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Tracing the development of the agropastoral economy in Southeastern Anatolia and Northern Syria

Naomi F. Miller

Introduction

Many lines of evidence point to the environmental, economic and social changes associated with the transition to farming from the Epipaleolithic to the end of the Pre-Pottery Neolithic B (PPNB). Increasingly substantial domestic structures show that people began to live in more permanent settlements (Bar-Yosef, 1998), as does the presence of commensal animals such as mice and house sparrows (Tchernov, 1991). By the beginning of the PPNB, people had begun to cultivate plants, though no one site has more than just a few types of cultigens. By the end of the PPNB, evidence of environmental degradation in the immediate vicinity of some sites suggests that people had at least a local impact on the environment through the gathering of wood for fuel, the hunting of wild animals, the cultivation of cereals and pulses, and the maintenance of grazing herds (e.g., Köhler-Rollefson, 1988). Not until the end of the PPNB, however, can we see the morphological changes in bone structure that provide direct evidence for animal domestication.

This chapter draws together data from PPNB plant remains that provide practical markers for tracing how humans had been manipulating the herd animals for the previous thousand years. From this changing relationship among people, plants, and animals emerged the Near Eastern agricultural system based on cereal and pulse farming and sheep and goat husbandry.

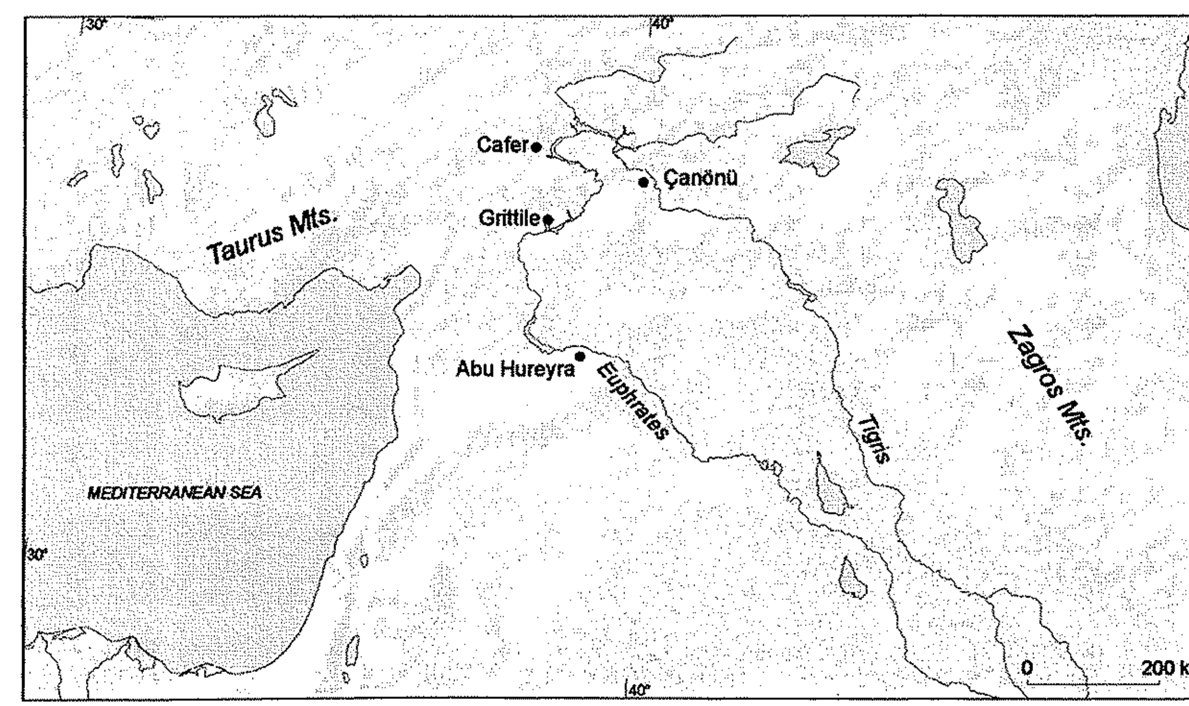

Figure 1 Map of the area

Aspects of the PPNB in southeastern Anatolia

Although there are broad cultural similarities over a large area in PPNB archaeological assemblages, there does seem to be some regional variation (Hours & Copeland, 1982). For example, in addition to some material culture which distinguishes the different regions characterised by "PPNB" assemblages, differences in land use practices between southeastern Anatolian sites and those on the Syrian steppe - represented here by phases 2A, 2B, and 2C at Abu Hureyra - reflect their respective environments (Figure 1).

Southeastern Anatolian sites associated with the PPNB share several features. Three with botanical evidence are Cafer (De Moulins, 1993, 1997) Çayönü (Van Zeist & de Roller, 1991), and Gritille. Cafer has the oldest sequence, with phases III, II, and I spanning the period ca. 9600 to 8200 BP. The radiocarbon dating of Çayönü has some uncertainty in the later levels; current evidence suggests the occupation began a bit later than the beginning of Cafer and extended through to the end of the Gritille sequence. With dates between 8500 and 7500 BP, Gritille overlaps with the latest levels at Cafer and the latter part of the Çayönü sequence.[1]

These three southeastern Anatolian sites share several traits. For example, each of them has fire pits which are associated with domestic structures and probably were used at least occasionally for cooking (see Molist, 1988). These pits frequently are filled with cobbles or other stone, but only some of them contain substantial quantities of charred food or wood fuel remains. A second characteristic of these sites is that pulses such as *Vicia ervilia* and *Lathyrus* were very important in the beginning of the PPNB but then declined relative to cereals. A third similarity is that, compared to sites in the drier regions to the south, the assemblages contain quite a bit more wood charcoal. They also have low proportions of the seeds of wild plants relative to both wood and cultigens.

Finally, sheep and goat from Cafer and contemporary deposits at Çayönü and Gritille were not domesticated (Helmer, 1988; Stein, 1989). Although super-ficially these observations may seem unconnected to one another, they reflect, to varying degrees, integrated systems of agriculture and land use.

Gritille

The study of Gritille provides an example of how one might monitor changes in the agropastoral economy through an examination of cooking practices, the use of pulses and fuel and associations between the results of archaeobotanical and faunal studies. All reflect increasing human control over herds. From the beginning, the site had domesticated plants. By the end of the PPNB, it had domesticated animals as well (Stein, 1989).

Gritille was a small village occupied from about 8500 to 7500 BP. It is a one-hectare tell on the edge of the Euphrates River, within a rolling landscape that was once covered with oak-dominated steppe forest. Mary Voigt (1985, 1988) excavated the Neolithic levels in the 1980's as part of a larger project directed by Richard Ellis of Bryn Mawr College. Later phases are stratigraphically separate from the Basal phase deposits. A hard erosion surface separates deposits of phases C and B (Voigt, 1988). Therefore, for the purposes of the present analysis an earlier occupation period (Basal and phase C) is distinguished from a later one (phases A and B).

I have analysed 52 flotation samples from a variety of deposit types. Cobble and ash filled pits that are cut into layers of occupational debris characterise the Basal deposits. Archaeobotanical samples from the other phases come from hearths, ovens, trashy deposits associated with mudbrick structures, as well as fire pits.

The crop plants from Gritille are comprised of four cereals (two-row barley, einkorn, emmer, and free-threshing wheat), four pulses (bitter vetch, lentil, grass-pea, and pea) and flax (Table 1). There is good reason to think all of these were cultivated: size and shape of the cereals and size of the lentil and flax in at least one sample are consistent with domesticated taxa found at contemporary sites. The bitter vetch and grass-pea occur as two nearly pure samples both containing hundreds of seeds. Most samples have mixed charred remains that include different amounts of wood charcoal, cereals and pulses, flax, wild seeds, a few fragments of pistachio and almond shell, and a few cereal rachis fragments. Overall, however, the Gritille seed assemblage has a substantial quantity of pulses relative to cereals.

1 Cauvin (1994: 20-21) seems to discount the most recent radiocarbon date for Cafer (8150 ± 210 BP [Cauvin & Molist, 1991]), thereby putting the end of the Cafer sequence earlier than Gritille. Mary Voigt (personel communication, September 28, 1998) thinks the lowest level at Gritille is probably contemporary with Cafer based on aspects of lithic technology (distinctive retouch on some tools and presence of Çayönü rods). Fortunately the trends observed here do not depend on precise cross-dating between the sites.

Table 1. List of cultigens found at Neolithic Gritille.

Hordeum vulgare ssp. distichum	(two-row) barley
Triticum monococcum	einkorn
Triticum dicoccum	emmer
Triticum durum (or T. aestivum?)	free-threshing wheat
Vicia ervilia	bitter vetch
Lens	lentil
Lathyrus sativus/cicera	grass-pea
cf. Pisum	pea
Linum	flax

Cooking

The primary cultigens all require some kind of cooking to maximize their digestibility (see below). Yet, if we looked for evidence of cooking only in archaeological features associated with fire, we would be disappointed. In dealing with charred archaeobotanical assemblages, we must leave behind traditional ideas about archaeological context, the idea that excavated contents of storage pits and hearths must reflect activities like storing and cooking. Instead, regardless of where on a site we find charred plant remains, in antiquity they were burned in controlled fires within the settlement. For example, at Gritille, trash was deposited in or near domestic structures, but it was not burned there. Even so, some samples have a high density of charred material, suggesting they have a certain integrity of association, by which I mean things that were burned together stayed together.

Samples from four features identified as hearths and ovens have relatively low densities of charred remains, and the deposits probably reflect post-occupation fill. The samples with the most wood charcoal are from other types of deposits: trash, a burnt layer, and a number of pits, some of which are cobble-filled. Even then, only four out of seven cobble-filled pits had a high density of charred wood.

Pulses and cereals

The distribution of seeds among the samples is not uniform. For example, of the 52 samples, only three had more than a few grams of seeds. I deal with these atypical samples first because they each have a high concentration of cultigens that might be interpreted as food remains (Figure 2) and because they would distort the general pattern of archaeobotanical deposition at the site if they were incorporated into the analysis of the other samples:

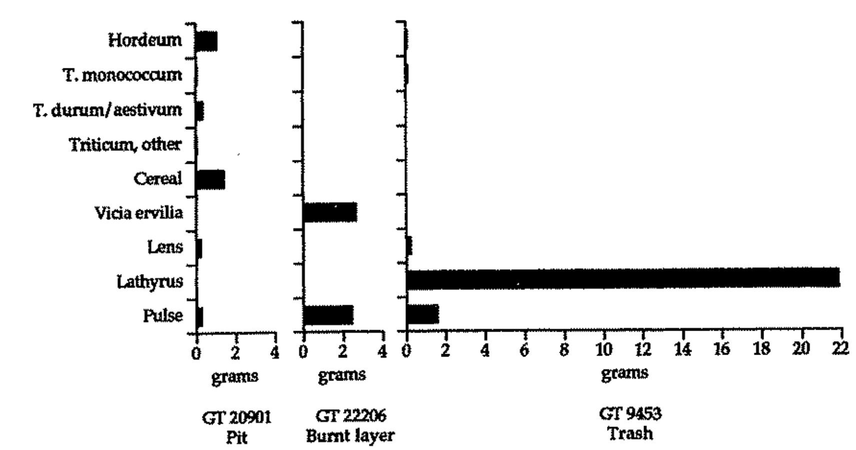

Fig. 2. Cereal and pulse concentrations in three crop seed samples from Neolithic Gritille

Sample GT 20901: Large cobble-filled pit
Basal level; 1984, Operation 48/51, locus 14
Density: 0.50 g/l of charred material larger than 2 mm (from 8 litres of soil)
Seed material larger than 2 mm: 2.76 g
Wood charcoal larger than 2 mm: 1.21 g

This pit had a fair amount of barley mixed with other cultigens, wood charcoal, and some wild seeds. It therefore seems to be an *in situ* deposit of burnt material that includes wood fuel. The cultigens might come from seeds accidentally charred when they were roasted. Because they are a mixed group, their presence together in this pit probably derives from several depositional episodes. Alternatively, some portion of the seed assemblage might have come from dung burning or burnt crop-processing debris (see Hillman, 1984). This sample was one of several that came from the same pit, but its high concentration of cultigens was unique.

The sample dates to about 8500 BP, yet in several ways it stands out as a "modern" assemblage. First, barley is common in the Levant, but it is fairly rare in the southeastern Anatolian sites in the Middle PPNB. Second, there is more free-threshing wheat than einkorn in this sample, which is unusual for Gritille (cf. Figure 2 [left] and Figure 4). Third, the flax seeds are as large as those from Ramad, a PPNB site in the Damascus Basin in Syria though they may be a century or two older.[2] Fourth, the lentils are large compared to others in the earliest Gritille deposits as well as in other PPNB sites.[3] And finally, unlike most of the other samples, cereals outweigh pulses by a factor of more than six to one. This sample therefore exemplifies the PPNB as a time of agricultural expansion and crop development.

Sample GT 22206: Burnt layer
Basal level; 1984, Operation 48/51, locus 43
Density: 0.37 g/l of charred material larger than 2 mm (from 8 litres of soil)
Seed material larger than 2 mm: 2.40 g
Wood charcoal larger than 2 mm: 0.52 g

This is a nearly pure sample of bitter vetch roughly contemporary with the mixed one discussed above. Since bitter vetch has a large seed of regular dimensions, sieving by ancient people would easily remove weed seeds, so this sample may well be an accidentally burned deposit of cleaned crop seeds. This finding agrees with the conclusion of Van Zeist (1988: p. 55) that bitter vetch was first domesticated in southeastern Anatolia. Best evidence of its early use comes from Çayönü. With about 500 whole seeds and numerous fragments, the Gritille concentration adds another site with early evidence of bitter vetch cultivation.

Sample GT 9453: Trash deposit
Phase B; 1983, Operation 16, locus 60
Density: 3.00 g/l of charred material larger than 2 mm (from 8 litres of soil)
Seed material larger than 2 mm: 23.93 g
Wood charcoal larger than 2 mm: 0.05 g

This is a nearly pure sample of grass-pea; in fact, it had over 800 whole seeds along with a substantial number of identified fragments, but almost no charcoal or weed seeds. It is somewhat more recent than the other two samples, and dates to between 8000 and 7500 BP. Following Kislev (1989: p. 263), such a large quantity of grass-pea is likely to be from a crop, so this Gritille cache is among the earliest evidence for grass-pea cultivation.

If we exclude these three crop seed concentrations and look at the ordinary occupation debris (as represented by the remaining 49 samples), we can get a more realistic picture of the relative impor-tance of cereals and pulses at Gritille, and how that might have changed over time (Figure 3). The digestibility of both the cereals and pulses is enhanced by cooking. Many pulses, especially bitter vetch and grass-pea, have toxic chemical compounds, some of which are readily removed with soaking in water and heating (Enneking, 1995).[4]

2 Gritille flax size in GT 20901: average length, 3.3 mm (2.6 mm-3.9 mm), SD=0.54, n=7. Ramad (Van Zeist & Bakker-Heeres, 1982): average length, 3.2 mm (2.8 mm-3.6 mm), n=80.

3 Gritille lentil size in GT 20901: avergae diameter, 3.4 mm (1.6 mm-4.1 mm), SD=0.73, n=20; other lentils from Gritille: average diameter 2.6 (1.6 mm-3.5 mm), SD=0.40, n=57. Ramad (Van Zeist & Bakker-Heeres, 1982): average diameter, 3.0 mm (1.8 mm-4.1 mm), n=222.

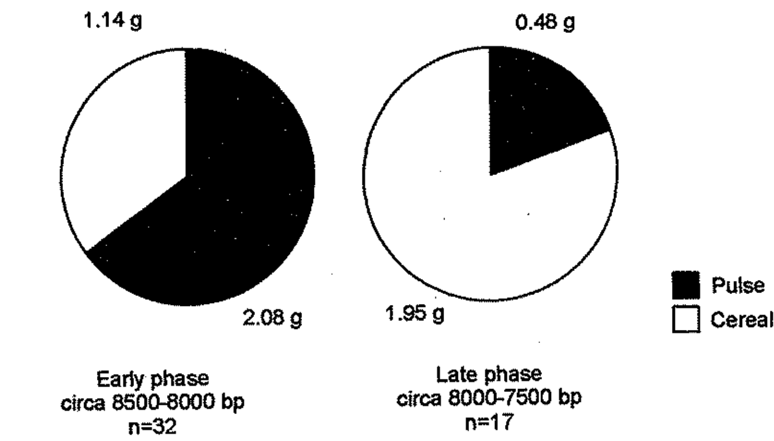

Figure 3. Relative amounts of cereals and pulses from Neolithic Gritille

Over time, the most toxic pulses (i.e., bitter vetch and grass-pea) decline in samples from trash deposits at Gritille (Figure 4), although even in the later period the seed concentration mentioned above (sample GT 9453) shows that grass-pea continued to be a crop. Lentil constitutes about a third of the identified pulses in the trashy samples from the beginning, and about half of them at the end of the Gritille sequence. The proportion of cereals relative to legumes rises, and among the cereals, barley comes to predominate.

Because the PPNB was an aceramic period, pre-soaked pulses would have been roasted or, more likely, cooked by stone-boiling with indirect heat, because the seeds or their container would burn up if processed in direct contact with fire. So even if individual archaeological features do not have pulses, when we consider the site as a whole, the reason for the co-occurrence of cobble-filled pits and substantial quantities of large legumes appears to be functional. Originally developed for detoxification of pulses, people thereafter might have applied the same cooking technology to other foods, such as cereals; the use of cobble-filled pits continues even after pulses decline in importance.

The timing of shifts in the proportions of crops varies among PPNB sites. Comparison of the Gritille assemblage with that of Cafer shows the same trend: there is a decline in pulses relative to cereals between Cafer III and Cafer I (Figure 5 [left and middle]).[5] Thus, pulses have nearly disappeared from the Cafer assemblage when Gritille has substantial amounts. The trend at the Syrian steppe site, Abu Hureyra, parallels that of south-eastern Anatolia; although the amounts differ, pulses ultimately decline relative to cereals there as well.

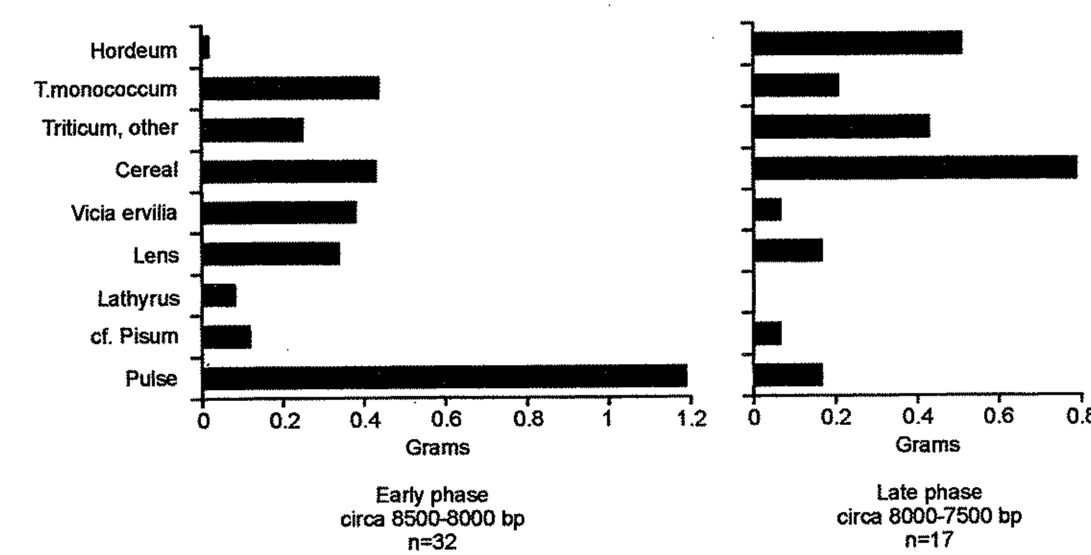

Figure 4. Cereals and pulses, by taxon, from Neolithic Gritille.

4 Enneking (1995: 7) cites a 12^{th} century treatise which says detoxification of *Vicia ervilia* "required the soaking of the seed in serveral changes of water for some days, followed by decortication achieved by heating of the soaked seed." Later he comments (ibid.: 9) that "the seeds, whose bitterness can be removed through steaming and leaching with hot water are to dome extent used for human consumption" (see also Enneking, 1995: 27). *Lathyrus* seeds, too, must be soaked to remove toxins (Duke, 1981: 108; Enneking & M. Wink, 1998).

5 In Figures 6, 7, and 8, approximately contemporary phases are on the same horizontal line.

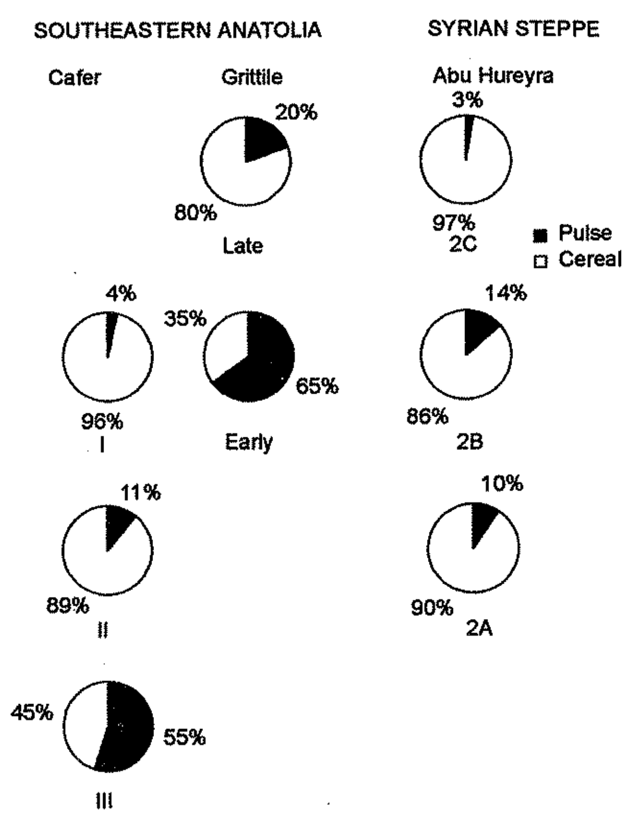

Figure 5. Relative amounts of cereals and pulses at Euphrates PPNB sites, based upon data listed in Table 2.

Among the major cereals, the proportion of wheat declines over time (Figure 6). Within the wheat category, einkorn predominates at late Cafer and contemporary early Gritille. It is only after Cafer is abandoned that barley has a significant presence at Gritille. PPNB Abu Hureyra had a significant proportion of barley from the beginning, and it too increases through time. Therefore, although there are some absolute differences in the steppe-forest and steppe as-semblages, there are also some parallels. Abu Hureyrans apparently did not use cobble-filled roasting pits, which might ex-plain some of the differences in the cultigen assemblage. On the other hand, perhaps the crop mix simply reflects the drier condi-tions out on the steppe.

Fuel

During the PPNB, people could actively choose which crops they would cultivate. People would have preferentially used fuel that was close to hand, so fuelgathering depended more on existing vegetation. The assemblages of Çayönü (Van Zeist & De Roller, 1991), Cafer (De Moulins, 1997), and Gritille have a substantial amount of wood charcoal. Since these sites lie in two environmental zones – the steppe-forest and the steppe – the plant remains from them reflect the types of fuel available. The Çayönü charcoal assemblage includes woodland types. At Cafer, Willcox (1991) reported woodland and riparian species; at Gritille, oak is most common, but other woodland and riparian types occur. In addition, remains of forest products such as shell fragments of pistachio and of almond-like nuts are present at Çayönü, Cafer, and Gritille. In contrast, by PPNB times at Abu Hureyra, the primary wood fuels available in the steppe zone would have been only the riverine types such as willow, poplar and tamarisk (cf. Willcox, 1992).

Most of the charred material found in occupation debris on Near Eastern archaeological sites was burned intentionally for fuel (see Miller, 1984). This generalisation is most obvious for wood charcoal, but also may apply to seeds. As is true in many places today, when wood fuel is used up in an area, dung becomes an attractive alternative. One suspects that dung is a particularly good medium for the preservation of seeds because it burns at a lower heat than wood and may even provide its own anaeorobic combustion micro-environment. Consequently, many seeds from archaeological contexts originated in dung fuel.

In areas where dung was used as fuel, one might expect to find many seeds relative to charcoal. Conversely, if the primary fuel was wood, one would expect to see fewer seeds. Therefore, it is not surprising that in the moister, more forested regions seeds, especially of fodder plants, are relatively scarce. Unfortunately it is not really possible to precisely quantify differences between sites analyzed by different researchers, because we report data in different units and different categories. Even so, certain gross observations can be made.[6] For example, De Moulins (1997) reports that there are far fewer seeds, either cultivated or wild, from Cafer than from Abu Hureyra (Table 2). Also, compared to Abu Hureyra, Çayönü and Gritille seem to have lower proportions of wild seeds relative to cultigens. It is note-worthy that within the category of wild plants, the percentage of small legume seeds is highest in the earliest levels of Abu Hureyra. Going north from there, the proportions of small legumes decline (Figure 7).

6 Archaeobotanical data usually do not lend themselves to rigorous statistical methodologies mostly because of between-sample variability and low numbers of seeds. In order to use the available information, I have treated most of the samples as though their contents could be added together by phase. The only justification is that some form of quantification does make possible relatively objective comparisons between sites and time periods.

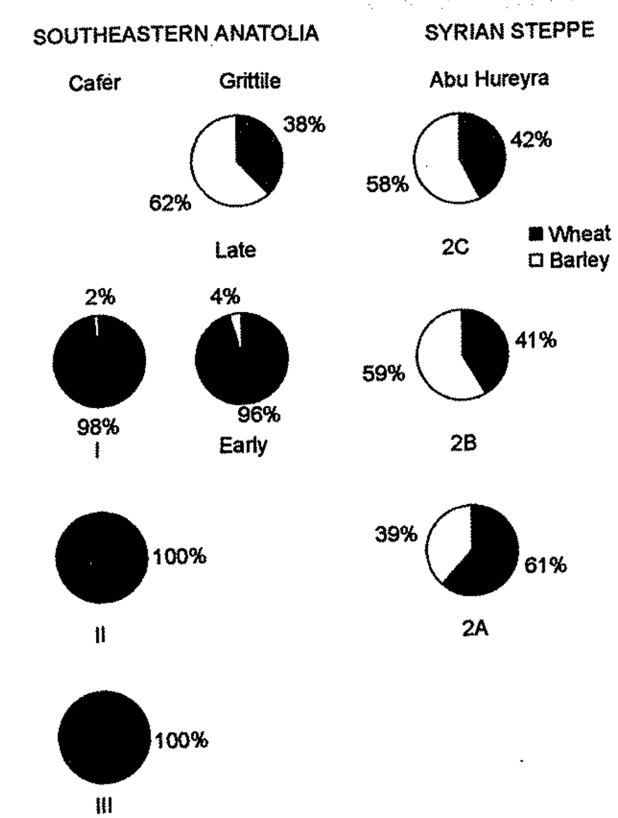

Figure 6. Relative amounts of wheat and barley at Euphrates PPNB sites, based upon data listed in Table 2.

If one accepts the idea that charred assemblages from occupation debris consist primarily, though not exclusively, of fuel remains, and that many of the seeds reflect animal fodder because they come from dung fuel, one can see the connection between the prevalence of wood charcoal and relative paucity of seeds in the Anatolian sites, as against high quantities of seeds, especially wild ones, in the drier Syrian steppe. Indeed, there is a potentially useful analogy with the way seeds and charcoal are distributed in later Chalcolithic and Bronze Age sites along almost the same stretch of the Euphrates river (Miller, 1997). After the Neolithic, botanical assemblages generally have low proportions of pulses relative to cereals; the wild seed component, especially near the steppe, is high relative to cultigens; and, among the wild seeds, there are many small legumes. From north to south, the proportion of wood charcoal declines; the proportion of wild seeds to cereals increases; and the proportion of barley relative to wheat increases. Significantly, the proportion of sheep and goat relative to cattle and pig also increases. Thus, toward the steppe, pastoral production is more important, animals are sent out to graze, and dung fuel is burned. Toward the forest, agriculture is more secure, animals eat more cultigens, and dung fuel is less necessary.

The agropastoral economy

One may reasonably ask how could people have used dung fuel in settlements occupied before animals were domesticated? Although some may disagree (e.g., Hillman *et al.*, 1997), I have argued elsewhere that even as early as the Epipaleolithic, Abu Hureyrans were probably supplementing their wood fuel supplies with gazelle dung (Miller, 1996, 1997). We know that the PPNB was a time of experimentation with animal domestication. So we can be confident that over time people gained more control over animals and animal products.

This interpretation clarifies the patterns discussed above. Neither Çayönü nor Cafer had morphologically domesticated animals. But Brochier (1993) found evidence from sediments at the end of the sequence that animals were kept on the site at Çayönü. At Abu Hureyra, Legge and Rowley-Conwy determined that phase 2A fauna is primarily gazelle; the phase 2B assemblage reflects the shift to sheep and goat exploitation, with a good chance that the animals were under human control (De Moulins, 1997: p. 87). Gritille, too, shows evidence for an in-crease over time in the control of sheep and goat (Stein, 1989).

The most striking pattern can be seen in southeastern Anatolia. Where people used pulses most, they decline over the period when animal domestication was becoming established. This makes some sense on nutritional grounds, since regardless of peoples' conscious knowledge, a steady supply of meat or milk satisfies the same human protein needs as the consumption of pulses together with cereals. Another pattern is the emphasis on wheat in the southeastern Anatolian sites. This is what we would expect on environmental grounds. But why would both Gritille and Abu Hureyra show an increase in barley relative to wheat over time? Today in the steppe zone, animals are given stored fodder during part of the year (Tully, 1984: p. 58; Sweet, 1974: p. 96), and it is likely that in antiquity barley served that purpose.

The Near Eastern agricultural complex was established during the PPNB. As Willcox notes in his contribution to this volume, regional variation in the importance of wheat, barley, and pulse cultivation was probably related to the sources and requirements of the different crops. Some spatial differences seem to reflect cuisine; the cobble-filled pits of the Anatolian sites may partially reflect the practices developed for the cooking of pulses. Other differences reflect ecology; barley is more drought-tolerant than wheat, so it would be more important in Syria than Turkey.[7] Similarly, the small legumes, even today most prevalent on the steppe, are more prominent in Syria than in the southeastern Anatolian sites.

Table 2a. Data for Cafer and Abu Hureyra upon which Fig. 6, 7, and 8 are based.

				SEED COUNT			
		Cereal	Pulse	Wheat	Barley	Small legume	Other wild
Cafer (De Moulins, 1993)							
III	(n=33)	168	206	133	0	36	342
II	(n=16)	102	13	68	0	10	38
I	(n=13)	269	10	174	4	5	287
Abu Hureyra (De Moulins, 1997)							
2A	(n=38)	460	50	158	100	3618	2841
2B	(n=44)	521	85	97	138	3720	2695

Table 2b. Data for Gritille (N.F. Miller, unpublished laboratory notes) upon which Fig. 6, 7, and 8 are based. Note that one cereal grain weighs about 0.01 g.

				SEED WEIGHT (GRAMS)		SEED COUNT	
		Cereal	Pulse	Wheat	Barley	Small legume	Other wild
Early	(n=32)	1.14	2.11	0.47	0.02	63	641
Late	(N=17)	1.94	0.48	0.31	0.51	205	1954

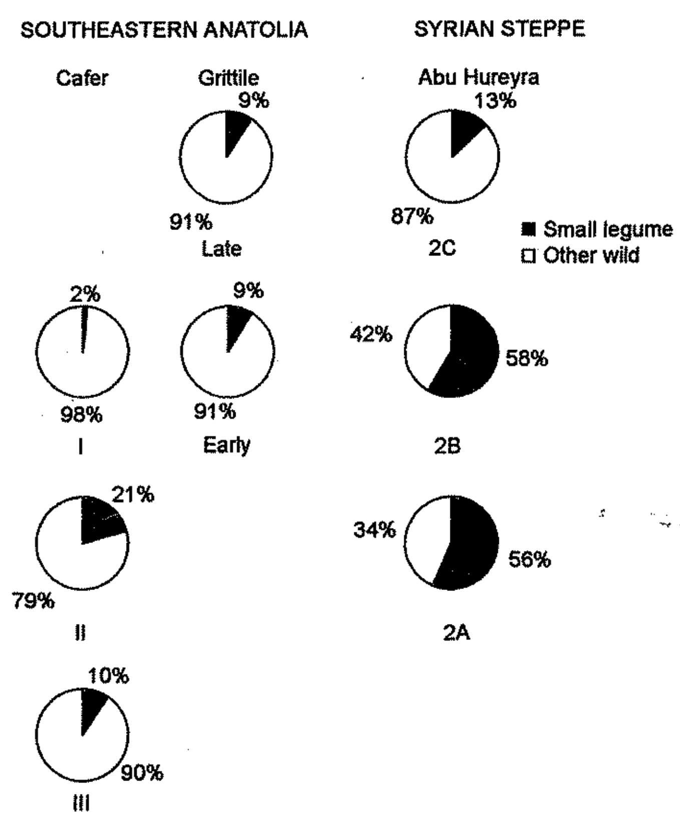

Figure 7. Relative amounts of small legumes on Euphrates PPNB sites, based upon data listed in Table 2.

Conclusions

It was during the PPNB that patterns of animal exploitation shifted from hunting to controlled herd management and ultimately animal husbandry. At least in the Levant, the emphasis shifted from gazelle hunting to sheep and goat herding. Corresponding changes occurred in the way people used and manipulated their botanical environment. Several of the archaeobotanical patterns discussed above can be explained in relation to animal herding, especially if one accepts the idea that as one goes from wooded to steppe regions an increasing proportion of the seed remains is likely to come from dung fuel. In the north, where a good portion of the seeds in trash could come from food processing accidents or debris, the drop in pulses relative to cereals at the end of the Cafer and Gritille sequences might reflect increasing dependence on animal protein. The increase in barley relative to wheat at both Abu Hureyra and Gritille is associated with the keeping of domestic herds – perhaps the barley, like today, was more likely to be fodder than food. Finally, the decline in small legumes relative to other wild plants could be a result of grazing pressure, since the small-seeded legumes are a preferred food for the herd animals.

The study of the Gritille PPNB plant remains has several analytical implications for archaeobotanical interpretations. First, although specific archaeological contexts can be very informative, most plant remains are not found *in situ*. For that reason, patterning within a site at single time period may be difficult or impossible to see. Regularities can nonetheless be discerned, because charred material originated in a restricted range of activities involving fire, and gross differences between time periods or between sites in different locations may be easier to explain. It is likely that patterns observed in the archaeobotanical data from the PPNB assemblages discussed here will hold fast with future research. Even so, the arguments presented in this chapter that relate the seeds, charcoal, animals and fire-pits to each other should be seen more as hypotheses to be tested than as a definitive description of PPNB lifeways.

7 This was certainly true later, during the Chalcolithic and Bronze Ages (Miller, 1997).

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References

Bar-Yosef, O. (1998) The Natufian culture in the Levant, threshold to the origins of agriculture. *Evolutionary Anthropology* 6, pp. 159-177.

Brochier, J.E. (1993) Çayönü Tepesi. Domestication, rythmes et environnement au PPNB. *Paléorient* 19(2), pp. 39-49.

Cauvin, J. (1994) *Naissance des divinités Naissance de l'agriculture*. Paris: CNRS.

Cauvin, J. & Molist, M. (1991) Les niveaux inférieurs de Cafer Höyük (Malatya, Turquie): stratigraphie et architecture (fouilles 1984-1986). *Cahiers de l'Euphrate* 5-6, pp. 85-114.

Duke, J.A. (1981) *Handbook of legumes of world economic importance*. New York: Plenum Press.

Enneking, D. (1995) *The toxicity of Vicia species and their utilisation as grain legumes*, 2nd ed. Nedlands: University of Western Australia, Center for Legumes in Mediterranean Agriculture (CLIMA). Occasional Publication no. 6.

Enneking, D. & Wink, M. (1998) *Towards the elimination of antinutritional factors in grain legumes*. Paper presented at III International Food Legume Research Conference, Adelaide 1997.

Helmer, D. (1988) Les animaux de Cafer et des sites précéramiques du Sud-Est de la Turquie: essai de synthèse. *Anatolica* 15, 37-48.

Hillman, G.C. (1984) Interpretation of archaeological plant remains: the application of ethnographic models from Turkey. In: Zeist, W. van & Casparie, W.A. (eds.), *Plants and ancient man*. Rotterdam: Balkema, pp. 1-41.

Hillman, G.C., Legge, A.J. & Rowley-Conwy, P.A. (1997) On the charred seeds from Epipaleolithic Abu Hureyra: food or fuel? *Current Anthropology* 38, pp. 651-655.

Hours, F. & Copeland, L. (1982) Les rapports entre l'Anatolie et la Syrie du Nord à l'époque des premières communautés villageoises de bergers et de paysans 7600-5000 B.C. In: Young Jr., T.C., Smith, P.E.L. & Mortensen, P. (eds.), *The hilly flanks and beyond*. Chicago: Studies in Ancient Oriental Civilization 36, pp. 75-90.

Kislev, M.E. (1989) Origins of the cultivation of Lathyrus sativus and L. cicera (Fabaceae). *Economic Botany* 43, pp. 262-270.

Köhler-Rollefson, I. (1988) The aftermath of the Levantine Neolithic revolution in the light of ecological and ethnographic evidence. *Paléorient* 14(1), pp. 87-93.

Miller, N.F. (1984) The use of dung as fuel: an ethnographic model and an archaeological example. *Paléorient* 10(2), pp. 71-79.

Miller, N.F. (1996) Seed eaters of the ancient Near East: human or herbivore? *Current Anthropology* 37, pp. 521-528.

Miller, N.F. (1997) Reply to Hillman *et al. Current Anthropology* 38, pp. 655-659.

Miller, N.F. (1997) Farming and herding along the Euphrates: environmental constraint and cultural choice (fourth to second millennia B.C.). In: Zettler, R.L., *Subsistence and settlement in a marginal environment: Tell es-Sweyhat, 1989-1995. Preliminary report*. Philadelphia: MASCA Research Papers in Science and Archaeology 14, pp. 123-132.

Molist, M. (1988) Foyers et fours néolithiques de Cafer Höyük et d'Anatolie au Vème millénaire B.C. *Anatolica* 15, pp. 111-125.

Moulins, D. de (1993) Les restes de plantes carbonisées de Cafer Höyük. *Cahiers de l'Euphrate* 7, pp. 191-234.

Moulins, D. de (1997) *Agricultural changes at Euphrates and steppe sites in the mid-8th to the 6th millennium B.C.* Oxford: BAR International Series 683.

Stein, G.J. (1989) Strategies of risk reduction in herding and hunting systems of Neolithic southeast Anatolia. In: Crabtree, P.J., Campana, D. & Ryan, K. (eds.) *Early animal domestication and its cultural context*. Philadelphia: MASCA Research Papers in Science and Archaeology, supp. to vol. 6, pp. 87-97.

Sweet, L.E. (1974) *Tell Toqaan: A Syrian village*. Ann Arbor: University of Michigan Museum of Anthropology.

Tchernov, E. (1991) Biological evidence for human sedentism in southwest Asia during the Natufian. In: Bar-Yosef, O. & Valla, F.R. (eds.), *The Natufian culture in the Levant*. Ann Arbor: International Monographs in Prehistory, pp. 315-340.

Tully, D. (1984) *Land use and farmer strategies in Al Bab: the feasibility of forage legumes in place of fallow*. Aleppo: International Center for Agricultural Research in Dry Areas (ICARDA) Research Report No. 12.

Voigt, M.M. (1985) Village on the Euphrates, excavations at Neolithic Gritille in Turkey. *Expedition* 27(1), pp. 10-24.

Voigt, M.M. (1988) Excavations at Neolithic Gritille. *Anatolica* 15, pp. 215-232.

Willcox, G. (1991) Cafer Höyük (Turquie): les charbons de bois néolithiques. *Cahiers de l'Euphrate* 5-6, pp. 139-150.

Willcox, G. (1992) Timber and trees: ancient exploitation in the Middle East: evidence from plant remains. *Bulletin on Sumerian Agriculture* 6, pp. 1-32.

Zeist, W. van (1988) Some aspects of Neolithic plant husbandry in the Near East. *Anatolica* 15, pp. 49-67.

Zeist, W. van & Bakker-Heeres, J.A.H. (1982) Archaeobotanical studies in the Levant 1. Neolithic sites in the Damascus Basin: Aswad, Ghoraifé, Ramad. *Palaeohistoria* 24, pp. 165-256.

Zeist, W. van & Roller, G.J. de (1991/1992) The plant husbandry of aceramic Çayönü, SE Turkey. *Palaeohistoria* 33/34, pp. 65-96.

R.T.J. Cappers & S. Bottema (Eds.) *The Dawn of Farming in the Near East*.
Studies in Early Near Eastern Production, Subsistence, and Environment 6, 2002 (1999). Berlin, *ex oriente*.

Changing paradigms, wild cereal ecology, and agricultural origins

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Introduction

A few years ago, I discussed at some length the implications for archaeology, particularly for agricultural origins, of the paradigm shift within ecology from a so-called equilibrium viewpoint to a non-equilibrium one (Blumler, 1996). I also included some brief comments regarding Near Eastern wild cereal ecology and its possible relationship to the adoption of farming. Since then, ecologists have extended the implications of the non-equilibrium paradigm to an increasing diversity of situations, geographical regions, and ecosystems (e.g. Zimmerer and Young, 1998; Blumler, 2002; Young *et al.*, in press), while I have continued to explore the role of wild cereal ecology in the Near Eastern Neolithic transition (Blumler, 1998b, c, 1999). Here, I extend my 1996 paper with some further comments on the implications of the new paradigm, and a more extended discussion of some problems of wild cereal ecology as they relate to the agricultural origins question.

The Non-Equilibrium Paradigm

> "Ecological and conservation thought at the turn of the century was nearly all in what might be called closed systems of one kind or another. In all of them some kind of balance or near balance was to be achieved. The geologists had their peneplain; the ecologists visualized a self-perpetuating climax; the soil scientists proposed a thoroughly mature soil profile, which eventually would lose all trace of its geological origin and become a sort of balanced organism in itself. It seems to me that social Darwinism, and the entirely competitive models that were constructed for society by the economists of the nineteenth century, were all based on a slow development towards some kind of equilibrium. I believe there is evidence in all of these fields that the systems are open, not closed, and that probably there is no consistent trend towards balance. Rather, we should think in terms of massive uncertainty, flexibility and adjustability."
> *H. M. Raup, 1964:19*

The above may be the earliest clear statement of the non-equilibrium perspective (the paradigm shift began in earnest in the late 1970's, with the publication of two highly influential papers by Connell [1978; Connell and Slatyer, 1977]), and certainly is one of the most succinct summaries of the difference between the new paradigm and the older equilibrium view. The emphasis is no longer on balance but on change, no longer on predictability but on possibilities and variation. Traditional succession theory is now so thoroughly discarded that (at least in the English-speaking world, where non-equilibrium theory originated) most plant ecologists prefer to use the term "vegetation dynamics", which connotes vegetation change without suggesting a predictable sequence towards taller, woodier plants in the absence of disturbance. No less an authority than Daniel Botkin now asserts that climax " is an imaginary condition never attained in nature" (Botkin and Keller, 1994:169). It is now widely believed that there is no single natural vegetation for any given environment, but rather, a range of possibilities that may occupy the site depending upon contingencies. Similarly, plant communities do not really exist, since the species that associate with each other change continuously both in space and time, and each species responds to climate and other change idiosyncratically. Human behavior and human impacts are increasingly seen as natural, as occurring within rather than upon ecosystems, and as producing conflicting, often diffuse effects, rather than the dramatic, degradational view of human impacts that flowed from the equilibrium paradigm (e.g. Blumler, 1994).