Late Pleistocene and early Holocene climate and the beginnings of cultivation in northern Syria

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Abstract: Climate change has been interpreted as a contributing factor to the emergence of agriculture in the Near East. We examine how climate change may have affected the availability of food plants and their cultivation in northern Syria at the end of the Pleistocene and the beginning of the Holocene. Charred plant remains from sites representing 11 archaeological levels indicate that during the late Pleistocene rye was commonly used, together with seeds gathered from the floodplain. During the early Holocene, rye and floodplain plants go out of use and barley then emmer wheat become common, pulses, lentils, peas and vetches increase in use and figs, chickpeas and horse beans were introduced. Pre-domestic cultivation is difficult to identify in the absence of morphologically domesticated plants. We cannot identify precisely when cultivation started but the possibility of cultivation is not excluded for the late Pleistocene, however we argue that it did not become a reliable means of subsistence until the Holocene. This period coincides with a decrease in the amplitude of climatic oscillations and global warming. With these conditions, combined with an increase in rainfall, we suggest cultivation developed into a sustainable economy. The earliest morphologically domestic cereals found in this area date to about 10 000 cal. yr BP. These may have been slow to become established because seed for sowing may have occasionally been replenished from the wild.

Key words: Holocene, Younger Dryas, Syria, climate, cultivation, wild cereals.

Introduction

The Younger Dryas has been interpreted as being a factor contributing to the transition from gathering to cultivating and it has been suggested that cultivation occurred at the start of this period at Abu Hureyra 1 (Hillman *et al.,* 2001). Willcox *et al.* (2008) suggest that during the early Holocene there are signs of pre-domestic cultivation at Jerf el Ahmar, Tell 'Abr and Dja'de (Willcox *et al.*, 2008). They base this interpretation on five lines of converging evidence: (1) a reduction in gathered plants, (2) introduction of cultivars, (3) grain size changes, (4) distance from wild stands and (5) weeds of cultivation. For the same period Weiss *et al.* (2006) argue for pre-domestic agriculture in the southern Levant, while at PPNA sites situated farther east and north, such as Hallan Çemi and Demirköy in Turkey and Nemrik, Qermez Dere and M'lefaat in Iraq, there is no evidence for cultivation (Savard *et al*., 2006).

Despite this supposed long period of pre-domestic agriculture at Euphrates sites, the non-shattering (domestic) ear, which is the first unequivocally recognizable adaptation of wild cereals to cultivation (Hillman and Davies, 1990), does not appear until between *c*. 10 000 cal. BP on the Syrian Euphrates sites of Halula and Abu Hureyra 2, and *c*. 10 500 years ago at the sites of Nevalı Çori, Tell el Kerkh, Aswad, Cayönü, and Cafer Höyük. Wild types continue to be present at these sites (van Zeist and de Roller, 1994; de Moulins, 1997; Pasternak, 1998; Nesbitt, 2002; Tanno and Willcox, 2006a, b; Fuller, 2007).

The archaeological sites of Abu Hureyra, Mureybet, Tell Qaramel, Jerf el Ahmar, Dja'de, Halula and Tel 'Abr (Figure 1), situated in northern Syria, span a date range from *c*. 13 250 to 9300 cal. yr BP. This period coincides with climate changes during the late Pleistocene/early Holocene and with the beginnings of agriculture. In the light of evidence from these seven sites which have produced tens of thousands of charred plant remains, we examine the role of climate in relation to selected food plants during this crucial period for human development.

The sites

Dating of the sites was based on over 100 ^{14}C dates. Abu Hureyra 1 (late Natufian) dates to before the Younger Dryas, Mureybet 1 (late Natufian) and Mureybet 2 (Khiamian) and the earliest levels at Tell Qaramel (Khiamian) date to the Younger Dryas. Jerf el Ahmar, Tell 'Abr, Mureybet III (all PPNA), Dja'de (early PPNB) and Halula (middle PPNB) belong to the early Holocene. ^{14}C date ranges (dates are given in cal. yr BP) for these sites are given in Table 1.

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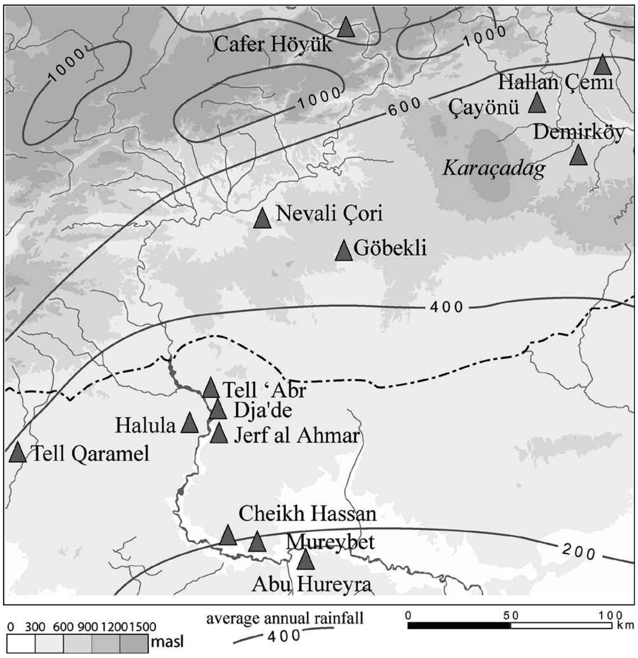

Figure 1 Locations of the principal sites mentioned in the text. Karaçadag is the area nearest to the sites where stands of wild rye are found today

Jerf el Ahmar, Mureybet, Halula and Abu Hureyra (van Zeist and Bakker-Heeres, 1986; Stordeur, 2000; Stordeur *et al.,* 2000; Molist, 2001) are the most southerly sites situated in an area which receives an average annual rainfall of 150–250 mm. Dja'de (Coqueugniot, 2000) has an annual average rainfall of about 300 mm and is situated 50 km upstream of Jerf el Ahmar. Tell 'Abr (Yartah, 2004 and 2005) is situated about 25 km farther north in an area with an annual rainfall similar to that of Dja'de. Tell Qaramel, on the river Quwayq about 25 km north of Aleppo (Mazurowski, 2004), is the only site which is not situated on the Euphrates. This area today has an average annual rainfall of nearly 400 mm, which is higher than that of the Euphrates sites. We include this site because it has a different cereal assemblage, which may help to explain the special case of the Euphrates sites (for site location see Figure 1).

Climate and vegetation in northern Syria at the end of the Pleistocene/beginning of the Holocene

There are no palaeoclimatic records or pollen spectra for the middle Euphrates region in northern Syria. Ice cores from Greenland provide high-resolution data including the amplitude of oxygen isotope oscillations, which is relevant to some of the arguments presented here.

How did climate change affect the availability of food plants in northern Syria? The site of Abu Hureyra is coincident with the end of the Lateglacial interstade. High altitude continental lakes such as Zeribar at 1300 m a.s.l. in the Zagros mountains of Iran (Stevens *et al.,* 2001; Wasylikowa *et al.,* 2006) and lake Van (Wick *et al.,* 2003), at 1648 m a.s.l. in eastern Turkey have low arboreal pollen counts and high counts for *Artemisia* and Chenopods for the duration of the late Pleistocene. At Eski Acigöl at 1270 m a.s.l. (Roberts *et al.,* 2001) in central Anatolia, the steppe species start to decrease before the Younger Dryas; arboreal and grass pollen are frequent. At lake Hula at 70 m a.s.l. and lake Ghab at 240 m a.s.l. deciduous oak and grass pollen frequencies are relatively higher for the late Pleistocene (Baruch and Bottema, 1999; Yasuda *et al.,* 2000; Meadows, 2005). This suggests that between the end of the Glacial and the beginning of the Younger Dryas forest vegetation expanded in low-lying areas. Temperatures were probably lower than at present. For the Euphrates region (between 280 and 500 m a.s.l.) in northern Syria, charcoal and seed analyses from Epipalaeolithic Abu Hureyra indicate a forest-steppe vegetation consisting of *Pistacia atlantica* trees, grasses and occasional oaks (Hillman, 2000; Roitel and Willcox, 2000; Willcox, 2002a). These taxa occur today in vegetation zones found at higher altitudes.

The Younger Dryas can be discerned from lake-level changes, diatom analyses and stable isotopes (Roberts *et al*., 2001). It was cooler and drier than today. The aridity may have been offset because low temperatures would have meant less evaporation and transpiration. Isotope data indicate that the Younger Dryas was more severe at the high-altitude continental sites than those nearer the Mediterranean (Jones *et al*., 2007). Vegetation zones (and sea levels) were lower than today. Evergreen oak and olive pollen was absent or rare at lakes Hula, Ghab and Acigöl during the late Pleistocene and did not increase until the Holocene. In the Euphrates area during the Younger Dryas at Mureybet 1 and 2 (290 m a.s.l.), *Pistacia,* grasses and oak were exploited (Willcox, 2008; van Zeist and Bakker-Heeres, 1986), so these resources were still available despite climate deterioration. Some levels also had high levels of Chenopod charcoal.

The early Holocene is characterized by an increase in both temperature and rainfall. However, at high altitude sites steppe species continue at high frequencies but data from low altitude lake sites and marine cores indicate forest expansion in the Near East (Rossignol-Strick, 1999; Roberts, 2002). This can be seen in the Euphrates valley sites by the finds of *Pistacia* and *Amygdalus* charcoal and fruits at Jerf el Ahmar and Dja'de (Willcox, 1996, 2002a; Hillman, 2000).

The charred remains of food plants

Table 1 gives counts of identifications of seeds and fruits from 19 selected food plants taken from 11 occupation horizons. The charred assemblages included over 120 taxa. Presence/absence demonstrate that several founder crops are absent in the early part of the sequence, and then appear as they came into use for the first time. In Figure 2 we compare percentages of key taxa calculated from total counts of the 19 food plants (upper diagram). Ubiquity values are given in the lower diagram where percentages are based on presence of a taxon in samples calculated from the total number of samples from each site. This method ignores the number of seeds. Both graphics indicate increasing or decreasing trends for certain taxa.

The occurrence of food plants in relation to climate change

Wild rye (*Secale* sp.), a cool-climate cereal, was common prior to and during the Younger Dryas at Abu Hureyra 1 and Mureybet 1 and 2. Two-grained wild einkorn (*Triticum boeoticum thaourdar* and *T. urartu*) was present but less frequent (G. Hillman, personal communication, 2006). Because grains of these two taxa are difficult to distinguish we refer to them as *Secale/Triticum.* Spikelet bases of these two taxa can be distinguished. No spikelet material

Table 1 Absolute counts of selected food plants

	Abu Hureyra 1	Mureybet 1	Mureybet 2	Tell ‘Abr	Mureybet 3	Jerf el Ahmar 1	Jerf el Ahmar 2	Dja’de	Abu Hureyra 2	Halula	Qaramel
Dates cal. yr BP	13 250–12 750	12 500–12 000	12 000–11 500	11 500–11 200	11 500–11 200	11 500–11 200	11 200–11 000	11 000–10 300	10 000–9300	9800–9300	12 000–11 500
Secale/Triticum grain	888	12	8	2999	2000	1382	1055	1120	50	0	1170
Triticum spikelet base	0	0	0	0	0	0	5	16	1	11	292
Secale sp. spikelet base	0	0	p	p	p	121	22	16	1	0	0
H.spontaneum/distichum grain	0	3	2	190	164	2353	6474	3763	134	113	217
H. spontaneum spikelet base	0	0	0	?	6	1546	1746	153	**5**	**2**	0
T. b. aegilopoides grain	0	0	0	90	1	18	49	302	24	3	1108
T.dicoccoides/dicoccum	0	0	0	0	0	0	0	192	*c*.**30**	**163**	4
Triticum sp. free-threshing	0	0	0	0	0	0	0	0	*c*.**30**	**496**	0
Lens sp.	48	1	6	230	28	452	1147	5850	32	57	1113
Pisum/Vicia/lathyrus	48	1	6	37	13	146	237	1952	22	27	682
Cicer	0	0	0	0	0	0	0	3	0	0	0
Vicia faba	0	0	0	0	0	0	0	2	1	1	0
Vicia erilia	3	0	0	0	4	10	46	34	1	0	11
Stipa	1573	0	0	0	0	2	51	272	52	1	526
Panicoid grasses	342	35	35	0	24	19	1	0	19	0	1
Rumex/Polygonum	4848	312	1037	0	351	359	126	37	325	25	11
Ficus carica	0	0	0	0	3	1	10	42	1	5	4
Amygdalus spp.	0	0	0	0	0	760	666	2	0	1	2214
Pistacia sp. frags	357	8	10	0	12	1302	1274	911	16	1	1705
Rodent droppings	0	0	0	0	0	8	39	221	0	0	49
Totals of edible plants	8107	372	1104	3546	2606	8471	12909	14888	684	906	9058
Vol. sediment litres	7925	?	?	452	?	6210	5904	6122	?	1772	1772
Number of samples	21	11	22	30	27	154	81	229	39	108	108
Period	Late Natufian	Late Natufian	Khiamian	PPNA	PPNA	PPNA	PPNA	Early PPNB	Middle PPNB	Middle PPNB	Khiamian

p indicates identifications from impression in daub which were not counted. Bold signifies morphological domestication. Data for Abu Hureyra came from the data base compiled as part of AHRB/C funded project, based at the Institute of Archaeology, UCL (2001–4): ‘The origin and spread of Neolithic plant economies in the Near East and Europe’ principal investigators: Stephen Shennan and James Conolly; research assistant: Sue Colledge; for Mureybet, van Zeist and Bakker-Heeres (1986); for Jerf el Ahmar, Tell ‘Abr, Dja’de and Tell Qaramel, Willcox *et al.* (2008); and for Halula, R. Buxo unpublished results, 2007.

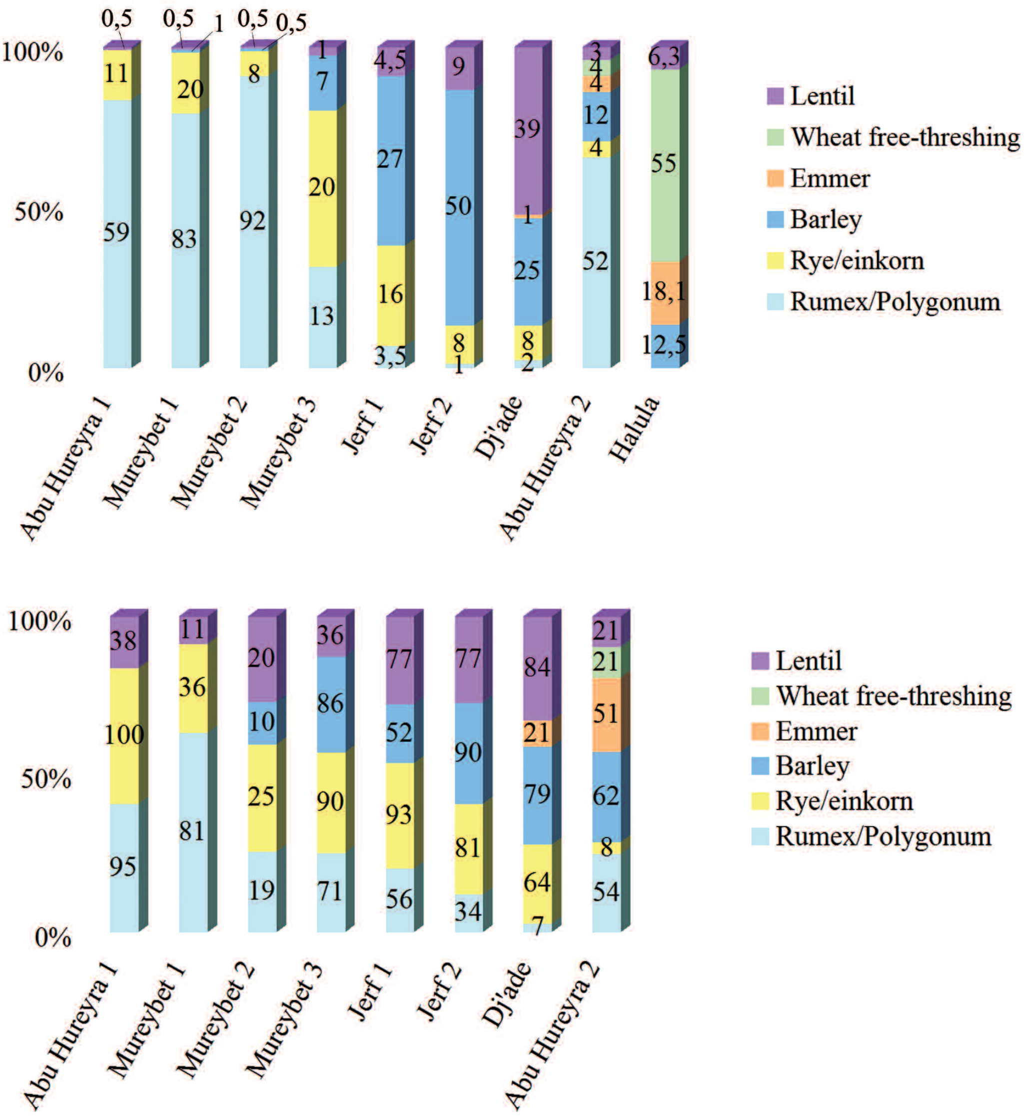

Figure 2 Relative proportions of selected taxa. In the upper bar diagram key taxa are compared. Percentages, given in the bars, are based on the totals in Table 1. Their relative proportions are indicated by the bar colours. In the lower diagram ubiquity percentages are compared. These are based on the number of samples in which a taxon is present as a percentage of the total number of samples from each site. This removes possible bias when quantities of seeds are compared. *Rumex/Polygonum* and *Secale/Triticum* were frequent in the late Pleistocene, during the Holocene they diminished and barley and emmer increased. Lentils increased between the Natufian and early PPNB. Ubiquity percentages were not available from Halula at the time of writing

was found at Abu Hureyra, but at Jerf el Ahmar rye spikelet bases decline between the lower and upper levels and are rare or absent on later sites. The nearest annual rye (*Secale vavilovii*) is found today more than 200 km to the north of Abu Hureyra on the basalt massif of the Karaçadağ at 1000 m a.s.l. (Figure 1). Wild einkorn extends farther south than rye onto basalt lava flows near the Turkish–Syrian border. Today's climate in the Euphrates region of northern Syria is too hot and dry for wild rye and wild einkorn; in addition the poor chalk soils are not suitable for these cereals (Willcox, 2005).

Cool conditions probably allowed wild rye to extend farther south during the late Pleistocene. But how far were the rye and einkorn habitats from the sites? The distance would have varied depending on the climatic conditions and the relative position of the sites. Rye would have grown in areas with low pH soils, such as those found on basalt. The nearest basalt outcrops, located about 30 km northeast of Dj'ade and Tell 'Abr, are possible ancient habitats for rye. The southernmost Euphrates sites lay beyond or were in a marginal position to wild rye and einkorn stands during the Younger Dryas. During the Holocene, rye gradually goes out of use because it would not have tolerated the increase in temperatures at this altitude. Rye was absent at Tell Qaramel. At this site wild einkorn was the dominant cereal. It probably grew within easy reach on favourable soils which existed not far from the site.

Wild emmer (*Triticum dicocciodes*) was absent on early Euphrates sites, appearing for the first time at Dja'de (Table 1). Emmer became the principal cultivated hulled wheat in the region, as seen at Abu Hureyra 2 and Halula (Figure 2).

Wild barley (*Hordeum spontaneum*), was absent at Tell Abu Hureyra 1 and only five grains were recovered from Mureybet I and II (van Zeist and Bakker-Heeres, 1986). At the start of the Holocene, barley becomes increasingly frequent and replaces the rye/einkorn types (Figure 2). Wild barley is the only wild cereal growing naturally in the region of the Euphrates sites today. It is more resistant to hot, dry conditions and poor soils than rye and einkorn. It is probable that during the last glacial its habitat lay to the south and it advanced north as temperatures increased. Barley became the most commonly cultivated cereal in the area.

The most abundant pulse was lentil. The specimens resemble the wild ancestor of domestic lentil (*L. orientalis)*. This taxon was present on late Pleistocene sites (Table 1, Figure 2) and becomes common on PPNA and early PPNB sites. Wild lentils are not a common component of Near Eastern vegetation and are restricted to small stands, making gathering on a large scale a difficult task. The Euphrates area in northern Syria is not an optimum habitat for wild lentils which is why we suggest that increase in frequencies of this species (Figure 2) could be explained by the adoption of cultivation. Bitter vetch (*Vicia ervilia)* and pea (*Pisum* sp.) were common during the PPNA and early PPNB. Chickpea (*Cicer* sp.) and faber bean, which is also known as horse or broad bean (*Vicia faba*) appear for the first time at the site of Dja'de where they may have been introduced. Faber bean occurs at Halula and Abu Hureyra 2 (Table 1). Both these pulses were found farther west at Tell el Kherkh in levels dated to 10 500 cal. BP (Tanno and Willcox, 2006b). This increase in the use of pulses during the PPNA and early PPNB we suggest is linked to the adoption of cultivation.

Pistacia atlantica is common on most sites and is known to have been an economically important plant during the Neolithic in the Near East. It was little affected by climate change, being able to tolerate extreme aridity; it is found today in areas with 200 mm of rain per annum. It is present throughout the sequence, including the Younger Dryas (Hillman, 2000; Roitel and Willcox, 2000; Willcox *et al*. 2008). High frequencies were found at Jerf el Ahmar (Table 1) and this species is known to have expanded throughout the eastern Mediterranean during the early Holocene (Rossignol-Strick, 1999). By the mid Holocene the species started to decline; probably this was due to human impact. Today this species is only found in isolated relic stands.

Wild almond trees were also more widespread during the early Holocene than today. At Tell Qaramel fragments of *Amygdalus* cf. *communis* stones are common, while at Jerf el Ahmar, *A. orientalis* and *A. webbii* occur. It is not known whether these almonds were toxic. If they were, they could have been consumed as the toxicity is easily removed by roasting. The difference in almond taxa between Tell Qaramel and Jerf el Ahmar reflects the differences in the plant associations found near the sites. Stones of hackberry (*Celtis* sp*.)* and two acorns (*Quercus* sp.) were also found at Tell Qaramel. The presence of these taxa during the early Holocene suggest a higher rainfall than at present. Today they are extremely rare in northern Syria.

Fig (*Ficus carica*) seeds do not occur on the early Euphrates sites of Abu Hureyra and Mureybet I and II. At Jerf el Ahmar and Qaramel they are insignificant, but become more frequent at Dja'de. This augmentation coincides with the increased temperatures of the early Holocene. In the southern Levant figs became common earlier, presumably because it was warmer. They are frequent at PPNA sites and it has been proposed that they were cultivated and even domesticated by 11 400 cal. BP (Kislev *et al.,* 2006).

Edible seeds gathered from the Euphrates floodplain would have had the advantage of being less affected by climatic variability than the wild cereals and pulses growing away from permanent water. *Polygonum/Rumex* (the grains are similar to buckwheat; for this study the two taxa have been combined because of the difficulty in distinguishing them) are frequent at late Pleistocene Abu Hureyra and Mureybet 1 and 2. They become less frequent at PPNA sites and later sites across the Near East with the exception of Abu Hureyra 2 where the aridity may have made cereal cultivation unreliable (Figure 2). During the occupation of Jerf el Ahmar there is a decrease in frequencies of *Polygonum/Rumex* between early and late levels. Panicoid grasses also decline, but counts are low. The gathering of these wild plants gradually gave way to the cultivation of founder crops.

Climate change and the beginnings of cultivation

Late Pleistocene gatherers would have inadvertently sown grain when it spilt near cereal processing areas. These gatherers must have observed this phenomenon and could have imitated it. Thus we should not ignore the possibility of late Pleistocene small-scale cultivation. Cultivation may first have been applied to plants important for the diet which were not growing near the sites. At Tell Qaramel and Göbekli einkorn may have grown locally thanks to a moist climate and rich basaltic soils which are present not far from these sites. In these cases there may have been little incentive to cultivate. In contrast, if the Euphrates sites were situated far from wild cereal and pulse stands, the incentive to cultivate would have been strong. This would have been possible because conditions near the Euphrates sites were not so unfavourable that if cereals and pulses were planted in suitable localities, they would have flourished under cultivation.

The changes in frequencies of charred food plants from the sites suggest long-term trends. It is improbable that if abrupt changes in taxa took place they would be recognized, because sampling was incomplete and does not represent a continuous sequence. However the long-term trends appear to be coincident with long-term climate change. Thus with the cooler conditions of the late Pleistocene including the Younger Dryas, rye was in use at Abu Hureyra 1 and at Mureybet 1 but was less important than *Polygonum/Rumex* gathered from the floodplain which would have been a more reliable source of food, being less affected by the climatic instability than rye (shown by the elevated oscillations see Figure 3). Hillman argued for cultivation of rye for the last phase of Abu Hureyra 1 (Hillman *et al.,* 2001). Whether rye exploitation involved gathering, cultivation or both, it was on a small scale because rye is found at low frequencies in these levels. In the case of cultivation it may not have been sustainable.

After the Younger Dryas with the warming of the early Holocene, rye diminished and wild emmer and barley, which are more tolerant of warmer conditions, came into use. Pulses increased in frequency. The gathering of *Polygonum/Rumex* and other small-seeded food plants diminished. We argue that it was at this time, during the PPNA between 11 500 and 11 000 cal. yr BP that cultivation became an established practice when founder crops of barley, single-grained einkorn, emmer and pulses began to be exploited on Euphrates sites. We suggest that the start of more stable climatic conditions at the beginning of the Holocene allowed cultivation to develop into a reliable subsistence economy and not before during the Younger Dryas. This is not the first time that more stable climatic conditions, as shown by the oxygen isotope oscillations, have been linked to the adoption of agriculture (Figure 3; Willcox, 2000a, b; Richerson *et al.*, 2001; Hoek and Bos, 2007; Feynman and Ruzmaikin, 2007). But this is new evidence which supports this argument. The intensity of cereal exploitation at the Euphrates PPNA sites is borne out by (1) the large quantities of chaff used as a tempering medium found in building earth (Willcox and Fornite, 1999), not known on late Pleistocene sites, (2) the occurrence of domestic mice (Cucchi *et al.,* 2005) identified from faunal remains and from associated charred droppings (Willcox *et al*., 2008), (3) the large number of querns, often found three to a room at Jerf el Ahmar and (4) grain storage in communal buildings (Stordeur and Willcox, unpublished data, 2008).

Cultivation at this stage did not select for morphological domestication. Theoretically, less than 200 years of cultivation could have selected for a domestic population (Hillman and Davies, 1990), yet cereals remained wild at least until 10 300 years ago at Dj'ade, which is *c*. 1000 years after the first signs of cultivation at

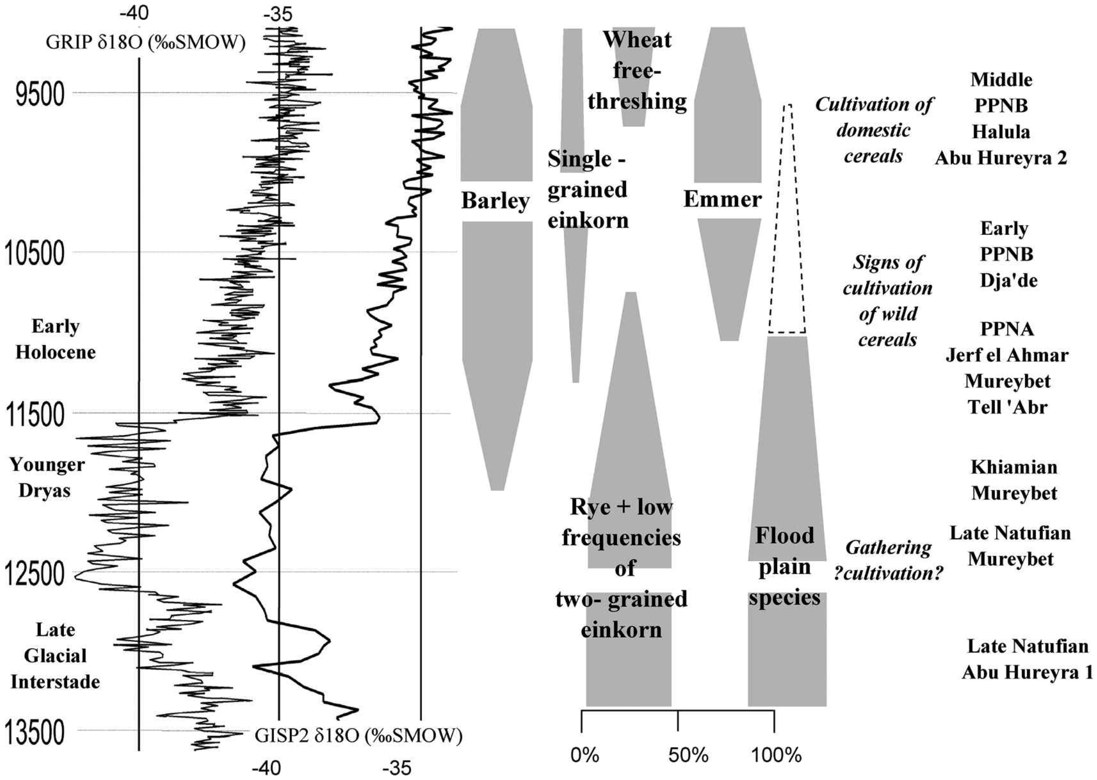

Figure 3 Schematic diagram of the approximate relative frequencies of selected grains from the Euphrates sites. Changes in frequencies are given in relation to the oxygen isotope curve adapted from Hoek and Bos (2007, with their permission). Rye is present during the late Pleistocene; it goes out of use with the warmer conditions of the Holocene when barley and emmer are frequent. On the left note the amplitude of the oscillations for the oxygen isotope curve which are high in the late Pleistocene indicating unstable climatic conditions which would not be favourable to agriculture. The amplitude diminishes with the Holocene indicating more stable climatic conditions which would be favourable to agriculture. The two breaks in the bars indicate that the archaeobotanical sequence is not continuous

Jerf el Ahmar. The first morphologically domestic cereals appeared *c.* 10 000 years ago in the area at Abu Hureyra 2 and at Halula (Table 1). This is coincident with the end of the warming period of the early Holocene. Sites of this period cover a much larger surface area than those of the preceding periods. The long period of pre-domestic cultivation may have occurred because seed stock was occasionally replenished from wild stands to counter poor harvests and famine. In addition, if harvests took place before the ears started to shatter, the probability of selection for a rare mutant that had lost its ability to disperse would have been extremely slim. Studies on a wider geographical scale and for a wide variety of cereals indicate that morphological domestication was slow to be established and mixed populations of wild and domestic cereals persisted side by side for long periods (Tanno and Willcox, 2006a; Fuller, 2007). Mixed populations occur in the Near East today where wild einkorn and wild barley are common weeds of cultivation. We argue that during the early Neolithic, non-shattering and shattering forms were inseparable and so similar that Neolithic farmers considered them both to be part of the crop.

Conclusion

The archaeological sites reported on here cover a period of *c.* 4000 years during which major climate change is well known on a global scale. These major changes were punctuated by short-term oscillations which are not recognizable in the archaeobotanical record. Analyses of over 20 000 charred plant remains from Jerf el Ahmar indicate trends between upper and lower levels which concord with wider long-term trends at the other sites (Figure 2). This concordance and repetition validates to some extent the data.

If small-scale cultivation occurred sporadically during the late Pleistocene at Euphrates sites, it may not have been reliable because of the unstable climate conditions. With the Holocene came more stable conditions which favoured cultivation as a sustainable economy, when founder crops such as barley followed by emmer, chickpea, faba bean and figs, were brought into cultivation in the Euphrates area.

The advent of stable climate conditions and the establishment of sustainable agriculture coincide with spectacular archaeological developments. Natufian dwellings at Abu Hureyra were merely shallow pits; Khiamian houses at Tell Qaramel were constructed in stone and were up to 5 m in diameter. These developments culminate at PPNA sites with large communal buildings that were used for storage at Tell ‘Abr, Jerf el Ahmar and Mureybet. The ‘kitchen’ discovered at Jerf el Ahmar (Willcox, 2002b) shows a material investment in food preparation. To the north the huge standing stone circles of Göbekli Tepe are evidence of a complex society (Schmidt, 2006). The motifs sculptured on the massif stones at Göbekli Tepe also occur, albeit on a smaller scale at Qaramel, Tell ‘Abr, Mureybet and Jerf el Ahmar. These material advances suggest the development of social complexity and probably social stratification which are coincident with the gradual adoption of cultivation as a dependable form of subsistence.

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