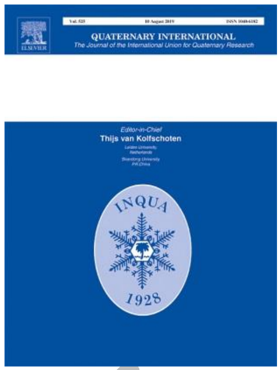

People and plant entanglements at the dawn of agricultural practice in Greece. An analysis of the Mesolithic and early Neolithic archaeobotanical remains

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Abstract

Investigation of the incipience of agriculture in Greece employing archaeobotanical remains is a challenging field of inquiry, aiming at gaining insights into the complex socio-economic transformations that gradually shaped the way of Neolithic life. Yet, primary archaeobotanical evidence dating to the 7th and early 6th millennium BCE from Greece still remains scarce and, to a certain degree, incomplete as regards the kind of information it can provide. This paper forms anew an approach to explore aspects of early agricultural practices in Greece on the basis of plant macroremains. The aim is to set the Mesolithic background against which the Early Neolithic archaeobotanical dataset is then fully reviewed. In doing so we first introduce new Mesolithic and early Neolithic data (Theopetra in Thessaly, and Revenia and Paliambela in Macedonia) and we then provide a critical overview of all other sites in Greece dated to these periods, to ultimately set new 'seeds' for future research on the incipience of agriculture in the area.

1. Introduction

The archaeological discourse on the incipience of plant cultivation in Greece as a fundamental element of Neolithic life has oscillated for many decades between two contradictory theoretical poles. The first one maintains that the transition from Mesolithic gathering traditions to Neolithic food production practices was the result of a rather brief episode of their direct or indirect adoption in a fully shaped form from the initial Southwest Asian cores to Greece and Europe (e.g. Ammerman and Cavalli-Sforza, 1971, 1973; 1984; Van Andel and Runnels, 1995; Perlès, 2001; Runnels, 2003). The main arguments in this approach are the absence of both substantial pre-Neolithic background in Greece in the form of identified sites and of wild plant progenitors from which most cultivated species that dominate the Neolithic archaeobotanical assemblages derived. In the 1980s a different view emerged, supporting the active contribution of indigenous elements in the socio-cultural processes involved in the emergence of agriculture in Greece (e.g. Dennell, 1983; Barker, 1985; Kotsakis, 1992, 2000; 2001, 2003; Seferiadis, 1993; Halstead, 1996). This position was founded in the 1967 work of Dimitris Theocharis' “The Dawn of Thessalian Prehistory”, who put forth for the first time the idea of an autochthonous Greek Neolithic and searched its cultural continuity in elements of the Mesolithic past, which was barely known at the time.

Crucial in these debates is the archaeobotanical evidence, as it provides primary data that can shed light into the very processes that stood at the core of the pre- and early agricultural societies. Indeed a few attempts have been made in the past to explore the agricultural beginnings in Greece through such primary information (Hansen, 1999; Colledge et al., 2004). Nevertheless, still only a few archaeobotanical studies on the transitional and initial periods of predominantly agricultural societies are available as the bulk of the material derives from the Middle and Late Neolithic phases. The Mesolithic datasets are even more scant due to the nature of archaeological research in Greece on this period that has taken place mostly in the form of surface surveys, which were not accompanied by excavations (Kotzamani and Livarda, 2014). This paper contributes to the investigation of the on-going debate on the nature of early agriculture in the Aegean, drawing on archaeobotanical remains and using thus primary material directly relevant to these issues. The term ‘archaeobotany’ is employed here in its narrow sense, referring to the study of plant macroremains and excluding charcoal studies or anthracology. The aim is to review the existing archaeobotanical evidence and add new data from three sites, Theopetra cave, Revenia and Paliambela, in central and northern Greece in order to elucidate the human-plant interactions in the transition from the Mesolithic to the early Neolithic period, building on an earlier review conducted by Valamoti and Kotsakis (2007). The Mesolithic data are reviewed first to set the scene and provide the necessary background that can illuminate the later transition to agriculture.

1.1. The sites

To date archaeobotanical information exists for three Mesolithic, seven Aceramic or Incipient Neolithic and twelve Early Neolithic sites, distributed mostly across central and northern Greece (Fig. 1). To this dataset material from three new sites, Theopetra cave, Revenia and Paliambela, can now be added and these are described in detail below.ds, to ultimately set new 'seeds' for future research on the incipience of agriculture in the area.

Figure 1. 1. Map of Mesolithic, Aceramic and Early Neolithic sites in the Aegean from where archaeobotanical remains have been recovered (M= Mesolithic; A= Aceramic/Incipient Neolithic; EN= Early Neolithic): 1. Knossos (A, EN); 2. Franchthi cave (M, A); 3. Maroulas, Kythnos (M); 4. Toumba Balomenou (EN); 5. Cyclops cave, Youra (M); 6. Achilleion (A, EN); 7. Argissa (A, EN); 8. Soufli Magoula (A, EN); 9. Ghediki (A); 10. Sesklo (A, EN); 11. Otzaki Magoula (EN); 12. Prodromos (EN); 13. Theopetra cave (M); 14. Servia-Varytimides (EN); 15. Revenia (EN); 16. Paliambela (EN); 17. Phyllotsairi (EN); 18. Nea Nikomedeia (EN); 19. Giannitsa B (EN).

1.2. Theopetra cave

Theopetra is situated in the northwestern part of the Thessalian plain, about 5 km east of the Koziaka mountain (Fig. 1). The site was excavated between 1987 and 2006 by the Ephorate of Palaeoanthropology and Speleology, directed by Kyparissi-Apostolika. The actual cave is on the north side of a large calcareous outcrop, which is located at about 280 m a.s.l. and its diameter is roughly 1.5 km (Fig. 2). The cave has one main chamber. Its roof is about 4–5 m tall at the centre of the chamber and the entrance measures roughly 17 m × 3 m, allowing plenty of light and air to enter (Kyparissi-Apostolika, 1994). Due to its orientation the cave cannot be seen easily from far away but from inside there is good visibility to the northeast and west. The dating of the cave was based both on material culture typologies and radiocarbon dates, which confirmed the occupation of the cave from the Middle Palaeolithic to the late Neolithic, with only some occasional subsequent habitation until the modern period (Kyparissi-Apostolika, 1998, 1999a, 1999b, 2000, 2003). The Mesolithic occupation levels of the cave were radiocarbon dated to between 9940 and 8550 cal. BC and 7060-6780 cal. BC (Facorellis, 2003).

Figure 2. Location of Theopetra cave (Photo provided by N. Kyparissi-Apostolika).

1.3. Revenia Korinos, Pieria

The settlement of Revenia is situated at the north part of Pieria prefecture in Macedonia and was excavated between 2002 and 2004 by the 16thand 27th Ephorates of Prehistoric and Classical Antiquities under the direction of Besios and Adaktylou. It is a flat-extended settlement and according to pottery finds it was first occupied in the Early Neolithic period and until the Late Bronze Age, although some sporadic occupation continued until the historic period (Besios et al., 2005). The architectural features of the settlement include eighty-six pits of various sizes and shapes, mostly on the east side of the excavated area, as well as three ditches and seventy-one post-holes.

1.4. Paliambela Kolindros, Pieria

The Neolithic settlement of Paliambela is situated at the northeast part of Pieria prefecture and it is being excavated since 2000, following an initial survey in 1999, under the direction of Prof. Kostas Kotsakis (Aristotle University of Thessaloniki, Greece) and Prof. Paul Halstead (University of Sheffield, UK). Material culture indicates the habitation of the site also during the Late Bronze Age and the Byzantine period. The site started as an extended-flat settlement in the Early Neolithic and later, during the Middle and Late Neolithic, it developed into a tell (Halstead and Kotsakis, 2001). The Early Neolithic phase is found at the north part of the excavated area and provides evidence for one of the earliest settlements in the north of Greece. Radiocarbon dating has identified the Early Neolithic period at Paliambela as one of the earliest in the region at about 6600–6400 cal BC, together with Mavropigi-Filotsairi and Lefkopetra (Maniatis et al., 2015). Architectural features dated to the Early Neolithic include mostly small, shallow pits, dug into the natural bedrock, which were used possibly as bases for shelter construction (Halstead and Kotsakis, 2005).

2. Methods

2.1. Primary data

During the excavation of the sites at Theopetra, Revenia and Paliambela systematic soil sampling was employed, which resulted in the collection of 567, 199 and 2378 samples respectively, corresponding to the whole chronological sequence of the sites' occupation. All samples were processed first with dry-sieving and then by flotation, using a modified version of the machine described by French (1971). The sieves employed for the collection of the coarse and fine flot had 1 mm and 0.3 mm apertures respectively in all three sites. The heavy residue was collected in a 1 mm mesh. Sorting of the flots and identification of their archaeobotanical material was carried out using stereoscopes with magnification between×8 and ×40. The material of Revenia and Paliambela were processed at the Laboratory of Prehistoric Archaeology, Aristotle University of Thessaloniki, Greece, and that of Theopetra at the Ephorate of Palaeoanthrpology and Speleology.

The identification of the archaeobotanical remains was carried out using morphological criteria with the aid of the modern plant reference collection at the Aristotle University's Laboratory of Prehistoric Archaeology, and various identification manuals (e.g. Cappers et al., 2006; Jacomet, 2006; Cappers et al., 2009). Nomenclature follows Flora Europaea (Tutin et al., 1964, 1968; 1972, 1976; 1980). For the quantification of the material the minimum number of individuals (MNI) was calculated by assigning and counting only a diagnostic zone for each plant part, such as the embryo ends of cereals.

2.2. Secondary data

All published reports of sites with archaeobotanical material dated from the Mesolithic to the Early Neolithic period were accessed. A database was created in Microsoft Excel following a tripartite structure (see also Livarda and Kotzamani, 2014). For each site the following data were recorded: A) site and publication information; B) sampling and assemblage information; and C) plant taxa information per major context type and phase (Table 1). The first component included information on site location, the type and date of site, information about the excavation and publication date, as well as the full reference. The second component included information on sampling and recovery methods, such as the strategy adopted for the collection of plant remains, the volume of the samples taken, their processing method, the minimum mesh size for the collection of material, and information about the state of the assemblage (preservation mode and types of material included). This information allows an assessment and the identification of any potential biases contributing to the formation of plant assemblages that may have been introduced by archaeological methods or taphonomic processes. A note was also made when a site contained one or more samples with more than 100 or 350 items, as this quantity of material has the potential to provide statistically significant results (see van der Veen and Fieller, 1982). The last component was divided into three tables, recording plant taxa for each period of interest, Mesolithic, Aceramic/Incipient and later Early Neolithic. Within each period a further break down of the site information was made according to whether the data derived from domestic areas or burials. Only the presence of taxa was recorded and not any numerical information, in order to standardise the dataset that resulted from the employment of different quantification methods in each site.

Table 1. Type of information recorded in the archaeobotanical database (Mesolithic to Early Neolithic Greece).

A.	**Site and publication**	**B.**	**Sampling and assemblage**	**C.**	**Species information per context type and phase**
1	Site name	1	Sampling strategy (systematic, random, judgment, observation by naked eye)	1	Context type (domestic, burial)
2	Area (prefecture)	2	Total number of samples for all phases	2	Phase (Mesolithic, Incipient Neolithic, Early Neolithic)
3	Geographic location (latitude, longitude, altitude)	3	Volume of soil sample (minimum, maximum, total)	3	Total number of samples per phase
4	Site type	4	Recovery method (flotation, wet-sieving, hand-picking)	4	Total number of items per phase
5	Chronological period	5	Minimum mesh/sieve size	5	Species list
6	Numerical dating	6	Preservation mode (carbonization, mineralization, impressions)		
7	Date of excavation	7	Species presence (>100 items in at least one sample)		
8	Date of publication	8	Species presence (>350 items in at least one sample)		
9	Full reference	9	Presence of cereals (yes/no)		
10	Type of publication (preliminary, final)	10	Presence of pulses (yes/no)		
		11	Presence of fruits/nuts (yes/no)		
		12	Presence of wild taxa (yes/no)		
		13	Quantification mode		
		14	Total items		

3. Setting the scene – the Mesolithic archaeobotanical dataset

The available archaeobotanical data from Mesolithic contexts currently derive only from the following three sites: Franchthi cave (Hansen, 1991), the cave of Cyclops at the island of Youra (Sarpaki, 2011), and the open site of Maroulas at the island of Kythnos (Mueller-Bieniek, 2010). Of these, the evidence from Maroulas is very poor and equivocal in nature, as most seed macroremains were uncharred and their dating has not been verified. Therefore, these data have been excluded from this analysis. The range of plant remains at Franchthi and Youra is presented in Table 2. A much greater variety of plant remains were found at Franchthi, although it should be noted that the material from Youra suffers from poor recovery methods, which may have impacted these results. In particular, dry-sieving was implemented for the recovery of plant remains and no flotation was carried out due to the difficulty in transporting sediment (Sarpaki, 2011). In addition, only a few contexts were sampled from a single excavation season, and thus, the representativeness of this material for the cave as a whole needs to be treated with caution (ibid.). The plant remains from Youra were mostly fragmented in nature. The quantification of this material was based on counting either fragments or individuals and thus it is hard to judge the exact quantities. Nevertheless, the overall assemblage seems to be small. Most of the identified fragments are of terebinth (Pistacia cf. terebinthus), which would have been collected from the surrounding area, either for the fruit itself or as part of branches that would be brought to the cave. A few other wild taxa were also present, mostly Leguminosae, but their identifications are too broad or tentative to allow detailed insights into the resources used.

Table 2. The archaeobotanical remains recovered from the Mesolithic levels of Franchthi and Cyclops (Youra) caves (identifications as provided in the original publications).

Site name	**Franchthi cave**	**Cyclops cave, Youra**
Reference	Hansen, 1991	Sarpaki, 2011
Date	**Mesolithic**	**Mesolithic**
Total number of samples recovered	**62**	**32**
Samples with archaeobotanical remains	**61**	**22**
CEREALS		
Hordeum vulgare ssp. *spontaneum*	x	
Avena sp.	x	
Cerealia (cf. *Avena* sp.) fragments		x
cf. Cerealia fragments		x
LEGUMES		
Vicia ervilia	x	
Vicia/Lathyrus sp.	x	
Lens sp.	x	
cf. *Lens* sp.		x
Lathyrus sp.	x	
Pisum sp.	x	
Pisum/Vicia sp.	x	
Large Leguminosae	x	
Medium Leguminosae	x	
Small Leguminosae	x	

Leguminosae pod fragments		x
FRUITS/NUTS		
cf. *Corylus* sp.		x
cf. *Quercus* sp.fragment		x
cf. *Celtis* sp.		x
Prunus amygdalus	x	
Pyrus amygdaliformis	x	
Pistacia cf *lentiscus*	x	
Pistacia cf. *terebinthus* fragments		x
cf. *Pistacia* sp.		x
Coriandrum sp.	x	
WILD		
Silene sp.		x
Adonis sp.	x	
Fumaria sp.	x	
Capparis sp.	x	
Cruciferae	x	
Medicago sp.	x	
Malva parviflora	x	
Lithospermum arvense	x	
Alkanna sp.	x	
Anchusa sp.	x	
Labiatae (cf. *Salvia* sp.)		x
Calendula sp.	x	
Liliaceae	x	
cf. *Colchicum/Polygonatum*	x	
Phalaris sp.	x	
Graminaeae	x	
Graminae culm fragments		x
Graminae cf. glume		x
cf. Graminae wild rachis		x
Wild indeterminate	x	
Monocotyledonae capsule	x	

Franchthi cave has provided the best data available, being systematically sampled for archaeobotanical remains. A variety of plant resources were found at the Mesolithic levels of the cave. The data indicate the collection and use of wild barley (Hordeum vulgare ssp. spontaneum), oat (Avena sp.) and lentil (Lens sp.) as well as of some fruits and nuts, such as almond (Prunus amygdalus) and pistacia (Pistacia sp.), and occasionally of pear (Pyrus sp.), caper (Capparis sp.), and various Leguminosae taxa (Table 2). The contextualisation and interpretation of these data suggested the presence of possible earlier redeposited material in some cases, whereas the more secure deposits hinted at a possible decrease in the intensity of human occupation of the cave or even at its abandonment during the latest phase of the Upper Mesolithic period, before the appearance of domesticates (Hansen, 1991, 161-3).

To this restricted dataset of Mesolithic Aegean, new evidence from the site of Theopetra cave in western Thessaly can be added (for a brief introduction to this material see Kotzamani and Livarda, 2014). One hundred and ten samples were available from the Mesolithic levels of the cave, 95 of which contained archaeobotanical remains. The total soil volume was 1402 L and included 3389 plant items (Kotzamani, 2010). More specifically, the plant assemblage of this phase includes 99 taxa that belong to 20 different plant families (Table 3), and were recovered from 24 excavated squares of the cave (Fig. 3).

Table 3. The Mesolithic archaeobotanical assemblage of Theopetra cave (taxa whose presence is likely intrusive are indicated with an*).

	Theopetra cave
CEREALS	
Triticum monococcum grains*	3
Triticum monococcum glume bases*	4
Triticum monococcum/boeoticum grains	2
*Triticum monococcum/dicoccum** grains	2
*Triticum dicoccum** grains	3
Glume wheat* glume bases	5
*Triticum aestivum/durum** grains	2
Triticum sp. grains	3
Triticum/Hordeum grains	3
Hordeum vulgare ssp. *spontaneum* grains	13
Hordeum vulgare ssp. *spontaneum* rachis	1
Avena sp. floret	1
*Panicum miliaceum** grains	2
LEGUMES	
Vicia ervilia	12
Vicia/Lathyrus sp.	23
Lens sp.	9
Lathyrus cf. *cicera*	7
Lathyrus cf. *aphaca*	1
Lathyrus sp.	6
Pisum sp.	28
small Leguminosae	11
Legumes indeterminate	15
FRUITS/NUTS	
Pinus sp.	1
Juniperus sp. Type 1	1167
Juniperus sp. Type 2	484
Juniperus sp.	571
Juniperus sp. fruit fragment	1
Celtis cf. *tournefortii*	35
Ficus carica	24
Rubus fruticosus	1
Prunus sp.	1
Malus/Pyrus	1

Crataegus monogyna	8
Vitis sp. pip	1
Hippophae rhamnoides	65
Fruit/nut shell indeterminate	1
Fruit/nut indeterminate	3
WILD	
Polygonum spp.	15
Bilderdykia convolvulus	1
Rumex spp.	9
Polygonaceae	10
Chenopodium cf. *album*	2
Atriplex sp.	1
Chenopodiaceae	12
Petrorhagia cf. *velutina*	7
Caryophyllaceae	3
Fumaria cf. *offinalis*	1
Capparis spinosa	1
Sisymbrium sp.	2
Cruciferae	5
Rosa sp.	2
Rosaceae	7
Melilotus spp.	1
Trigonella sp.	13
Medicago spp.	11
Trifolium sp.	18
Leguminosae	3
Linum sp.	5
Malvaceae	1
Thymalaea sp.	1
Hypericum cf. *perforatum*	2
Torilis cf. *arvensis*	1
Umbelliferae	1
Galium cf. *verum*	2
Galium spurium	1
Galium/Asperula	8
Rubiaceae	1
Heliotropium europaeum	1
Lithospermum arvense	524
Alkanna sp.	1
Echium sp.	31
Myosotis arvensis	45
Boraginaceae	4
Verbena officinalis	1
Labiatae	5
Solanaceae	26
Verbascum spp.	1
Planatago sp.	1

Compositae	10
Muscari/Bellevalia	1
Liliaceae	7
Cynodon dactylon	3
Gramineae	29
Carex sp.	1
Cyperaceae	9
bud	10
spine	2
wild seed indeterminate	7
wild plant part indeterminate	3
TOTAL	**3389**

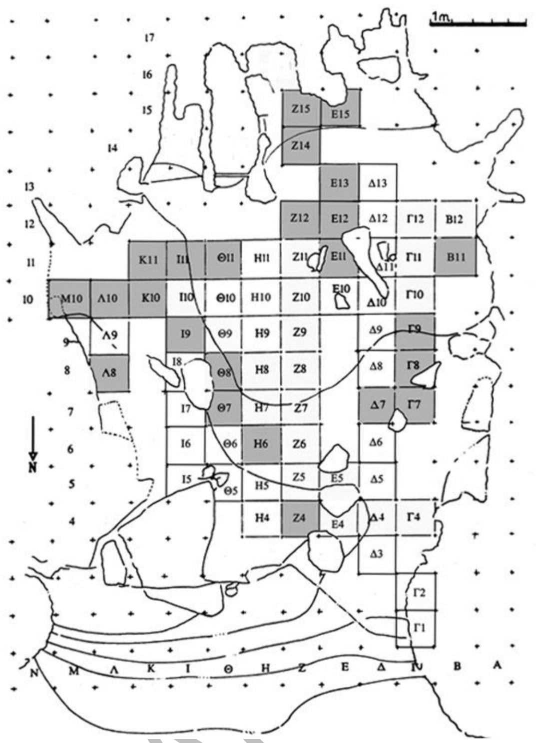
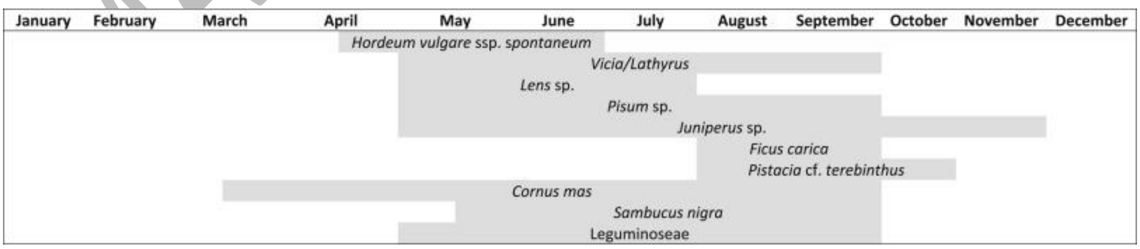


Figure 3. Excavation trenches at Theopetra cave. In grey shade those that yielded archaeobotanical material of Mesolithic date.

The plant range at Theopetra overall shows a stronger dependence on wild legumes in comparison to wild cereals, a trend observed at the site already since the Middle Palaeolithic period. Legumes have a regular presence across samples with Mesolithic archaeobotanical remains, and include pea (Pisum sp.), bitter vetch (Vicia ervilia), grass pea (Lathyrus sp.), and lentil (Lens sp.). The few whole specimens of pea and bitter vetch recovered were small, which can be indicative of the wild type. At the same time the occurrence of wild cereals in Theopetra seems limited, with only some remains of barley (Hordeum spontaneum), oat (Avena sp.) and possibly wild einkorn (Triticum boeoticum) occasionally identified in one to seven samples according to the species. A restricted number of domesticated cereals were also encountered but their inclusion in these early levels is problematic. The presence of millet (Panicum miliaceum), for instance, which is a later introduction in the area, seems to be the result of intrusive seeds from later strata due to the action of water and burrowing animals in the cave. Einkorn (Triticum monococcum), emmer (Triticum dicoccum) and free-threshing (Triticum aestivum/durum) wheat could also be intrusions but until radiocarbon dating is conducted the possibility that they were acquired from other groups cannot be excluded. These potential intrusions highlight the possibility of other intrusive taxa in the assemblage and the need for tight radiocarbon dating. The variety of fruits and nuts in the Mesolithic samples of Theopetra, including mainly juniper (Juniperus sp.), sea-buckthorn (Hippophae rhamnoides), hackberry (Celtis sp.), hawthorn (Crataegus monogyna) and fig (Ficus carica), is largely indicative of the mountainous and woodland environment of the site, while their relative abundance hints at the potential importance of these resources in the dietary habits of the cave's users. Similarly, wild taxa with a wide variety of potential uses significantly contribute to the Mesolithic archaeobotanical assemblage.

The Mesolithic plant remains of Theopetra were found exclusively at the sides of the cave. Their absence from the central area is probably an artefact of the taphonomic processes that followed the burial of the plants and is not considered indicative of habitation and activity patterns within the cave. Most samples derive from fire spots or from areas with traces of burning episodes. The richest ones, containing mainly fruits and particularly juniper berries (seeds and fruits), were found in the southern and southwestern part of the cave. The dominance of juniper, however, may be partly the result of the selection of fruit-bearing branches that could have been used to fuel the hearths. There is indeed an increased presence of juniper charcoal in the cave in the Upper Palaeolithic period although in the Mesolithic levels this is relatively reduced (Ntinou, 2000, 73; Ntinou and Kyparissi-Apostolika, 2016). The plant resources recovered at the cave suggest its habitation at least between the middle of spring and the end of autumn, taking into account the seasonal availability of the main food plants identified (Table 4). However, occupation of the cave cannot be excluded beyond this time span as food plants could have also been stored, for instance in containers made of perishable material.

Table 4. Seasonal availability of the main food plant taxa identified at Theopetra cave (recording of seasonality is based on the time of the year during which the preserved plant parts recovered from the cave would have been available for collection. In addition, when ancient sources or ethnographic evidence suggest the use for food, medicine or other purposes of another, unpreserved, part of a plant included here, the season in which that part would be available has been also considered).



4. The Early Neolithic: new archaeobotanical data

Having explored the archaeobotanical dataset in the period just before the incipience of agriculture, the early Neolithic plant evidence can be now discussed in order to investigate how the observed trends were potentially crystallised. To date there are 14 sites in Greece from which archaeobotanical material corresponding to the Aceramic and Early Neolithic has been collected and published, most of which derive from Thessaly and northern Greece. To this dataset material from another two sites in northern Greece, Revenia and Paliambela in Pieria, can be added (Fig. 1). In the sections that follow the new material is presented first, followed by a synthesis of all the evidence dated to these periods together.

4.1. Revenia, Korinos

The archaeobotanical assemblage of Revenia includes 199 samples from a variety of contexts that were grouped into 187 units. Of these, 111 samples contained archaeobotanical remains, deriving from pits and postholes. No plant remains were found in any other sampled context, which included a cobble floor, a small ditch and a concentration of mudbricks. In total 997 plant items were recovered from 4383 L of soil from the Early Neolithic phase of the site. Their overall preservation, however, was rather poor allowing their identification mainly to Family or Genus level.

In total 54 taxa were identified, including both domesticates and wild species, with cereals clearly dominating the assemblage (Table 5). Einkorn wheat, in the form of chaff and grains, was the most numerous and ubiquitous find, followed by barley (hulled and naked) (Hordeum vulgare) and then emmer wheat. Legumes had a limited presence in the assemblage and they were represented mainly by lentil (Lens culinaris), although a few finds of bitter vetch and grass pea (Lathyrus sativus) also occurred. Thus, it seems that the main dietary element in regards to plants was einkorn, which although matures quickly and yields smaller crops compared to other cereals, is more resilient to poor soils and dry conditions (Gennadios, 1914; Zohary and Hopf, 2000). This may have rendered einkorn less risky and prompted its inclusion in agricultural experimentations in this early settlement. Agricultural husbandry practices are more difficult to be inferred on the basis of the current evidence but it is possible that an intensive, small-scale cultivation system was implemented for the production of food, as has been observed in later Neolithic settlements in the area (e.g. Jones, 1987a; Valamoti, 2004; Vaiglova et al., 2014).

Table 5. The archaeobotanical remains recovered at Revenia, Korinos.

Context	**pits and postholes**
Date	**late 7th millennium BC**
Total no of samples	**199**
Samples with plant remains	**123**
Total soil volume	**2821**
CEREALS	
Triticum monococcum grains	74
Triticum monococcum glume bases	48
Triticum monococcum/dicoccum grains	47
Triticum monococcum/dicoccum glume bases	334
Triticum dicoccum grains	8
Triticum dicoccum glume bases	1
Triticum sp. grains	5
Triticum/Hordeum grains	60
Hordeum vulgare hulled grains	10
Hordeum vulgare naked grains	1
Hordeum vulgare grains	76

Hordeum vulgare rachis	21
Avena sp. grains	1
Avena sp. pedicil tip	3
Cerealia fragments	x
LEGUMES	
Vicia ervilia	3
Vicia/Lathyrus sp.	7
Lens sp.	24
Lathyrus sp.	1
Small seeded legumes	5
Legumes indeterminate	6
Legume fragments	x
FRUITS/NUTS	
Ficus carica	7
Ficus carica fruit fragment	1
Rubus sp.	2
Pistacia cf *terebinthus*	1
Prunus sp.	1
Malus/Pyrus	1
Vitis vinifera pips	3
Cornus mas	3
Sambucus ebulus	19
Sambucus nigra	1
Sambucus sp.	5
Fruit/Nut indeterminate	3
WILD	
Polygonum spp.	1
Bilderdykia convolvulus	2
POLYGONACEAE	2
Chenopodium cf *album*	20
Atriplex sp.	1
CHENOPODIACEAE	5
Portulaca oleracea	4
Agrostemma githago	1
Silene sp.	24
PAPAVERACEAE	1
CRUCIFERAE	12
Sanguisorba sp.	1
Medicago sp.	1
Trifolium sp.	4
Lotus sp.	1
LEGUMINOSAE	6
Linum sp.	3
MALVACEAE	1
Hypericum cf. *perforatum*	4
Galium/Asperula	10
RUBIACEAE	1

Convolvulus sp.	1
Lithospermum arvense	1
BORAGINACEAE	3
LABIATAE	10
Verbascum cf *nigrum*	1
Valerianella dentata	1
COMPOSITAE	7
Lolium temulentum	11
Lolium sp.	10
Bromus sp.	3
Cynodon dactylon	3
Digitaria sanguinalis	1
GRAMINEAE	31
Carex sp.	1
bud	1
spine	2
plant stem	4
Wild indeterminate	19
Carbonised plant material indeterminate	x
TOTAL	997

The scale of contribution of fruits to the dietary regime of the inhabitants of Revenia is difficult to infer as this class of material is mostly preserved in waterlogged contexts (Willerding, 1971, 1991; Jacomet, 2012), which are absent in this site. Fruits are usually consumed raw and their sparse presence at Revenia may be thus partly attributed to limited contact with fire. Nevertheless, according to the available data a variety of fruits seems to be present. The most common was elderberry (Sambucus ebulus), followed by fig. Other fruits/nuts included apple or pear (Malus/Pyrus), blackberry (Rubus sp.), cornelian cherry (Cornus mas), terebinth, grape (Vitis vinifera) and members of the genus Prunus that includes plums, cherries and so on. Another taxon present in very low numbers but worth mentioning is flax (Linum sp.). This probably derived from wild stands, as its dimensions fall within the range of the wild type (length not exceeding 3 mm, Van Zeist and Bakker-Heeres, 1975).

Examining the sample composition the first observation is that most samples contained only a small number of plant remains. Only 12 samples had 20 or more items and only four of these included more than 50 items (but still less than 100). All these 12 relatively richer samples included a mixture of items and mostly cereals. In particular, ten samples, recovered from seven pits and two postholes, included mostly glume wheat bases (identified as einkorn or einkorn/emmer) while the two remaining samples, recovered from the same pit, had slightly more grains (wheat and barley) than chaff and were more mixed in nature, including also relatively high quantities of wild taxa, legumes and fruits. The dominance of chaff is interesting as it preserves less well compared to grains under charring (Boardman and Jones, 1990). This suggests that certain activities at the settlement were taking place that have favoured their preservation, such as storage of cereals in their glumes and their later removal prior to cooking. In certain samples the co-occurrence of a mixture of a few grains with more chaff and wild taxa, such as Lolium temulentum or Lolium sp. that can be classified as weeds of cultivation and are big, heavy and not in flower heads ('free'), possibly represents a mixture of mostly the by-product of pounding and fine sieving in the crop processing sequence (see Jones, 1984; 1987b). The widespread presence and dominance of glume bases can be also explained by their potential employment as fuel. Indeed, the use of chaff as tinder or mixed in dung for fuel is a practice that has been observed in several other sites in the broader area dated to the Middle and Late Neolithic periods (Valamoti, 2004, 2006). Experiments using controlled feeding regimes to animals, followed by analysis of their dung, showed that glume bases can survive the digestive track of the animals in variable degrees leaving identifiable traces in some cases (Valamoti, 2013; Wallace and Charles, 2013). A closer examination of the glume bases present in the samples across the site is scheduled for the future.

Furthermore, one pit (pit 5) seems to have a rather higher concentration of wheat grains and another (pit 24) has a more substantial presence of barley but the overall low number of plant remains does not allow for nuanced insights into potential spatial differences regarding use of space. The small quantities of plants and their generally mixed nature, however, suggest that the pits were not used primarily for storage of food plants. The mixed nature of the plant assemblage of pit 5 for instance points to low level secondary accumulation of the by-products of a number of everyday activities, such as food processing and preparation, and cleaning, and supports the excavators' hypothesis that this context was part of one of the round houses of the settlement.

4.2. Paliambela, Kolindros

The settlement of Paliambela at Kolindros lies relatively close to Revenia. The study of this material is on-going but so far stratigraphic information exists for a few samples, 60 of which were confidently assigned to the Early Neolithic period. These derive from eight pits (627/8, 629, 630, 631, 2108, 2109, 2705, and 2715) and the soil from a cavity that had been dug into the natural substrate (unit 27225) at the north part of the Neolithic settlement. A summary of the results in each context is shown in Table 6. Similarly to the Revenia archaeobotanical assemblage all samples had a rather low amount of remains. In fact only two pits, 629 and 2715 that also yielded the highest number of samples, include more than 100 plant items and even in these cases no individual unit of the pits has more than 20 and 52 items respectively.

Table 6. The archaeobotanical remains recovered from Early Neolithic pits and a cavity at Paliambela, Kolindros.

	Pit 627/8	Pit 629	Pit 630	Pit 631	Pit 2108	Pit 2109	Pit 2705	Cavity 2714	Pit 2715	SUM
Number of samples (and units if different)	**3**	**20 (19)**	**5 (4)**	**8**	**3**	**3**	**2**	**1**	**15**	**60 (58)**
CEREALS										
Triticum monococcum grain	2	12	0	5	2	6	0	3	6	**36**
Triticum monococcum glume base	0	1	0	1	0	8	0	0	39	**49**
Triticum monococcum/dicoccum grain	2	29	0	7	3	2	0	0	4	**47**
Triticum monococcum/dicoccum glume base	5	15	0	17	7	19	0	5	93	**161**
Triticum dicoccum grain	2	9	0	4	0	0	1	1	0	**17**
Triticum dicoccum glume base	0	1	0	0	0	0	0	3	2	**6**
Triticum dicoccum/New type wheat glume base	0	0	0	0	0	0	0	0	2	**2**
Triticum dicoccum/aestivum/durum grain	0	1	0	0	0	0	0	0	0	**1**
Triticum aestivum/durum grain	1	1	0	0	0	0	0	0	0	**2**
Triticum aestivum rachis	0	1	0	0	0	0	0	0	0	**1**
Triticum sp. grain	1	0	0	0	0	0	1	1	4	**7**
Triticum sp. glume base	0	3	0	0	0	0	0	0	6	**9**
Triticum/Hordeum grain	1	8	2	3	3	1	0	2	1	**21**
Hordeum vulgare grain	1	14	2	2	4	4	0	0	3	**30**
Hordeum vulgare six-row rachis	0	0	0	0	1	0	0	0	0	**1**
Hordeum vulgare rachis indeterminate	0	0	0	1	0	1	0	1	0	**3**
rachis indeterminate	0	1	0	0	0	0	0	0	0	**1**
awn	0	x	0	0	0	0	0	0	0	**x**
embryo end	0	0	0	x	0	0	0	0	x	**x**
Cerealia grain	0	0	0	0	0	0	0	0	7	**7**
Cerealia grain fragments	x	x	x	x	x	xx	0	0	xx	**x**
PULSES										
Vicia ervilia	0	0	0	0	0	1	0	0	0	**1**

Vicia/Lathyrus sp	0	4	1	1	1	0	0	0	0	**7**
Lens culinaris	0	0	0	0	8	6	0	0	8	**22**
Lens sp.	2	5	0	5	0	0	0	0	2	**14**
Lathyrus sativus	0	0	0	0	0	1	0	0	1	**2**
Small-seeded legume indeterminate	1	2	0	3	0	1	0	0	0	**7**
Legume indeterminate	2	3	1	4	0	2	1	0	2	**15**
Legume fragments	0	x	x	x	x	xx	0	0	x	**x**
FRUITS/NUTS										
Ficus carica seeds	0	7	1	6	2	5	0	3	12	**36**
Ficus carica fruit fragment	0	x	0	x	0	0	0	0	0	**x**
Linum sp.	0	0	1	0	0	0	0	0	0	**1**
Rubus fruticosus	0	1	0	0	1	0	0	0	1	**3**
Prunus sp.	0	0	0	0	0	1	0	0	0	**1**
Pyrus sp.	0	0	0	0	0	0	0	0	1	**1**
Malus/Sorbus sp.	0	0	0	0	0	0	0	0	1	**1**
Malus/Sorbus sp.	0	0	0	0	0	0	0	0	1	**1**
Vitis vinifera pips	0	0	0	0	0	0	0	1	2	**3**
Cornus mas	0	0	0	0	0	0	0	0	2	**2**
Sambucus nigra	0	4	0	1	0	0	0	0	0	**5**
Sambucus sp.	0	1	0	0	0	0	0	0	0	**1**
Fruit/Nut indeterminate	0	x	x	0	0	0	0	0	2	**2**
Fruit/Nut shell fragment	0	0	0	x	0	x	0	0	x	**x**
WILD										
Chenopodium album	0	1	0	0	0	0	0	0	0	**1**
Polygonum aviculare agg.	0	1	0	0	0	0	0	0	1	**2**
Polygonum sp.	0	1	0	0	0	0	0	0	0	**1**
Rumex sp.	0	2	0	0	1	0	0	1	1	**5**
CHENOPODIACEAE	0	0	0	0	0	2	0	0	0	**2**

Portulaca oleracea	0	1	0	0	4	0	0	0	1	**6**
CARYOPHYLLACEAE	0	0	0	0	0	0	0	1	0	**1**
CRUCIFERAE	0	2	0	0	0	0	0	0	0	**2**
BRASSICACEAE	0	6	0	1	0	0	0	0	0	**7**
Medicago sp.	0	0	0	0	0	0	0	0	1	**1**
Erodium sp.	0	0	0	0	0	0	0	1	0	**1**
Tilia sp.	0	1	0	5	0	0	0	0	0	**6**
MALVACEAE	0	1	0	1	0	0	0	0	0	**2**
Galium/Asperula sp.	0	3	0	1	0	0	0	0	0	**4**
Heliotropium europaeum	0	1	0	0	1	0	0	0	1	**3**
Lithospermum arvensis	0	0	0	0	0	0	0	0	1	**1**
Verbena officinalis	0	0	0	0	0	0	0	0	1	**1**
LABIATAE	0	0	0	1	0	0	0	0	0	**1**
Teucrium chamaedrys	0	3	0	0	0	1	0	0	0	**4**
Verbascum sp.	0	0	0	1	0	0	0	0	0	**1**
Scrophularia sp.	0	1	0	0	0	0	0	0	0	**1**
COMPOSITAE	0	1	0	0	0	0	0	0	0	**1**
Juncus sp.	0	3	0	0	0	0	0	0	0	**3**
GRAMINAE	2	9	0	1	0	0	0	1	7	**20**
Lolium sp.	0	2	0	0	0	2	0	1	0	**5**
Bromus sp.	1	1	0	0	0	0	0	0	0	**2**
Phalaris sp.	0	1	0	0	0	0	0	0	0	**1**
Stipa sp.	0	0	0	0	0	0	0	0	2	**2**
Digitaria sp.	0	0	0	1	0	0	0	0	0	**1**
Carex sp.	0	0	0	0	0	0	0	0	1	**1**
Wild indeterminate	0	3	0	2	2	0	0	0	2	**9**
spine	0	x	0	0	0	0	0	0	0	**x**
plant stem	x	0	0	0	0	x	0	0	0	**x**

Carbonised plant material indeterminate	0	x	0	0	0	0	0	0	0	**x**
TOTAL	**23**	**167**	**8**	**74**	**40**	**63**	**3**	**25**	**220**	**623**

In terms of sample composition all contexts contain a variety of plant remains. They all include cereal remains; pulses occur in the pits but are absent from the cavity; fruits/nuts are present in all contexts apart from pits 627/8 and 2705; and wild plants occur in all samples except in pits 630 and 2705. The last two pits were also those with the lowest number of plant items, having less than ten items across all their sampled units dated to this period. Cereals, although relatively few in absolute quantities, include a good range of species. Einkorn, emmer, free-threshing wheat, possibly 'new type' wheat and barley, including the six-row type, are all present in the assemblage. Einkorn seems to be the most common cereal at Early Neolithic Paliambela but emmer may be equally prevalent as more such items may be under the category 'Triticum monococcum/dicoccum', which was used for poorly preserved specimens that could not be confidently assigned to a species.

Examining further the type of plant remains present and taking into account taphonomic parameters, it must be noted that the relevant importance of the different cereals is hard to judge on current evidence. In particular, when comparing only the grain finds, einkorn, emmer and barley occur in more or less similar amounts, given also the number of indeterminate specimens. When chaff, however, is taken into account then it is the glume wheats that become dominant. According to both ethnographic studies and archaeological evidence, glume wheat grains are often stored in their glumes for protection against adverse environmental conditions and pests, as well as for spreading the labour involved in their processing for consumption (e.g. Jones et al., 1986). The piecemeal cleaning of these crops during daily routines has as a consequence the increased visibility of their chaff compared to that of other types of cereals, which is normally removed during earlier stages of crop processing that take place often nearer the fields (see e.g. Hillman, 1984; Jones, 1984). The process of carbonization adds another bias in favour of the increased visibility of glume wheat chaff, as according to experiments this survives better under charring compared to that of free-threshing wheat and barley chaff (Boardman and Jones, 1990). A closer investigation of the composition of each sample in each context indicates that in all cases apart from a small number of samples from pit 2715, glume bases occur in low numbers together with a mixture of grains, legumes, fruits and wild taxa, which points to refuse assemblages from a variety of activities, mostly related to food preparation and consumption. The plant material in pit 2715 is clearly dominated by glume bases and a mixture of a small number of other types of plant remains. Similarly to Revenia, the possibility of chaff included in dung and used as fuel for these samples needs exploring in the future (see Valamoti, 2013; Wallace and Charles, 2013).

The presence of legumes and fruits is similar to that at Revenia. Only a limited number of specimens of legumes has been recovered, among which lentil, bitter vetch and grass pea have been positively identified. A variety of fruits and wild taxa is also present, all of which occur in very low numbers. The plant assemblage overall does not differ significantly across the various early Neolithic contexts and seems to be mainly an amalgamation of refuse deposits accumulated over time during food preparation, cooking and cleaning activities. Pits 630 and 2705 had particularly few plant items, while pits 629 and 2715, included the highest number of plant remains. Pit 630, interpreted as residential, had instead a very large concentration of shells and the highest variety of such food items across all early Neolithic contexts (Veropoulidou, 2011, 212–4). The shell concentration was far greater at the upper levels of the pit and the condition of these shells (excellent preservation and articulated items) pointed to their quick deposition (ibid.). On the basis of this evidence and the presence of ash and broken stones at this level, Veropoulidou (2011, 214) suggested that this pit might have changed function during the last phases of its use, and the material present may be refuse that was deposited to seal the pit. Following this rationale, the few food plant remains may constitute part of the remnants of food preparation incorporated in the ash deposit, potentially all part of the same consumption event that either directly or indirectly marked the end of this structure. Notably, the material in pit 629, also interpreted as a residential structure but about two centuries earlier than pit 630, had the lowest density of shell remains, many of which were highly fragmented, and a great quantity of tools and other material culture. The whole assemblage points to accumulation of refuse from a range of everyday activities, and in regards to food plants, may provide insights into the basis of the site's dietary habits. Overall, no significant differences have been observed between the various Early Neolithic contexts in regards to the choice of basic food plants. Similarly, in the case of shells one main species, the lagoon cockle (Cerastoderma glaucum) was the largely preferred mollusc food across all contexts, although some differences in cooking methods have been identified (Veropoulidou, 2011, 212). In the case of plants, the spatial observations indicate a rather broad subsistence base and a similar suite of food plants across the community. This, however, does not exclude other potential differences in regards to land access and the agronomic methods employed, which can be tested in the future with the help of stable isotope studies.

5. Exploring the Aceramic and Early Neolithic dataset

5.1. Data quality

5.1.1. The Aceramic dataset

The archaeobotanical testimonies of the earlier phase of the Neolithic derive from five sites in the Thessalian plain, Ghediki, Sesklo, Achilleion, Soufli Magoula and Argissa, and two sites in Southern Greece, Franchthi cave and Knossos (Table 7). The initial archaeobotanical analysis of the five sites in Thessaly had been conducted in the 1960s and in most cases (Ghediki, Soufli Magoula, Sesklo) there had only been handpicking of visible seeds rather than a targeted sampling strategy. A few samples from Achilleion and Argissa were specifically taken for the recovery of plant macroremains and flotation has been implemented although no information on the minimum mesh size is available for the former. The result is a very partial record of the potentially available plant remains. In the case of Franchthi total sampling was implemented and all samples were processed with flotation but in this case the mesh size was large (1.5 mm), which could have potentially resulted in the loss of smaller seeds and other plant parts. At Knossos both visible seeds from the earlier excavations and targeted soil samples (from the later excavation in 1997 directed by Karetsou, Efstratiou and Banou) were collected and the latter floated. The seeds from Neolithic Knossos were also re-examined and the identifications were checked by Sarpaki (2009, 2013). With the exception of Knossos the other six sites resulted in very restricted datasets, the largest of which is from Sesklo and includes 209 plant items (Kroll, 1983). Knossos, in contrast, provided a significant dataset that allows some more detailed insights into the plant resources and their management. Despite these limitations, the available material from Aceramic levels provide the first registers of plant resources in the Aegean and can serve as a starting point for the discussion on the incipience of agricultural activity in this area.

Table 7. Archaeobotanical assemblages of Aceramic/Incipient Neolithic sites in Greece (identifications as provided in the original publications).

	Achilleion (Renfrew, 1966)	Ghediki (Renfrew, 1966)	Soufli Magoula (Renfrew, 1966)	Sesklo (Kroll, 1983)	Argissa (Hopf, 1962, Kroll, 1983)	Knossos (Sarpaki, 2009, 2013)	Franchthi Hansen, 1991)
CEREALS							
Triticum monococcum grain		x		x	x	x	
Triticum monococcum 2-grained grain					x		
Triticum monococcum spikelet fork					x	x	
Triticum dicoccum grain	x	x		x	x	x	x
Triticum dicoccum spikelet fork					x	x	
Triticum cf. *dicoccum* grain			x				
Triticum aestivum rachis						x	
Triticum aestivum/turgidum grain						x	
Triticum aestivum/durum grain						x	
Hordeum vulgare grain				x	x		
Hordeum vulgare hulled 2-row/straight grain		x				x	
Hordeum vulgare hulled 2-row rachis						x	
Hordeum vulgare hulled 6-row/twisted grain					x	x	
Hordeum vulgare hulled 6-row rachis						x	
Hordeum						x	

vulgare hulled grain							
Hordeum vulgare 6-row grain				x	x		
Hordeum vulgare 4-row rachis					x		
Hordeum vulgare (distichum) grain				x			x
Hordeum vulgare naked 2-row/straight grain		x				x	
Hordeum vulgare naked twisted grain						x	
Avena sp. grain	x			x			x
cf. *Panicum miliaceum*					x		
LEGUMES							
Vicia ervilia				x			
Vicia sp.		x					
Vicia/Lathyrus sp.							x
Lens sp.					x		x
Lens esculenta		x	x	x		x	
Pisum sp.		x		x			
Leguminosae					x		
FRUITS/NUTS							
Quercus sp.				x			
Ficus carica				x	x	x	
Rubus sp.				x			
cf. *Crataegus* sp.					x		
Amygdalus communis						x	x
Pistacia atlantica		x		x			
Vitis vinifera					x		
Olea sp.			x				
Sambucus ebulus					x		
WILD							
Polygonaceae				x			
Chenopodiaceae				x	x		
Portulaca oleracea				x			
Capparidaceae				x			
Cruciferae							x
Leguminosae				x	x		x
small Leguminosae						x	
cf. *Medicago* sp.							x
Malva sp.						x	
Lithospermum arvense							x

Alkanna sp.							x
Plantago sp.						x	
Graminae				x	x		x
Lolium sp.						x	
Lolium temulentum					x		
Cyperaceae					x		

5.1.2. The Early Neolithic dataset

More sites have yielded Early Neolithic deposits that were sampled for archaeobotanical analysis, but the vast majority of these derives from Thessaly and western Macedonia (Fig. 1; Table 8). Therefore, the available dataset provides a skewed representation of plant resources and practices in terms of geographical coverage, which needs to be taken into account. Only in four out of the 14 Early Neolithic sites archaeobotanical material were collected when visible to the naked eye and were not processed by flotation (Soufli Magoula, Sesklo, Prodromos, Nea Nikomedeia). The lack of sieving and flotation means that smaller items (e.g. chaff and various wild taxa) would have been potentially lost (see also Van Zeist and Bottema, 1971) and thus pose limitations to the understanding of early agriculture in these sites.

Table 8. Archaeobotanical assemblages of Early Neolithic sites in Greece (identifications as provided in the original publications).

	Achilleion (Renfrew, 1966, 1989)	Giannitsa B (Valamoti , 1995)	Nea Nikomedeia (Van Zeist and Bottema, 1971)	Prodromos (Halstead and Jones, 1980)	Servia-Varytimides (Hubbard, 1979)	Otzaki Magoula (Kroll, 1983)	Soufli Magoula (Renfrew , 1966)	Sesklo (Renfrew, 1966; Kroll , 1983)	Phyllotsairi -Mavropigi burials (Valamoti, 2011)	Phyllotsairi -Mavropigi settlement (Valamoti, 2011)	Revenia (Kotzamani , 2010)	Toumba Balomenou (Sarpaki, 1995)	Knossos (Sarpaki, 2009, 2013)	Argissa (Hopf, 1962; Kroll , 1983)	Paliambela (Kotzamani and Livarda this paper)
CEREALS															
Triticum monococcum grain	x	x	x	x	x	x	x	x	x	x	x			x	x
Triticum monococcum 2-gr grain				x	x										
Triticum monococcum glume base		x	x		x					x	x	x			x
Triticum monococcum spikelet fork												x			
Triticum cf. *monococcum* grain												x	x		
Triticum cf. *monococcum* glume base									x			x			
Triticum monococcum/dicoccum grain											x				x
Triticum monococcum/dicoccum glume base											x				x
Triticum dicoccum grain	x	x	x	x	x	x	x	x	x	x	x			x	x
*Triticum dicoccum*1-gr grain			x	x											
Triticum dicoccum glume base		x			x				x	x	x				x
Triticum dicoccum spikelet fork			x	x											
Triticum cf. *dicoccum* grain													x		
Triticum dicoccum/new type glume base															x
Triticum new type glume base										x					
cf. *Triticum* new type glume base									x						
Triticum dicoccum/aestivum/durum grain															x
Triticum aestivum/durum grain		x				x		x							x
Triticum aestivum/durum rachis		x													
Triticum aestivum rachis															x
Triticum cf. *aestivo-compactum* grain													x		
Triticum sp. grain											x	x	x		x
cf. *Triticum* sp. grain												x			

Triticum sp. glume base													x		x
Triticum/Hordeum grain											x				x
Hordeum vulgare rachis					x						x	x	x		x
Hordeum vulgare 6-row/twisted grain		x	x		x	x		x						x	
Hordeum vulgare 6-row rachis															x
Hordeum vulgare distichon/straight grain				x	x		x								
cf. *Hordeum vulgare* distichon grain								x							
Hordeum vulgare 2-row hulled floret					x										
Hordeum vulgare hulled grain				x							x	x	x		
Hordeum vulgare naked grain			x		x						x				
cf. H*ordeum vulgare* naked grain						x							x		
Hordeum vulgare grain	x	x				x		x	x	x	x	x			x
cf. *Hordeum* sp. grain												x	x		
Avena sp. grain	x					x		x			x	x		x	
Avena sp. pedicil tip											x				
Avena awn												x			
cf. *Avena* sp.												x	x		
cf. *Panicum miliaceum*					x										
Cerealia												x	x	x	x
Cerealia culm nodes												x			
LEGUMES															
Cicer arietinum						x									
Vicia ervilia			x		x	x		x			x			x	x
cf. *Vicia ervilia*												x			
cf. *Vicia faba*													x		
Vicia/Lathyrus sp.											x				x
Lens culinaris			x		x		x					x	x		x
Lens sp.	x	x		x		x		x		x	x			x	x
cf. *Lens* sp.															
Lathyrus sativus				x											x
Lathyrus cicera/sativus												x			
Lathyrus cicera												x			
Lathyrus sp.											x				
Pisum sp.				x		x	x			x				x	
cf. *Pisum* sp.													x		
Pisum sativum			x		x							x			
cf. *Pisum sativum*												x			
small legume											x	x			x
Legume indeterminate											x	x	x		x
FRUITS/NUTS/HERBS/OIL-PRODUCING															
Corylus cf. *avellana*					x										

Quercus sp.	x		x	x											
cf. *Quercus* sp.												x			
Ficus carica						x		x			x	x	x	x	x
Ficus carica fruit fragment											x				x
Linum usitatissimum					x	x									
Linum cf. *usitatissimum*												x			
Linum sp.											x				x
cf. *Linum* sp.												x	x		
cf. *Linum flavum*												x			
Raphanus raphanistrum pod												x	x		
cf. *Raphanus raphanistrum* seed													x		
Rubus fruticosus															x
Rubus fruticosus/idaeus					x										
Rubus sp.										x	x	x			
Prunus cf. *amygdalus*					x										
Prunus cf. *spinosa*			x												
Prunus avium															
Prunus mahaleb					x										
Prunus sp.											x				x
cf. *Prunus* sp.												x			
Pyrus sp.															x
Malus/Pyrus sp.											x				
Malus/Sorbus sp.															x
Pistacia atlantica								x							
Pistacia atlantica/terebinthus		x													
Pistacia terebinthus												x			
Pistacia cf. *terebinthus*											x	x			
cf. *Pistacia terebinthus*												x			
Pistacia sp.	x								x	x					
Vitis vinifera		x						x			x	x	x		x
Vitis silvestris	x														
Vitis sp.												x	x		
Cornus sanguinea					x										
Cornus mas		x	x	x	x				x	x	x				x
Satureja thymbra												x	x		
cf. *Thymus*												x			
Sambucus ebulus											x			x	
Sambucus nigra											x				x
Sambucus sp.		x								x	x				x
fruit/nut indeterminate											x				x
WILD															
Fagus sylvatica cupule fragments					x										
Quercus cf. *pedunculiflora* cupu le fragments					x										

Polygonaceae						x		x			x	x		x	
Polygonum aviculare agg.															x
Polygonum cf. *arenastrum*					x										
Polygonum sp.											x				x
Bilderdykia convolvulus											x				
Polygonum/Rumex sp.		x													
Rumex sp.		x			x							x	x		x
cf. *Rumex* sp.												x			
Chenopodiaceae						x		x			x	x		x	x
Chenopodium botrys					x										
Chenopodium album					x										x
Chenopodium cf. *album*											x				
cf. *Chenopodium*												x			
Atriplex sp.											x				
Portulaca oleracea						x		x			x				x
Caryophyllaceae		x						x							x
Stellaria sp.	x														
Scleranthus sp.						x									
Agrostemma githago								x			x			x	
Silene sp.											x	x	x		
Papaveraceae											x				
Fumaria sp.						x									
Capparidaceae								x							
Cruciferae											x		x		x
cf. Cruciferae													x		
Neslia sp.						x									
Brassicaceae															x
Brassica sp.					x										
Sanguisorba sp.											x				
Leguminosae		x	x			x		x			x	x	x	x	
Biserrula pelecinus					x										
Trigonella sp.					x										
cf. *Trigonella* sp.													x		
Medicago cf. *minima*					x										
Medicago sp.											x				x
cf. *Medicago* sp.													x		
Trifolium sp.					x						x		x		
cf. *Trifolium* sp.												x	x		
Lotus sp.											x				
Coronilla sp.					x										
Hippocrepis sp.					x										
cf. *Onobrychis* sp.													x		
Erodium sp.															x
Euphorbiaceae						x									
Tilia sp.															x

Malvaceae											x				x
Malva sp.												x	x		
Thymelaea hirsuta													x		
Hypericum cf. *perforatum*											x				
Rubiaceae											x				
Sherardia arvensis												x	x		
Galium/Asperula sp.		x									x				x
Gallium rivale													x		
Galium spurium						x		x						x	
Galium aparine												x			
Galium sp.	x											x			
Cuscuta europea					x										
Convolvulus sp.											x				
Boraginaceae											x				
Heliotropium europaeum															x
Lithospermum arvense					x	x		x			x			x	x
Buglossoides arvensis		x											x		
Verbena officinalis					x										x
Verbena cf. *officinalis*												x			
Labiatae											x	x	x		x
Teucrium chamaedrys															x
Teucrium sp.		x			x										
Verbascum cf. *nigrum*											x				
Verbascum sp.															x
Scrophularia sp.															x
Plantaginaceae						x		x							
Valerianella dentata											x				
Valerianella sp.													x		
Compositae											x				x
Carduus sp.															
cf. *Carduus* sp.					x										
Centaurea cf. *solistitialis*					x										
Juncus sp.															x
cf. *Juncus* sp.												x			
Gramineae		x	x			x		x			x	x	x	x	x
Lolium temulentum						x					x	x			
cf. *Lolium temulentum*												x			
Lolium temulentum/remotum		x													
Lolium sp.		x									x				x
cf. *Lolium* sp.												x	x		
cf. *Bromus secalinus*								x							
Bromus sp.	x										x				x
cf *Bromus* sp.		x											x		
Phalaris sp.													x		x
Stipa sp.															x

Cynodon dactylon											x				
Digitaria sanguinalis											x				
Digitaria sp.															x
Setaria viridis					x										
Eleocharis sp.					x										
cf. *Chloris* sp.												x			
Cyperaceae								x						x	
Cyperus sp.					x										
Carex sp.											x				x
wild indeterminate											x				x

In the remaining 11 sites samples were processed with flotation and by using sieves with small enough aperture opening to allow the recovery of small plant items. It should be noted, however, that for Achilleion no information on the mesh size exists. Most sites of the Early Neolithic group are represented by only a few archaeobotanical samples, and it is only at Phyllotsairi Mavropigis, Revenia and Paliambela that substantial sampling took place. At Revenia and Paliambela the strategy was in fact systematic, sampling all stratigraphically non-mixed units.

Regarding the archaeobotanical data in five out of the 14 sites no numerical information per sample has been provided so far. The other nine sites yielded a variable amount of plant remains with Nea Nikomedeia including the largest assemblage of almost 11000 specimens. Overall, in most cases there are generally low quantities of plant remains per sample, but five sites (Nea Nikomedeia, Sesklo, Servia-Varytimides, Otzaki Magoula and Phyllotsairi-Mavropigi) include also samples with more than 100 or 350 items.

5.2. Plant resources and the subsistence base

The basic plant species composing the earliest Neolithic assemblages from Greece are einkorn and emmer, barley (mostly hulled two-row and six-row type, but also naked), lentil, and a variety of fruits and nuts gathered from the wild. Other cereals and pulses have also been recorded but in very low numbers and in less than half of the sites (Table 7). Examining qualitatively and quantitatively these assemblages some heterogeneity becomes apparent. Emmer is present in all the incipient Neolithic assemblages of Greece and should be definitely considered an introduced domesticate since its wild progenitor does not appear in the Greek flora. Other crops, however, such as einkorn, barley, lentil, bitter vetch, and pea, do not show a homogeneous pattern of occurrence in the archaeological deposits of this period. For instance, einkorn is absent from the Incipient Neolithic layers of Franchthi, Achilleion and Soufli Magoula, although it must be noted that in the latter two only one sample was collected while the total number of seeds at the Aceramic levels of Franchthi is very low. Bitter vetch and pea are present in only one and two sites respectively. Charred pulses are traditionally recovered in lower quantities compared to cereals, possibly due to cultural practices (e.g. processing and cooking methods that result in fewer chances of charring), and this may also influence their lower visibility. Overall, the dataset is too limited and with several sampling or recovery weaknesses to allow firm conclusions. Nevertheless, on current evidence it seems that these absences could be also due to the plant management preferences of the first farmers, owed to a mixture of socio-economic, environmental and cultural components. Together with plant macroremains that indicate the practicing of agriculture, the other expressions of material culture in most of the abovementioned sites (with the probable exception of Franchthi cave) are indicative of a fashioned Neolithic way of life, organized in permanent settlements, economically based on plant cultivation and animal husbandry and making systematic use of ceramic technology.

The main contents of the later Early Neolithic assemblages are generally similar to those of the Incipient Neolithic, but there is a significant expansion of the range of both food and wild/weedy plants available (Table 8). Einkorn predominates at Revenia, Paliambela and

Toumba Balomenou, and contrasts with the pattern observed at Nea Nikomedia, Prodromos, Achilleion and possibly the two burials at Phyllotsairi Mavropigis (Valamoti, 2011), where emmer seems to be the dominant crop. At the rest of the sites of this period both emmer and einkorn are present in roughly equal proportions. Finds of the 'new type' glume wheat (on its identity see Jones et al., 2000) in this period are also gradually coming to light, as identified at Mavropigi and Paliambela, although final verification of the species determination is necessary in both cases. At Knossos continuity in the basic cereal plant resources is observed, with free-threshing wheat still dominating the assemblage. Its early presence in Crete has been interpreted as possible evidence of exchange networks within the Eastern Mediterranean as this plant is present in Neolithic archaeobotanical assemblages of Turkey, Syria and Cyprus, that are earlier than the one at Knossos (Colledge and Conolly, 2007, 68–70). Further north, free-threshing wheat seems rather restricted, although this may also be partly attributed to its different processing mode and to the highly susceptible nature of its processing by-products when in contact with fire (Boardman and Jones, 1990). It has been found at Sesklo, Otzaki Magoula, Giannitsa B for which no quantification is provided, and at Paliambela. At Paliambela the free-threshing wheat finds are very few and radiocarbon dating is needed to examine whether they are intrusions from later strata. Other cereals include a single carbonised millet grain at Servia, the identification of which is however tentative due to its poor preservation status (Hubbard, 2000, 350), and oat. For the latter the absence of chaff prevents distinguishing whether it is the cultivated or a wild form growing around the settlements. In the cases where numerical data are available the oat finds constitute only a minor part of the plant assemblages.

The archaeobotanical data recovered from burials 1 and 3 at Mavropigi offer a different view of the contribution of cereals in the socio-cultural expressions of the Early Neolithic communities in the area. Almost pure concentrations of emmer seeds were found associated with these burials, dated to the middle of the 7th millennium. These rare finds, interpreted as offerings associated with some burial custom/ritual of the local Neolithic community (Valamoti, 2011), testify the involvement of plants in Neolithic cultural behaviour connected to the treatment of the dead. They also hint at the symbolic load put on the notion of food plant produce in expressing meanings beyond the economic sphere of everyday life, already during the first centuries of agricultural practice.

Legumes were plentiful at Prodromos, Nea Nikomedia and Toumba Balomenou, and they were present in all other sites in variable proportions, pointing to their incorporation in the subsistence systems of Early Neolithic farmers. Systematic consumption of this high in proteins food plant type is evidenced already in the Palaeolithic and Mesolithic of Greece through archaeobotanical finds encountered in human habitational contexts at the caves of Franchthi and Theopetra (Hansen, 1991; Kotzamani, 2010; Kotzamani and Livarda, 2014). The variety of fruit and nut remains recorded in all Early Neolithic sites also provides convincing evidence that wild fruit gathering and consumption was playing an important role in diet, probably following well established local traditions and living customs of earlier periods. The main fruits encountered were figs, grapes, and cornelian cherries, but remains of a great variety of other fruits and nuts are evident across the Early Neolithic assemblages. An example of the choices behind this variety can be demonstrated for acorn. The nuts of oak are present only at Toumba Balomenou, Nea Nikomedia, Prodromos, and Achilleion, while their absence in the other sites, given the high preservation potential of this species and its occurrence in the natural vegetation of all areas, is particularly noteworthy.

5.3. Transition to agriculture: indigenous processes and the 'Neolithic package'

The Mesolithic archaeobotanical data can delineate a rough picture of plant-human interactions to allow insights into the plant resources and their management in the period preceding the beginning of agriculture in the Aegean. The first observation is that a broad range of plant resources were utilized, which was largely similar to that of the later phases of the Upper Palaeolithic assemblages (see Kotzamani and Livarda, 2014). Although little can be argued on current evidence regarding the exact nature of the relations between the Mesolithic human groups and their surrounding vegetative environment, these could potentially involve a wide behavioural spectrum. They could have ranged from simple collection and procurement of wild plants, to care and tending of wild plant population stands or even the cultivation of wild species, through application of practices such as seeding and harvest, or small scale tillage, without leading to genetic and subsequent phenotypic alterations of the plants. Extensive evidence for the presence of artefact types associated with the cultivation of plants and the processing of plant products, like those occurring in abundance in Natuffian sites and early agricultural settlements of southwest Asia, such as stone mortars and pestles, and blades with use marks, is lacking from Greek sites (for more details see Valamoti and Kotsakis, 2007). This was put forward to suggest the absence of tight links between people and plants in the Greek Mesolithic (e.g. Perlès, 2001). However, qualitative and quantitative differences in material culture expressions associated with plant use between the two regions cannot be used a priori to support the absence of interactive relations of this kind in the Aegean region. Indeed, the broad range of taxa recorded so far in Greek Mesolithic botanical assemblages associated with anthropogenic activity, together with the local species variations, offer some hints for the existence of certain relationships between humans and plants. Additional recovery of bioarchaeological remains and further sample-by-sample analysis of the existing assemblages holds great potential to provide insights towards this direction. Through this emerging picture of tighter links of increasing complexity between Mesolithic human groups and their surrounding plant world, the adoption of the agricultural way of production as the primary choice for food procurement during the 7th millennium BC does not strike as a radical and sudden change. Instead it seems to be the outcome of a long-term sequence of interactive links between humans and plants.

The Incipient and later Early Neolithic datasets, despite their limitations, point to heterogeneity in the choice and use of plant resources. This variety may be considered as another indication against the hypothesis of the sudden appearance of agriculture in Greece in the form of a 'Neolithic package' of crops, introduced from the principal domestication loci of the Near East. Other crops, notably chickpea and flax, that form part of the 'Neolithic package' as defined for Anatolian sites are missing from all the sites of the Incipient Early Neolithic period. Valamoti and Kotsakis (2007) reviewing the presence of chickpea in later Neolithic assemblages, they further demonstrate that this species was never established in northern Greece. At the same time, the occurrence of several other plant species in the Incipient Neolithic of Greece, which do not participate in this 'Neolithic package', raises concerns regarding the utility of this term per se. Such examples include the significant presence of naked hexaploid Triticum aestivum wheat in the Aceramic layers of Knossos and the occurrence of grass pea in several other later Early Neolithic assemblages. This also marks out the degree of complexity involved in understanding the mechanisms of adoption and incorporation of different plant forms in early agricultural communities across the Mediterranean. In addition, the domesticated nature of some plant species found in archaeobotanical assemblages of Incipient Early Neolithic Greece is not always substantiated, weakening the arguments in favour of the sudden adoption of a fully domesticated Near Eastern 'Neolithic package'. Seed finds of lentils from the Incipient Neolithic layers of Franchthi cannot be indisputably attributed to either the domesticated or the wild form (Hansen, 1991, 47–56; Hansen, 1999, 160). At Aceramic Argissa lentil finds were attributed by Hopf (1962, 104) on the basis of their morphometric features to the wild type Lens nigricans (but note that the wild progenitor of cultivated lentil is considered to be L. orientalis). Taking into account also the recorded presence of wild populations of the genus Lens in Greece (Tutin et al., 1968, 136; Polunin, 1980, 296), this hints at potential cultivation experimentations with available wild plants by the 7th millennium, gradually leading in each occasion to successful or ineffective domestication episodes. It is thus possible that the early farmers were using plant varieties or species different to those that were later on established as more suitable in the plant food production chain and were eventually domesticated, as attested archaeobotanically. Such varieties or species, an example of which could be Lens nigricans, whose use was never widespread and eventually diffused, would have very limited possibilities of incorporation in the archaeobotanical datasets of early agricultural settlements.

The emerging pattern raises thus questions as to whether the Aegean could have constituted a more active field in the domestication of certain plants, and in regards to the contribution of local traditions and ancestral knowledge of local environments in the shaping of early agricultural landscapes. Valamoti and Kotsakis (2007), revisiting the Franchthi evidence that range from the Mesolithic to the Aceramic Neolithic, in the context also of general genetic information of key taxa, concluded that not all domesticated crops were necessarily introduced from far away and a variety of pathways for their introduction, domestication, and use was possible. Overall, on current evidence the idea of a 'Neolithic package' imposed as an entity directly from the east does not seem to be supported. This notion of 'Neolithic package' in explanations of the emergence and spread of agriculture may have in fact significantly overshadowed the varied and fine nuances that possibly feature in the combinations of the main plant components in early agricultural sites as well as the importance of specific plant species within these combinations. This may be seen in the case of einkorn, which seems to have had in reality a more important role than previously thought in assemblages retrieved from northern Greece, a trend that continued later on in several Middle and Late Neolithic and Bronze Age sites (Valamoti, 2004, 2006; Valamoti and Kotsakis, 2007). The prominent role of einkorn has been interpreted as the result of cultural traditionalism (Sarpaki, 1995) and its possible designation as ancestral food (Valamoti and Kotsakis, 2007). The properties and resilience of einkorn facilitating successful yields may have also played a part in establishing this crop into the cultural processes and beliefs of the area.

In a geographical space such as that of Greece, characterised by fragmented landscapes and ecosystem variation, the acceptance of an utterly homogeneous process describing this transition cannot be considered realistic. It is possible that tracing and recording local variability will gradually replace the emphasis given on generalisations, and will rather stress the complexities that pertain to social, economic, cultural and ideological processes leading the transformations from the Mesolithic to the Neolithic realities (Pluciennik, 1998; Kotsakis, 2003). In this context, the indigenous Mesolithic groups can gradually disclaim the role of 'social amorphism' (Price, 2000) attributed to them in the past, and stand dynamically on the field of evolving interactions with new coming populations (Zvelebil, 2001). Then, through alliances and conflicts, competitions and exchanges, the amalgamation of the elements that compose the Neolithic way of life would have progressively arisen.

6. Conclusions

The archaeobotanical dataset of the Mesolithic, Incipient and Early Neolithic periods in Greece, although still limited, has been growing allowing new insights into the context and processes of the transition to agriculture in the area, and in combination with an increasing body of other evidence (see for instance in this volume Halstead, 2017; Marinova and Ntinou, 2017; Whelton et al., 2017) they can now contribute to a better understanding of the Neolithic way of life. New data have been added from three sites, Mesolithic Theopetra in Thessaly and the Early Neolithic Revenia and Paliambela in Macedonia. The Mesolithic assemblage of Theopetra has furnished new insights into the choices of plant use at the site, suggesting an increased reliance on leguminous taxa although a variety of other species was also present. The plant remains also indicated habitation of the cave during a specific period within the year at least from the middle of spring to the end of the autumn. Overall, only a few data are available for the Mesolithic period as a whole and the Incipient Neolithic, and these point to differential plant use across space, although sampling and taphonomic parameters are likely to have influenced this pattern. The new evidence from Revenia and Paliambela allowed the investigation of plant resource use and management in these sites and added new pieces to the Early Neolithic picture. The overall Early Neolithic data are more plentiful and suggest an increased variety of both food and wild plant taxa compared to the previous period, hinting at the diversity in the choices of plant resource management across space. The dataset as a whole supports the idea of a much more heterogeneous and complex process that led to the transition to agriculture across space rather than an introduction of a given 'Neolithic package' from the east, supporting earlier observations by Valamoti and Kotsakis (2007). As a concluding remark, we suggest that a more profitable way of investigating the emergence of agriculture in the study area would be, following Terrell et al. (2003), to attempt to understand the mechanisms that contributed to the 'domestication' of the landscape by early prehistoric foragers and the ways the new elements that penetrated the area, through small scale population movements and exchange networks, were incorporated into older traditions and practices. These changed dynamically but gradually the pre-existing social, economic, cultural and ideological structures. Within this theoretical framework, the explanation of the transition from the Mesolithic to the Neolithic and from gathering to cultivation constitutes a much more multileveled and fluid narration, focusing on the approximation and understanding of the different actions and blending processes that took place among various factors. Thus, what is slowly emerging from the on-going research and the increasing availability of new data is that the incipience of agriculture in Greece cannot be viewed as a linear event of movements and as an imposition of fixed practices. Instead it appears as a much more multifaceted and fluid historical process, in which many parallel realities were involved, incorporated, opposed, or emulated to create through time a landscape of complexity. What still remains as a prerequisite of primary importance in order to better approach such research questions, is the quest for more accurately dated and systematically collected archaeobotanical assemblages of this highly challenging period of prehistory.

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