The role of wild grasses in subsistence and sedentism: new evidence from the northern Fertile Crescent

Manon Savard, Mark Nesbitt and Martin K. Jones

Abstract

Sedentism is usually regarded as a pre-condition for the development of crop husbandry in Southwest Asia and, consequently, sedentary pre-agrarian sites are an important focus of research on the origins of agriculture. It is often assumed that wild grasses were as important for hunter-gatherers as domesticated cereals were for early farmers, and that wild grass exploitation may therefore have had a critical role in enabling sedentism. Results from the analysis of archaeobotanical assemblages from Hallan Çemi, Demirköy, Qermez Dere and M'lefaat, and comparison with those of other sedentary pre-agrarian sites in Southwest Asia, challenge the role often attributed to the exploitation of grasses at this time. Archaeobotanical and ethnographical evidence instead suggests that hunter-gatherers took an opportunistic approach to the resources available and their subsistence strategies were not necessarily centred on grasses and 'wild cereals'.

Keywords

Neolithic; Epipalaeolithic; Natufian; domestication; foraging; hunter-gatherers.

Sedentism, grasses and the origins of agriculture

Sedentism is widely seen as an essential precursor to the earliest agriculture in the Fertile Crescent of Southwest Asia. Three perspectives support this view: first, there is extensive archaeological and bioarchaeological evidence for year-round occupation of many settlements in the Epipalaeolithic period in the form of solidly built architecture, abundant immovable goods, such as ground stone, and evidence from bones, seeds and molluscs of harvesting of food resources at different times of the year. The second perspective is based on ethnographic evidence that links sedentism to increasing population size. As many explanations for the development of food production invoke increased population density during the Epipalaeolithic, there is a natural tendency to seek evidence for sedentism during this period. Third, common sense suggests that once hunter-gatherers started any

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form of cultivation of wild plants, the demands of cultivation and of crop storage would favour sedentism.

Both ethnographic and archaeological evidence show that sedentism in hunter-gatherer societies depends on access to abundant food resources, whether in the form of acorns or salmon in ethnographically documented societies in western North America (Keeley 1988) or archaeological examples such as the fish-dependent society of Mesolithic Lepenski Vir (Chapman 1996). Since the 1960s, grasses (particularly the wild progenitors of cereals) have been identified as the abundant wild food resource that enabled widespread sedentism in the Epipalaeolithic of Southwest Asia. Although archaeological evidence for Epipalaeolithic diet has, until recently, been scanty, the important (if not the dominant) role of domesticated cereals in early farming sites has often led to the assumption that their wild progenitors had the same importance to hunter-gatherers. Grasses are indeed an important component of several Epipalaeolithic/early Neolithic archaeobotanical assemblages (Table 1) and are useful to archaeobotanists because they can, unlike legumes, show clear evidence of domestication. As a result, a substantial body of research has focussed on wild grasses (e.g. Anderson 1999; Colledge et al. 2004; Harlan 1999; Kislev et al. 2004; Nesbitt 2002; Willcox 1999a, 1999b, 2004). However, the importance of grasses has slipped into the theoretical domain and may have unduly influenced concepts and vocabulary: for example, the practice of referring to the wild progenitors of cereals as 'wild cereals'.

The focus on wild grasses in pre-agrarian subsistence can be traced back to the 1950s excavations at Eynan-Mallaha (Perrot 1966). The presence of storage pits at Natufian Eynan and the apparent concentration of Natufian sites in areas with dense stands of grasses (including the wild progenitors of cereals) led to the Natufian being considered 'not only as the first sedentary communities in the Levant, but as ''harvesters of cereals''' (Cauvin 2000: 15). However, Cauvin also writes: 'we concluded too rapidly, in the absence of any botanical studies, that they [the Natufians] were specialized gatherers of cereals who were somehow preparing, through this choice, the future cultivation of these plants' (1999: 180). Nonetheless, the role of 'wild cereals' remained deeply rooted in the theoretical domain. For instance, Henry (1989: 19, 35) states that the most important change in subsistence strategies during the Natufian was the intense harvesting of 'wild cereals' and nuts, which both allowed and demanded sedentism. Other work incorporates a similar approach: see, for example, Flannery (1969: 80–1), McCorriston and Hole (1991), Bar-Yosef and Meadow (1995: 69) and Smith (1998: 70).

In this paper, the role of grasses in sedentary hunter-gatherer subsistence strategies is re-examined, along with its implications for theoretical models of sedentism and the origins of agriculture. New evidence from four broadly contemporary sites from the northern Fertile Crescent (Hallan Çemi, Demirköy, M'lefaat and Qermez Dere) is presented and compared to archaeobotanical results from other Epipalaeolithic, Natufian or early Neolithic sites[1] that display some evidence for sedentism, most of them from the Levantine and the Euphrates corridors (Fig. 1).

Some key assumptions and questions

It is not the purpose of this paper to re-evaluate the evidence for sedentism in pre-agrarian Southwest Asia. We agree that most round-house villages of the Epipalaeolithic, Natufian

Table 1 Proportions of seed remains from Palaeolithic to PPNA sites in Southwest Asia

Sites	*Phase*	*Period*	*Date (uncal BP)*	*Number of samples*	*Total seeds number*	*Large legumes (pulses)*		*Other legumes*		*Unidentified legumes*		*Large grasses*		*Other grasses*		*Unidentified grasses*		*Nuts*	
						number	*%*	*number*	*%*	*number*	*%*	*number*	*%*	*number*	*%*	*number*	*%*	*number*	*%*
Kebara Cave, Israel	All	Middle Palaeolithic	60,000–48,000	c. 500	4205	2431	57.8	888	21.1			6	0.1	1	0.0	0	0.0	546	13.0
Ohalo II, Israel	All	Epipaleolithic	23,000	?	90000							2605	2.9	16000	17.8				
Wadi al-Hammeh 27, Jordan	All	Epipalaeolithic	12,200–11,900	14	3423	1	0.0	2	0.1	10	0.3	8	0.2	181	5.3	0	0.0	3	0.1
Abu Hureyra, Syria	I	Epipalaeolithic	11,500–10,000	?	>14000	+		+++				+++		+++				++	
Iraq ed-Dubb, Jordan	Late Natufian	Epipalaeolithic	11,200–10,800	6	602	22	3.7	0	0.0	2	0.3	15	2.5	44	7.3	0	0.0	149	24.8
Cayonu, Turkey	Roundhouse	PPNA	10,200–9200	16	<200?	+						++		+		+		++	
M'lefaat, Iraq	All	PPNA	9900–9700	4	4556	2388	52.4	8	0.2	0	0.0	645	14.2	1122	24.6	0	0.0	6	0.1
Demirkoy, Turkey	All	PPNA	10,000	12	936	52	5.6	40	4.3	3	0.3	8	0.8	37	3.9	0	0.0	11	1.2
Qermez Dere, Iraq	All	PPNA	10,100–9700	47	707	213	30.1	52	7.4	2	0.3	111	15.7	204	28.9	0	0.0	10	1.4
Hallan Cemi, Turkey	All	PPNA	10,000–9500	175	13751	1248	9.1	64	0.5	31	0.2	199	1.4	452	3.3	0	0.0	301	2.2
Netiv Hagdud, Israel	All	PPNA	10,000–9400	58	12589	439	3.5	23	0.2	1173	9.3	1420	11.3	78	0.6	622	4.9	54	0.4
Mureybit, Syria	III	Epipalaeolithic	10,000–9600	28	3893	53	1.4	27	0.7	4	0.1	2869	73.7	38	1.0	9	0.2	20	0.5
Jerf el Ahmar, Syria	PPNA	PPNA	9800	?	?	p		p				p		p				p	
Tell Aswad, Syria	I	PPNA?	9800–9300	9	1972	90	4.6	830	42.1	6	0.3	318	16.1	12	0.6	25	1.3	66	3.3
Iraq ed-Dubb, Jordan	PPNA	PPNA	9950	7	1043	83	8.0	0	0.0	76	7.3	33	3.2	102	9.8	0	0.0	106	10.2

Absolute numbers of seeds are given, but where these data are not available, subjective rankings are given on the following scale: p – presence, unknown abundance; + infrequent; ++ frequent; +++ dominant. Some sites from which few seeds have been published are omitted from this table: Hayonim Cave and Terrace, Jericho, Mallaha and Nemrik 9.

Notes on categories: in this table, large-seeded legumes are the *Cicer*, *Lathyrus*, *Lens*, *Pisum* and *Vicia* genera, and seeds scored as Vicieae or large/medium unidentified legumes. Large-seeded grasses are *Aegilops*, *Avena*, *Hordeum spontaneum*, *Secale* and *Triticum*, and those scored as unidentified large-seeded grasses. Nuts are *Amygdalus*, *Pistacia* and *Quercus*. Numbers are for seeds broadly defined (i.e. reproductive propagules), and include nutshell but not legume pod or grass chaff remains.

References: Abu Hureyra: Hillman (2000); Çayönü: van Zeist and de Roller (1991–2, 2003); Iraq ed-Dubb: Colledge (2001); Jerf al Ahmar: Willcox (1996); Kebara Cave: Lev et al. (2005); Mureybit: van Zeist and Bakker-Heeres (1984); Netiv Hagdud: Kislev (1997); Ohalo II: Weiss et al. (2004a, 2004b); Tell Aswad: van Zeist and Bakker-Heeres (1982); Wadi al-Hammeh 27: Colledge (2001).

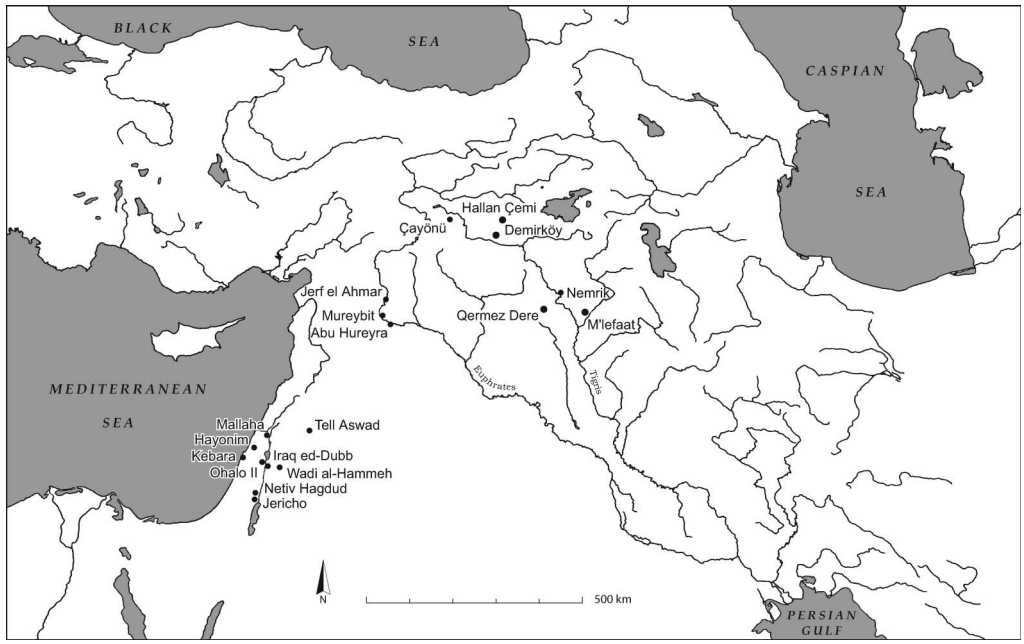

Figure 1 Location map (adapted from Aurenche and Kozłowski 1999).

('base camps') or PPNA were probably occupied year-round (though only solid bioarchaeological evidence can attest it) and that their inhabitants depended on food resources obtainable within a few days' walk of the settlement (c.f. Belfer-Cohen and Bar-Yosef 2000). It is therefore reasonable to assume that the plant and animal remains found at these sites will go some way towards answering the question of how sedentary hunter-gatherers were able to support a sedentary lifestyle. Was the plant element of diet dependent on the harvesting of wild grasses, or on another dominant resource, or on collection of a wide range of plant foods?

Our second key assumption is that the bulk of the plant remains found at these sites are in some way representative of the seeds consumed. Some plants may have been incidentally introduced to the site, but it is expected that they would represent only a minor portion of the assemblage. Other alternatives have been considered, such as dung burning, and the use of plants as construction material. It is unlikely that dung was an important source of fuel on sites where animals were hunted. Nonetheless, this possibility was closely examined for the four sites we studied: the absence of chaff (except at M'lefaat where the robust chaff of a single taxon, goat-grass, was found), the low seed-charcoal ratio, and the presence of various riparian tree taxa among the charcoals identified suggest that, if used at all, dung was not an important source of fuel (Savard 2005: 250–3). Similar conclusions were drawn for Abu Hureyra I (Hillman et al. 1997). There is indeed a possibility that some plants could have been used as fibre, for bedding, thatching, etc. Though it is not excluded that some plants might have had multiple purposes, evidence (presented later in this paper) suggests that the bulk of the seed assemblage is not derived from the use of plants as fibre.

Interpretation of plant remains is complicated by differential survival, whereby fragile material, such as leaves or nut cotyledons, are under-represented, by processing practices that result in plant remains being generated off-site and by cooking practices. Abundance as an indicator of importance is also obscured by the varying size and frequency of seeds produced by different species. It is obviously inappropriate to take seed abundance as a direct index of use; at the same time, there is a great deal of variation between the proportions of seeds at hunter-gatherer sites, which requires explanation. There is little evidence of context-related variation in seed composition at the study sites: at Epipalaeolithic and early (pre-Pottery) Neolithic sites, seeds are most often present at low concentration, with relatively little variation between contexts, which suggests that seed material has been subject to secondary deposition and homogenization. Amalgamation of results from individual samples for comparison between sites is (although a crude tool) therefore justified.

New archaeobotanical evidence from the northern Fertile Crescent

Hallan Çemi, Demirköy, Qermez Dere and M'lefaat (Fig. 1) belong to the Taurus-Zagros Round House Horizon, as defined by Peasnall (2000) and were occupied by hunter-gatherers. Two of these sites offer convincing bioarchaeological evidence for sedentism: plant and bone remains and, especially, the growth bands on clam shells (*Unido tigridus*) suggest that Hallan Çemi was occupied year-round (Rosenberg et al. 1998: 34). The M'lefaat bone assemblage includes the remains of birds that are present in Mesopotamia in winter only (Dobrowolski 1998: 225–7). Except perhaps at Hallan Çemi, where circular clay platforms were interpreted as possible silo bases (Rosenberg and Redding 2000: 47), no storage facilities were found.

The four sites are located in a region for which few archaeobotanical analyses have been undertaken. Most of the other Epipalaeolithic/PPNA sites for which plant remains have been published are located within the present-day potential vegetation zone of the steppe. In contrast, Hallan Çemi, Demirköy, Qermez Dere and M'lefaat have the advantage of being located along an ecological transect running from the potential vegetation zone of the steppe to that of an open oak forest.

Hallan Çemi

Hallan Çemi is located in south-east Turkey, 40km north of the city of Batman, on the west bank of the Sason Çayi, a tributary of the Batman river, itself a tributary of the Tigris. It lies within the present-day potential vegetation zone of an open oak forest. It was discovered in 1990, during a survey that aimed at identifying sites threatened by the construction of dams (Rosenberg and Togul 1991). A rescue excavation was carried out from 1991 to 1994 by Rosenberg and his team.

Hallan Çemi is considered to be the oldest fully settled village site known so far in eastern Anatolia (Rosenberg and Redding 2000). At least four building levels were identified. The lower part of the semi-subterranean round building structures were made of stones, but a large quantity of burnt clay fragments with impressions of wood sticks or reed bundles suggests that the higher parts were made of wattle and daub (Rosenberg and Davis 1992: 3). The building structures were organized around an open central area over

15m in diameter, containing fire-cracked stones and a high density of animal bones. Though rubbish dumping is not excluded, the zooarchaeological evidence and the presence of dark lenses suggest that the central area might be associated with primary deposition remains of meat preparation (Rosenberg pers. comm.). A series of nineteen new AMS dates on carbonized seeds suggest a relatively short occupation during the first half of the tenth millennium BP (uncal.) (ORAU in press).

The chipped stone industry is made from obsidian, flint and chert and has strong typological links with that of Zawi Chemi Shanidar and other late Zarzian sites (Rosenberg 1999: 29). Projectile points were rare, but most could be classified as variants of the Nemrik point (Rosenberg 1994: 129).

An impressive quantity of querns, mortars, handstones and pestles was found at Hallan Çemi. Sandstone was most commonly used for both mobile and stationary ground tools, along with limestone and metamorphic rocks (Rosenberg et al. 1995: 56). The querns belong to both trough and basin types, and some reach up to 50cm in length (Rosenberg et al. 1998: 7). The ground stone assemblage also includes stone bowls made from limestone and from a grey-green chloritic stone (Rosenberg and Redding 2000: 50). Those made from chloritic stone are often elaborately decorated with incised naturalistic or geometric designs. Elaborately decorated pestles made from the same chloritic stone or, occasionally, sandstone, were also found. They were extensively conserved and refashioned until they were too small to be used (Rosenberg and Redding 2000: 50–2).

The bone assemblage is dominated by wild ovicaprids, followed by red deer, and boar. The presence of canids, brown bear, cape hare, fallow deer, stone marten, wild cat, beaver and European hedgehog has also been noted. Turtle remains were the main non-mammalian remains found, followed by bird, fish and lizard. Rosenberg et al. (1998: 32–3) suggested the possibility of early pig husbandry, along with the hunting of wild boar. Though more analyses need to be conducted, a recent study found no conclusive evidence of pig domestication (Starkovich 2005: 34).

Demirköy

The site of Demirköy is also located near Batman, on a west-bank terrace of the Batman river, about 20km upstream from its confluence with the Tigris. It was discovered in 1998, during a survey of the Tigris-Euphrates Archaeological Reconnaissance Project (Algaze et al. 1991). Soundings were conduced by Peasnall and Rosenberg in 1997, as the site had already been partly destroyed and was in danger of further erosion. Though no building structures were found, the soundings revealed successive plaster surfaces, ashy fills, concentrations of stones, pits, human burials and a canid burial (Rosenberg and Peasnall 1998: 199–200). The two AMS dates available suggest an occupation towards the beginning of the tenth millennium BP (uncal.) (ORAU in press).

Most of the lithic assemblage was made of flint, but obsidian and quartzite were also used. The tool assemblage comprises blades, geometric microliths and points (most of them variations of the Nemrik points) (Peasnall and Rosenberg 2001: 371–82). It was suggested from the chipped stone industry that the occupation of Demirköy corresponds to the chronological gap between the abandonment of Hallan Çemi and the initial occupation of Çayönü (Rosenberg et al. 1998: 35–6). A detailed analysis of the lithic

material and comparisons with that of Hallan Çemi show a significant decrease in the use of obsidian at Demirköy, and an increase in the intensity of the use of individual obsidian pieces. Obsidian may have become scarcer when Demirköy was occupied, indicating a possible collapse in the obsidian trade (Peasnall and Rosenberg 2001: 382–4).

The artefact assemblage includes stone bowls and sculpted pestles similar to those found at Hallan Çemi. Clay was used to make ceramic figurines and vessels. The presence of a hole along the rim of a clay vessel, similar to those found on the stone bowls, suggests that it was deliberately fired, as these holes, probably used for suspension, would not be functional on unfired vessels (Rosenberg and Peasnall 1998: 199).

Qermez Dere

Qermez Dere is located in Iraq near the town of Tell Afar, about 50km from the Jebel Sinjar range, overlooking the Jezirah plain and a deeply cut wadi (Watkins and Baird 1987; Watkins et al. 1989). It lies within the present-day potential vegetation zone of the moist steppe. The site had already been damaged by the construction of a road, a pipeline and a communication cable trench, and was further endangered by a modern housing development when rescue excavations were undertaken by Watkins and his team. Initial soundings were conducted in 1986 and excavation took place in 1987, 1989 and 1990.

Three stages were identified, based in large part on the lithic assemblage composed almost exclusively of flint (Watkins et al. 1991): 1) a first Epipalaeolithic-Neolithic transitional stage characterized by an assemblage comprising both microliths and Kiam points; 2) an early aceramic Neolithic stage with no residual Epipalaeolithic traits; 3) a later stage characterized by Nemrik points progressively increasing in number, and by truncated structural remains and their deliberate fill. The ground stone tools and equipment include mortars and crude pestles made of local limestone, and querns and rubbers made from imported basalt (Watkins and Baird 1987: 10).

The occupation seems to have been continuous from *c*. 10,100 to 9700 BP (uncal.) (Watkins 1995). Seven subterranean buildings have been found; all, except one small stone structure, were made of clay. The structures seem to have been deliberately destroyed after use and back-filled. A sequence of three buildings was identified, and human cranial remains from both adults and children were found in the lower fill of the latest building of the sequence.

Remains of gazelle, a small canid, sheep/goat and hare dominate the bone assemblage. Wild cat, badger, pole cat, a variety of bird species, reptiles and amphibians are also represented, along with a very small number of aurochs, onager and boar remains (Watkins et al. 1991).

M'lefaat

M'lefaat is located in northern Iraq, about 35km east of Mosul, within the present-day potential vegetation zone of the moist steppe. The small tell is flanked by two small valleys, nowadays dry, and was first identified and sounded by Braidwood in 1954. The site had already been damaged by a Second World War concrete machine-gun emplacement and by a tank trench (Dittemore 1983: 671). A rescue excavation was conducted in 1984 during the construction of the Mosul-Erbil road. Kozłowski led two seasons of fieldwork in 1989

and 1990 on the remaining part of the tell and made a synthesis of all the results available (Kozłowski 1998; Kozłowski et al. 1991).

The village dates to the beginning of the tenth millennium BP (uncal.). Eleven round-to-oval buildings, mostly subterranean, were identified; they belong to two different phases of occupation, not far apart in time, and some of these structures are superimposed. The buildings are organized around a central courtyard made of two or three superimposed clay surfaces (Kozłowski 1998: 187).

A local flint was the main material used for the chipped stone industry, as well as a small quantity of obsidian (Kozłowski 1998: 196). The assemblage resembles those of the nearby sites of Nemrik, Qermez Dere and Jarmo but does not include Nemrik-type points (Kozłowski 1998: 197).

The ground stone assemblage includes grinders and querns made from sandstone, mortars made from calcareous mudstone and from limestone, and mortar pounders made from pebbles of various rocks, as well as celts, adzes, hammerstones, mace heads, bowl vessels, whetstones, choppers, ornaments, various pieces described as plates and trays, etc. (Mazurowski, 1998: 200–8).

Small ruminants, mainly gazelle, dominate the hand-collected mammal assemblage (Lasota-Moskalewska 1998: 215). Bones from wild goat, wild goat/sheep and wild cattle (*Bos primigenius*) were also identified, along with remains of hare, badger, wild boar and rodents. Carnivore remains include fox and wild cat. The bone assemblage also comprises remains of birds, fish, tortoise, freshwater crab and molluscs (Lasota-Moskalewska 1998: 216; Rielly 1998: 222–3). Isolated human bones have been found in both levels.

New archaeobotanical evidence

Archaeobotanical analyses were conducted on 175 samples from Hallan Çemi, twelve samples from Demirköy, forty-seven samples from Qermez Dere and four samples from M'lefaat. Most samples were from secondary deposition contexts. Among the 175 samples from Hallan Çemi, thirty-six came from the central area of the site and may be associated with primary deposition contexts. Figure 2 presents the result of the charred seed and fruit analyses in terms of overall proportions, while Figure 3 presents the ubiquity figures (percentage of samples in which a taxon was present). Because of the small number of samples, ubiquity figures were not calculated for M'lefaat, and those from Demirköy must be considered with caution. Table 1 also includes numbers and percentages for these sites.

Except at M'lefaat, no chaff was found and there is no evidence of domestication at any site. The four archaeobotanical assemblages form two distinct pairs: the assemblages of Hallan Çemi and Demirköy are very similar in being highly diverse and both dominated by valley-bottom species, while the assemblages of M'lefaat and Qermez Dere are both dominated by legumes and grasses (Savard 2005).

The Hallan Çemi assemblage is characterized by a large diversity of plants. Overall, grasses (Poaceae) represent a minute component of the Hallan Çemi assemblage in terms of proportion (Fig. 2). In terms of both ubiquity and proportions, the assemblage is dominated by sea club-rush (*Bolboschoenus maritimus*), followed by dock/knotgrass (*Rumex*/*Polygonum*) (Figs 2 and 3). Other well-represented plants include mullein (*Verbascum* sp.), large-seeded legumes (Vicieae and *Vicia*/*Lathyrus*) and Compositae

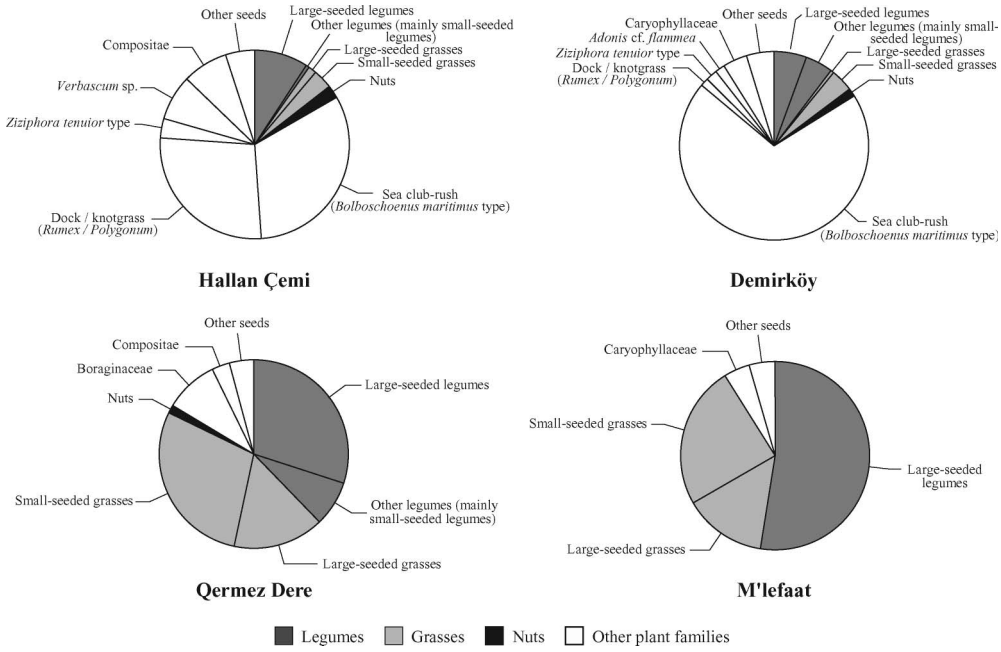

Figure 2 Proportions of plant taxa found at Hallan Çemi, Demirköy, Qermez Dere and M'lefaat.

(particularly wild lettuce (*Lactuca* sp.)). Some taxa that are not proportionally well represented show high ubiquity figures: almonds (*Amygdalus* sp.) and terebinth nut (*Pistacia* cf. *khinjuk*/*atlantica* var. *kurdica*) remains each represent about 1 per cent of the assemblage in proportions but were found in more than half of the samples; *Ziziphora tenuior* type, *Taeniatherum caput-medusae* and other indeterminate small-seeded grasses were also relatively frequent, though they were not abundant in terms of proportion (Fig. 3).

The Demirköy assemblage is largely dominated by sea club-rush in terms of both proportions and ubiquity (Figs 2 and 3). Other well-represented taxa include large-seeded pulses (Vicieae and *Lathyrus*/*Vicia*) and small-seeded legumes (Trifolieae/*Astragalus*). Although they were of minor importance in terms of proportion, unidentified small-seeded grasses and small-seeded barleys (*Hordeum murinum* complex) are nonetheless present in more than half of the samples (Fig. 3). As at Hallan Çemi, nuts are not well represented in terms of proportions, but the remains of almonds and terebinth nuts were found in many samples, along with those of barley (*Hordeum* cf. *spontaneum*), dock/knotgrass and crucifer (*Alyssum*/*Lepidium* type) (Fig. 3). However, with only twelve samples analysed at Demirköy, the ubiquity figures must be considered with caution.

In terms of proportion and ubiquity, the Qermez Dere assemblage is dominated by unidentified small-seeded grasses and large-seeded pulses (Vicieae, *Lathyrus*/*Vicia* and *Lens* cf. *orientalis*) (Figs 2 and 3). Other proportionally important taxa include small-seeded legumes (Trifolieae/*Astragalus*), Boraginaceae (*Arnebia*/*Lithospermum* and *Lithospermum* cf. *tenuiflorum*), barleys (*Hordeum* cf. *spontaneum* and *Hordeum murinum* complex) and einkorn/rye (*Triticum boeoticum*/*Secale*). Except for Boraginaceae, the same taxa dominate in terms of ubiquity (Fig. 3).

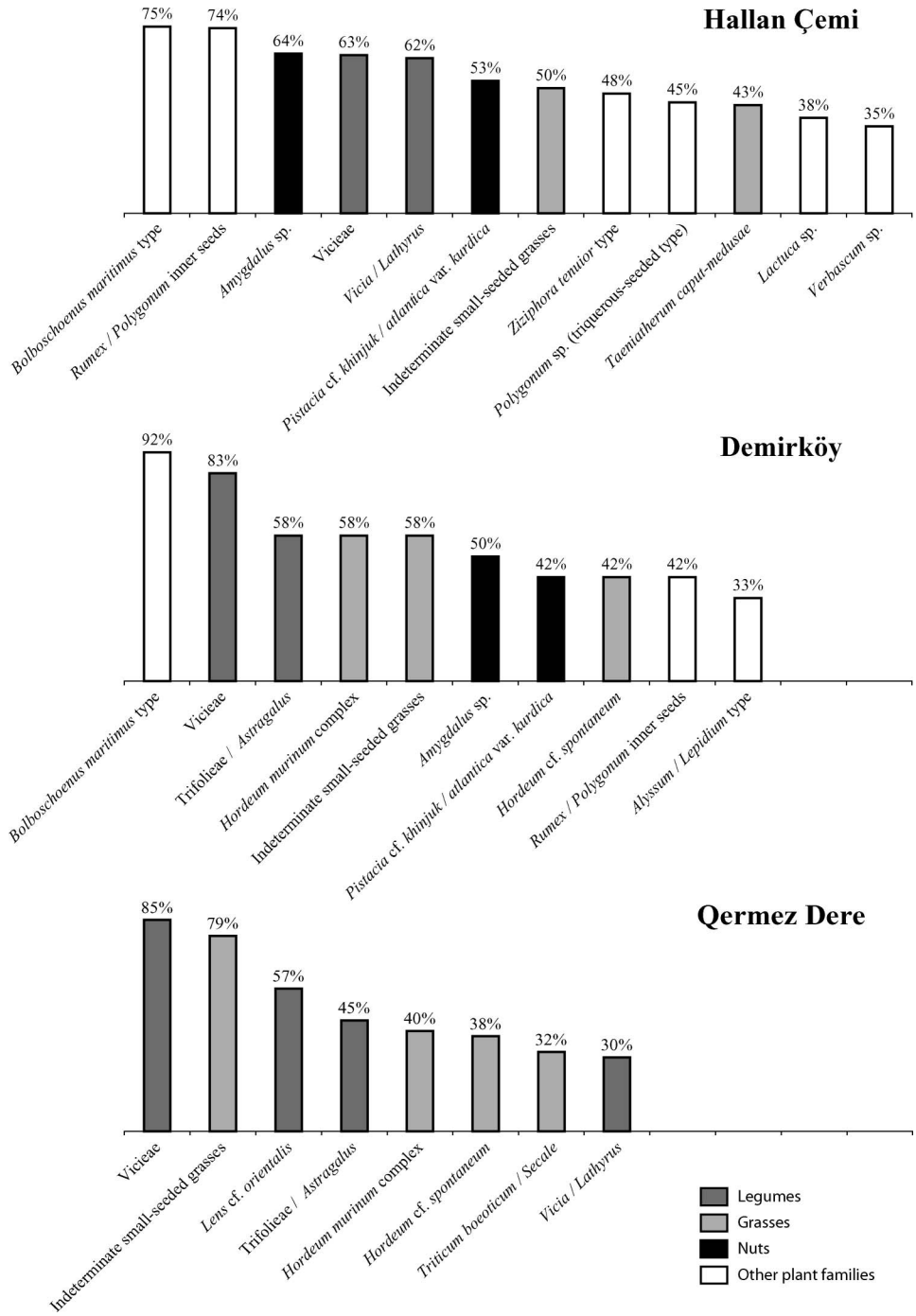

Figure 3 Ubiquity figures for the plant taxa found at Hallan Çemi, Demirköy and Qermez Dere. The taxa shown are those that were found in at least 30 per cent of the samples at each site. Because of the small number of samples, ubiquity figures were not calculated for M'lefaat, and those from Demirköy must be considered with caution.

Large-seeded legumes (Vicieae, *Lathyrus/Vicia*, *Vicia ervilia* and *Lens* cf. *orientalis*) dominate the M'lefaat assemblage in terms of proportion (Fig. 2). They are followed by unidentified small-seeded grasses, goat-grass (*Aegilops cylindrica/tauschii/speltoides*) and barley (*Hordeum* cf. *spontaneum*) (Savard et al. 2003).

Except for the Boraginaceae, the commonest plants of the four assemblages were most likely deliberately gathered as food. In addition to being well represented in terms of proportions and/or ubiquity, there is much archaeological and ethnographical evidence that suggests these plants have been used as food (e.g. Ertuğ-Yaraş 1997; Hillman 2000; Zohary and Hopf 2000). There is also good evidence that the bulk of the sea club-rush seed assemblage and, possibly, that of dock/knotgrass[2] were introduced as food rather than with construction material: no building structures were found in the central area of Hallan Çemi, while sea club-rush and dock/knotgrass were an important part of its charred seed and fruit assemblage; in most samples, they did not occur alone but with other food plants. Ethnographic records and experiments at Abu Hureyra showed that club-rush and knotgrass seeds can be roasted before being ground to flour to produce mush or griddle cakes (Hillman 2000: 354–8). Roasting would have favoured their preservation. As for Boraginaceae, they are quite commonly found in steppe vegetation (van Zeist and Bakker-Heeres 1982: 211). Their relative robustness and their high silica content have favoured their preservation. They were most likely introduced incidentally and the fact that preservation of charred remains was relatively poor at Qermez Dere might explain why they were proportionally well represented.

Food plants that are important both in terms of proportions and ubiquity were probably among the staple foods. Among the various food plants represented at each site, a limited number clearly dominate and may have been stored. Indeed, at Hallan Çemi, evidence of year-round occupation, along with high ubiquity figures for taxa available seasonally, suggests storage practices. Storage may have taken place in above-ground structures with poor archaeological visibility.

Results at other sites

Table 1 and Figure 4 present archaeobotanical results at Palaeolithic, Epipalaeolithic and PPNA sites. PPNA sites are included because they are either without evidence of domestication or with only questionable evidence (Nesbitt 2002). They are therefore treated as sites with economies based on foraging, or foraging with some cultivation of wild plants.

It is striking that large-seeded grasses ('wild cereals') are dominant (74 per cent of seed remains) at only one site: Mureybit on the Euphrates. However, at Mureybit, grasses, particularly einkorn, become an important part of the assemblage only in phase III; before that, they seem to have played a minor role. For the earliest phases, knotgrass, Boraginaceae, asparagus and small-seeded legume remains dominate the archaeobotanical assemblage (van Zeist and Bakker-Heeres 1984). Large-seeded grasses form between 11 and 16 per cent of the seed remains at M'lefaat and Qermez Dere in northern Iraq, Netiv Hagdud in Israel and Tell Aswad in Syria. Allowing for the fact that large-seeded grasses have robust grains that char well in fires, and that archaeobotanists devote extra effort to identifying them, these frequencies appear low for a staple food resource. Small-grained grasses form between

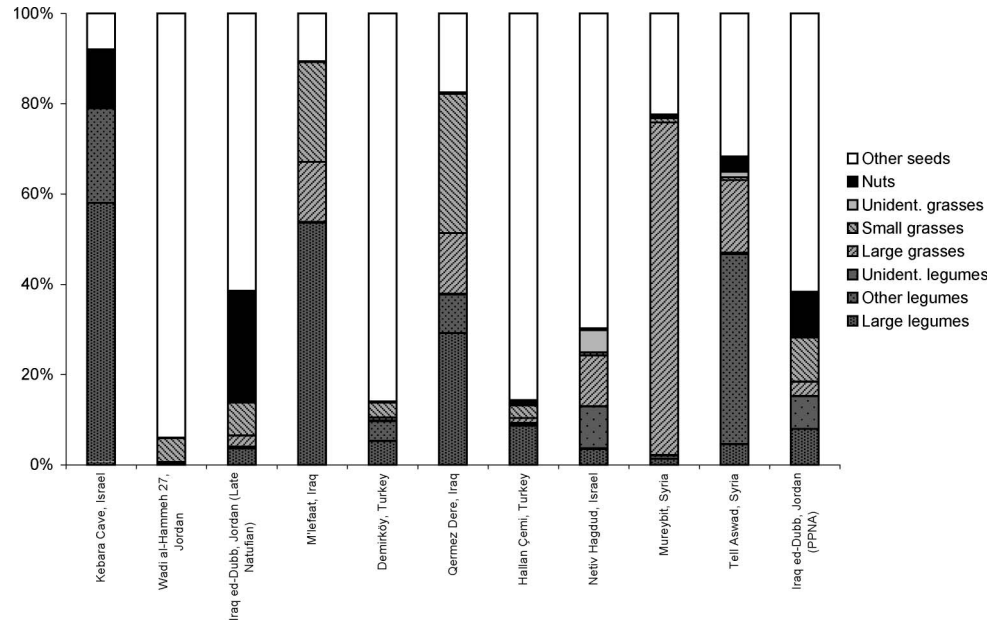

Figure 4 Proportions of seed remains from Palaeolithic to PPNA sites in Southwest Asia.

17 and 29 per cent of the seeds at Ohalo II, M'lefaat and Qermez Dere, and outnumber large-seeded grasses at eight of the twelve sites for which we have figures. Even allowing for the greater seed numbers of small-seeded grasses, this supports Weiss et al.'s (2004b) view that small-seeded grasses were an important food resource.

The assemblages of M'lefaat, Kebara Cave and, to a lesser extent, Qermez Dere are dominated by large-seeded legumes (respectively 52.4, 57.8 and 30.1 per cent) (Table 1 and Fig. 4). Small-seeded legumes dominate the assemblage of Tell Aswad (42.1 per cent). Hallan Çemi and Demirköy are both dominated by sea club-rush (respectively 32.1 and 70 per cent) (along with dock/knotgrass at Hallan Çemi (27.3 per cent)). Of the twelve sites with seed counts available, strong dominance by a single seed type occurs at M'lefaat, Kebara Cava, Mureybit, and Demirköy (Figs 2 and 4). The other sites are highly diverse in their seed remains.

Conclusions

Grasses in pre-agrarian subsistence

Examination of plant remains from the four sites reported in detail here, and eleven others, shows that large-seeded grasses are a minor component at pre-agrarian sites, with the exception of Mureybit. At five to seven other sites (the abundance at Abu Hureyra and Jerf el Ahmar is uncertain) the abundance of large-seeded grasses exceeds 10 per cent, suggesting that they are one of a number of staple foods. At the remaining seven to nine sites their presence is negligible.

Small-seeded grasses are often an important component of archaeobotanical assemblages; their exploitation seems to be a significant part of hunter-gatherer subsistence strategies in the Levant. The remains found at Ohalo II suggest this has been the case since at least 19,500 (uncal.) BP (Kislev et al. 2002; Weiss et al. 2004a). However, contrary to Weiss et al. (2004b: 9553–4), we find that the use of small-seeded grasses does not fall sharply after the Epipalaeolithic period. Small-seeded grasses are more abundant than at Ohalo II (17.8 per cent) at the PPNA sites of M'lefaat (24.6 per cent) and Qermez Dere (28.9 per cent), and are important at Abu Hureyra and Iraq ed-Dubb (9.8 per cent).

Overall, sites show much diversity in both time and space. Grasses appear not to have had the same importance everywhere: Hallan Çemi and Demirköy mark one extreme in the low importance of grass exploitation in hunter-gatherer subsistence strategies. The relatively high ubiquity figures for some of the grasses (including barleys) within the Hallan Çemi and Demirköy assemblages indicate that they might have been relatively common in the vicinity of the site, and frequently gathered and/or maybe even stored, but their extremely low proportions suggest that they were not staple resources. Instead, valley-bottom plants were undoubtedly among the staple foods.

Given the paucity of large-seeded grasses at pre-agrarian sites, it is all the more striking that the Neolithic 'founder crops' were to include four cereals: einkorn and emmer wheat, barley and rye. The selection of these, and a small number of large-seeded legumes, is most plausibly explained by their morphological and ecological suitability for cultivation (cf. Bar-Yosef and Kislev 1989: 636–40), rather than their abundance in pre-agrarian diet. Where grasses were indeed an important part of hunter-gatherer subsistence strategies, they may have been neither the main nor the only staple food: for example, in the Qermez Dere and M'lefaat assemblages, legumes also played an important role throughout the occupation of the site. Published results at comparison sites have also shown that other food-plants, such as legumes, were often at least as important as grasses in terms of proportions. Finally, Mureybit illustrates that, when grasses are dominant within the overall assemblage of a site, they are not necessarily dominant in all sub-phases, especially those associated with the initial occupation.

At Hallan Çemi, where there is bioarchaeological evidence for year-round occupation, sedentism was possible without the exploitation of grasses as an important subsistence strategy. At M'lefaat, where there is also strong bioarchaeological evidence for year-round occupation, other food plants are as important as grasses in terms of proportions and ubiquity.

Sedentism and dietary diversity

The model by which hunter-gatherers became sedentary by exploiting a small number of staple foods, typically thought to include grasses (particularly the wild progenitors of cereals) and nuts, was based on data from a small number of Levantine sites. New data suggest that this model may not be applicable throughout Southwest Asia or, indeed, in the Levant itself. Furthermore, the archaeobotanical remains from Ohalo II show some continuity in food-plant gathering between 19,500 BP and 10,000 BP (uncal.), suggesting that there might have been little difference between the diet of hunter-gatherers thought to be mobile in 19,500 BP and sedentary in 10,000 BP. Even in the Levant, the exploitation of

grasses might not have triggered nor have been an important factor for sedentism, as argued earlier by Olszewski (1993). As suggested by Peter Rowley-Conwy (2001: 58–65), the first domesticates in this and other agricultural societies would not have been the staple foods of pre-agrarian societies.

The progressivist perspective usually applied to sedentary hunter-gatherer sites, and the quest for the earliest evidence for agriculture, translate into a quest for 'wild cereals'. Instead, the archaeobotanical assemblages of Hallan Çemi, Demirköy, Qermez Dere and M'lefaat and those of broadly contemporary sites fit with elements of Flannery's (1969) broad spectrum model. Subsistence strategies seem to have been as diverse as the local environments. Although the exact causes of the variability in plant diet between different sites remain to be established, it appears that hunter-gatherers were taking an opportunistic advantage of the resources available. Sedentism was possible in areas offering a wide diversity of resources, both locally and seasonally. The presence of reliable resources (such as valley-bottom plants) probably had more importance for sedentism than 'wild cereals'.

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Notes

1 There is no consensus yet on how one should label sedentary hunter-gatherer sites from Southwest Asia: they are described variously as Epipalaeolithic, Proto-Neolithic, Pre-Pottery Neolithic A (PPNA), Natufian, etc. For example, Hallan Çemi has been labelled Epipalaeolithic (Peasnall and Rosenberg 2001: 363; Rosenberg et al. 1998: 27), Proto-Neolithic (Peasnall 2002: 5; Rosenberg and Redding 2000: 40) and early Neolithic or aceramic Neolithic (Rosenberg 1999: 26; Rosenberg et al. 1995: 1; Rosenberg and Davis 1992: 1). Peasnall (2000) also suggested the Taurus-Zagros Round House

Horizon. The diversity in chrono-cultural labels is not linked with a lack of consistency, but rather reflects the difficulty of classifying these sites within strict categories.

2 There are over fifty species of dock/knotgrass documented in Turkey and their seed edibility varies between species.

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