New archaeobotanical data from the Early Neolithic sites of Dja'de el-Mughara and Tell Aswad (Syria): A comparison between the Northern and the Southern Levant

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Abstract. *Numerous archaeobotanical studies have shown that agriculture developed simultaneously over a wide area of Southwest Asia during the Early Holocene. Nevertheless inter-regional studies of individual sites are rare. This paper presents a comparison between charred seed and chaff remains from the Early Neolithic levels of Dja'de el-Mughara situated in the Northern Levant and from Tell Aswad in the South. Both sites have undergone new analyses of samples not included in the previous publications. That the two regions developed independently culturally is not in doubt, but this comparison demonstrates the dissimilarity between locally exploited wild plants and the cultivars which led agriculture to develop autonomously in each region during the PPNA and PPNB. Despite the long sequence at both sites, changes in the plant economies are barely perceptible. In accordance with this selection within cultivated cereal populations for domestic traits appears to proceed very slowly compared to hypothetical estimates. We give three reasons for this might be the case.*

Résumé. *De nombreuses études archéobotaniques ont montré que l'agriculture s'est développée simultanément dans l'ensemble du Proche-Orient au début de l'Holocène. Toutefois, les comparaisons inter-régionales s'appuyant sur des études détaillées de sites restent rares. Cet article présente une comparaison des carporestes carbonisés datant du début du Néolithique et provenant des sites de Dja'de el-Mughara situé au Levant nord et de Tell Aswad au Levant sud. Ces deux sites ont bénéficié de nouvelles analyses avec l'ajout d'échantillons qui n'avaient pas été inclus dans les précédentes publications, élargissant ainsi le corpus. Bien que le développement culturel indépendant des deux régions ne fasse aucun doute, cette comparaison pointe les dissemblances entre les taxons sauvages exploités et les cultivars, ayant conduit au développement de l'agriculture de manière autonome dans chacune des deux régions au PPNA et PPNB. Malgré la longue période d'occupation de chacun des deux sites, les changements dans l'économie végétale sont très peu perceptibles. La sélection de traits domestiques au sein des populations de céréales cultivées s'avère particulièrement lente, contrairement aux estimations. Nous donnons ici trois explications permettant d'expliquer la lenteur de ce processus.*

Keywords. *archaeobotany, Syria, Levant, Pre-Pottery Neolithic, development of agriculture*
Mots-clés. *archéobotanique, Syrie, Levant, Néolithique acéramique, développement de l'agriculture*

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Archaeobotanical studies suggest that agriculture developed simultaneously and independently in different areas of Southwest Asia during the Early Holocene (Willcox 1999 and 2005, Fuller *et al.* 2011). In order to substantiate this hypothesis the comparison of individual sites from different regions is necessary. It is for this reason that in this paper we present new results from the sites of Dja'de el-Mughara and Tell Aswad, dated to between the 10th and 8th millennia cal BC, located respectively in Northern and Southern Syria (fig. 1). The study was carried out as part of a PhD thesis (Douché 2018) and provides new information about the emergence of agriculture in the two regions. The full results of this work will be the subject of future publications. Earlier studies of the charred remains from Dja'de were published in 2008 (Willcox *et al.* 2008) and they suggested that pre-domestic cultivation was practiced at the site. At Aswad morphological domestication had been identified (Van Zeist and Bakker-Heeres 1982). More recent excavations by Stordeur and Jamous showed that domestic cereals were present by *ca.* 8500 cal. BC (Stordeur e*t al.* 2010) corresponding to the PPNB[1] and not, as previously suggested, to the PPNA. Given that numerous Levantine sites show signs of pre-domestic cultivation during the PPNA followed by morphological domestication during the PPNB and that these events occurred independently in different regions of Southwest Asia (Willcox 1999, 2005, Fuller *et al.* 2011), it is of particular interest to compare in detail the archaeobotany of these two sites. Dja'de, dated to 9310-8290 cal. BC, is earlier than Aswad, dated to 8700-7000 cal. BC, but there was a chronological overlap of four centuries (table 1). The two sites also differ in that Dja'de is considered to have had pre-domestic cultivation with only limited signs of animal domestication (Helmer *et al.* 2005), while Aswad was an early farming site with animal and plant domestication (Helmer and Gourichon 2008, Stordeur *et al.* 2010).

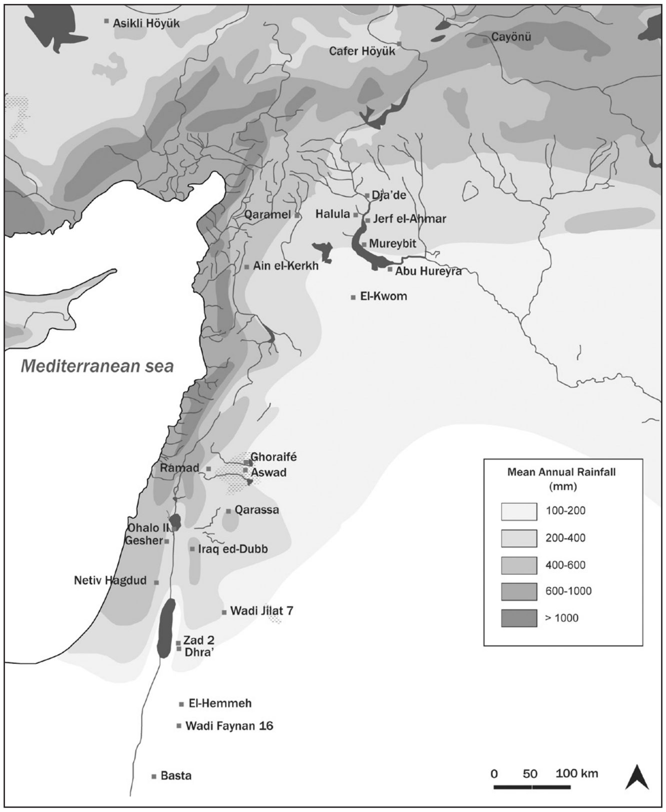


Fig. 1 – *Location map of sites mentioned in the text and mean average rainfall for the area (C. Douché).*

MATERIALS AND METHODS

The two sites are situated in different climatic zones. Contemporary average annual rainfall is given in Figure 1 but it should be noted that inter-annual variability is high. Today's averages probably do not reflect rainfall at the time of occupation. The Early Holocene was a period of climatic amelioration which was more favorable to plant growth compared to the proceeding Younger Dryas period. How this affected humans at this time is difficult to assess. A recent paper suggests that "early farming communities were resilient to the abrupt, severe climate changes at 9250 and 8200 cal. BP" (Flohr *et al.* 2016). In this paper we have purposely avoided using deterministic reasoning in relation to early cultivation based on climate change.

DJA'DE EL-MUGHARA

Dja'de el-Mughara is located on the Middle Euphrates, in Northern Syria (fig. 1). The settlement lies on a Pleistocene terrace overlooking the Euphrates. The local vegetation consists of a riparian formation of the Euphrates and with a degraded steppe in the surrounding area.

The site was excavated by É. Coqueugniot between 1991 and 2010, and a deep stratigraphy of up to 9 m of archaeological deposits was uncovered (Coqueugniot 1998 and 2014). The Pre-

1. For the chronological periods we use the traditional terminology originally used by Kenyon 1981 of the Pre-Pottery Neolithic (PPN) divided into PPNA (10000 cal. BC) and Early (EPPNB), Middle (MPPNB) and Late (LPPNB) PPNB (8700-7000 cal. BC). For dates and discussion on these periods see Aurenche *et al.* 1981, Cauvin 2010, Borrell *et al.* 2016 and Edwards 2016.

Table 1 – *Left, dating and phases of Dja'de el-Mughara and Aswad. Right, volume and density of samples and total identifications (C. Douché). At Tell Aswad phase AW3 samples came from two areas, the four samples from sector C were recovered from storage structures, which explains the high density. Several samples have been excluded from the calculation of density due to the unknown volume of sediment (this concerns 11 samples for DJ2 and 30 samples for DJ3).*

	Phases		Dates (cal. BC)	Period	Number of samples	Volume of sediment (L)	Volume of flot (mL)	Minimum Number of Individuals (MNI)	Average density of MNI (per L)
Dja'de	DJ1	Early	9310-8830	end of PPNA	52	934	3091	4989	5,34
	DJ2	Middle	8800-8500	first half of Early PPNB	84	1795	10449	27310	13,48
	DJ3	Late	8540-8290	second half of Early PPNB	153	4246	28349	19425	3,87
	Total				289	6975	41889	51724	7,56

	Phases		Dates (cal. BC)	Period	Number of samples	Volume of sediment (L)	Volume of flot (mL)	Minimum Number of Individuals (MNI)	Average density of MNI (per L)
Aswad	AW1	Early	8700-8200	end of Early PPNB	50	2487	702	13410	5,39
	AW2	Middle	8200-7500	Middle PPNB	110	2393	2140	30396	12,70
	AW3 [B]	Late	7500-7000	beginning of Late PPNB	102	2643	1247	16994	6,43
	AW3 [C]				4	80	23	2852	35,65
	Total				266	7603	4112	63652	15,04

Pottery Neolithic occupation dates from the end of the PPNA to end of the Early PPNB (9310-8290 cal. B.C). It was subdivided into three phases according toarchitectural, technological changes in the lithics and radiocarbon dates. DJ1 (table 1) was excavated primarily to explore a "communal building" consisting of a large semi-subterranean circular building with painted walls. DJ2, is characterized by rectangular and multicellular buildings. At the end of this phase, "grill-plan" structures appear which are located in external spaces and consist of parallel stone walls lying on a pebble layer. Finally, DJ3, the late occupation phase, has a small mortuary building (Coqueugniot 2000) which contained skeletons representing 50 individuals (Coqueugniot 2014).

TELL ASWAD

Tell Aswad is situated in the Damascus basin in Southern Syria 10 km from the seasonal Lake Aateibe which is fed by the Barada, a seasonal river which flows from the Lebanese mountains. At the time of occupation, Aswad was situated a short distance from Lake Aateibe, which was more extensive during the Early Holocene (Van Zeist and Bakker-Heeres 1982, Stordeur *et al*. 2010). Even in the late 19th century AD, the lake and marshland vegetation covered a much wider area than today (Porter 1870). To the east, a dry steppe vegetation probably prevailed throughout the Holocene, whereas to the west, the forest vegetation on the Anti-Lebanon and Hermon may have extended farther east and been nearer to the site. Test trenches were excavated by H. de Contenson in 1971 and 1972 (Contenson *et al*. 1979, Contenson 1995, Van Zeist and Bakker-Heeres 1982) and then, between 2001 and 2006 an area excavation was carried out by D. Stordeur and B. Jamous (Stordeur *et al*. 2010). The Early Neolithic occupation has been divided into three phases, from the end of the Early PPNB to the beginning of the Late PPNB (for dates see table 1). In the AW1 phase buildings are semi-subterranean and sub-circular. The AW2 phase is characterized by dense occupation and terracing, with alternate expansion and contraction of the village. The third occupation phase is represented by domestic and funerary areas in sector B and by small storage structures and a "workshop" area in sector C.

THE SAMPLES

At both sites, flotation samples were recovered from diverse archaeological contexts predominantly hearths, occupation layers, middens, demolition deposits, floors, pits, etc. In this paper, 555 samples from well dated contexts, consisting of a total of 115,376 identified items from the two sites, has been used. Details of the volume, density and total identifications are given table 1. The comparison between the two sites has been enabled by grouping totals from each phase or each site. This was necessary in order to obtain statistically significant results which also assumes that most remains were deposited arbitrarily, with the exception of a storage structure from the late phase AW3 [C] at Aswad. Much of the sorting and identification was carried out by Willcox and colleagues between 1991 and 2007, and as part of a European project between 2003 and 2006. However, between 2007 and 2010 additional samples were recovered from Dja'de, which have been analysed by C. Douché. All the samples recovered from both sites were taken into account her PhD dissertation (Douché 2018).

The vast majority of items were preserved by charring with the exception of biomineralised seeds of the Boraginaceae family and a few sedge and fig akenes which were mineralized. Quantification methods include total seed counts, their percentages (*ibid.*) and ubiquity, that is, the percentage of samples in which a taxon is present.

For the identification of morphological domestication in this study, the criteria and categories as described by Tanno and Willcox 2012 were used.

RESULTS

EDIBLE TAXA

Finds of edible taxa from recent unpublished analyses (Douché 2018) and those already published (Willcox *et al.* 2008) have been combined. At Dja'de, barley (*Hordeum vulgare* subsp. *spontaneum*) and lentil (*Lens* sp.) make up the major components of the crop assemblage. Rye (*Secale* sp.), emmer (*Triticum turgidum* subsp. *dicoccoides/dicoccocum*) and einkorn (*Triticum monococcum* ssp.) are minor components and appear to have increased in frequency during the occupation (fig. 2). This is in contrast to Aswad, where barley (*Hordeum vulgare* subsp. *spontaneum/vulgare*) followed by emmer wheat are the most frequent cereals. Rye is absent and einkorn is a minor component.

Pulses were more frequent at Dja'de but at both sites lentils were the most common pulse. Apart from lentils the differences in the frequencies of pulses between the two sites are not very informative (fig. 3). This is because many pulses were fragmented and for various reasons unidentifiable. Many of these were grouped as *Pisum/Vicia/Lathyrus* shown in Figure 3. In terms of presence/absence, chickpea (*Cicer* sp.) is present at Dja'de and absent from Aswad, and faba bean (*Vicia faba*) is present in all phases at Aswad but only in phase three at Dja'de.

For the fruits (fig. 4), oriental terebinth (*Pistacia* cf. *atlantica*) was the most common fruit at both sites and this is typical of this period for the whole region. Caper seeds (*Capparis* sp.) were frequent at both sites. The most significant difference is that fig akenes (*Ficus* cf. *carica*) were common at Aswad but rare at Dja'de.

EVIDENCE FOR MORPHOLOGICAL DOMESTICATION

No evidence for morphological domestication was recognized at Dja'de. The low percentages of domestic types could occur in wild populations (Kislev 1989). Morphological domestication was present at Aswad but wild types were by far the most common. Frequencies of domestic (fig. 5) *versus* wild barley suggest that domestic barley only starts to occur in significant proportions in phase AW2 (*ca.* 8200 cal. BC), while domestic emmer appears to be significant only in phase AW3 (*ca.* 7500 cal. BC; fig. 6). The information given here uses only samples from secure PPNB contexts, which although providing fewer results than in Tanno and Willcox 2012, renders the results more reliable. Indeed the dates for domestication are slightly later than those proposed previously. In the 2012 paper, Tanno and Willcox identified >30% domestic barley from AW1. The new results based on a revised stratigraphic sequence, indicate that morphological domestication appears during AW2, not in AW1. It is significant that during the period of overlap of the two sites neither has evidence for morphological domestication.

WILD/WEED TAXA

A comparison of wild/weed taxa is given in Figure 7. Only those taxa with more than 5% ubiquity were used. Species identification was rarely possible due to a) poor preservation, b) the large number of closely related species for each genus which occur in the Near East, and c) many of which were not available in the reference collection. Taxa which may represent obligatory arable weeds (Willcox 2012a) such as *Centaurea* sp., *Onobrychis* sp., *Glaucium* sp. and *Fumaria* sp. were quite common at Dja'de. This adds weight to the interpretation of pre-domestic cultivation at Dja'de. Other arable weed taxa like *Vaccaria* sp. and *Melilotus* sp., common at Aswad, were perhaps better adapted to the south. These differences suggest how arable weeds may have developed and evolved separately in the two regions. However, some arable weed taxa such as *Adonis* sp., *Erodium* sp., and *Galium* sp. were moderately frequent at both sites.

Fig. 2 – *Totals and relative abundance of cereals from the two sites (C. Douché). Barley predominates at both sites. Emmer is frequent at Aswad and rare at Dja'de. Rye is absent from Aswad and the second most common cereal at Dja'de. Throughout the sequence at both sites barley is in decline and emmer increases.*

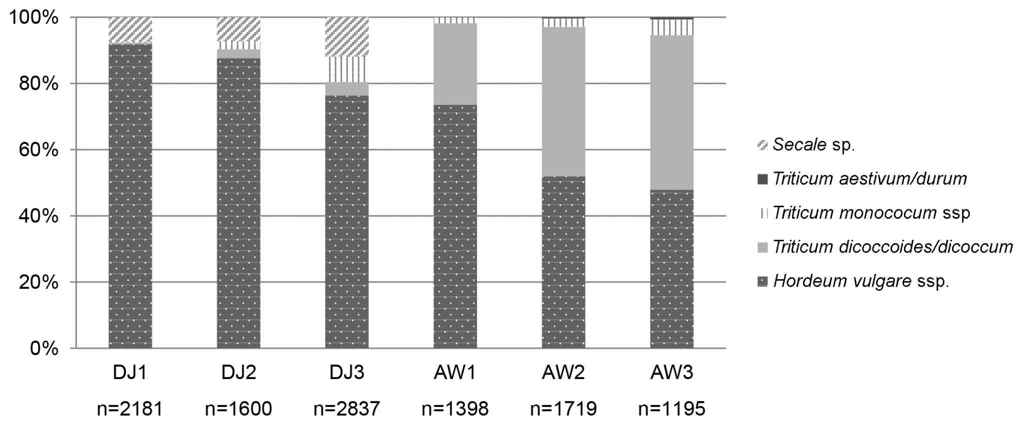


Fig. 3 – *Totals and relative abundance of pulses from the two sites (C. Douché). Pulses are more common at Dja'de than Aswad. Lentils are the most frequent pulse. Many pulses were fragmented and unidentifiable. Chickpea is present at Dja'de and absent from Aswad. Faba bean is present at all phases at Aswad but only in phase three at Dja'de.*

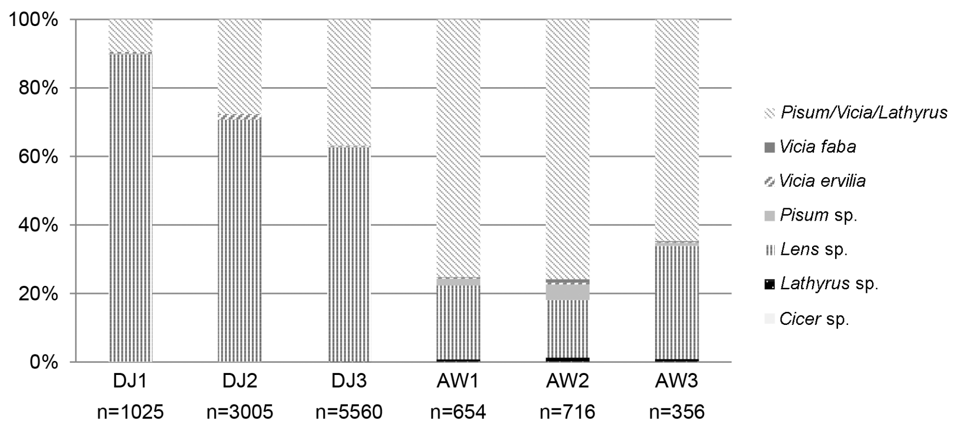
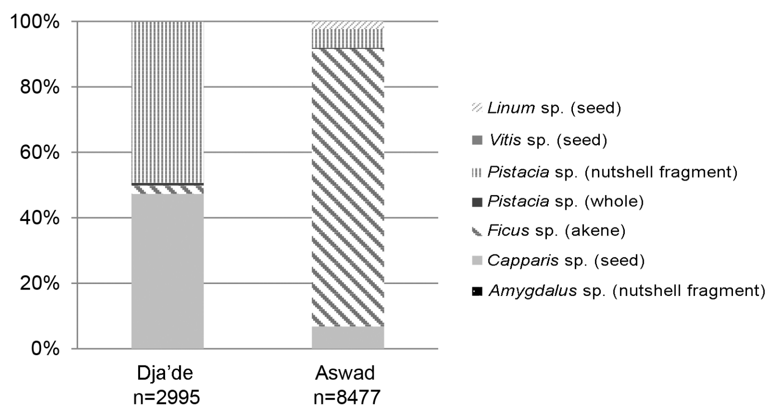


Fig. 4 – *Totals and relative abundance of fruits and flax from the two sites (C. Douché). Fig achenes are common at Aswad and rare at Dja'de. Fragments of oriental terebinth were common at Dja'de and quite well represented at Aswad. A few whole endocarps were found (not shown here). Flax was present at Aswad and absent from Dja'de. Caper seeds were frequent at Dja'de and quite well represented at Aswad. The fruits of figs and capers produce large numbers of seeds, hence the large quantities. Four grape pips were recovered from Dja'de but not from Aswad.*



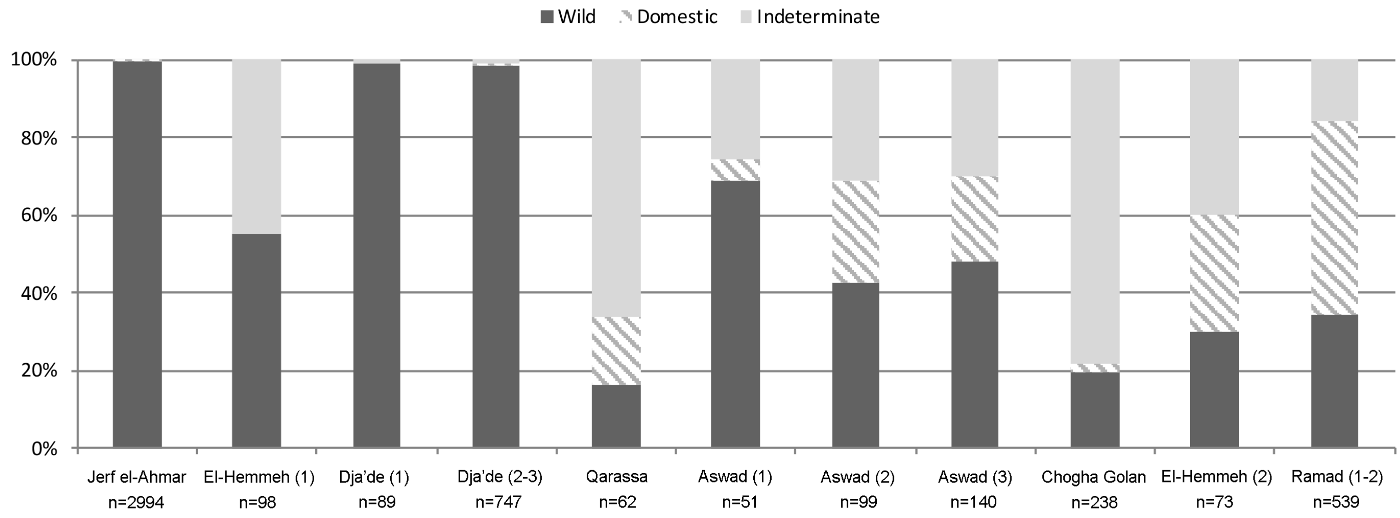


Fig. 5 – *The proportions of domestic and wild barley spikelet bases of from a selection of sites (C. Douché). The frequencies of domestic types only start to become significant in the MPPNB phase 2 at Aswad. The number of indeterminate specimens from Qarassa was not available. References: Jerf el Ahmar (Willcox 2012b), El-Hemmeh (White and Makarewicz 2012, White and Wolff 2012), Dja'de (personal data), Qarassa (Arranz-Otaegui* et al. *2016b), Aswad (personal data), Chogha Golan (Weide* et al. *2017), Ramad (Van Zeist and Bakker-Heeres 1982).*

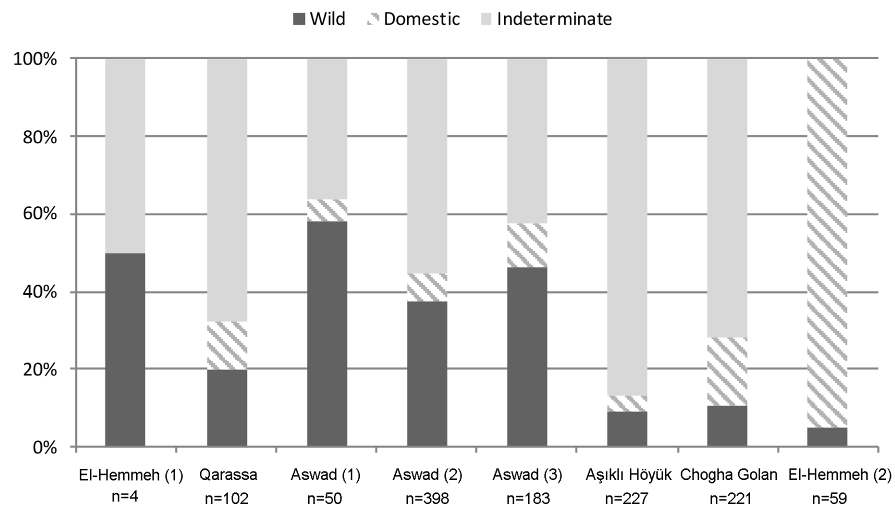


Fig. 6 – *The proportions of emmer spiklet bases from a selection of sites (C. Douché). Domestic types are infrequent. With eleven % found in Aswad 3 and Chogha Golan it is difficult to know if this is the beginning of the domestication process or bias in favor of wild types. Only at El-Hemmeh 2 does morphological domestication appear to be securely established. The indeterminate specimens from Qarassa was not available. References: El-Hemmeh (White 2013, White and Wolff 2012), Qarassa (Arranz-Otaegui* et al. *2016b), Aswad (personal data), Aşıklı Höyük (Tanno and Willcox 2012), Chogha Golan (Weide* et al. *2017).*

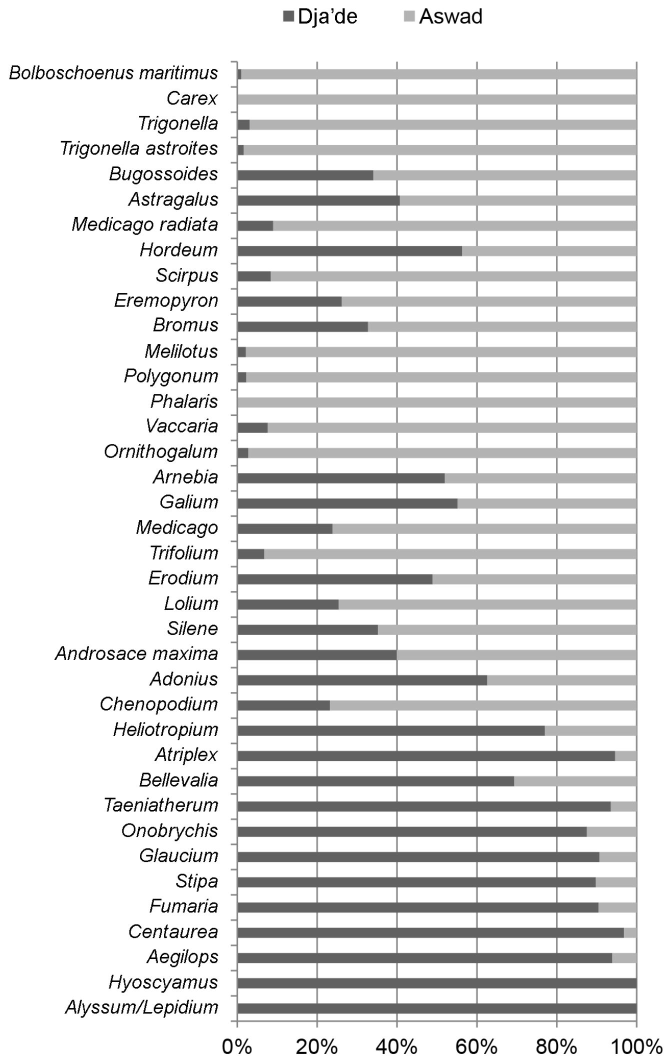


Fig. 7 – *Ubiquity percentages of wild/weed taxa (C. Douché). Only taxa occurring in more than 5% samples are given. Species identification was rarely possible. Arable weed taxa were frequent at both sites. Others taxa such as* Bolboschoenus maritimus, Taeniatherium *sp.,* Aegilops *sp.,* Stipa *sp.,* Hyoscyamus *sp. and Atriplex sp. were more specific to one site or the other.*

The differences between the two sites reflect the different vegetation types in the two areas. Thus high frequencies of taxa such as *Carex* and *Bolboschoenus* see *glaucus* at Aswad may be due to the presence of the lake, while *Trigonella astroites*, *Medicago radiata, Phalaris* sp., *Ornithogalum* sp. could be weeds or remains from the burnt dung of domestic herbivores (Helmer *et al*. 2005). At Dja'de, *Stipa* sp., *Taeniatherium* sp., *Aegilops* sp., and *Hyoscyamus* sp. reflect the moist steppe, *Atriplex* type *tatarica* is found in Euphrates valley today and *Alysumm/Lepidium* was a plant possibly used for its oil.

DISCUSSION

The differences in the cereals found on the two sites may be due to local and regional differences in climate and soils which affect local vegetation. Finds of rye are restricted to the Northern Levant in general and in particular to Euphrates sites (fig. 8). Today's natural distribution of two likely progenitors, *Secale montanum* and *S. cereale* subsp. *vavilovii*, is located farther north and northeast of Dja'de, on acidic soils (mainly basalt) in regions at higher altitudes with cooler climates. These habitats are approximately 160 km from Dja'de. At the beginning of the Holocene, rye could have grown much nearer on the basaltic outcrops that occur to the south of Dja'de near the village of Sireen and also to the north on the road to Kobani, less than 15 km away (observations by Willcox). Rye was identified at Abu Hureyra (Hillman *et al*. 2001), Jerf el Ahmar (Stordeur and Willcox 2009) and Tell Abr'3, and was also recognized at Tell Mureybet in chaff impressions in pisé (Willcox and Fornite 1999). On these PPNA sites rye was present in lower quantities than barley and evidence from Dja'de show it persists during the Early PPNB. This persistence is surprising because this period coincides with the Early Holocene global warming which would have been unfavorable to rye in this region.

During the MPPNB, changes in the proportions of cereals can be seen across the Near East. Emmer tends to increase at the expense barley, einkorn and rye depending on the region. This is true for the north and the south alike. At Aswad and Dja'de this is seen in a decrease in barley relative to the other cereals (fig. 2 and 8). This decrease of barley has also been observed at Jerf el Ahmar between the beginning and the end of the PPNA occupation, and at El-Hemmeh from the PPNA to the Late PPNB occupation (White and Makarewicz 2012, White and Wolff 2012). The predominance of barley in the early periods could be explained by its availability and its wide adaptability to a wide range of soils and climates, which is why it has a large distribution today in the Near East. The distribution of the wild progenitor, *H. spontaneum*, encompasses much of the Fertile Crescent (Zohary *et al*. 2012). Despite this, barley as a major component is rather erratic. It was rare or absent from Epipalaeolithic and Khiamian levels at Abu Hureyra, Tell Qaramel (Willcox and Herveux 2013) and Mureybet (Van Zeist and Bakker-Heeres 1984, Willcox 2008) which may be due to the cool conditions of the Younger Dryas. At PPNA Tell Abr'3 (Willcox *et al*. 2008) and PPNA Mureybet barley is a minor component, but this may be bias due to the small number of samples, while at PPNB sites such as Qarassa (Arranz-Otaegui *et al*. 2016a), Ghoraifé and

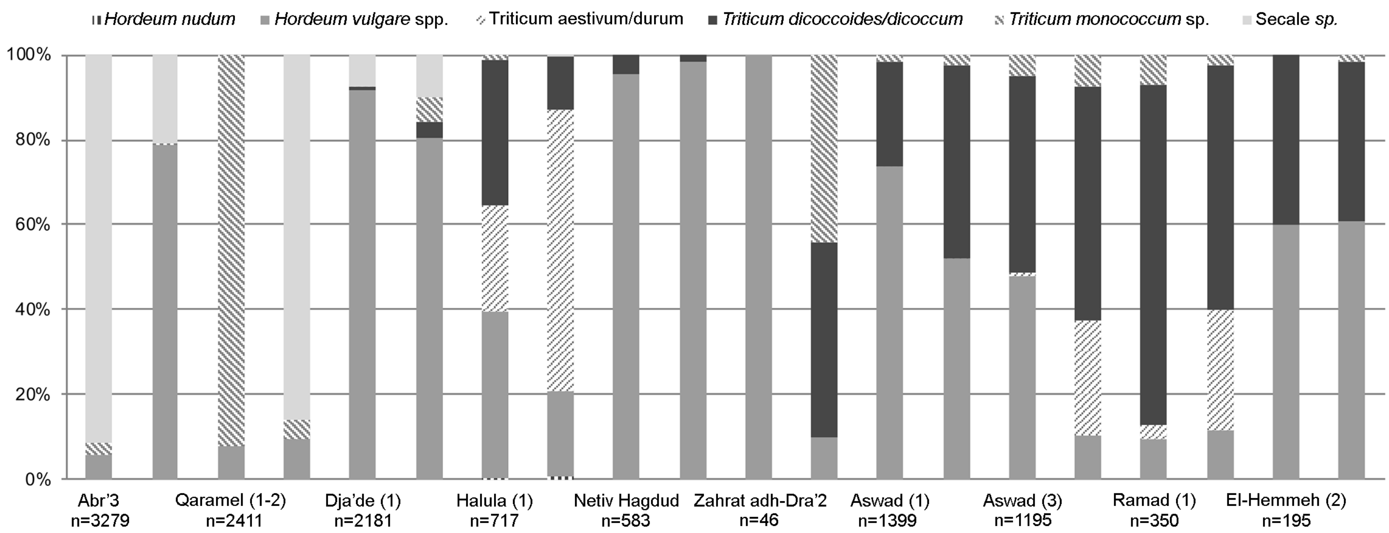


Fig. 8 – *Totals and relative proportions of cereals from selected sites (C. Douché). Rye is restricted to Euphrates sites. Emmer is frequent in the south and rare in the north. Einkorn is rare in the south with the exception of Tell Qaramel. Barley is somewhat erratically represented (results from Mureybet are based on recent re-examination by C. Douché). References: Abr'3 (Willcox* et al. *2008), Jerf (Willcox and Stordeur 2012), Qaramel (Willcox and Herveux 2013), Mureybet (Van Zeist et Bakker-Heeres 1984, personal data), Dja'de (Willcox and Douché personal data) Halula (Buxó and Rovira 2013), Netiv Hagdud (Kislev 1997), Zahrat adh-Dhra'2 (Edwards* et al. *2004), Qarassa (Arranz-Otaegui* et al. *2016a), Aswad (personal data), Ghoraifé (Van Zeist and Bakker-Heeres 1982), Ramad (van Zeist and Bakker-Heeres 1982), El-Hemmeh (White 2013, White and Wolff 2012), Basta (Neef 2004).*

Ramad (Van Zeist and Bakker-Heeres 1982) low frequencies are more difficult to understand. Could this be explained as the start of the general decline of barley seen across Southwest Asia during the PPNB?

The comparison between the two sites and evidence from other sites indicate that a combination of barley, emmer (fig. 8) combined with fig (fig. 9) are characteristic of the PPNA and EPPNB in the Southern Levant. Hulled barley and emmer wheat are the major cereal crops at Aswad. They both have a wide natural distribution, including large parts of Southern Syria. Emmer has been identified in the north on sites such as at Çafer Höyük (Moulins 1997) and Aşıklı Höyük (see Ergun in this volume), but at these sites einkorn is more frequent than barley. Figure 9 illustrates the distribution and quantities of figs achenes for the Near East, they are rare or absent on PPN sites in the north and common in the south.

To sum up the differences in cereal composition between north and south given the number of sites and the number of samples are significant. One exception is Qarassa which has higher frequencies of einkorn than other PPNA and PPNB sites in the south. However this may be explained by small sample size and the presence of runt grain (Arranz-Otaegui *et al*. 2016a).

Flax was quite common at Aswad; it is absent from PPNA sites in the north and rare on later sites. Future analyses could explain how flax dispersed. Was it introduced from south to north or vice versa? Flax seeds were recovered at the Middle/Late PPNB sites of Ghoraifé and Ramad in the Damascus area (Van Zeist and Bakker-Heeres 1982), approximately in the same period at Halula in the Middle Euphrates area (Buxó and Rovira 2013) and farther north at Çafer Höyük (Moulins 1997).

Pulses such as *Cicer* sp. *Vicia faba* or *Pisum* sp. are difficult to compare statistically between sites and regions because in most cases they are very rare except when found exceptionally in storage structures as at Yiftah'el in Israel. Some Early PPNB sites in the north have higher frequencies of pulses than cereals and Dja'de is an example (fig. 10). Lentils are the most common pulse at Dja'de and Aswad, indeed they are ubiquitous across the Near East during the Neolithic period. Chickpea is present at Dja'de but absent from Aswad. It is rarely found on PPN sites. It was identified at several sites in the Northern Levant, in some cases in substantial quantities, for example at Tell el-Kerkh (Tanno and Willcox 2006). Finds of chickpea are rare in the south, indeed the only finds come from the LPPN period at Tell Ghoraifé and Ramad. Present-day wild chickpea (*Cicer arietinum* subsp. *reticulatum*) is restricted to a small area of

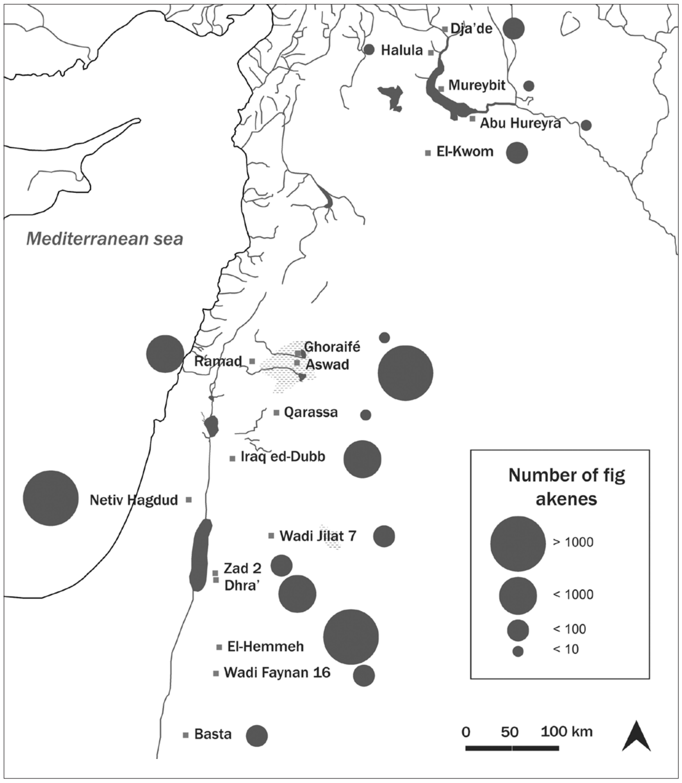


Fig. 9 – *Map of sites where fig achenes have been found from PPNA and PPNB sites (C. Douché). The early finds combined with high frequencies in the south suggest that its use may have originated there rather than in the north. References: Mureybet (Van Zeist et Bakker-Heeres 1984), Dja'de (Willcox and Douché personal data), Halula (Buxó and Rovira 2013), Netiv Hagdud (Kislev 1997), El-Hemmeh (White 2013, White and Wolff 2012), Zahrat adh-Dhra'2 (Edwards* et al. *2004), Qarassa (Arranz-Otaegui* et al. *2016a), Aswad (personal data), Ghoraifé (Van Zeist and Bakker-Heeres 1982), Ramad (Van Zeist and Bakker-Heeres 1982), Basta (Neef 2004), El-Kwom (Moulins 1997), Abu Hureyra (De Moulins 1997), Iraq ed-Dubb (Colledge 2001), Wadi Jilat 7 (Colledge 2001), Dhra' (Colledge and Conolly 2018), Wadi Faynan 16 (Kennedy 2007).*

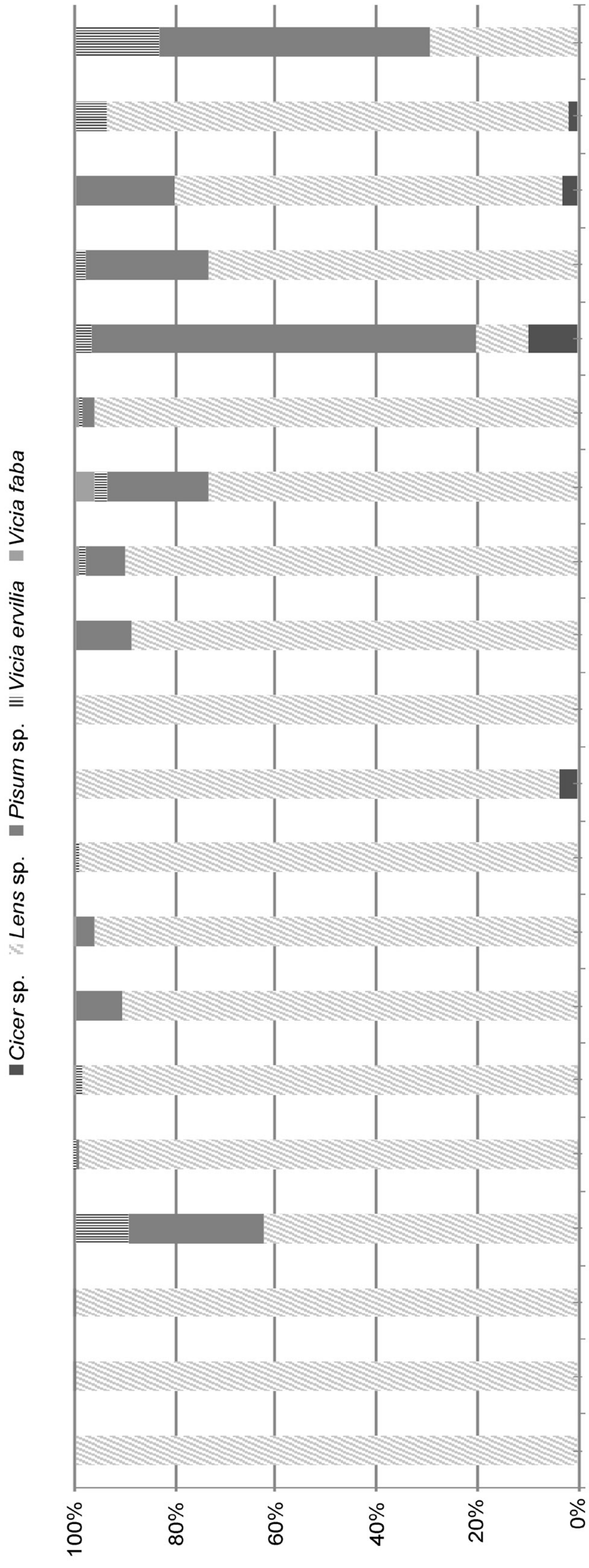


Fig. 10 – *Totals and relative proportions of pulses from selected of sites (C. Douché). Lentils are the most frequent pulse across the Early Neolithic of the Near East other species are erratically distributed which may be due to poor preservation of large pulses. References: Abr'3 (Willcox* et al. *2008), Jerf (Willcox and Stordeur 2012), Qaramel (Willcox and Herveux 2013), Mureybet (Van Zeist et Bakker-Heeres 1984, personal data), Dja'de (Willcox and Douché personal data) Halula (Buxó and Rovira 2013), Netiv Hagdud (Kislev 1997), El-Hemmeh (White 2013, White and Wolff 2012), Zahrat adh-Dhra'2 (Edwards* et al. *2004), Qarassa (Arranz-Otaegui* et al. *2016a), Aswad (personal data), Ghoraifé (Van Zeist and Bakker-Heeres 1982), Ramad (Van Zeist and Bakker-Heeres 1982), Basta (Neef 2004).*

Southeast Anatolia (Zohary *et al*. 2012), at a relatively high altitude (600-1200 asl). The nearest present-day wild habitats are located approximately 80 km from Dja'de (Tanno and Willcox 2006). Thus the finds of charred chickpea and its natural distribution suggest an introduction from north to south. As for the other pulses, any interpretation would be hazardous, given that finds are few and erratic across the Near East.

Identifying pre-domestic cultivation relies largely, but not exclusively, on the identification of taxa which correspond to arable weeds, plants which proliferate and evolve under the conditions of cultivation. Based on this evidence it has been claimed that cultivation may have started during the Upper Palaeolithic at Ohalo II (Snir *et al*. 2015). For a long period that follows there is no evidence until the beginning of the Holocene during the PPNA (10,200-8500 cal. BC), for which pre-domestic cultivation has been suggested for numerous sites in both the Northern and the Southern Levant. Morphological domestication did not appear until the Early/Middle PPNB (8800-7500 cal. BC).

Using data from Zohary 1950 and Willcox 2012a (35 and 41) potential arable weed taxa were selected for Dja'de and Aswad respectively. Despite the absence of morphological domestication at Dja'de the presence of these potential arable weed taxa suggests cultivation. To identify evolution over time we are hampered by problems of taphonomy, the varying number of seeds produced by different taxa, and inconsistent sampling. For the moment it will suffice to note that the ubiquity of 13 of the 35 (37%) taxa at Dja'de and 16 of the 41 at Aswad increases between the early and the late phases, perhaps suggesting that these weeds were becoming more frequent. A full analysis of the potential weed flora and a comparison with other sites will be the subject of a future publication.

Morphological domestication was slow to become established in the Near East. Our evidence bears this out; for example at Dja'de despite an occupation of up to a millennium there is no evidence for domestication. The low proportion of domestic types (<10%) corresponds to those observed in modern wild populations (Kislev 1989). Similar frequencies of domestic types have been obtained from sites such as Jerf el Ahmar and El-Hemmeh 1 (PPNA levels) where the overall population is considered wild.

Morphological domestication appears during the MPPNB and the LPPNB for which examination of cereal spikelet bases show that wild types persisted alongside domestic types. At Aswad 290 barley spikelets were examined, which demonstrates that domestic populations were in the process of becoming established. This new analysis of the spikelet bases from Tell Aswad was based on only those samples with a reliable stratigraphic context relative to the three phases (Douché 2018). For barley, significant frequencies of domestic types appear in phase 2 at 26% (fig. 5). For emmer, 631 spikelet bases were examined and even in phase 3 only 11% were domestic (fig. 6). At late PPNB Ramad, also situated in the Damascus basin, domestic barley spikelet bases make up 50% of the total (Tanno and Willcox 2012). Thus the frequencies of domestic cereals at EPPNB sites in the region are very low compared to wild types. This is not easy to explain. As Hillman and Davies 1990, and Zohary 1989 proposed, one would expect that natural selection would eliminate the wild types in less than 200 generations and probably much faster. But there are four reasons, which are by no means exclusive, that could explain why wild types persist in the archaeobotanical record: 1. Cultivation and gathering from the wild continued side by side; 2. Cultivation techniques were such that selection for domestic types was low (Willcox 2017); 3. Domestic types could be more susceptible to damage than wild types which would lead to wild types being over-represented; 4. Wild cereals propagated like arable weeds alongside their domestic counterparts. Could these four factors be the reason why wild types persist in the archaeobotanical record? If so, this nuances the protracted domestication paradigm.

CONCLUSION

What does the comparison of the two sites tell us about the development of agriculture across the Near East? First the two sites have different crop assemblages, demonstrating that local plants were taken into cultivation. These plants formed the basis from which agriculture developed independently in the autonomous regions. This is confirmed by similar findings from other sites. Indeed it makes sense because the local plants would have been better adapted to local conditions than crops introduced from elsewhere. In both regions there is continuity with the PPNA period in terms of the edible plants used. Yet by the MPPNB we are at the start of a period of standardization of agricultural products across the Near East, which we see in the increase in emmer, in the decline in barley and an increase in domestic types. Importation of obsidian, marine shells, and semi-precious stones had already occurred in the Late Pleistocene (Ibáñez *et al*. 2015), but by the MPPNB came the start of the spread of minor crops such as fig and perhaps flax, apparently emanating from the south, and chickpea possibly spreading from the north to the south. While it is possible that plant products may have been imported, what we see in the archaeobotanical record is more probably the introduction of crops. The archaeobotanical evidence is too erratic to trace these movements in detail, but crop movement would have started on a local level and then moved to a regional level. Introductions were made possible because with domestication came not just loss of the dispersal mechanism but also a selection for populations that were better adapted to a wider range of environments and hence could be introduced into new regions with new climatic regimes. Along with these introductions, arable weeds would have inadvertently spread from one region to another. Finally, the mixture of wild and domestic types in the archaeobotanical "populations" at Aswad, which persisted for so long and which goes against theoretical selection predictions (Zohary 1989, Hillman and Davis 1990), could result from identification bias, low selection cultivation techniques and occasional gathering from the wild, for example after a poor harvest, or simply wild forms behaved like arable weeds.

Finally this study takes into account a larger number of samples than earlier work allowing us to make a precise comparison of major taxa between two sites which as we have said are from geographically and culturally different regions. Because totals from phases or sites were used in order to be statistically significant, information about individual samples in relation to their archaeological context such as their relation to plant processing items and areas, or storage facilities is lacking. Detailed analyses of individual samples will hopefully provide more information about the differences in the plant economy at both sites and with regard to the development of farming at each site. But this will be the subject of a further publication.

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