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The Earliest Farmers? Archaeobotanical Research at Pre-Pottery Neolithic A Sites in Jordan

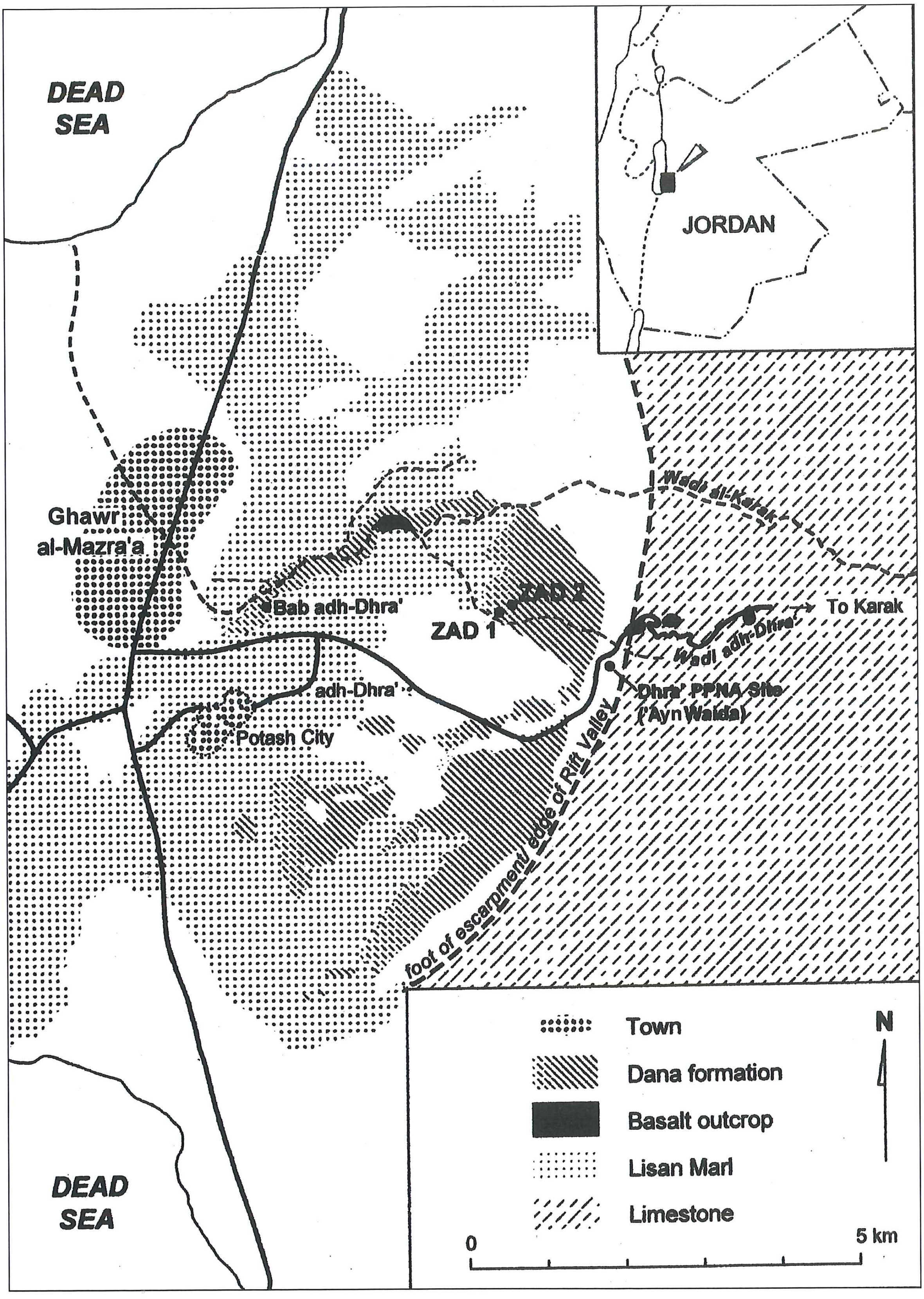
Abstract
Two seasons of archaeobotanical research at the PPNA site of Ẓahrat adh-Dhrā‘ 2 have shed light on the transition from foraging to farming. An intermediate subsistence strategy, in which the cultivation of wild cereals and pulses supplemented the use of gathered plant foods, can be identified. Grain size may have increased under ‘pre-domestication cultivation’, due to intentional selection of larger seeds for re-planting, without true domestication taking place. There were inherent limits to the productivity of wild cereal cultivation. Consequently, foraging for wild plant foods remained a vital part of the PPNA subsistence strategy.

Introduction
This paper considers a question of identity: the extent to which the PPNA inhabitants of Jordan were farmers. It is less concerned with the issues of where, when and why farming was first practiced, questions that continue to generate research and debate (e.g., Harris 1996; Heun *et al* 1997; Bar-Yosef 1998; Damania *et al* 1998; Anderson 1999; Zohary and Hopf 2000). Agriculture, narrowly defined as a subsistence strategy based on the cultivation of domestic plant varieties, probably began only in the PPNB. There is some evidence, however, that the Neolithic ‘founder crops’, which were the basis of Levantine agriculture from the PPNB onwards, were cultivated, and perhaps domesticated, during the PPNA (e.g., Harris 1998; Kislev 1999; Garrard 1999).

Cultivation, in this sense, is merely the intentional propagation of harvested plant species. It entails several tasks that foragers can avoid, such as tillage, weeding and watering, which may be expressed in terms of increased intensity of land use, or labour input per unit of land area (Harris 1989). Sedentism, population growth, territorial competition, technological development and vulnerability to climatic stress, each of which can undermine foragers' ideology and social structure, may favour and be favoured by the adoption of cultivation. Much of the ‘transition to agriculture’ debate consists of attempts to identify which of these factors triggered the others (Bar-Yosef 1998). While the order of causation remains a matter for conjecture, archaeobotanical research at PPNA sites can attempt to identify ‘pre-domestication cultivation’, the cultivation of wild plants (Colledge 1998). Unlike agriculture, it will be argued, ‘pre-domestication cultivation’ could not have replaced foraging as a subsistence strategy.

Domestication, in an evolutionary sense, means the establishment of genetic mutations whose expression confers a selective advantage to plants under cultivation, but which is disadvantageous in the wild. In the case of cereals, the key mutation results in spikes, or ears, that do not spontaneously disarticulate at maturity. Domestic cereals are said to have tough, rather than brittle, rachis internodes. Theoretical and experimental work with wild cereals (Hillman and Davies 1990) has demonstrated that harvesting wild stands of cereals cannot result in domestication, because foragers will disproportionately collect and remove tough-rachis mutants, leaving only brittle-rachis plants to contribute to the seedbank. Cultivation must therefore have preceded domestication. In certain circumstances, wild cereal cultivation can quickly lead to domestication, but various criteria (area cultivated, harvesting techniques, etc.) have to be met for tough-rachis mutants to become dominant; otherwise, there will be an indefinite period of ‘non-domestication’ cultivation (Hillman and Davies 1990: 168). The latter is probably the best interpretation of the archaeobotanical remains from Ẓahrat adh-Dhrā‘ 2 (ZAD 2).

Ẓahrat adh-Dhrā‘ 2
ZAD 2 is situated on the Dead Sea Plain at about 160m below sea level, just east of the modern town of Ghawr al-Mazra‘a and the Early Bronze Age site of Bāb adh-Dhrā‘ (FIG. 1). Two brief seasons of excavation were carried out in late 1999 and early 2001, as part of Dead Sea Plains Archaeology and Environment project of La Trobe and Arizona State Universities (Edwards *et al.* 2001; 2002). Several curvilinear stone structures were visible on the deflated surface of the 0.2ha site. All apparently belonged

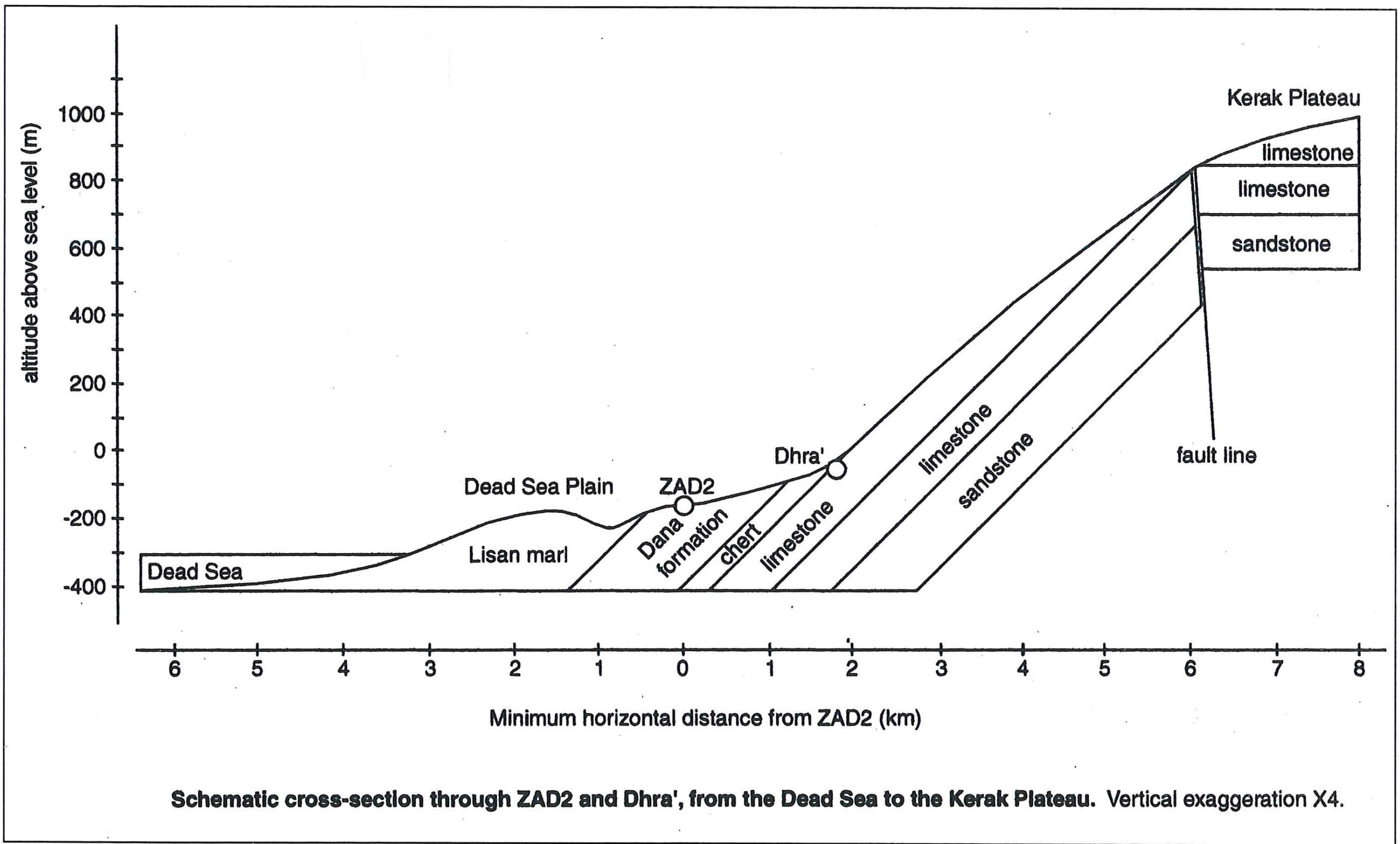


1. Map of the Dead Sea Plain.

to a single period of occupation, the PPNA. Chipped stone artefacts (Sayej, this volume) are consistent with this attribution, which is also now supported by eight radiocarbon dates (Edwards *et al.* 2002) between 9600 and 9300BP.[1] Dozens of ground stone artefacts associated with the processing of plant foods, such as cup-hole mortars and saddle querns, have been found on the modern surface and in excavation. Four structures have been sampled to date. The archaeological deposits are 1.0-1.2m deep, and directly overlie the sterile Dana Conglomerate Formation, which was reached in three of the four structures.

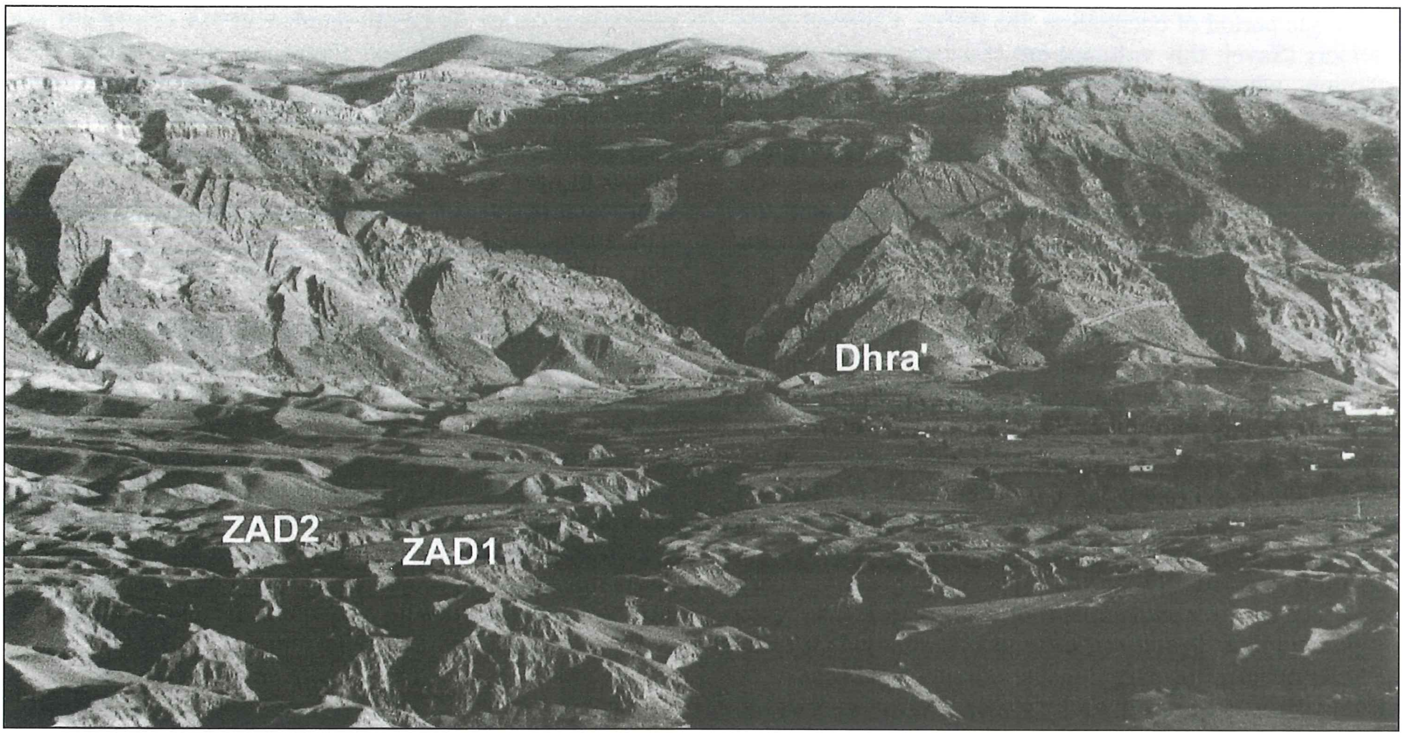
The surface of the Dead Sea may have been significantly higher in the early Holocene than it is today, but could not have been above the altitude of Jericho, 210m below sea level (Frumkin 1997). ZAD 2 was therefore at least 2km inland during the PPNA (FIG. 2). About 2km east of the site, bare limestone crags slope steeply up to the Karak Plateau, at 900 to 1100m above sea level (FIG. 3). At the foot of the escarpment, near ʿAyn al-Waʿīda, a permanent spring, is Dhrāʿ, another PPNA site (Kuijt and Mahasneh 1998; Kuijt and Finlayson 2001). Water from the spring is today used to irrigate the land south of the Wādī adh-Dhrāʿ, around the modern village of adh-Dhrāʿ. The wadi has cut a course through the Dana Conglomerate up to 60m below the level of the plain. Most of this erosion has probably taken place in the last four or five thousand years, judging by the dissection of Bāb adh-Dhrāʿ and the Middle Bronze site of ZAD 1 (Donahue 1985; Edwards and Higham 2001; Frumkin *et al.* 1994).

The Wādī al-Karak and Wādī adh-Dhrāʿ would have provided access from the Dead Sea Plain to the Karak Plateau, which is well beyond the conceivable daily foraging range of ZAD 2. Fruit and nut trees in the wadis leading up to the plateau would certainly have been exploited, but there is no arable land east of ʿAyn al-Waʿīda until at least 600-700m above sea level. The modern vegetation of the region (Kürschner 1986) consists of a salt desert on the Lisan Peninsula and Dead Sea Plain, grading into rock and gravel desert on the slopes to the east of Dhrāʿ. At



2. Schematic cross-section from the Dead Sea to the Karak Plateau, passing through ZAD 2.
Note: The Dead Sea surface, currently-410m, is shown as-300m, a reasonable estimate of its level during the PPNA.

[1] These dates are relatively late for the PPNA, and may help to explain the apparent absence of Early PPNB sites in Jordan (Edwards *et al.* 2002). Calibration of the dates, using the program OxCal 3.5 (Bronk Ramsey 2000) indicates that it is very likely that the site was occupied at some point in the period 8800-8500 BC, but possibly as early as 9100 BC.



3. The Dead Sea Plain and the Karak Plateau.

over 600m above sea level, dwarf shrub vegetation marks the interface between the rock desert and the xeric Mediterranean vegetation of the plateau (above 900m). On the eastern side of the plateau, there is a broad band of steppic vegetation (shrubs and herbs) before the eastern desert.

There is some archaeobotanical evidence (below, and Edwards *et al.* 2002) that in the PPNA there was also a wider band of steppic vegetation on the western side of the Karak Plateau, possibly extending as far as the Dead Sea Plain itself. This would indicate significantly higher annual rainfall at ZAD 2: 150-300mm instead of the present 50-100mm. According to a synthesis of palaeoclimatic data (Sanlaville 1996), it appears that the climate of the Levant rapidly ameliorated in the course of the early Holocene, reaching modern conditions by 9000 cal BC and then continuing to improve. Evidence from the Dead Sea (Frumkin 1997) and the recent publication of a new pollen diagram from Lake Huleh ([Baruch and Bottema 1999) also suggest a more humid phase at the beginning of the Holocene. An extension of the steppe zone during the PPNA into what is now desert is therefore consistent with current palaeoclimatic models.

Archaeobotanical Research at ZAD 2

All loci (excavation contexts) were sampled for plant remains during the 1999 and 2001 seasons. Samples were processed in the field by manual (bucket) flotation, using a minimum mesh size of 500 microns (0.5mm). Over 100 samples, each representing 2 to 4 litres of sediment, have been analysed to date. Only carbonised remains were considered to be ancient. A surprisingly large quantity of modern plant material (roots and seeds) was found in samples from the upper 30-40cm of the site. The preservation of carbonised remains in the same samples was very poor, presumably due to bioturbation and soil movement (expansion/contraction) over the last 11,000 years. In the lower levels, which were rapidly buried by the later occupational phases, plant preservation was moderate or in some cases quite good.

While better preservation conditions were often associated with richer deposits, this was not always the case, some of the better specimens were found in Structure 3, where the incidence of plant remains was relatively low. The concentration of plant remains varied markedly between areas of the site. The richest samples were from midden deposits on occupation surfaces, against the interior of the structures. Samples from around the hearths were relatively poor, and those from exterior surfaces were extremely sparse.

Four categories of plant remains were ubiquitous in the samples from both seasons. Pistachio (*Pistacia* sp.) nutshell fragments occurred in every sample with identifiable remains; cereal grain fragments, barley chaff fragments, pulse (large legume) fragments and fig seeds were each found in 70-80% of samples (Edwards *et al.* 2002). No other taxon, or plant category, was found in over 40% of samples. The staple plant foods, therefore, seem to be these four: barley, legumes, fig and pistachio. Remains of several non-cereal grass taxa were found in 20-40% of samples, and these may represent minor food sources. Plants that were consumed raw or prior to seed-set may be under-represented in this assemblage.

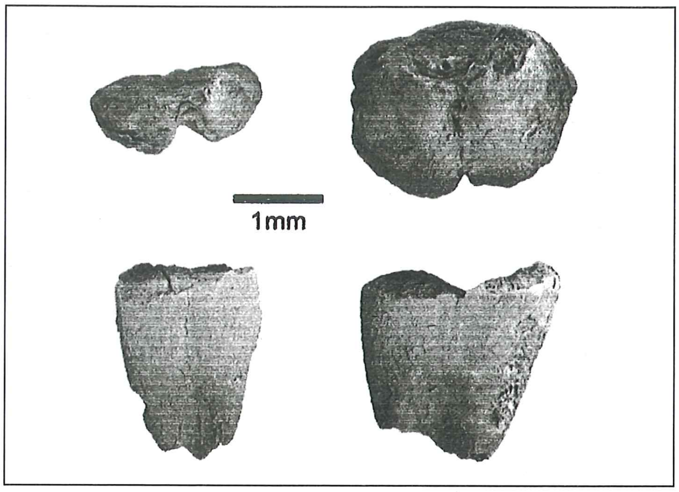
Evidence for 'Pre-Domestication Cultivation'

Wild and domestic barley are often found in archaeobotanical assemblages from PPNB (and later) farming sites in Jordan. Barley is the most drought-tolerant of cereals, and wild barley is native to the southern Levant, growing almost anywhere with rainfall of at least 250mm per annum. It is also a common weed of domestic cereal crops. There are several forms of domestic barley, but the most commonly found is *Hordeum distichum,* or hulled two-row barley. It differs from *H. spontaneum,* its wild ancestor, in two principal respects: it has tough rachis internodes and larger, more rounded, grains.

Ears of wild barley break up spontaneously as they dry, leaving smooth abscission scars at the point of attachment between the rachis internodes. Ears of domestic barley are broken up by threshing, and the rachis internodes do not separate cleanly. In theory, then, rachis internodes may be identified as domestic or wild types, if the abscission scar is preserved. In practice, a few wild barley internodes do not separate cleanly when harvested, and may be mistaken for domestic barley (Kislev 1999). At ZAD 2, the vast majority of barley rachis internodes appear to be of the wild type. Moreover, most have sturdy lateral floret bases, which are characteristic of wild barley (van Zeist and Bakker-Heeres 1982: 204). The ZAD 2 barley chaff, therefore, is probably all of the wild variety.

By contrast, there appear to be two distinct types of barley grains, wild and 'domestic' (FIG. 4). While none was complete, 40 grain fragments were sufficiently intact for their breadth and thickness to be measured (FIG. 5). When charred, wild barley grains can swell to the size of domestic barley grains. A single grain, therefore, cannot be identified with certainty as domestic barley when there is wild barley present in an assemblage.[2] The small sample from ZAD 2, however, clearly includes two size clusters. There may be several explanations for this, but the most plausible is that the clusters represent wild and 'domestic' (cultivated) barley.

The dashed lines in Figure 5 are the upper size limits for wild barley found by Colledge (1994: Fig. 4.6) in her study of plant remains from ten Epipalaeolithic and early Neolithic sites in Jordan. These limits clearly separate the two size clusters at ZAD 2. Furthermore, before measurement each grain fragment was classified, as far as possible, as wild or 'domestic' on morphological grounds other than size (domestic barley grains are less angular and have narrower hilar grooves than wild barley grains). With one exception, all the wild-type grains are in the smaller-grain cluster and all the domestic-type grains are in the larger-grain cluster.



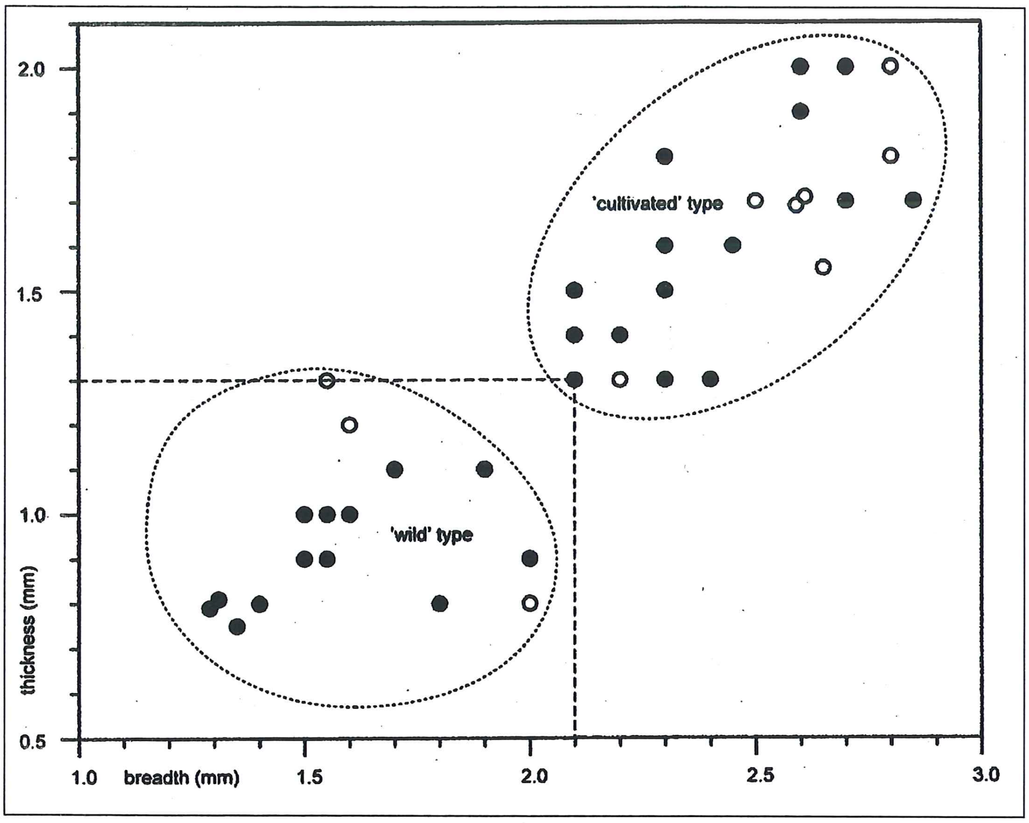
4. Barley grain fragments, ZAD 2.
Left (upper and lower): wild type. Right (upper and lower): 'domestic' type.

In sum, while all the barley chaff at ZAD 2 is of the wild variety, barley grains fall into two size groups that are consistent with wild and domestic barley. This suggests that wild barley was cultivated. For domestication to take place, a disproportionate fraction of the grains used as seed should be from domestic-type mutants (plants with tough rachis). This mutation is not visible in the grains themselves, and domestication must therefore have been an unconscious process. The barley chaff from ZAD 2 shows no sign of true domestication. The existence of two size clusters of grains, however, points to the intentional selection of larger grains as seed. Grain size, unlike the mutation 'for' tough rachis, is apparent from the grain itself, and is therefore amenable to conscious selection.[3] The smaller (wild-type) grains may have been weeds of cultivated barley, or grains that were collected from wild stands of the cereal.

Some cereal grain fragments apparently belong to one of the hulled wheats, although the fragments are too small to identify to species level. Fragments of wheat chaff occur in almost a quarter of the samples. While these fragments (usually single glume bases) cannot be identified to

[2] In the case of symmetric, hulled barley grains. Asymmetric (twisted) grains, found only in six-row barley, and naked grains, regardless of size, occur only in domestic barley.

[3] In fact, it is probably the only characteristic that early cultivators could or would have selected intentionally. The morphological criteria for separating wild and domestic grains, mentioned above, are probably the results of increased grain size. Other useful attributes, such as drought tolerance, can only be discerned in terms of yield, which is linked to grain size.



5. Scatter graph of maximum breadth and thickness, barley grain fragments, ZAD 2. Poorly-preserved fragments represented by hollow circles.

species either, the most likely candidate is *Triticum dicoccoides,* or wild emmer. The modern distribution of wild emmer is more northerly than that of wild barley. It grows in the north Jordan valley, particularly on basaltic soils, often in association with Tabor oak (*Quercus ithaburensis*) (Zohary and Hopf 2000: 44). Einkorn (*T. boeticum*), the other wild wheat species, is native to Anatolia. From the PPNB onwards, hulled wheat chaff generally dominates archaeobotanical assemblages in the Levant; its relative scarcity at PPNA sites (below) suggests that emmer was not yet domesticated. Wild emmer may have been a minor crop plant, a weed of barley, or even a wild food resource, if its range during the PPNA was greater than it is today.

Between two and four species of large-grained legumes, or pulses, are represented in the ZAD 2 samples. Lentils (*Lens sp.*), found in a fifth of samples, are readily identified by their lenticular cross-section. Most of the pulse seeds, however, are more globular. Spherical seeds probably belong to the genus *Pisum*, or field pea. More angular seeds probably represent bitter vetch (*Vicia ervilia*) or grass pea (*Lathyrus sp.*). Chickpea (*Cicer* sp.) and broad bean (*Vicia faba*) were not found. There are no accepted criteria for distinguishing domestic from wild varieties of pulses, as the critical mutations involve the loss of seed dormancy and the evolution of non-dehiscent pods, neither of which is evident from the seeds themselves (Kislev and Bar-Yosef 1988; Ladizinsky 1989). It is also unlikely that harvesting wild stands of pulses would have promoted the establishment of these mutations; only under cultivation can 'domesticates' have become dominant. In that case, it is assumed that there was a period of 'pre-domestication cultivation' of pulses as well as of cereals. At ZAD 2, pulse fragments were found almost as often as cereal fragments, and, as the pulse types identified were some of those that were ultimately domesticated, it can be argued that these pulses were at least cultivated in the PPNA.

Other Plant Types

Species of both *Pistacia* and *Ficus* occur along wadis within the escarpment, and *Pistacia* is an important component of Mediterranean and steppe woodland ecosystems. Most Neolithic sites yield the remains of both fig and pistachio, and it is generally assumed that these represent the collection of fruits and nuts from wild trees (Zohary and Hopf 2000: 164, 191; but c.f. Kislev 1999). The species of pistachio that was ultimately domesticated is not native to the Levant.

Half a dozen non-cereal grass taxa were identified. Some of these are relatively common, occurring in about a quarter of the samples. Of these, *Stipa* sp. (feathergrass) is the most frequent. *Stipa* is usually considered an indicator of steppic conditions. A wild oat species (*Avena* sp.) and a wild millet (*Panicum/Setaria* sp.) may be those identified by Kürschner (1986) in the upper Wadi al-Karak, in the transition zone between desert and Mediterranean regions. Bulbils of *Poa* sp. are of interest, as they were identified as food resources at Netiv Hagdud (Kislev 1997). A small-seeded grass type has not yet been identified. These taxa (oat, millet, *Poa* and small grass) each appeared in about 10% of samples. Only one grass seed was found uncharred, reflecting the scarcity of grass at ZAD today.

By contrast, *Aizoon hispanicum, Arnebia* sp. and *Suaeda* sp. were found in both the modern seedbank and in the archaeobotanical remains. They point to some continuity between the ancient and modern vegetation of the Dead Sea Plain. *Aizoon* and *Suaeda* are often treated as indicators of saline soils. More than a dozen other plant types were found that would probably be considered crop weeds if found at a later site (Edwards *et al.* 2002). One must not assume, however, that the typical weed flora of later periods was already established in the PPNA. Some of these plants are potentially useful in their own right, and may have been collected intentionally. None occurs in more than 10% of samples.

The ZAD 2 Subsistence Strategy

In summary, then, the subsistence strategy practiced at ZAD 2 includes reliance on four staple plant foods: cereals (wild and cultivated), pulses (wild and/or cultivated), fig and pistachio (both wild). Non-cereal grass seeds and perhaps other wild plants may also have been collected occasionally. There was remarkably little evidence of hunting or herding, in terms of stone tools (Sayej, this volume) or animal bones (Edwards *et al.* 2001). While the very location of the site, only 2km from the pre-existing PPNA site at Dhrā‘, invites the interpretation that plant cultivation was its *raison d'être*, gathered plant foods were apparently as important to subsistence as were cereals and pulses.

A possible explanation for this is that the productivity of pre-domestication cultivation was inherently limited. The argument is that traditional agriculture faces a severe shortage of labour at harvest time. Attempts to estimate the labour required to harvest enough grain for self-sufficiency (e.g., Russell 1988; Akkermans 1993) show that even with domestic cereals, the brevity of the harvest season dictates that labour is the factor that limits the area under cultivation. Because wild cereals spontaneously shed ripe spikelets, they must be harvested even more rapidly than domestic cereals. The actual time of ripening varies according to altitude and aspect, allowing foragers to harvest wild stands of cereals in various locations, as the grain ripens, effectively extending the duration of the harvest.

Wild (brittle-rachis) cereals grown in a single location, however, would ripen almost simultaneously, resulting in a shorter harvest season under pre-domestication cultivation than in either pure foraging, when wild stands of cereals are exploited, or pure farming, when domestic (tough-rachis) cereals are cultivated. In turn, this restricts the area that can be cultivated (because of the labour bottleneck during the harvest) and, therefore, means that some reliance on gathered plant foods is unavoidable.[4] Other constraints, such as the availability of cultivable land, could have been even more limiting, depending on the location of the site.

Ironically, one of the requirements for the emergence of domestic cereals, according to Hillman and Davies' (1990) model, is that a sufficient area be cultivated; the larger the population of cereal plants, the more likely it is that tough-rachis mutants will arise. Another requirement is that the cereals be cultivated where they did not grow naturally; that is, where wild cereals are not already present in the seedbank. ZAD 2 probably meets only the second of these requirements. It is possible, then, that it was a 'non-domestication cultivation' site, too small to give rise to the domestic cereals that might have allowed it to expand.

ZAD 2 in Context: Subsistence Strategies in the PPNA

It is suggested here that ZAD 2 practised a mixed subsistence strategy, of pre- or non-domestication cultivation combined with a continued reliance on foraging. There is evidence of the cultivation of wild cereals and pulses, as well as of the routine exploitation of wild fig and pistachio. Assuming that all the fields or garden plots were located close to the site, to make use of the flat land and permanent stream flow, it follows that the harvest season was very short, and therefore that the site's inhabitants were unable to feed themselves by cultivation alone.

Given the location of the site, this scenario appears to explain the ZAD 2 archaeobotanical evidence. It does not follow, however, that all PPNA sites followed the same subsistence strategy. The inhabitants of upland sites, with better access to cultivable land at different altitudes and in a variety of aspects, may have been able to stagger the harvest and thus increase the area under pre-domestic cultivation.[5] A major lowland site might cultivate a large

[4] Looked at another way, pre-domestication cultivation combines the inefficiency of harvesting brittle-rachis cereals with the additional workload of tilling and sowing them, and is therefore a poor substitute for foraging. Pre-domestication cultivation would therefore have only been adopted on a limited basis as long as wild food resources were abundant (see Simms and Russell 1997).

[5] This need not lead to domestication, as the same areas might support naturally-occurring stands of wild cereals, but it could mean a greater dependence on cultivated plants than at ZAD 2.

enough area for domestic plant varieties to emerge rapidly, but to achieve this critical mass a relatively rich setting, such as the oasis of Jericho, may be required. At the other extreme, some environments may have been too poor to support any sedentary settlement that lacked domesticated plants. These factors may help to explain the uneven PPNA archaeobotanical record in the southern Levant.

Four PPNA sites have been excavated in Jordan: 'Irāq ad-Dubb, in the Wādī al-Yābis west of 'Ajlūn, adh-Dhrā' ('Ayn Wa'ida) and Ẓahrat adh-Dhrā' 2, on the Dead Sea Plain, and Wādī Faynān 16, at the edge of the Wādī 'Arabah. Jericho and Netiv Hagdud, on the western edge of the south Jordan Valley, and Tall Aswad, just east of Damascus, offer the best regional comparisons. The sites vary significantly in size, longevity, situation and probably in subsistence practices.

The adh-Dhrā' excavation report notes only that "despite good sample sizes and preservation conditions, preliminary examination of carbonized materials recovered in excavation has provided no evidence for domesticated seeds" (Kuijt and Mahasneh 1998: 156). Existing radiocarbon dates (Kuijt and Finlayson 2001) suggest that the site was founded well before ZAD 2, but do not exclude a hiatus or an overlap between the two sites, which are only 2km apart. More data are required, but the contrasts between the sites (see Sayej, this volume) suggest different economic functions. An obvious interpretation is that ZAD 2 was established when cultivation was adopted, and that adh-Dhrā' had previously depended entirely on hunting and gathering.

Plant remains from 'Irāq ad-Dubb have been described by Colledge (1994: 163-165, Table 5.4). Only seven PPNA samples were analysed, but these were relatively rich, and each included barley, wheat, pulses, pistachio, fig and almond. The barley chaff was either of the wild type or indeterminate. Some of the barley grains were identified as belonging to the domestic variety, as at ZAD 2. The single grain of wheat may be wild einkorn (*Triticum boeticum*), which would be considered a cultivar on biogeographical grounds. The wheat chaff, however, was apparently a tough-rachis (i.e., domestic) form of either einkorn or emmer. Unlike the other PPNA sites in Jordan, 'Irāq ad-Dubb is in a hilly and relatively humid area of the country, and hence within easy reach of wild stands of cereals. Cultivation is inferred from the large, domestic-type barley grains recovered, as well as the probability that an exotic wheat species, einkorn, was present. The range of pulses (lentil, broad bean and vetch/grass pea) also hints at cultivation, as each of these species was ultimately domesticated.'Irāq ad-Dubb is probably a 'pre-domestication cultivation' site, although the evidence is open to interpretation.

Preliminary reports of the recent excavations at Wādī Faynān 16 (Mithen *et al.* 2000) are inconclusive with regard to subsistence behaviour. Cereal grains and pulses were rare, and no cereal chaff was preserved, but fig and pistachio were common. Both pure foraging and a mixture of cultivation and foraging can be argued as the basis of the site's subsistence; a case for substantial dependence on farming is difficult to make.

Some of the earliest finds of 'domestic' cereals were claimed in the Jericho archaeobotanical report (Hopf 1983). For a number of reasons, the Jericho data cannot easily be compared to those of more recent excavations. Plant remains were collected by dry-sieving, rather than flotation, and sampling was limited. The entire PPNA assemblage consists of about 100 identified specimens, half of them fig seeds. The sheer size of Jericho during the PPNA phase, and the large public structures it contains, were seen as inarguable evidence that this was a well-regulated farming society. Moreover, the absence (in the archaeobotanical assemblage) of the wild ancestors of domestic cereals implied that farming had begun elsewhere, and that the PPNA inhabitants were migrants who brought with them "grain that had already produced the mutations that made them more suitable for agriculture" (Kenyon 1979: 27, 28-29). In fact, if Hillman and Davies' calculations are correct, cultivation of wild cereals on a large enough scale, in an environment without endemic wild cereals, would favour the rapid emergence of a domestic variety. If cereal cultivation at Jericho began early in the PPNA phase, a brief 'pre-domestication cultivation' stage may not be reflected in the sparse archaeobotanical data. The assemblage is too small for the absence of any species to be meaningful.

The presence of domesticates at PPNA Jericho and their absence at ZAD 2 can thus be reconciled. Netiv Hagdud, however, only 15km from Jericho, apparently relied on wild cereals (among a very diverse range of species), whether or not these were cultivated (Kislev 1997). It is something of a mystery that these two sites could have coexisted for centuries without the former acquiring the domestic varieties from the latter. It is possible that the domestic specimens from Jericho post-date the abandonment of Netiv Hagdud, but the size and longevity of PPNA Jericho suggest otherwise. Three possibilities remain: that Jericho was really a pre-domestication cultivation site; that Netiv Hagdud, and perhaps the other PPNA sites, actually had domesticates; or that even though Jericho shared a common culture with Netiv Hagdud and the Jordanian PPNA sites in other respects, it did not share domestic seed stock.

The three Jordanian PPNA sites with archaeobotanical data fit well with the interpretation of Netiv Hagdud, and not with that of Jericho. Tall Aswad, by contrast, was apparently a farming site from the beginning (van Zeist and Bakker-Heeres 1982). Domestic varieties of emmer wheat, pea and lentil are attested in Phase Ia, as well as wild[6] barley, pistachio, fig, caper and almond. Both Jericho and Tall Aswad (ca. 4ha) were significantly larger in area during the PPNA than Netiv Hagdud (1.5ha) and the Jordanian sites (<1ha). At Aswad and at later Neolithic sites in the Damascus basin, the most common taxon was wheat chaff, in contrast to the minor role of wheat at ZAD 2 and Netiv Hagdud. Nevertheless, gathered plant foods were significant at all the PPNA sites.

On current evidence, therefore, the PPNA included a spectrum of subsistence strategies, with little or no dependence on cultivation at adh-Dhrā' and WF16, foraging supplemented by non-domestication cultivation at ZAD 2 and Netiv Hagdud, and farming supplemented by foraging at Aswad and probably Jericho. 'Irāq ad-Dubb may belong with ZAD 2 and Netiv Hagdud. If so, site size appears to determine the relative importance of foraging and cultivation in the PPNA. Arguably, it was the domestication of cereals that permitted sites to grow to the size of Jericho and Aswad, but one should not discount the converse argument that domestication could only take place after a site had reached a critical size.

Conclusion

It is interesting that a site as late as ZAD 2 had not acquired domestic cereal varieties, when in other respects it was not isolated from PPNA material culture. Prehistoric cultures, which are defined by the classification of material remains, are constructed by archaeologists. Nevertheless, the identification of a regional material culture implies that there was a wider collective identity than just the community associated with an individual site. In this sense, a Levantine 'interaction sphere' existed, but the weakness of that interaction is demonstrated by the mosaic of subsistence strategies practised at various PPNA sites, as well as the apparent persistence of the PPNA at ZAD 2 after 9500BP. Perhaps that weakness reflects the strength of local, communal identity and the resilience of hunter-gatherer clan affiliation.

Acknowledgments

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[6] In Phase Ia, most barley rachis internodes are of the brittle (i.e., wild) type, but most grains are apparently of the domestic variety, indicating a semi-domesticated crop (van Zeist and Bakker-Heeres 1982: 204, Table 18).

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