediate vicinity was probably ephemeral, with the primary effect being the clearing of dead branches and brush for fuel.

Macroremains from one of the earliest sites from which plant remains have been found, Ohalo I (Kebaran, 17,000 BC), confirm pollen-based reconstructions which posit shrubby vegetation (with *Zizyphus*) near the site, not far from *Pistacia-Amygdalus-Crataegus* forest-steppe uplands⁶. The many wild grasses and nuts that are today characteristic of

Fig. 2 : Sites mentioned in text.

1 – Cafer, 2 – Çayönü, 3 – Hallan Çemi, 4 – Aqab, 5 – Kurban Höyük, 6 – Hacinebi, 7 – Sweyhat, 8 – Mureybit, 9 – Abu Hureyra, 10 – Umm Qseir, 11 – Bouqras, 12 – Ras Shamra, 13 – Ghoreifé, 14 – Aswad, 15 – Ramad, 16 – Ohalo II, 17 – Gilgal, 18 – 'Ain Ghazal, 19 – Dhuweila, 20 – Araq 31, 21 – Jilat 6, 22 – Nahal Hemar, 23 – Feinan, 24 – Basta, 25 – Gijlar, 26 – Ganj Dareh, 27 – Abdul Hossein, 28 – Hissar, 29 – Malyan.

the “sub-Mediterranean deciduous oak-park forest”⁷ are also consistent with the Van Zeist and Bottema model. Located in a much drier climate, the Jilat 6 (14,000 BC) assemblage is dominated by chenopods, characteristic of the modern steppe vegetation in the area⁸.

LATE GLACIAL WARMING AND THE YOUNGER DRYAS

Palynological and other studies strongly suggest the worldwide warming trend stopped for about a thousand years, between 9,000 and 8,000 BC (the Younger Dryas)⁹. Epipaleolithic sites before 9,000 BC have not yielded much in the way of macroremains, so vegetation changes associated with the onset of late glacial warming remain undocumented by seeds and charcoal. The earliest substantial archaeobotanical assemblage comes from Abu Hureyra.

5. MILLER, 1991.

6. Van ZEIST and BOTTEMA, 1991 : 109.

7. KISLEV *et al.*, 1992 : 164.

8. GARRARD *et al.*, 1996 : 214.

9. ROSSIGNOL-STRIK, 1993 ; SANLAVILLE, 1996.

The late Epipaleolithic deposits of Abu Hureyra are dated between 9,500 and 8,000 BC, that is, from just before the Younger Dryas cool/dry period to the beginning of the Holocene. The closest pollen evidence is from lake Ghab, where the maximum retreat of oak forest occurred in the second half of the Younger Dryas¹⁰. As of this writing the Abu Hureyra report is not published, but allowing for imprecision in dating the Ghab core, Hillman *et al.* consider the remains to be fully consistent with that pollen evidence¹¹. In particular, the earliest deposits at Abu Hureyra (c. 9,500 BC) have fruits from the oak (*Quercus*) forest; after 9,000 BC, these types disappear, although a steppe forest type, pistachio, manages to hang on¹². By the Neolithic, not even pistachio remains¹³. Note that at Mureybit, which was occupied a little later than Abu Hureyra (8,500-6,900 BC), the oak forest types designated by Hillman do not occur at all. Pistachio nut remains frequent throughout the sequence, but wood charcoal is restricted to the river valley types, *Populus*, *Tamarix*, and *Fraxinus*¹⁴ b). People at Mureybit might have collected nuts in the moister upland to the north, though that territory seems to have been too distant to exploit for wood fuel.

The seed assemblage from Abu Hureyra is consistent with the conclusion that steppe vegetation spread at the expense of forest during the Younger Dryas (after 9,000 BC), even though conditions were still more favorable than today for trees. While the density of most seed types declines over time, steppe legumes and grasses hold their own, effectively increasing their relative importance within the assemblage. The only other type with a similar distribution is *Polygonum*, a plant of the moist valley bottom¹⁵. I have suggested that many of the Abu Hureyra seeds originated in gazelle dung burned as fuel¹⁶. If so, the increase in steppe plant seeds could well reflect favorable growing conditions for those taxa.

The situation may be similar at Mureybit. As Van Zeist and Bakker-Heeres point out, between-sample disparities in seed proportions make generalization difficult. Some samples seem to be relatively pure crop remains, and, as at many other sites, the Boraginaceae at Mureybit are probably over-represented. Even if one omits from consideration problematic types such as the wild einkorn (*Triticum boeoticum*), which

may be food remains, and the borages, the proportions of different taxa do not fall into a neat chronological pattern. Overall the amount of grasses seems low, steppe legumes (primarily *Astragalus*) have a significant presence, and as at Abu Hureyra, *Polygonum* seeds are fairly numerous¹⁷.

Both Abu Hureyra and Mureybit were most probably occupied year-round. Some local manipulation of vegetation was inevitable, especially through fuel gathering. Hillman *et al.* propose that the riparian forest vegetation was rich enough to supply virtually all the fuel needs of the settlement¹⁸, though it is at least as likely that the Euphrates forest was harvested annually, but not continually¹⁹. In any case, the Abu Hureyra and Mureybit assemblages are best understood as reflections of the natural vegetation. It has been suggested that, like foragers elsewhere, people in the Near East could have used fire to clear underbrush or encourage the growth of edible plants or browse for herbivores²⁰, though evidence is lacking. Foragers manipulate the botanical environment, if only by harvesting edible plants, but there is no clear botanical evidence for permanent human impact on the vegetation from that time.

EARLY HOLOCENE FOREST EXPANSION

One of the questions macroremains are well-suited to address is the rate of woodland advance to the east in the early Holocene. Widely spaced pollen evidence shows that the cold dry glacial conditions in the Zagros supported *Artemisia*-Chenopodiaceae steppe; forest seems to have spread around Lake Zeribar, in the central Zagros, between 10,500-5,500 BP [c. 8,500-3,500 BC], around Lake Urmia between 9,500 and 6,000 BP [c. 7,500-4,500 BC] and around Lake Van after between 7,350-4,500 BP [c. 7,150-2,500 BC]²¹. At Zeribar, pistachio led the return of trees, and not until 3,500 BC was the oak maximum reached. As late as the eighth millennium, oak had barely begun colonizing the central Zagros, but pistachio (an insect-pollinated tree which therefore tends to be underrepresented in pollen cores) contributed substantially to the arboreal vegetation. Charcoal from sites to the east and west of the Zagros cores provide additional evidence. Both Ganj Dareh (mid-eighth to mid-seventh

10. ROSSIGNOL-STRIK, 1993.

11. HILLMAN *et al.*, 1996.

12. MOORE and HILLMAN, 1992. HILLMAN *et al.*, 1989.

13. HILLMAN, 1975.

14. VAN ZEIST and BAKKER-HEERES, 1984 (1986)b).

15. HILLMAN *et al.*, 1989 : fig. 14 : 1.

16. MILLER, 1996 : Arguments for and against this proposition are presented in : HILLMAN *et al.*'s comments to MILLER, 1996 in : *Current Anthropology* and MILLER's reply : HILLMAN *et al.*, 1997 ; MILLER, 1997 a.

17. VAN ZEIST and BAKKER-HEERES, 1984 (1986)b).

18. HILLMAN *et al.*, 1997.

19. MILLER, 1997 a.

20. MCCORRISTON and HOLE, 1991 : 57.

21. VAN ZEIST and BOTTEMA, 1991 : 65.

millennia BC)²² and Tepe Abdul Hossein (mid-seventh millennium aceramic Neolithic)²³ are 150 and 300 km south and east of Zeribar. Today they lie at or near the probable border between the oak and pistachio-almond forests. They have charcoal and/or nut remains of pistachio and almond, but no oak, which is consistent with the modern vegetation, but may be even more representative of the early Holocene forest expansion, in which more drought-tolerant trees (like pistachio and almond) colonized the area first²⁴.

Charcoal and seeds²⁵ from Hallan Çemi (c. 8,000 BC), at a lower altitude but close in latitude to Urmia, include types characteristic of the modern forest (oak and almond wood and nuts of almond (here designated *Prunus*) and pistachio). Çayönü (7,200-6,750 BC) lies deeper in the modern oak forest zone. The wood of oak, pistachio and a rosaceous type (probably almond), and the nuts of oak, pistachio and almond suggest that the basis for the modern vegetation was in place, but the absence of juniper wood suggests that modern conditions had not been reached²⁶. The vegetation around the somewhat later site of Cafer (7,000 BC), over 300 km west of Lake Van, already seems to have been dominated by oak²⁷.

Despite gradually increasing drought just before 9,000 BC, the continuous sequence at Abu Hureyra suggests that the eastward expansion of arboreal vegetation in the Levant reached its maximum area and extent²⁸. Unfortunately, no other archaeobotanical assemblages span this period. For example, Gilgal, north of Jericho, has a Natufian (c. 9 300 BC) occupation, and then a break until the Pre-pottery Neolithic A (7,900-7,700 BC). Any indication of the Younger Dryas is therefore absent. Indeed, both periods have charcoal characteristic of the modern vegetation: *Tamarix*, *Populus* and other woody types which grow in the region today, and pistachio on nearby slopes²⁹. The food remains include pistachio and acorn³⁰. This supports the view that in PPNA times, oak was close enough to warrant harvesting for food, but too far for firewood collecting, and that in the southern Levant, at least, the modern vegetation was established by then.

Since trees had never disappeared entirely in the Levant, the presence or absence of woodland more directly reflects climate there than it does in the Zagros (where absence of

trees may merely reflect distance from potential colonizers). It seems clear that the early agricultural sites (PPNA and PPNB) that are today in the steppe enjoyed more favorable conditions. With reference to Mureybit, Abu Hureyra, Azraq, Aswad, Ramad, Bouqras, Basta and Nahal Hemar, Willcox notes: "*C'est surtout la fréquence accentuée de taxons comme Pistacia, Amygdalus, Celtis et Crataegus qui suggère une association de forêt-steppe dans les régions présentement steppiques*" [*It is especially the pronounced frequency of taxa like pistachio, almond, hackberry, and hawthorn that suggests an association of forest-steppe in regions at present steppe*]³¹.

A more recent study by Willcox of PPNA and PPNB charcoal from the north Syrian Euphrates within the modern rainfall agriculture zone provides further confirmation. Even allowing for the results of millennia of deforestation, the degraded steppe in the area today would at best support some *Celtis tournefortii*, *Pistacia palaestina*, *Crataegus aronia*, *Rhamnus palaestina*, *Prunus microcarpa*, *Ficus carica* and *Ficus palmata*; the ancient samples include "*Pistacia type atlantica*, *Rhamnus*, and *Amygdalus*, which points to a moist steppe with a mosaic of trees and shrubs"³². The pattern holds even in the very arid steppe of southern Jordan (precipitation of 100 mm/yr); domestic barley, emmer, or einkorn are found at Jilat 6 (c. 7,500-6,500 BC), Azraq 31, and Dhuweila (both 6,500-6,000 BC), well outside the rainfall agriculture zone today³³.

It is less clear when climatic conditions favorable to tree growth in the present-day steppe ended, because as agriculture and pastoralism developed, humans began to have an increasingly important impact on the vegetation in the Near East.

ESTABLISHMENT OF AGRICULTURE

The act of planting necessarily breaks up sod, and may also require tree or shrub clearance, so we would expect that field weeds and other plants that thrive in disturbed habitats would increase in number. Initially, the source of such plants would be the native vegetation of the steppe. Eventually, some plants evolved to mimic crops (e.g., *Camelina sativa*) or came from outside the region as weeds in introduced crops (e.g., *Datura stramonium*, from the New World). The begin-

22. Van ZEIST *et al.*, 1984 (1986b).

23. WILLCOX, 1990.

24. HILLMAN, 1996: 186-187.

25. identified by R. Gale and M. Nesbitt: ROSENBERG *et al.*, 1995.

26. Van ZEIST and de ROLLER, 1991/1992.

27. WILLCOX, 1991a.

28. HILLMAN, 1996.

29. LIPSHITZ and NOY, 1991.

30. NOY, 1988.

31. WILLCOX, 1991b: 121.

32. WILLCOX, 1996: 149.

33. GARRARD *et al.*, 1994: fig. 1a.

ning of this process is difficult to identify, because the weedy plants were already components of the steppe-forest flora in the region where agriculture itself began³⁴.

The first major change in the intensity of land use occurred during the PPNB in the west. Sites become more archaeologically visible with long-term settlement and higher population densities. The first established agricultural system was based on the cultivation of various wheats, barleys, and pulses. Even if we cannot discern human impact on a regional scale, many individual settlements became more permanent, and so people would have modified the landscape in their immediate vicinity.

One way to trace this change is to examine the plants that fail or thrive under cultivation. Hillman noted that tufted grasses do poorly in disturbed conditions such as cultivated fields. In the Abu Hureyra Neolithic deposits, wild rye (*Secale montanum*), which does not tolerate soil disturbance, is absent³⁵ and the grass, *Stipa*, which is sensitive to over-grazing, declines precipitously³⁶.

In theory it should be possible to trace the spread of agriculturally disturbed habitat by looking at weedy types (e.g., *Vaccaria pyramidata* and *Cephalaria syriaca*) and types that are frequently weedy (e.g., *Lolium*), though in practice the effects of time and functional differences between assemblages cannot yet be overcome³⁷. Even so, it is clear that many of these types show up as early as the PPNB, with *Lolium* being common at sites from the Levant to the Zagros. To trace the spread of the agricultural habitat in Syria and Jordan, Susan Colledge³⁸ suggests a plausible set of indicator weeds (inferred from modern habits of the archaeologically known taxa)³⁹; in Mureybit and the Damascus basin sites of Aswad and Ghoraifé, "there was a tendency for the 'field' and batha taxa to be more common in the later periods/phases" i.e., PPNB, though the patterns did not hold up as well for the Jordanian sites considered⁴⁰. For PPNA to late PPNB deposits on the north Syrian Euphrates, Willcox assigns a group of native taxa to the category of "potential weeds of cultivation"⁴¹. Detailed quantitative information concerning changes through time in the numbers of these types is not available, but the PPNA assemblage has a rela-

tively low proportion of possible weedy taxa compared to the PPNB assemblages considered, though there is no straight line development. At Ras Shamra, van Zeist and Bakker-Heeres note much higher proportions of the field weed *Lolium* in the Halaf levels compared to earlier ones⁴². The weeds *Lolium*, *Vaccaria* and *Cephalaria*, though occurring in the PPNB Levant, do not appear in the north Syrian steppe sites until the pottery Neolithic.

IDENTIFYING AND MEASURING THE IMPACT OF DOMESTIC ANIMALS

The flora of the Near East evolved in the presence of herbivores, including the wild ancestors of domesticated sheep, goat, and cattle. From the human point of view, a reliable supply of animals stabilizes food supplies: goat was domesticated at the end of the eighth millennium BC, sheep in the mid-seventh, and cattle at the end of the seventh⁴³. Animal husbandry would not have had a major impact on the vegetation until the herds became more numerous than the landscape could comfortably support in any given environmental zone. Widespread settlement abandonment and an increase in the proportion of wild mammals in faunal assemblages at about 6,000 BC suggests environmental deterioration⁴⁴, though distinguishing the effects of overgrazing from drought is problematic.

The most casual traveller to the rural Middle East can see the negative effect of over-grazing; a dense network of roughly parallel trails follows the contours of hills covered with stunted and thorny shrubs and other unpalatable plants (fig. 3). In many areas, land degradation is historically documented. Elsewhere, the archaeobotanical record can help clarify this process. Macroremains are uniquely suited to tracking the effect of herbivores, especially the domesticates, on vegetation. Most of the archaeobotanical remains from Near Eastern sites are charred, and except for accidentally burned crops and buildings, the material mostly originated in fuel: wood, brush, and dung. Therefore, the proportion of seeds to charcoal could monitor dung vs. wood fuel use, and indirectly the state of the arboreal vegetation across time and space. The seeds (excepting fruit and nut remains) provide a rough indication of available pasture⁴⁵. There are, however, limits

34. VAN ZEIST and BAKKER-HEERES, 1985 (1988): 286-289; HILLMAN *et al.*, 1989: 254.

35. HILLMAN, 1975, 1989.

36. HILLMAN, 1975.

37. VAN ZEIST, 1987.

38. COLLEDGE, 1994b.

39. *Ibid.*: Tables 4.8 and 4.9.

40. *Ibid.*: 219.

41. WILLCOX, 1996.

42. VAN ZEIST and BAKKER-HEERES, 1984 (1986)a.

43. HELMER, 1989.

44. AKKERMANS, 1987; BUTTENHUIS, 1990.

45. MILLER, 1984, 1996.

Fig. 3 : Degraded pasture in central Anatolia.

to interpretive possibilities. Variability within and between archaeobotanical assemblages may reflect differences in the vegetation, but also how people used the available plants. Differing amounts of material may reflect a plant's usefulness to people or differing rates of seed production. It is also difficult to assign a given taxon (usually at the genus or family level) to a particular ecological zone. Thus, a precise quantified reconstruction of the vegetation cover is not possible.

At Abu Hureyra, Hillman noted that the suite of wild plants whose remains were burned in the Epipaleolithic were generally palatable types. By Neolithic times, the wild seed remains included a variety of less palatable or unpalatable types. Hillman *et al.* propose that the Epipaleolithic seed plants "were selected primarily for their edibility...i.e. that they were specifically gathered from the wild rather than arriving fortuitously with the crops," presumably in contrast to the Neolithic assemblage⁴⁶. It seems equally likely that the earlier assemblage reflects the vegetation of the steppe consumed by gazelle, and the later one reflects the flora's adaptation to cultivation and stock-raising. Not far from Abu Hureyra, Van Zeist and Bakker-Heeres note that differences between the Mureybit and third millennium BC Selenkahiye seed assemblages can be accounted for by the development of the weed flora⁴⁷. In addition to the introduction of types almost certainly growing as field weeds (e.g., *Lolium* and *Vaccaria pyramidata*), the unpalatable *Peganum harmala* and spiny *Onopordum* (a thistle) also occur only at the later site.

46. HILLMAN *et al.*, 1989 : 255.

47. Van ZEIST and BAKKER-HEERES, 1985 (1988) : 286-289.

A preliminary report on two Halaf sites, Tell Aqab and Umm Qseir (c. 5.500 BC) is one of the few which concern the period between the establishment of the village farming economy and the rise of the early civilizations⁴⁸. The vegetation around Tell Aqab, located well within the dry-farming zone of northern Syria a few kilometers from a river, could have already suffered from human activities. In contrast, Umm Qseir is located in the much more arid irrigation zone, yet its environment seems to have been richer, with greater access to wood fuel, both riverine and steppe. Some of the characteristics of the assemblages indicate the presence of at least some irrigated fields at Umm Qseir. For example six-row barley, an irrigated crop, occurs only at Umm Qseir. The Aqab material is more typical of a dry-farmed assemblage. Other aspects of the material may represent the relative role of pastoralism. For example the ratio of wild seeds to cereal grains at Aqab is 4.09, but only 0.85 at Umm Qseir (calculated from McCorrison's Table 1 data). If the seeds primarily come from dung fuel, this would suggest Aqab herds were sent out to pasture and Umm Qseir animals stayed closer to home. The faunal remains could shed light on the botanical assemblages. The Umm Qseir bones show a remarkably low proportion of sheep and goat (relative to pig and hunted animals)⁴⁹. In later times there seems to be a negative association between intensive farming (low proportions of wild seeds) and sheep and goat herding (high proportions of domestic caprid bone) on the Euphrates⁵⁰. If this observation holds for the Khabur, the paucity of seeds of wild plants could reflect their absence in animal fodder, not in the environment. (One also might expect the as-yet unreported Aqab fauna to have relatively high proportions of sheep and goat).

Two plants that are potentially useful for tracking long-term effects on the non-arboreal vegetation of the Near East are *Peganum* (wild rue) and *Alhagi* (camel thorn). *Peganum* has alkaloids that render it unpalatable to herbivores⁵¹. Despite that, a Turkish farmer told me it may be dried and fed to animals, and I once saw a sheep nibbling it fresh near Swayhat, Syria. It thrives in degraded pasture, but is rare in cultivated soil (fig. 4). *Alhagi* is also avoided by herbivores, though they can eat it when dry : it grows in degraded pasture, but also in fallow fields, because it is hard to uproot. Both are extremely widespread today, so at least on climatic

48. MCCORRISON, 1992.

49. ZEDER, 1994.

50. MILLER, 1997 c.

51. *Peganum* is traditionally associated with keeping away the evil eye : its seed cases are fashioned into protective decorations (*nazarlik*) in Turkey, and the seeds are tossed onto fires, as well. I do not think this is the source of the occasional archaeological *Peganum* seeds.

Fig. 4 : *Peganum harmala* (wild rue), a plant avoided by animals.

grounds could have grown, albeit sparsely, over a large area. Both are relatively rare in prehistoric samples. In contrast to many other seeds, these two types are more likely to have arrived as brush fuel than in herbivore dung. The earliest reported *Alhagi* reported to date is a single seed from an Ubaid deposit at Hammam et-Turkman, which has also yielded an Early Bronze Age *Peganum* seed⁵². Both types have also been found at third millennium Sweyhat⁵³. *Alhagi* has been recognized at late Chalcolithic Hacinebi and at two third millennium Iranian sites, Gijlar and Hissar⁵⁴. *Peganum* has been reported from the third millennium Selenkahiye⁵⁵. In

short, overgrazing does not seem to have had a major impact even as late as the third millennium BC, and certainly not before 4,000 BC.

DEFORESTATION

With the establishment of the agro-pastoral economy, the potential for surplus accumulation, population agglomeration, and environmental impact increased dramatically. These developments, along with pyrotechnologies like plaster, ceramic, and metal manufacture, ultimately caused vast tracts of woody vegetation to be eliminated. There is, however, no reason to suppose deforestation occurred simultaneously over the entire Near East. Localized effects of fuel-cutting occurred early. At 'Ain Ghazal, for example, post holes of successively

52. Van ZEIST *et al.*, 1989.

53. MILLER, 1997 b.

54. Hacinebi : STEIN, 1996 ; Gijlar and Hissar : COSTANTINI, 1984 ; COSTANTINI and DYSON, 1990.

55. Van ZEIST and BAKER-HEERES, 1985 (1988).

smaller diameter suggested to Köhler-Rollefson new growth never fully replaced trees cut for construction and fuel⁵⁶. But widespread deforestation had to wait until after the period under consideration in this issue of *Paléorient*. The pollen record suggests that until 2,000 BC, "much of the forest and woodland... was probably still of a primeval nature and suffered at most from firewood gathering and browsing and grazing by domestic animals"⁵⁷. More precisely dated and differently spaced archaeobotanical evidence supports this conclusion, while allowing us to refine our picture for particular sites and time periods.

Pollen cores show that regional declines in arboreal vegetation were not synchronous over the entire Near East. Thus, uniform, widespread climate change in the more recent periods cannot explain changes in the distribution of pollen and ultimately of vegetation. In southwest Anatolia, the Beyşehir and Sögüt Gölü diagrams point to deforestation attributable to humans occurring towards the end of the second millennium BC (i.e., after about 1,600 calib. BC). The Lake Van core in northeastern Anatolia shows a gradual increase in arboreal pollen between about 5,400 BC and 2,800/2,200 BC, and relatively high arboreal pollen until about 650 BC (800 calib. BC)⁵⁸. At that time, the gradual decline in tree pollen may reflect the impact of fuel cutting by the Iron Age Urartians.

Charcoal studies which consider changes over time in species composition have shown local forest declines in the third millennium. For example, Malyan (ancient Anshan) is situated in what would be the pistachio-almond-maple forest of the southern Zagros, but only about 20 km from the modern oak forest (fig. 5). The early third millennium charcoal assemblage has all the characteristic types plus juniper. By the beginning of the second millennium, the proportion of juniper had dropped considerably, and oak became more common. It is conceivable that oak had not attained its full post-Pleistocene extent until that time. Even so, the growth of the urban center, agricultural land clearance, and the development of fuel intensive industry would have resulted in a gradual enlargement of the radius of fuel procurement under any climatic circumstances⁵⁹. At Feinan, Jordan, as late as the Early Bronze Age, metallurgists used oak and juniper which today grow on nearby slopes, but in the the Bronze Age probably grew close to the site⁶⁰. By the Iron Age, the

Fig. 5 : Oak forest in the southern Zagros mountains near Malyan.

trees had most probably been cut down, because the ancient metal workers burned fast-growing wadi-bottom shrub types that are also common today, though Engel and his colleagues have not ruled out the possibility that climate changed⁶¹. Willcox reached a similar conclusion in his survey of Near Eastern charcoal remains – that widespread deforestation is not archaeobotanically visible until the Iron Age⁶².

Another way to monitor the state of woody vegetation is consider the relative quantities of wood and dung fuel. Wood charcoal in trashy deposits is likely to be the incompletely burned remnants of fuel. If wild and weedy seeds from the same deposits come primarily from dung fuel, then the proportion of seeds to charcoal at a site is a relative measure of dung to wood fuel⁶³. Since few archaeobotanists report the amount of wood charcoal in their flotation samples, it is not possible to calculate this ratio for most sites. At Kurban Höyük, at the northern edge of Mesopotamia, the seed to charcoal ratio is fairly constant from the fourth to the beginning of the third millennium (Halaf to Early Early Bronze Age), but increases substantially at about 2,500 BC⁶⁴. This approach can also confirm results obtained through charcoal analysis. For example, the great increase in the seed to charcoal ratio at Malyan supports the view that the shifts in charcoal taxa do not represent local forest change, but rather local forest disappearance – as trees close by were cut, dung fuel use increased and the available wood came from trees that grew further away⁶⁵.

56. KOHLER-ROLLEFSON, 1988.

57. Van ZEIST and BOTTEMA, 1991 : 144.

58. *Ibid* : 60-63.

59. MILLER, 1985.

60. BAHERLE *et al.*, 1989.

61. ENGEL, 1993 : 210.

62. WILLCOX, 1991.

63. MILLER, 1984.

64. MILLER, 1990.

65. MILLER, 1984, 1985, 1990.

CONCLUSIONS

Climate, geomorphology, animals (non-human and human), and previously existing vegetation all play a role in determining the plant cover at any one time and place. Simultaneously, vegetation cover helps determine climate, landforms and population densities of different species. It is very hard to hold any one variable constant and the causal factors are inter-related. Reconstructing the history of plant life in the Near East therefore requires many types of data, the most important of which is pollen. To effectively use the pollen record as a long-term baseline against which other types of evidence, such as archaeobotanical remains, can be assessed, we have to consider variables like the precision of dating, the location of suitable sampling sites, and the circumstances of deposition and preservation.

Although the pollen record is longer, dating is less precise than with macrobotanical assemblages, since archaeological sites usually have deposits with high densities of cultural material and charcoal. There are fewer good pollen sampling locales than archaeological sites, but the catchment area of any one pollen core is quite a bit larger. Palynologists have developed ways of analytically compensating for differential pollen production and transport, and natural processes can be reasonably assumed to apply. In contrast, the determinant of an archaeobotanical assemblage is more likely to be usefulness of the plants to the ancient human population and its flocks. Since most of the Near Eastern assemblages are charred, I have suggested the cultural filter was primarily fuel-burning, whether of wood or dung. Due to transport cost, these products tend to reflect vegetation growing relatively near the site on which they were deposited and so help refine regional, pollen-based reconstructions.

Though the record is incomplete, with large gaps prior to the aceramic Neolithic and during the later Neolithic periods, where direct comparisons are possible, macrobotanical and pollen-based reconstructions are in agreement. Climate was the primary determinant of vegetation in the Near East until the Bronze Age. Cultivation, herding, pyrotechnology and associated higher population densities began to have an effect on the vegetation, but the intensity of change at different times and places depended on local population densities and technologies. Environmental deterioration caused by deforestation and overgrazing is a relatively recent phenomenon. As late as 4,000 BC people seemed to have lived lightly, though not invisibly, on the land.

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