Revisiting the concept of the "Neolithic Founder Crops" in southwest Asia

Supplementary Information 1 – Quantitative Analysis

true true

2022-01-27

Contents

1 Introduction

This document describes the quantitative analysis supporting our paper:

> Arranz-Otaegui, Amaia and Roe, Joe. in prep. Revisiting the concept of the "Neolithic Founder Crops" in southwest Asia. Submitted to *Vegetation History and Archaeobotany*.

It is generated from the compendium of R code and data available at *insert Zenodo link* or as a git repository at https://github.com/joeroe/SWAsiaNeolithicFounderCrops.

2 Methods & Materials

Please refer to accompanying publication for an introduction and justification for the data and quantitative approaches selected. Here, we explain in more detail the steps necessary to reproduce the figures, tables, and other results presented in the main text, and present some supplementary results that were not included due to length constraints.

2.1 Study region and period

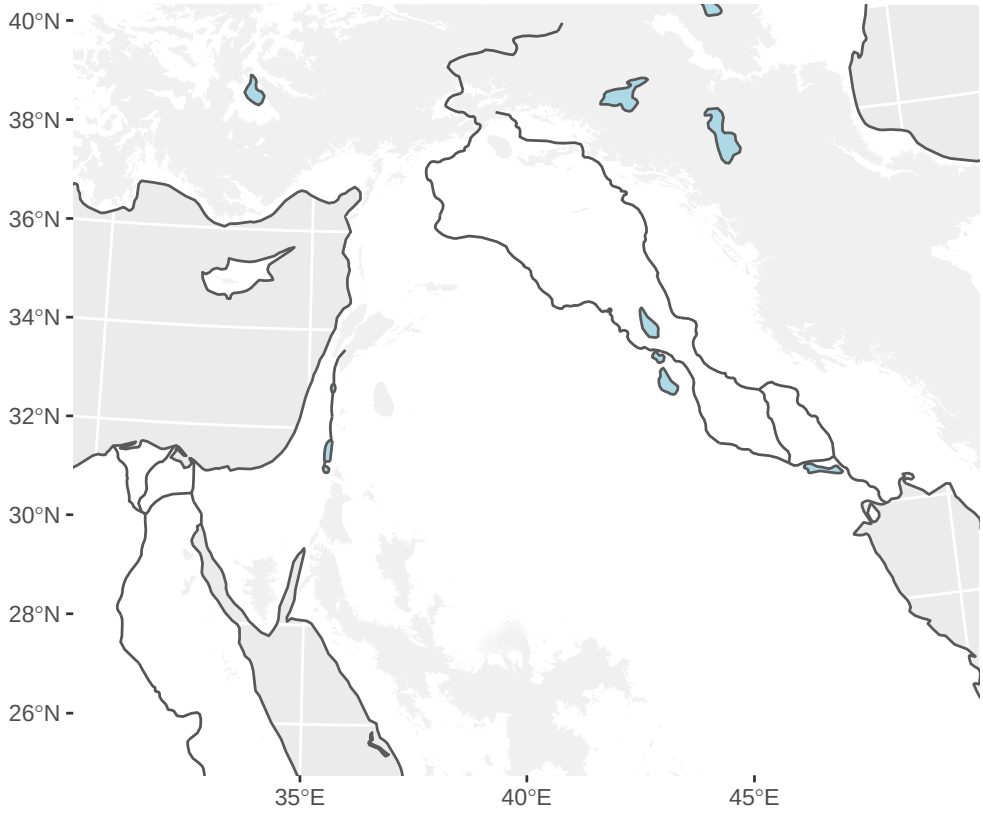

Figure 1: The study region

We aimed to collate archaeobotanical data from Southwest Asia (fig. 1) from the Neolithic period, c. 11,700 – 6500 BP (table **??**). To mitigate against an "edge effect," we also included samples in the source databases dated to the preceding Late Epipalaeolithic (c. 15,000–11,700 BP) and succeeding Chalcolithic (c. 6500–5000 BP).

Period	Subsistence	Start (cal BP)	End (cal BP
Late Epipal.	Foraging	15000	11700
PPNA	Pre-domestication cultivation	11700	10700
EPPNB	Cultivation of domesticated species	10700	10200
MPPNB	Cultivation of domesticated species	10200	9500
LPPNB/C	Agriculture	9500	8500
Pottery Neolithic	Agriculture	8500	6500
Chalcolithic	Agriculture	6500	5000

2.2 Archaeobotanical data (Southwest Asia)

We collated data from three large-scale archaeobotanical databases: ORIGINS (Wallace et al. 2018), and COMPAG Shennan and Conolly (2007), and ADEMNES (Riehl and Kümmel 2005). To clean and

make these datasets comparable, we:

- Standardised site names across databases (thesaurus available at https://github.com/joeroe/swapdata);
- Standardised taxonomic names across databases and applied various additional classifications described below;
- When sites were in multiple databases, preferred records from the most detailed/recent one (i.e. ORIGINS > COMPAG > ADEMNES);
- ORIGINS is recorded by sample, but COMPAG and ADEMNES by phase, so aggregated ORIGINS by phase for comparability – and because individual samples are more likely to be 'noisy';
- Calculated phase-level proportions for COMPAG, which only includes absolute frequencies;
- Excluded records from the source databases that:
  - Were not taxonomically determined to at least the level of genus;
  - Did not actually contain quantitative information (i.e. `n` is blank or missing);
  - Described wood remains.

Finally we filtered this data to include only samples from our region (Southwest Asia) and period (11.7–6.5 ka cal BP) of interest, with a buffer of ±2,000 years to reduce "edge effects" in our time series analyses.

The resulting collated dataset (`analysis/data/derived_data/swasia_neolithic_flora.tsv`) includes archaeobotanical assemblages representing 240 distinct phases from 135 sites.

2.3 Archaeobotanical data (Europe)

We also used Colledge et al.'s (2004) compilation of European data (see also Shennan and Conolly 2007). Since this data did not need to be formally incorporated into the rest of the analyses, we simply imported Colledge et al.'s dataset as is, excluding non-European countries. It includes 268 assemblages from 211 Neolithic sites across Europe, but only presence data. For completeness, Cyprus was included in both the European and Southwest Asian datasets.

We used this data to quantitatively assess early evidence for translocation of certain crops from Southwest Asia to Europe, reported in table X of the main text.

2.4 Chronological data

All three databases include rough absolute date ranges (in the vast majority of cases summarised the available radiocarbon dates) for each sample. Using this data, each phase was classified into one of the cultural periods defined above using its mid-point date (table **??**).

Period	ka cal BP	Subsistence	N sites	N assemblages
Late Epipal.	15–11.7	Foraging	4	6
PPNA	11.7–10.7	Pre-domestication cultivation	23	27
EPPNB	10.7–10.2	Cultivation of domesticated species	8	9
MPPNB	10.2–9.5	Cultivation of domesticated species	20	34
LPPNB/C	9.5–8.5	Agriculture	29	40
Pottery Neolithic	8.5–6.5	Agriculture	23	33
Chalcolithic	6.5–5	Agriculture	58	86

For a finer-grained chronology, we also sliced the assemblages into century bins. An assemblage was considered to belong to a bin (e.g. 5000–5099 BP) if any part of its absolute date range falls within that bin – this results in the duplication of data across bins, but better reflects the inherent imprecision of radiocarbon dating.

2.5 Sample coverage

We are now in a position to inspect the geographical (fig. 2) and temporal 3 coverage of the data. Unsurprisingly, the distribution is uneven. Notably, we have few Epipalaeolithic sites, but a very large number of Chalcolithic sites. The regional coverage reflects broader trends in the research history of the region, with a large body of evidence from the Southern Levant, especially for earlier periods, and the rest of the region more patchily covered. Nevertheless, we consider that we have a sufficient baseline number of samples for each time slice in our analysis—the lowest is 11 assemblages, for the EPPNB—especially for the key Neolithic periods.

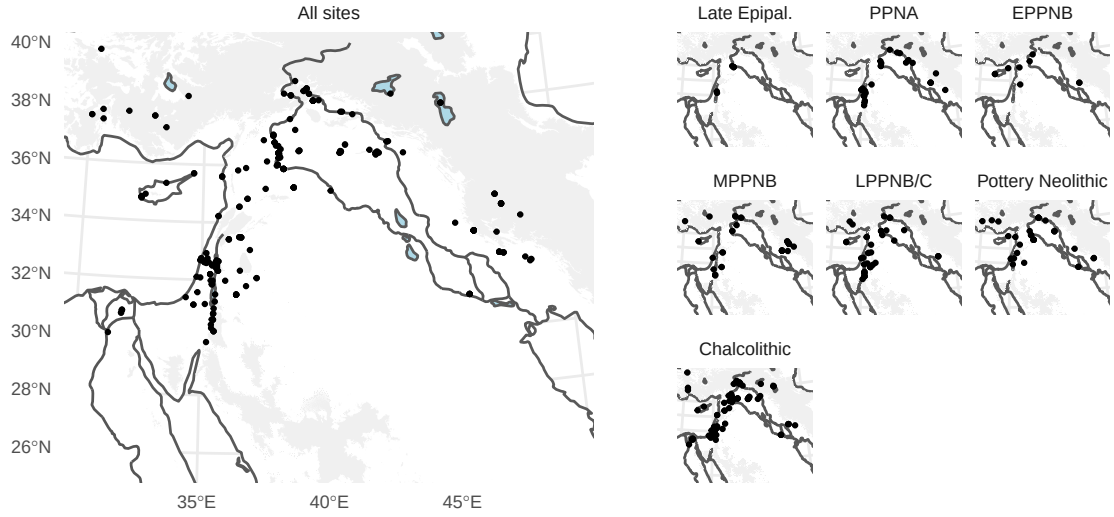

Figure 2: Geographical distribution of sampled archaeobotanical assemblages

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Table **??** lists all the assemblages included in our analysis.

3 Results

3.1 Ubiquity of all taxa in the Neolithic

Table **??** summarises the occurrence of each standardised taxon across Neolithic assemblages, broken down by plant category.

Taxa	N (
Fruits/nuts	
Pistacia spp. (incl. atlantica, lentiscus, palaestina, terebinthus, vera)	
Ficus spp. (incl. carica)	

Capparis spp. (incl. spinosa)
Amygdalus spp. (incl. communis, korshinskyi, webii)
Vitis spp. (incl. sylvestris, vinifera)
Crataegus spp. (incl. azarolus, monogyna)
Olea spp. (incl. europaea)
Prunus spp. (indeter)
Quercus spp. (incl. infectoria, ithaburensis)
Juglans regia
Punica spp. (incl. granatum)
Pyrus sp.
Rubus spp. (incl. caesius, fruticosus, idaeus, sanguineus)
Cupressus sempervirens
Phoenix spp. (incl. dactylifera, theophrasti)
Pinus halepensis
Prunus spp. (incl. microcarpa, spinosa, divariacata, argentea)
Rosa sp.
Vitex agnus-castus

Grasses
Hordeum spp. (spontaneum, distichum)
Triticum spp. (indeter. founder)
Triticum spp. (incl. dicoccoides/dicoccum)
Triticum spp. (indeter.)
Triticum spp. (incl. boeoticum/monococcum)
Bromus spp. (incl. arvensis, danthoniae, diandrus, hordeaceus, secalinus, sterilis, tectorum)
Lolium spp. (incl. perenne, persicum, remotum, rigidum, temulentum)
Aegilops spp. (incl. crassa, kotschyi, peregrina, speltoides, umbellulata)
Phalaris spp. (incl. minor, paradoxa, tuberosa)
Avena spp. (incl. barbata, clauda, fatua, sativa, sterilis, wiestii)
Stipa spp. (incl. capensis, gigantea)
Triticum spp. (inc. aestivum, durum)
Hordeum spp. (bulbosum, glaucum, murinum, marinum, hystrix, sphaerococcum)
Hordeum sp. (indeter.)
Eremopyrum spp. (incl. bonaepartis)
Taeniatherum spp. (incl. caput-medusae)
Echinaria sp.
Hordeum spp. (incl. durum)
Secale spp. (incl. cereale, montanum)
Agrostis sp.
Poa spp. (incl. bulbosa)
Eragrostis spp. (incl. barrelieri)
Setaria spp. (incl. verticillata, viridis)
Phleum sp.
Brachypodium distachyon
Cynodon spp. (incl. dactylon)
Triticum spp. (incl. spelta, turgidum, parvicoccum)
Vulpia sp.
Crypsis spp. (incl. alopecuroides, schoenoides)
Elymus sp.
Phragmites australis
Psilurus spp. (incl. incurvus)
Tragus sp.
Aeluropus sp.
Alopecurus spp. (incl. utriculatus)
Cutandia spp. (incl. dichotoma, memphitica)
Dactylis glomerata
Gaudiniopsis sp.
Imperata sp.

Melica persica
Panicum spp. (incl. miliaceum, turgidum)
Piptatherum miliaceum
Stipagrostis spp. (incl. obtusa, plumosa)

Pulses
Lens spp. (incl. culinaris, orientalis)
Vicia spp. (incl. faba, narbonense, peregrina, sativa)
Pisum spp. (incl. elatius, sativum)
Astragalus spp. (incl. annularis, callichrous, tribuloides, vogelii)
Trigonella spp. (incl. arabica, atroites, neoeana, sibthorpii)
Medicago spp. (incl. laciniata, minima, orbicularis, polymorpha, radiata, truncatula)
Vicia ervilia
Lathryrus spp. (incl. aphaca, cicera, hirsutus, nissolia, sativus)
Cicer spp. (incl. arietinum)
Melilotus sp.
Coronilla sp.
Onobrychis spp. (incl. crista-galli)
Prosopis spp. (incl. farcta)
Scorpiurus spp. (incl. muricatus)
Trifolium sp.
Ceratonia siliqua
Lupinus spp. (incl. albus, angustifolius, pilosus)
Ononis spp. (incl. serrata, viscosa)
Colutea sp.
Glycyrrhiza spp. (incl. glabra)
Retama raetam
Sophora sp.

Wild plants
Bolboschoenus spp. (incl. glaucus, maritimus)
Galium spp. (incl. aparine, mollugo, spurium, tricornotum, verrucosum)
Malva spp. (incl. aegyptia, nicaeensis, parviflora, sylvestris)
Buglossoides spp. (incl. arvensis, tenuiflora)
Heliotropium spp. (incl. europaeum, persicum, rotundifolium, suaveolens)
Brassicaceae indet. (edible)
Silene spp. (incl. aegyptiaca, arabica, colorata, dichotoma, gallica)
Linum spp. (incl. bienne, usitatissimum, mucronatum, strictum)
Adonis spp. (incl. aestivalis, annua, dentata, flammea, microcarpa)
Arnebia spp. (incl. decumbens, linearifolia)
Plantago spp. (amplexicaulis, arenaria, coronopus, lagopus, lanceolata, major, ovata, psyllium, squarrosa)
Centaurea spp. (incl. pallescens)
Rumex spp. (incl. acetocella, conglomeratus, crispus, dentatus, maritimus, pulcher, simpliciflorus, spinosus)
Carex spp. (incl. divisa, divulsa)
Chenopodium spp. (incl. album, glaucum, murale, rubrum)
Polygonum spp. (incl. aviculare, convolvulus, corrigioloides, lapathifolium, persicaria, salicifolium, venantianum)
Androsace spp. (incl. maxima)
Atriplex spp. (incl. lasiantha, leucoclada, prostrata, rosea)
Erodium spp. (incl. ciconium, gruinum)
Bellevalia sp.
Fumaria spp. (incl. densiflora, officinalis, parviflora)
Helianthemum spp. (incl. ledifolium, salicifolium)
Suaeda spp. (incl. fruticosa, maritima, palaestina)
Glaucium spp. (incl. aleppicum, corniculatum)
Salsola spp. (incl. inermis, kali, volkensii)
Ornithogalum sp.
Vaccaria spp. (incl. pyramidata, segetalis)
Aizoon spp. (incl. hispanicum)

Gypsophila spp. (incl. elegans, obionica, pilosa)
Papaver spp. (incl. dubium, setigerum)
Thymelaea spp. (incl. hirsuta)
Alyssum spp. (incl. damascenus)
Arenaria spp. (incl. serpyllifolia)
Teucrium spp. (incl. polium)
Ziziphora spp. (incl. tenuir)
Celtis spp. (incl. australis, tournefortii)
Brassica spp. (incl. nigra)
Convolvulus spp. (incl. arvensis)
Crucianella sp.
Verbena spp. (incl. officinalis)
Ammi majus
Ranunculus spp. (incl. acris, arvensis, repens, sceleratus)
Verbascum sp.
Amaranthus sp.
Capsella spp. (incl. bursa-pastoris)
Carthamus spp. (incl. creticus, tenuis)
Cephalaria spp. (incl. syriaca)
Echium sp.
Eleocharis sp.
Lepidium spp. (incl. niloticum, perfoliatum, ruderale, sativum)
Lycium sp.
Scirpus spp. (incl. setaceus, tabernaemontani)
Valerianella spp. (incl. coronata, dentata)
Artemisia sp.
Bupleurum spp. (incl. lancifolium, rotundifolium, subovatum)
Chrozophora sp.
Cleome spp. (incl. chrysantha, ornithopodioides)
Reseda spp. (incl. decursiva, lutea, luteola)
Solanum spp. (incl. dulcamara, nigrum)
Ajuga spp. (incl. iva)
Bassia spp. (incl. muricata, protrata)
Cerastium sp.
Cyperus spp. (incl. articulatus, aucheri, papyrus, rotundus)
Draba sp.
Euphorbia spp. (incl. falcata, helioscopia, peplus)
Hyoscyamus spp. (incl. muticus)
Neslia spp. (incl. paniculata)
Portulaca spp. (incl. oleraceae)
Sherardia spp. (incl. arvensis)
Alkanna spp. (incl. orientalis)
Anchusa spp. (incl. officinalis)
Asphodelus spp. (incl. aestivus, tenuifolius)
Beta spp. (incl. vulgaris)
Bifora sp.
Bryonia sp.
Cornus mas
Euclidium spp. (incl. syriacum)
Micromeria sp.
Minuartia spp. (incl. hybrida, rubella)
Peganum spp. (incl. harmala)
Scirpus lacustris
Sisymbrium spp. (incl. irio)
Stachys sp.
Torilis spp. (incl. nodosa)
Tribulus terrestris
Abutilon teophrasti

Achillea spp. (incl. wilhelmsii)
Alcea sp.
Anagallis spp. (incl. arvensis)
Anthemis spp. (incl. arvensis, cotula, pseudocotula)
Antirrhinum orontium
Anvillea garcinii
Asparagus sp.
Asterolinon linum-stellatum
Calendula spp. (incl. arvensis)
Camelina spp. (incl. microcarpa, sativa)
Camphorosma spp. (incl. monspeliaca)
Carduus australis
Carrichtera annua
Chrysanthemum spp. (incl. coronarium)
Citrullus colocynthis
Cladium mariscus
Clematis sp.
Cordia sinensis
Coriandrum sativum
Corydalis sp.
Crepis sp.
Crupina crupinastrum
Cuminum cyminum
Cuscuta sp.
Datura sp.
Descurainia sp.
Dianthus sp.
Equisetum sp.
Erucaria sp.
Geranium spp. (incl. dissectum)
Gundelia tournefortii
Halothamnus hierochunticus
Heteranthelium spp. (incl. piliferum)
Hypericum sp.
Juncus spp. (incl. rigidus)
Lallemantia sp.
Lithospermum spp. (incl. arvense, incrassatum, tenuiflorum)
Malcolmia sp.
Mesembryanthemum nodiflorum
Muscari sp.
Notobasis syriaca
Potentilla spp. (incl. supina)
Reboudia pinnata
Ruppia sp.
Salvia cryptantha
Saponaria sp.
Schoenoplectus spp. (incl. litoralis, triquetius)
Scleranthus sp.
Scrophularia sp.
Spergularia spp. (incl. arvensis)
Thlaspi sp.
Tragopogon sp.
Urtica spp. (incl. urens)
Viola sp.

This summary data underlies figure 5 in the main text.

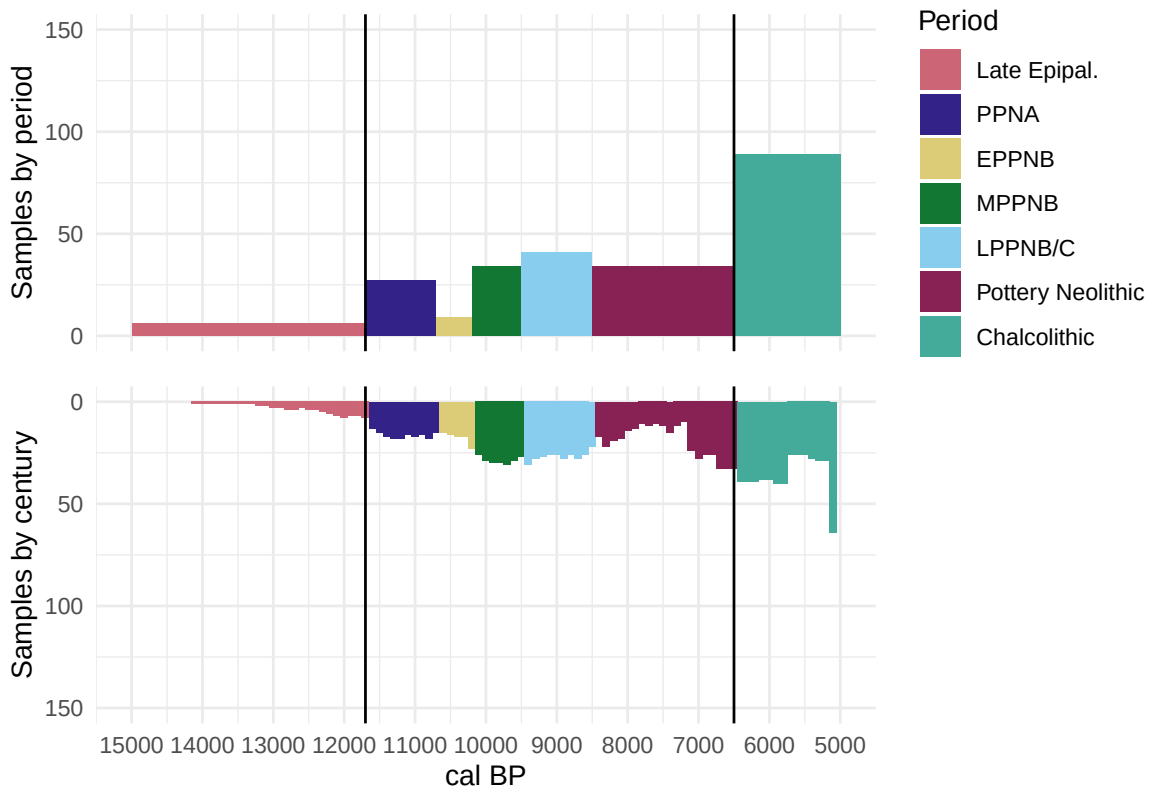

Figure 3: Distribution of sampled archaeobotanical assemblages by cultural period. Black lines indicate our period of interest (the Neolithic).

3.2 Founder crop ubiquity and abundance

3.2.1 By period

Table **??** summarises the ubiquity of the founder crop species in assemblages broken down by period, i.e. for each period, it shows the number of assemblages where N distinct founder species are present, for varying values of N. Given the inconsistent levels of identification between assemblages, emmer wheat and einkorn wheat are counted as one crop. Hence, the maximum possible number of founder crops present is seven rather than eight.

		Number of assemblages with N founder crops present:					
Period	Total assemblages	All	>= 6	>= 5	>= 4	>= 3	>=
Late Epipal.	6	0	0	1 (16.67%)	2 (33.33%)	4 (66.67%)	6 (100.00
PPNA	27	0	0	2 (7.41%)	7 (25.93%)	15 (55.56%)	16 (59.26
EPPNB	9	0	2 (22.22%)	4 (44.44%)	7 (77.78%)	9 (100.00%)	9 (100.00
MPPNB	34	1 (2.94%)	3 (8.82%)	5 (14.71%)	11 (32.35%)	25 (73.53%)	32 (94.12
LPPNB/C	41	1 (2.44%)	6 (14.63%)	8 (19.51%)	20 (48.78%)	29 (70.73%)	35 (85.37
Pottery Neolithic	34	1 (2.94%)	5 (14.71%)	9 (26.47%)	13 (38.24%)	22 (64.71%)	30 (88.24
Chalcolithic	89	0	2 (2.25%)	6 (6.74%)	15 (16.85%)	25 (28.09%)	66 (74.16

3.2.2 By century

For a more fine-grained look at the time series, we can use the century bins calculated above. Figure 4 shows the importance of the individual founder crops measured by both cross-assemblage ubiquity and by relative abundance. We measure ubiquity by calculated the proportion of assemblages dated to each century where one or more, two or more, etc., of the founder crops were reported present; and abundance

by the taking the mean proportion of the assemblage made up by each founder species for each century (hence NB., the y axis of the lower plot will not sum to 100%). These different measures reveal different trends, as discussed in the main text.

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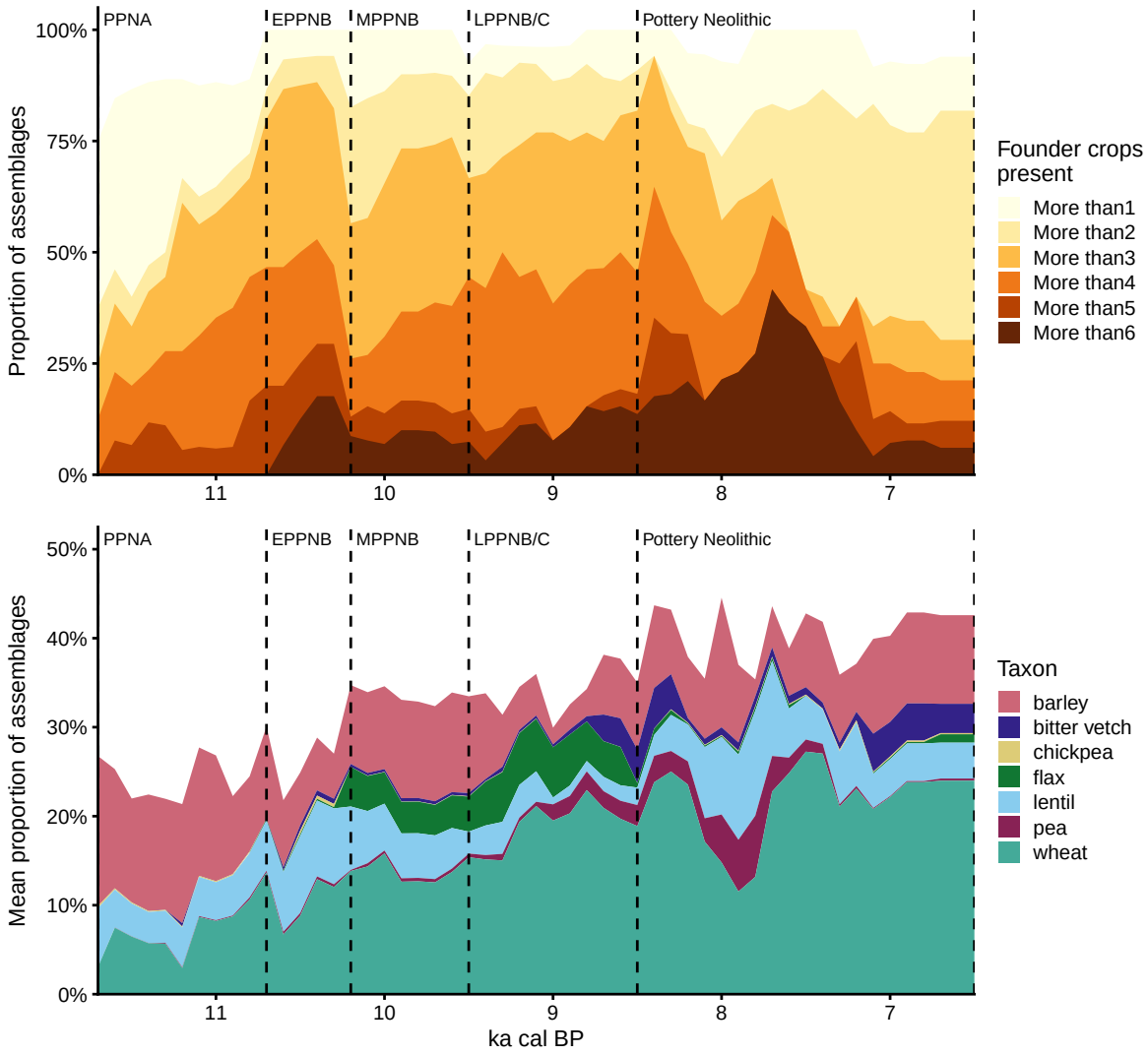

Figure 4: Ubiquity and abundance of the founder crops by century

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3.3 Abundance of plant categories

To move beyond the concept of "founder crops" vs. "wild plants," we classified each taxonomic record in our dataset on a number of other axes:

- Broad plant category, i.e. grasses, legumes, "wild plants," or fruits/nuts
- Its edibility
- For grasses and legumes, whether it is large/medium- or small-seeded

Category	Average proportion	Present	More than ½	More than ¼
Grasses	40.97%	138 (95.17%)	49 (33.79%)	82 (56.55%)
Wild plants	17.98%	120 (82.76%)	14 (9.66%)	27 (18.62%)
Pulses	13.40%	125 (86.21%)	6 (4.14%)	20 (13.79%)
Fruits/nuts	10.20%	115 (79.31%)	6 (4.14%)	16 (11.03%)
Unclassified	1.35%	6 (4.14%)	0	0

Category	Average proportion	Present	More than ½	More than ¼
Late Epipal.				
Wild plants	38.31%	6 (100.00%)	2 (33.33%)	4 (66.67%)
Grasses	9.46%	6 (100.00%)	0	0
Fruits/nuts	7.77%	6 (100.00%)	0	1 (16.67%)
Pulses	2.16%	6 (100.00%)	0	0
Unclassified	0.06%	1 (16.67%)	0	0
PPNA				
Grasses	29.95%	25 (92.59%)	5 (18.52%)	10 (37.04%)
Fruits/nuts	18.70%	21 (77.78%)	2 (7.41%)	7 (25.93%)
Wild plants	14.15%	20 (74.07%)	1 (3.70%)	3 (11.11%)
Pulses	13.59%	25 (92.59%)	1 (3.70%)	5 (18.52%)
Unclassified	0.18%	1 (3.70%)	0	0
EPPNB				
Grasses	41.34%	9 (100.00%)	2 (22.22%)	7 (77.78%)
Pulses	15.25%	9 (100.00%)	0	2 (22.22%)
Fruits/nuts	7.79%	9 (100.00%)	0	1 (11.11%)
Wild plants	6.61%	8 (88.89%)	0	0

MPPNB				
Grasses	38.90%	34 (100.00%)	11 (32.35%)	21 (61.76%)
Wild plants	14.56%	29 (85.29%)	2 (5.88%)	5 (14.71%)
Pulses	11.95%	32 (94.12%)	0	3 (8.82%)
Fruits/nuts	10.24%	29 (85.29%)	1 (2.94%)	3 (8.82%)
Unclassified	1.47%	1 (2.94%)	0	0
LPPNB/C				
Grasses	42.43%	37 (90.24%)	15 (36.59%)	24 (58.54%)
Wild plants	21.86%	38 (92.68%)	5 (12.20%)	11 (26.83%)
Pulses	12.32%	32 (78.05%)	1 (2.44%)	6 (14.63%)
Fruits/nuts	7.94%	33 (80.49%)	2 (4.88%)	4 (9.76%)
Unclassified	1.61%	4 (9.76%)	0	0
Pottery Neolithic				
Grasses	49.70%	33 (97.06%)	16 (47.06%)	20 (58.82%)
Wild plants	22.76%	25 (73.53%)	6 (17.65%)	8 (23.53%)
Pulses	15.61%	27 (79.41%)	4 (11.76%)	4 (11.76%)
Fruits/nuts	6.59%	23 (67.65%)	1 (2.94%)	1 (2.94%)
Chalcolithic				
Grasses	49.53%	86 (96.63%)	43 (48.31%)	64 (71.91%)
Pulses	20.19%	69 (77.53%)	6 (6.74%)	23 (25.84%)
Wild plants	11.60%	62 (69.66%)	3 (3.37%)	6 (6.74%)
Fruits/nuts	7.39%	26 (29.21%)	0	2 (2.25%)

Table **??** summarises the abundance of the broad plant categories across Neolithic assemblages, **??** the same data broken down by period, and figure 5 how this changed through time.

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In the following sections, we will analyse trends within these categories in more detail.

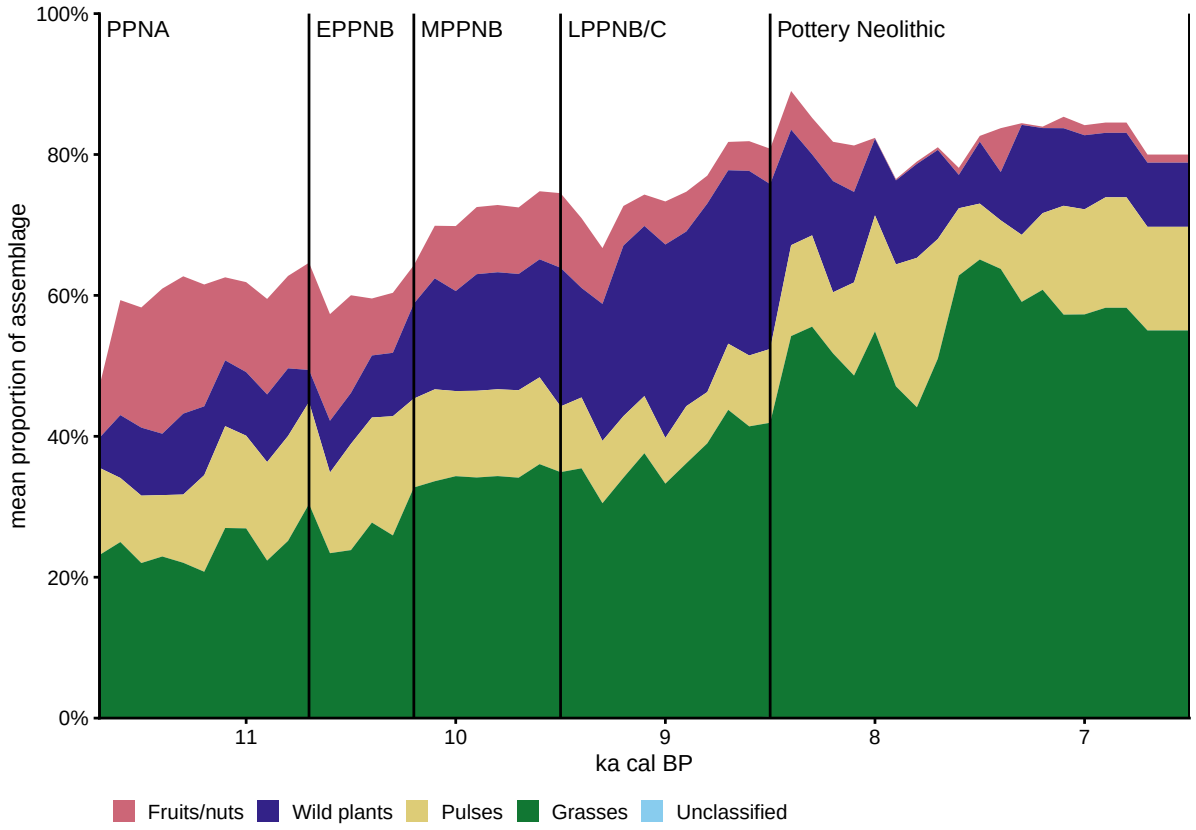

Figure 5: Abundance of broad plant categories through time

3.3.1 Grasses

The eight most ubiquitous grass taxonomic groups, measured by presence across Neolithic assemblages, are: Hordeum spp. (spontaneum, distichum), Triticum spp. (indeter. founder), Triticum spp. (incl. boeoticum/monococcum), Triticum spp. (incl. dicoccoides/dicoccum), Triticum spp. (indeter.), Lolium spp. (incl. perenne, persicum, remotum, rigidum, temulentum), Bromus spp. (incl. arvensis, danthoniae, diandrus, hordeaceus, secalinus, sterilis, tectorum), Aegilops spp. (incl. crassa, kotschyi, peregrina, speltoides, umbellulata). Figure 6 shows how the abundance of these taxa changed through time.

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3.3.2 Pulses

The eight most ubiquitous pulse taxonomic groups, measured by presence across Neolithic assemblages, are: Lens spp. (incl. culinaris, orientalis), Vicia spp. (incl. faba, narbonense, peregrina, sativa), Trigonella spp. (incl. arabica, atroites, neoeana, sibthorpii), Medicago spp. (incl. laciniata, minima, orbicularis, polymorpha, radiata, truncatula), Pisum spp. (incl. elatius, sativum), Astragalus spp. (incl. annularis, callichrous, tribuloides, vogelii), Vicia ervilia, Lathryrus spp. (incl. aphaca, cicera, hirsutus, nissolia, sativus). Figure 7 shows how the abundance of these taxa changed through time.

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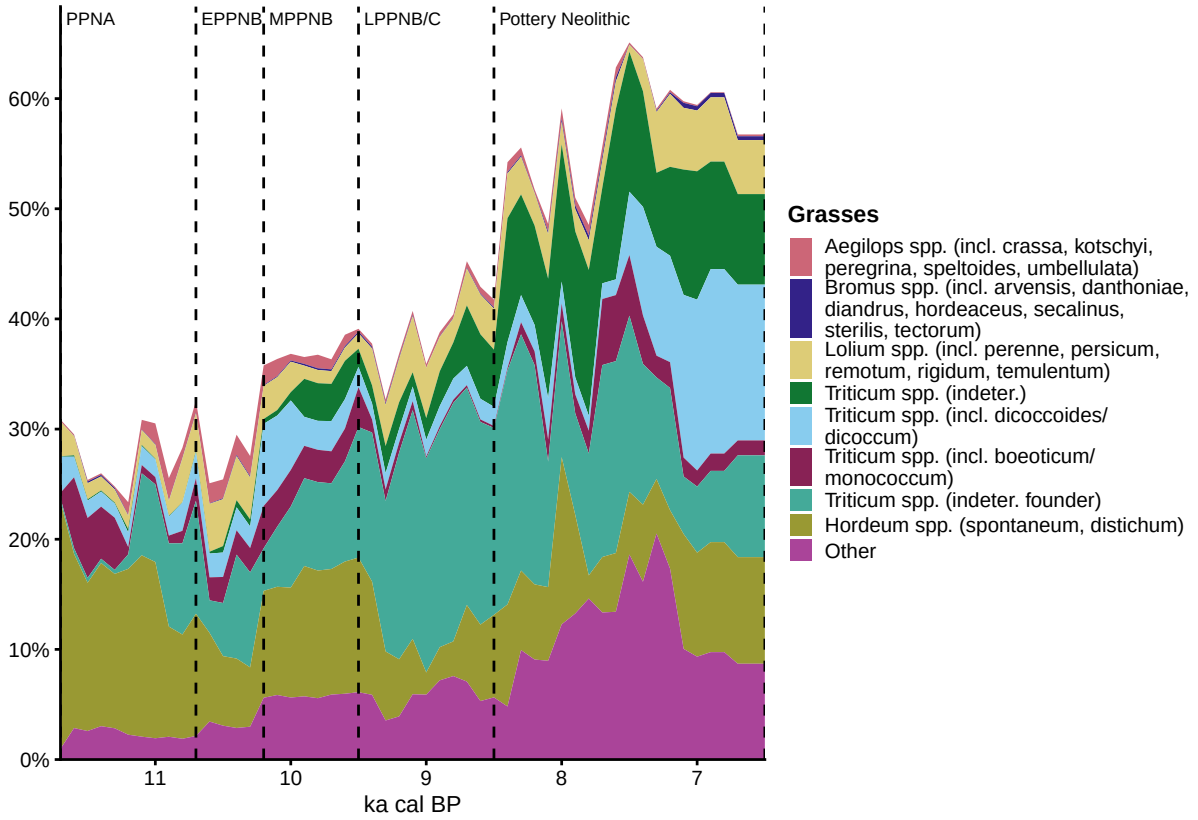

Figure 6: Abundance of grass taxa through time

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3.3.3 Wild plants

The eight most ubiquitous 'wild plant' taxonomic groups, measured by presence across Neolithic assemblages, are: Bolboschoenus spp. (incl. glaucus, maritimus), Buglossoides spp. (incl. arvensis, tenuiflora), Galium spp. (incl. aparine, mollugo, spurium, tricornotum, verrucosum), Malva spp. (incl. aegyptia, nicaeensis, parviflora, sylvestris), Brassicaceae indet. (edible), Arnebia spp. (incl. decumbens, linearifolia), Heliotropium spp. (incl. europaeum, persicum, rotundifolium, suaveolens), Silene spp. (incl. aegyptiaca, arabica, colorata, dichotoma, gallica). Figure 8 shows how the abundance of these taxa changed through time.

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3.3.4 Fruits and nuts

The eight most ubiquitous fruit/nut taxonomic groups, measured by presence across Neolithic assemblages, are: Pistacia spp. (incl. atlantica, lentiscus, palaestina, terebinthus, vera), Ficus spp. (incl. carica), Amygdalus spp. (incl. communis, korshinskyi, webii), Capparis spp. (incl. spinosa), Vitis spp. (incl. sylvestris, vinifera), Crataegus spp. (incl. azarolus, monogyna), Olea spp. (incl. europaea), Prunus spp. (indeter). Figure 9 shows how the abundance of these taxa changed through time.

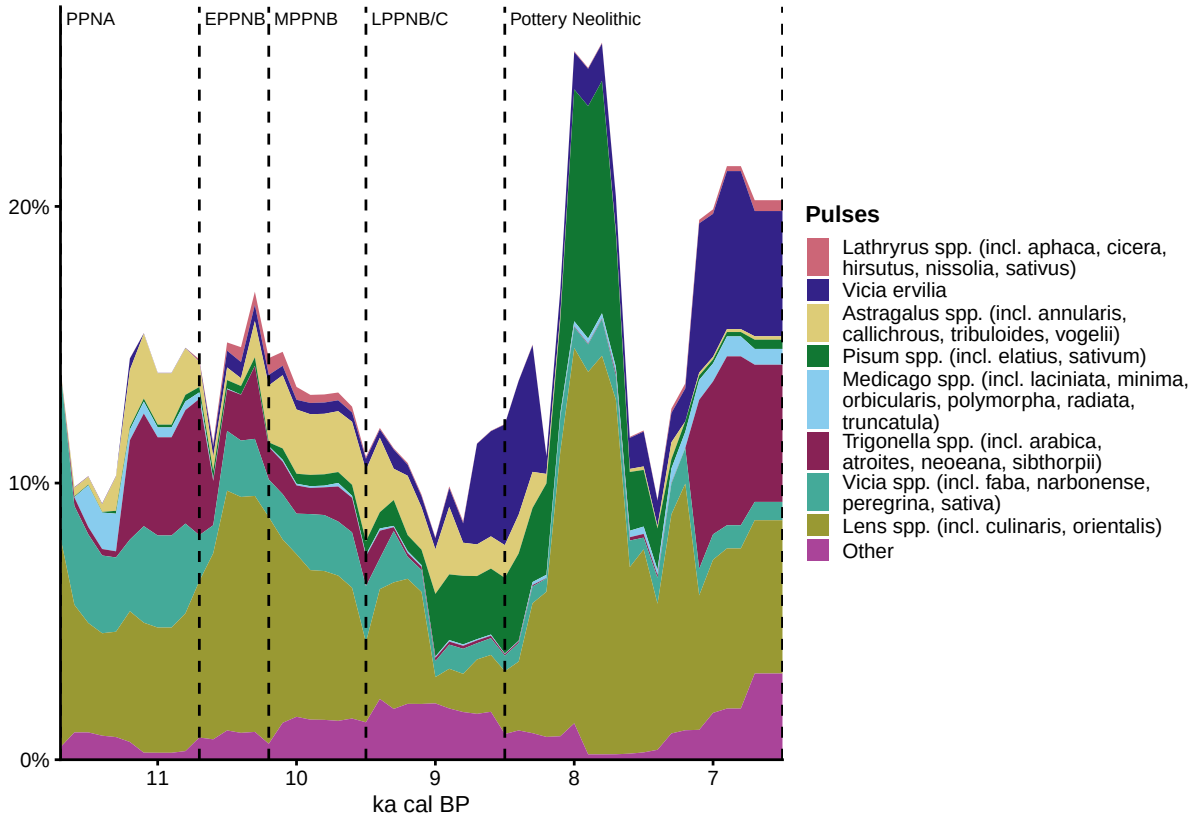

Figure 7: Abundance of pulse taxa through time

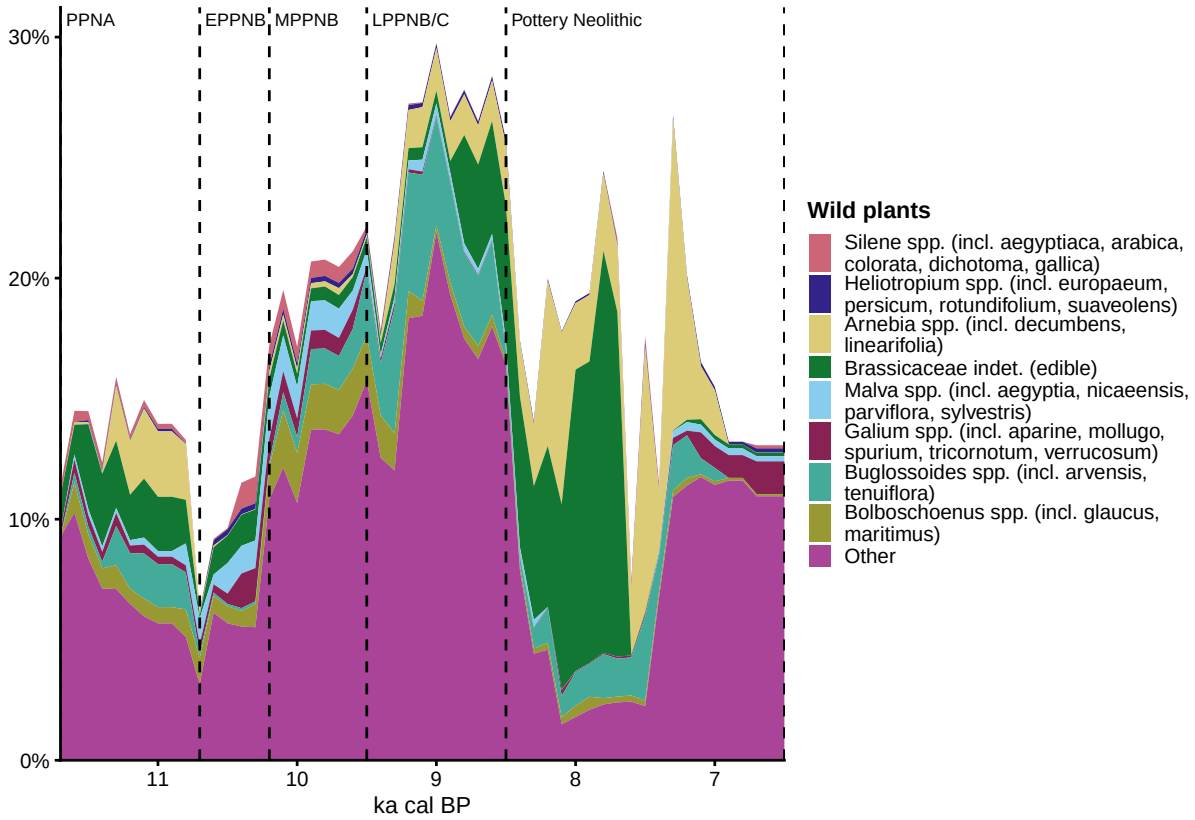

Figure 8: Abundance of wild plant taxa through time

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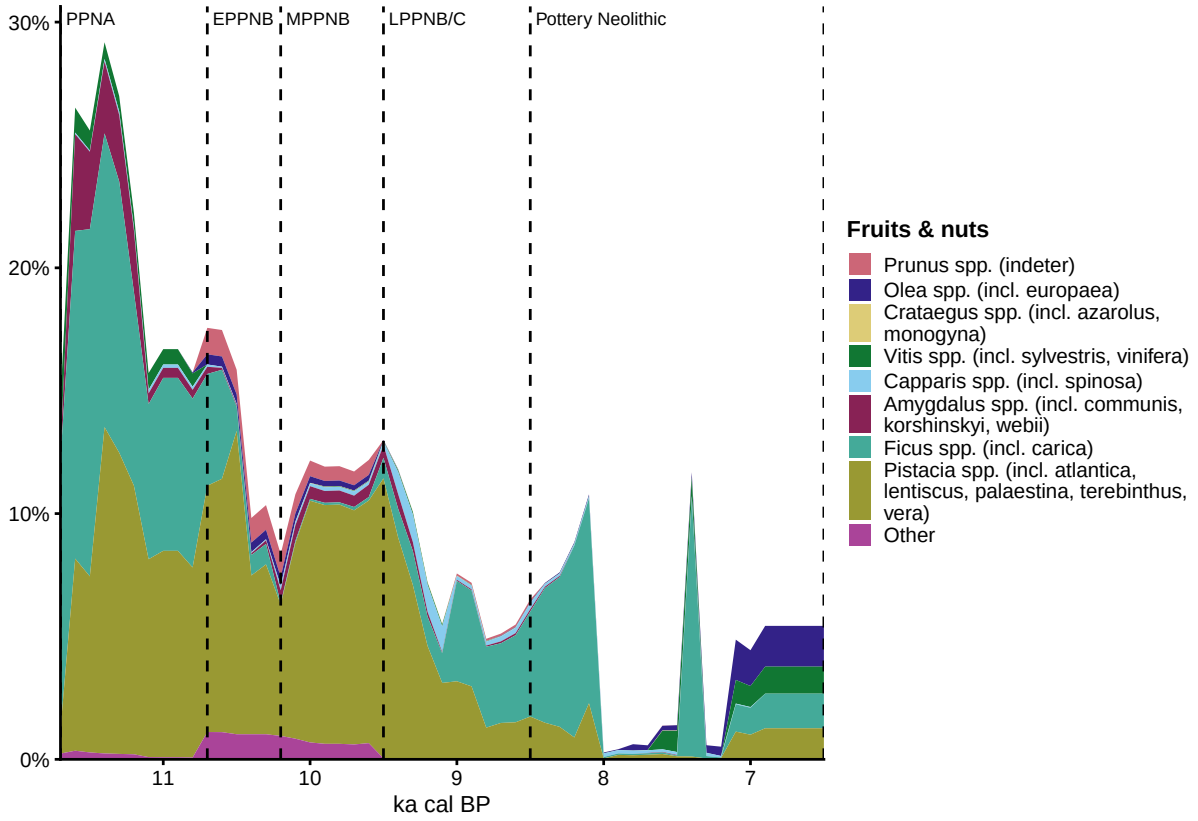

Figure 9: Abundance of fruit/nut taxa through time

Colledge, Sue, James Conolly, and Stephen Shennan. 2004. "Archaeobotanical Evidence for the Spread of Farming in the Eastern Mediterranean." *Current Anthropology* 45 (S4): S35–58. https://doi.org/10.1086/422086.

Fuller, Dorian Q, Leilani Lucas, Lara González Carretero, and Chris Stevens. 2018. "Trends in Wild Food Use, Domestication and Cultivation Among Early Villages in Southwest Asia." *Paléorient* 44 (2): 59–74. https://doi.org/10.2307/26595375.

Lucas, L, and D Fuller. 2018. "Dataset: From Intermediate Economies to Agriculture: Trends in Wild Food Use, Domestication and Cultivation Among Early Villages in Southwest Asia." London, UK: UCL Institute of Archaeology. https://discovery.ucl.ac.uk/id/eprint/10052960/.

Riehl, Simone, and Christoph Kümmel. 2005. "Archaeobotanical Database of Eastern Mediterranean and Near Eastern Sites (ADEMNES)."

Shennan, Stephen J., and James Conolly. 2007. "Dataset: The Origin and Spread of Neolithic Plant Economies in the Near East and Europe." Archaeology Data Service. https://doi.org/10.5284/1000093.

Wallace, Michael, Alexandra Livarda, Michael Charles, and Glynis Jones. 2018. "Origins of Agriculture: Archaeobotanical Database." Archaeology Data Service. https://doi.org/10.5284/1046750.