Plant food ingredients and 'recipes' from Prehistoric Greece: the archaeobotanical evidence

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Abstract

Τα αρχαιοβοτανικά δεδομένα από την Ελλάδα κατά τη Νεολιθική και την Εποχή του Χαλκού ερευνώνται με στόχο τον εντοπισμό εκείνων των φυτών που θα μπορούσαν να είχαν χρησιμοποιηθεί από τις προϊστορικές κοινότητες της περιοχής. Τα είδη των δημητριακών, οσπρίων, ελαιοδοτικών φυτών, φρούτων και καρπών (άγριων και εξημεφωμένων), φαφμακευτικών, ψυχοτφόπων και αφωματικών φυτών, που έχουν βφεθεί σε πλούσιες συγκεντφώσεις ή ως υπο-προϊόντα επεξεργασίας, συνθέτουν έναν μαχρύ χατάλογο δυνάμει συστατιχών των προϊστοριχών γευμάτων. Η ακριβής χρήση αυτών των φυτών στα καθημερινά ή εορταστικά γεύματα είναι δύσκολο να διαπιστωθεί και η προσέγγιση των τρόπων επεξεργασίας και προετοιμασίας του φυτού πριν το μαγείρεμα βασίζεται σε σύγχρονες εθνογραφικές και πειραματικές έρευνες σχετικά με τον καθαρισμό του σπόρου, την αποξήρανση, την απομάκρυνση των τοξινών, την έχθλιψη και την άλεση. Τα κατάλοιπα αλεσμένων δημητοιαχών (3η χιλιετία π.Χ.) και πιεσμένων σταφυλιών (5^η χιλιετία π.Χ.) παρέχουν τη δυνατότητα να εισχωρήσουμε περαιτέρω στα προϊστορικά εδέσματα. Τα κατάλοιπα των αλεσμένων δημητριακών μπορεί να αντιστοιχούν σε προμαγειρεμένα συστατικά, όπως το πλιγούρι και ο τραχανάς, αποτελώντας έτσι σπαράγματα προϊστορικών συνταγών. Τα αρχαιοβοτανικά κατάλοιπα επιβεβαιώνουν τη χρήση του χυμού των σταφυλιών και υποδηλώνουν πιθανές χρήσεις του για την προετοιμασία κρασιού ή ξυδιού ή σιροπιού. Τα φυτικά συστατικά της κουζίνας της προϊστορικής Ελλάδας μαρτυρούν μεγάλη ποικιλία στα υλικά και αύξησή της μέσα στο πέρασμα του χρόνου ως αποτέλεσμα πολιτισμικών επαφών. Αυτά τα συστατικά, μαζί με τις αποσπασματικές συνταγές που αναγνωρίζονται στο αρχαιοβοτανικό υλικό, υποδηλώνουν μια πολύ μακρά παράδοση στην κατανάλωση ορισμένων τροφίμων φυτικής προέλευσης σε αυτή την περιοχή της Ευρώπης, η οποία επιβιώνει αχόμη τόσο στα χαθημερινά όσο χαι στα εορταστιχά γεύματα.

Introduction

Prehistoric diet and the context of food consumption in the Aegean have been the subject of several recent papers and volumes (e.g. Vaughn and Coulson 2000; Halstead and Barrett 2004; Wright 2004; Megaloudi 2006a; Mee and Renard 2007; Tzedakis et al. 2008; Hitchcock et al. 2008). The food of distant ancestors seems to attract the interest not only of researchers but also of the wider public as the recent communication of research results on prehistoric food from Greece has shown. Prehistoric food may be used to reinforce modern national identities or it may create a sense of continuity between the distant past, the present and the future. It is widely accepted in the literature that plants must have constituted the main source of food while meat was mainly consumed on special occasions such as feasting, and in actions of hospitality (e.g. Halstead 1981, 1999; Perlès 2001; Pappa et al. 2004). So, what is the archaeological evidence for plant food in prehistoric Greece? This paper is based on archaeobotanical assemblages, preserved by charring from over 70 sites dating to the Neolithic (approximately between 7000-3500 B.C.) and the Bronze Age (approximately between 3500-1100 B.C.). It uses the knowledge accumulated on archaeological plant remains from prehistoric Greece over the past 20 years in order to approach the available plant food ingredients and provide snapshots of prehistoric recipes, sizzling hot from the hearth, watering the palate and intoxicating the senses.

Prehistoric plant food ingredients

The information on which our narrative is based may have been hiding in the soil for seven or nine millennia until archaeologists decide to excavate a site, unearthing together with prehistoric houses, constructions and artefacts, the remains of prehistoric plants among rubbish, or stored products, offerings, the remains of ordinary or special days, of daily meals and occasional feasts. These remains lie in most cases invisible among the soil debris of archaeological sites. The retrieval of archaeobotanical remains in Greece, rather than being mainstream practice, is the result of special care and effort invested by certain excavators who install flotation machines (fig. 1), which process soil samples: charred items float and the flow of water leads them to sieves with fine meshes; this material is then dried and studied with the aid of a stereomicroscope. Over 1570 archaeobotanical samples have been studied and published from as many as 79 sites in Greece and over 120 plant species and genera, cultivated and wild have been



1. - Flotation machine operating at the site of Makri, Northern Greece, after Valamoti 2009.

identified and recorded in published tables (Valamoti 2009). As various scholars emphasise, however, a species list needs to be 'translated' if we want to understand which ones were actually being used in prehistoric times (e.g. Dennell 1976; Halstead 1994). This is a very important task as a number of plant species may have been accidentally incorporated into archaeological deposits: they may, for example, correspond to the remains of grazed plants, contained in dung which was subsequently used for fuel (e.g. Charles 1998). Those ancient plant remains that have resulted from the storage and/or processing of certain species are most likely to have been used in prehistoric times. Having identified those species that were used by the inhabitants of a prehistoric settlement, it remains to determine which species were intended for human consumption and which for fodder. Needless to say, this distinction is highly problematic as there seems to be a fine line dividing what constitutes food and fodder, the boundaries shifting through time and among different cultures and social groups (e.g. Halstead 1990; Jones 1998; Jones and Halstead 1995). In the approach adopted here, all edible plant remains that have been found in prehistoric contexts as stored or processed resources are considered as ingredients of meals intended for the Neolithic and Bronze Age inhabitants of Greece.

The first Neolithic communities in Greece practiced agriculture, cultivating a wide range of species as the sparse archaeobotanical evidence from these early farming societies indicates. Some of these crops, for example einkorn, emmer and free-threshing wheat, were introduced to the region from the East, as their wild ancestors are not, at least nowadays, encountered in South-Eastern Europe, while others could have been brought into cultivation in the region, for example barley, lentils and grass pea (Valamoti and Kotsakis 2007). The introduction of new plant species available for food to Neolithic Greece might have involved the arrival of people carrying with them these new crops or the diffusion of new species through contact networks at play already from Mesolithic times (e.g. Runnels and van Andel 1988; Ammerman and Cavali-Sforza 1973; Dennell 1992; Perlès 2001; Runnels 2003). Similar interactions that introduced new plants to Greece are evidenced during the Bronze Age, though the contact networks appear more complex during this period, involving regions to the north, west and east (e.g. Valamoti 2007).

Cereals and pulses constitute the major component of the archaeobotanical assemblages of prehistoric Greece. During the Neolithic, the glume wheats, einkorn (Triticum monococcum), emmer (T. dicoccum), a recently identified glume wheat that resembles modern T. timopheevi, and barley, two-row and six-row, hulled and naked, (Hordeum distichum, Hordeum hexastichum), are the main cereals encountered at archaeological sites of the period. Free-threshing wheat (T.durum/T.aestivum) is present in very small numbers and in only a few cases appears to constitute a crop used at the time. The glume wheats may have been cultivated in their own right, or they might have been grown as maslins, in particular einkorn and the new wheat type, which are usually found together in archaeobotanical samples (Jones et al. 2000; Valamoti 2004). The wheats are sometimes found as stored caches of grain that became charred during cooking accidents or during the burning down of houses containing stored crops. In many cases, however, they are present as by-products of the processing of spikelets to remove chaff from grain, burnt as fuel per se or as part of dung fuel spent for cooking and/or heating (fig. 2). For many sites, these minuscule remains of wheat, invisible by eye in the soil, constitute over 90% of the plant remains (e.g. Valamoti 2004).

During the Bronze Age further cereal species are added to the list of plant ingredients available to the inhabitants of Greece. Spelt wheat is such an addition to the crop repertoire, appearing towards the end of the 3^{rd} millennium B.C., probably introduced to the region from central Europe (Valamoti 2007), where records of the plant have been reported earlier than in Greece (Kohler-Schneider and Caneppele 2009) and it has been suggested that spelt wheat might have originated from central Europe (Blatter *et al.* 2004)¹. Millet, found as single seeds in very few samples of the Final Neolithic and a rare cache of seeds in a miniature pot from Olyn-



2. - Einkorn glume bases from mid 6th millennium B.C. Apsalos, Northern Greece, after Valamoti 2009.



3. - Charred pulse species found at Arkadiko, Northern Greece: lentil (a), grass pea (b), after Valamoti 2009.

thus during the same period, becomes established as a crop during the 2nd millennium B.C., i.e. the Late Bronze Age. Millet, like spelt, may well have reached Greece via the north (Valamoti 2007) as rich millet finds are encountered earlier at sites further north than Greece (Nesbitt and Summers 1988). Free-threshing cereals are more prominent during the Bronze Age, encountered as stored grain, as is indicated by the rich storerooms of Assiros (Jones *et al.* 1986).

A wide range of pulse species is encountered at Neolithic assemblages from Greece, though, unlike cereals,



4. - *Lallemantia* sp. agglomeration of charred seeds found at Archondiko, Northern Greece, end of 3rd millennium B.C., after Valamoti 2009.

it is only the seeds of pulses that are preserved among the debris of burnt houses or cooking accidents. Lentils (*Lens* sp.) are by far the most common species in this category. Other species used in the Neolithic include grass pea (*Lathyrus sativus*, fig. 3), pea and bitter vetch (*Vicia ervilia*). These species continue into the Bronze Age while new ones are added, too, as is the case with cereals. Thus the range of pulse species used during the Bronze Age increases with the addition of Celtic Bean on insular and mainland Greece and of two more *Lathyrus* species, Spanish vetchling (*L. clymenum*) and Cyprus vetch (*L. ochrus*), evidenced so far only in the Aegean islands as the archaeobotanical remains from Akrotiri on Santorini and Knossos on Crete suggest (Jones 1984, 1992; Sarpaki and Jones 1990).

Besides cereals and pulses, other species are frequently encountered in archaeobotanical assemblages as rich concentrations, implying their use after harvesting. Linseed is one such example, found both at Neolithic and Bronze Age sites. The seeds of flax (Linum usitatissimum) are edible as such but are also rich in oil. The seeds may well have been used untreated as food but also for extracting oil, edible when cold water is used for this process. Terebinth nuts (Pistacia terebinthus) may also have been used for the oil content of their seeds during the Neolithic while, during the Bronze Age, species such as Lallemantia sp. (fig. 4), opium poppy (Papaver somniferum), mustard (Sinapis/Brassica) and gold of pleasure (Camelina sativa) could have been used for oil extraction. All of these plants are well attested in the north of Greece, while in the south the olive (Olea europea) prevails in the archaeobotanical record, starting from the Final Neolithic and increasing during the course of the Bronze Age (Hamilakis 1996; Sarpaki 2003). As these species have other uses, too, it is difficult to establish whether they were used for their oil-rich seeds or fruits per se, or in the form of extracted oil or both.



5. - Grape pressings from Dikili Tash, Northern Greece, end of 5th millennium B.C., from Valamoti *et al.* 2007, courtesy of Antiquity Publications.

Fruits and nuts are also prominent in the archaeobotanical record from prehistoric Greece. The fruits of the grape vine have left their traces in the archaeological deposits mainly as charred pips but occasionally also as stalks and pips covered by skins (fig. 5). Whether these remains correspond to wild or cultivated plants is quite uncertain as we do not know at what stage during the process of cultivation of the grape vine the pips acquired 'diagnostic' domesticated features (Valamoti 1998; Valamoti et al. 2007). Vitis wood on the other hand is a good indicator of tending of grape vines, its occurrence at archaeological sites implying some form of cultivation (Miller 2008). Taking therefore into consideration neolithic grape-pip measurements and the negative evidence for the presence of Vitis wood at most Neolithic sites (e.g. Ntinou and Badal 2000; M. Ntinou, pers. comm.), it is only towards the end of the Neolithic that the grape vine may have been cultivated, as is indicated by pip measurements from Dimitra (J. Renfrew 1997), Makri (Valamoti 1998) and the presence of Vitis wood at Makri (Ntinou and Badal 2000). Other fruits found as concentrations are blackberries (Rubus fruticosus), represented by charred seeds, abundant at Mandalo for example, and Cornelian cherries (Cornus mas), occurring mostly as a few stones but recently found in large quantities under waterlogged preservation conditions at prehistoric sites in the vicinity of lake Cheimaditis (Valamoti unpublished material). Pears (Pyrus amygdaliformis) and elderberries (Sambucus nigra and S. ebulus) are encountered more rarely. Figs (Ficus carica) are a very common find, either as seed or as whole fruit. At some sites large numbers of dried whole figs, apparently stored for later consumption have been unearthed: for example at Rachmani in Thessaly and Sterna in Crete, dating to the Neolithic and the Bronze Age respectively (J. Renfrew 1973; Sarpaki 1999). Terebinth nuts (Pistacia terebinthus) might have been collected for food but are only found as a concentration at Late Neolithic Makriyalos (Valamoti 2004). Almonds (*Prunus dulcis*), characteristic ingredients of modern Mediterranean recipes, are not so common though at a few sites such as Franchthi, for example, they are represented by numerous fragments during the Neolithic (Hansen 1991). By contrast, and especially in the north of Greece, acorns are a very common find at sites where storage contexts have been preserved by conflagration episodes. Such contexts are more abundant in Final Neolithic and Bronze Age sites, such as Mandalo, Dikili Tash and Archondiko (Valamoti and Jones 2003; Valamoti 2004; Valamoti *et al.* 2008a).

Other plant species encountered in the archaeobotanical record of Greece could have been used for their medicinal, aromatic or hallucinogenic properties. The list of plants which could potentially have been used for these properties is quite long (e.g. Valamoti 2001), including species that we usually tend to associate with food, and species that grow wild in fields, ruderal places and woods. In most cases it is difficult to tell whether or not these species were deliberately harvested from the wild or from fields, to be subsequently used for their 'special' properties. For certain species, their presence in pure, dense concentrations is indicative of their deliberate harvest for later use, but when these are crops such as barley, linseed, figs and grape, which could have been consumed as regular food, it becomes difficult to determine whether prehistoric people perceived them as therapeutic or not. Several species with medicinal properties happen to have seeds that are rich in oil (Lallemantia sp., linseed, mustard, opium poppy) as was mentioned earlier. It is likely that prehistoric people recognised the medicinal properties of many of the plants around them, cultivated and wild. Modern ethnobotanical evidence is very instructive in this respect as it reveals a great knowledge and use of plants, wild in particular, for medicinal and other purposes, by people living in rural communities (Hadjichambis et al. 2008). Some of these plants could also have been used as condiments or 'diet enhancers' (cf. Sherratt 1999). The aromatic properties of species such as terebinth and coriander (the latter found in a relatively rich concentration at Early Bronze Age Sitagroi (J. Renfrew 1973) could have been used in cooking but also in other activities such as fumigation and perfume preparation. The use of coriander was an important ingredient in the perfume 'industry' of Pylos, as is indicated by Linear B tablets (Shelmerdine 1984, 1985).

Post harvest processing

Cleaning the grain

Many of the potential ingredients revealed by the archaeobotanical record and presented in the preceding section would need to be further processed after harvest and prior to consumption. Cereals and pulses would have had to be threshed, winnowed and sieved to remove grain from chaff, straw and weed seeds, while the glume wheats would have required extra processing for the removal of the tough glumes surrounding the grain (e.g. Hillman 1984, 1985; Jones 1987, 1990; Samuel 1993, 2000; Peña-Chocarro 1999; Peña-Chocarro et al. 2009; D'Andrea and Mitiku-Haile 2002). The glume wheats are usually found stored in the glume (i.e. as spikelets) at sites where such contexts have been preserved, for example Mandalo, Dikili Tash and Assiros (Jones et al. 1986; Jones 1987; Valamoti and Jones 2003; Valamoti 2004). The numerous glume bases which dominate the assemblages at many neolithic sites, in northern Greece in particular, are indicative of the removal of the glumes in order to render the grain suitable for human consumption, though they could also correspond to digested chaff, fed to animals as fodder (cf. Valamoti and Charles 2005). There are modern ethnographic accounts of glume wheat dehusking that show beyond doubt that this work, undertaken in most cases by women, was considered by the people performing it as an extremely hard task, and that given the chance, they would happily avoid it (e.g. D'Andrea and Mitiku-Haile 2002; Giuliani et al. 2007). At the same time, this very labour demanding task of dehusking brought women together in collaboration, thus creating a specific context of female social interaction where stories, worries and happiness where shared (D'Andrea and Mitiku-Haile 2002). Cleaning of the glume wheat grain thus involved a great deal of hard work carried out piecemeal throughout the year. Especially labour demanding was the task of removing the glumes from the glume wheats, which appear to be the preferred cereal crops of Neolithic and Bronze Age Greece (e.g. Hansen 2000; Valamoti 2009).

Hulled barley, identified in the archaeobotanical record of prehistoric Greece, would have had to be hummelled for the removal of the awns, dangerous for both humans and animals; dehulling, on the other hand, was probably a matter of culinary preference (Hillman 1985) and it might prove difficult to demonstrate such a practice on archaeological remains as charring, rather than processing, may interfere with the preservation of the hulls. Moreover, if dehulling takes place piecemeal, for immediate consumption rather than storage, there would be limited chances of preservation of dehulled barley grains.

Cleaned grain could further be transformed through processing that involved mechanical and/or chemical alteration. Such alterations could have been induced by grinding, crushing, soaking, boiling. This extra processing of the clean grain was required many times in order to render food nutrients better absorbed by humans or to remove bitter or toxic substances, to increase storage life, and generate an easily cooked ingredient or a desirable foodstuff for special occasions. These activities, involving processing of plants for human consumption in Neolithic and Bronze Age Greece, are considered below.

Removal of toxins

Treatment of grain to remove undesirable (unpalatable or even dangerous) substances was probably applied to certain pulse species and acorns, though for prehistoric times we can only speculate on these practices on the basis of modern knowledge of the plants' properties, ancient written sources and the ethnographic record. Substances dangerous for human health are present in various pulse species. For the prehistoric inhabitants of Greece these species were grass pea and bitter vetch and for the Bronze Age the additional two Lathyrus species identified from the Greek islands, Cyprus vetch and Spanish vetchling. In the ancient Greco-roman world, the toxicity of grass pea and bitter vetch was well recognised as can be gleaned from the works of Hippocrates, Pliny and Dioskourides (e.g. Hodkinson 1988; Scarborough 1991; Simoons 1998; Flint-Hamilton 1999). The consumption of these plants can prove dangerous to both humans and animals (e.g. Dalianis 1993; Enneking 1995); it seems therefore reasonable to assume that prehistoric people who cultivated these plants, recognised their toxic properties and took special care as regards their consumption.

The toxicity of grass pea has been recorded in recent times in various parts of the world, including Greece, Ethiopia and India, and has been discussed in relation to their consumption by prehistoric communities (e.g. Cohn and Kislev 1987; Butler et al. 1999; Halstead 1990; Hansen 2000; Peña-Chocarro and Zapata-Peña 1999, Duke 1981). The substance initially considered toxic in grass pea was selenium (Rudra 1952) but subsequent research has shown that it is in fact an amino acid, b-N-oxalylamino alanine (BOAA) (Rao et al. 1964; Murti et al. 1964) which causes paralysis of the lower limbs, especially in male populations. A significant quantity of the dangerous substances is present in the seed testa; a means therefore to remove this substance is by removing the *testa*, while further reduction can be induced by brief boiling and discard of the water prior to cooking proper (Hansen 2000). Indeed, this is the means by which grass pea is consumed in modern Greece, i.e. split seeds with testa removed, boiled in water which is subsequently discarded prior to cooking proper of the seeds. Recent ethnographic accounts of grass pea processing in Ethiopia and Spain provide further insights of potential means that could have been used in preparing grass pea for human consumption in prehistoric times (Butler et al. 1999; Peña-Chocarro and Zapata-Peña 1999). In Ethiopia (Butler et al. 1999) grass pea is dehulled by brief soaking, drying, grinding and subsequent winnowing of the seeds. This processing results in split seeds in the form of cotyledons, very much like the modern Greek 'fava' (a name commonly used for grass pea and other pulses used as cooked split pulse seeds). In Ethiopia, cooking of grass pea involves soaking or boiling and discard of this water (Butler et al. 1999). In Spain soaking is also reported and the consumption of grass pea has various forms, e.g. eaten in stews or in the form of flour cooked as gruel. Soaking of grass pea seeds has been postulated for a rich concentration found among the destruction debris of a house at the Middle Neolithic site of Servia in western Macedonia, northern Greece (Hubbard 1979). This suggestion is based on the arrangement of the seeds around the broken parts of a clay pot, considered to have spread due to the presence of water in the pot. A safer criterion, however, would be the examination of the grain's internal structure as soaking might have affected the endosperm microstructure in a way that could be recognisable with the use of high power microscopy, as has been attempted for cereals (cf. Valamoti et al. 2008b).

Bitter vetch, common both in the Neolithic and the Bronze Age, is also such a pulse with detrimental effects on human health according to ancient written sources, which mention that the consumption of the seeds can cause headaches and hematuria (Dioskourides quoted in Scarborough 1991, see also Hodkinson 1988). For prehistoric times bitter vetch has been considered a potential food source for early Neolithic communities of the Near East, the bitter seeds rendered suitable food for humans by leaching of the toxic substances of the seeds in water (van Zeist 1988). The potential of recognising the effects of treatment with water in modern and ancient bitter vetch seeds is currently being investigated with the aid of experimental processing, charring and scanning electron microscopy at the Aristotle University of Thessaloniki.

Some sources mention that bitter vetch seed had to be soaked in water with subsequent removal of the testa, aided by roasting or sun-drying of the grains such as the account of an Andalusian agricultural text referring to 'the Nabathean Book of Agriculture' and recent ethnographic observations in the Rif region of Morocco (Enneking 1995; Enneking *et al.* 1995).

For all the Lathyrus species found in prehistoric Greece, as well as bitter vetch, it seems that in addition to their processing for the removal of toxins, a further means of counteracting their negative effects for human health might well have been their combined consumption with cereals as well as a moderation in their use. The benefits of such a combination have been demonstrated recently by food scientists (Lambein 2000; Getahun et al. 2005). In the case of bitter vetch it seems that human experience also resulted in the adoption of such a practice as various ancient and recent traditional recipes demonstrate. Although in recent agronomy text books bitter vetch is usually associated with fodder (e.g. Dalianis 1993; López Bellido 1994), there is ethnographic and ancient textual evidence where the consumption of bitter vetch by humans is mentioned (Hillman 1985; Psilakis and Psilakis 2001). Pliny mentions that it was used as

leaven in barley bread (*HN*, XVIII, 103, quoted by Hillman 1985) and a traditional recipe from Crete refers to the use of bitter vetch flour, mixed with barley for making bread (Psilakis and Psilakis 2001). The Andalusian written source mentioned above also recommends the mixing of bitter vetch with cereal flour or lentil flour when intended for human consumption (Enneking 1995), being thus in agreement with the other ancient and ethnographic sources presented above.

The removal of undesirable substances, in this case bitter tannins, was also important for acorns if consumed by humans. Of course there is no way of knowing whether the rich charred acorn concentrations, found in abundance among storage contexts destroyed by fire, in particular in the north of Greece, were intended for human consumption. It is, however, known that they have been used in human diet in the distant and recent past in Greece as well as in other parts of the world (e.g. J. Renfrew 1973; Mason 1995; Psilakis and Psilakis 2001). For the island of Crete it is mentioned that certain oak trees produced acorns that were 'sweet' and therefore required no further processing, other than simple roasting, while 'bitter' acorns from other trees had to be boiled, baked and ground (Psilakis and Psilakis 2001). Similar processes have also been investigated experimentally by Jørgensen (1977) in an attempt to interpret a rich acorn concentration from Denmark dated to the 2nd millennium B.C.

Drying

Storage of plant food in the form of grain or fruit requires drying. Drying could have been applied to various kinds of collected plants such as fruit and herbs. The latter are difficult to identify in the archaeobotanical record from Greece as they stand limited chances of preservation through charring, the major means of preservation of archaeological plan remains in Greece. Other fruit have been found in dense concentrations though it is difficult in some cases, especially for fruit with small seeds such as figs and blackberries, to determine whether they represent the remains of fruit stored for human consumption or the remains of fruit consumed by animals ending in their dung. Blackberries, figs, grapes, wild pears as well as other fruit could have been preserved through drying and consumed piecemeal throughout the year (cf. Wiltshire 1995). Charring experiments have shown that dried grapes, i.e. raisins, when charred, swell, resembling fresh grapes (Mangafa et al. 1998; Cartwright 2003). With the exception of a single occurrence of grape from Neolithic Makriyalos, which may represent a chance find rather than the intentional preservation of grapes through drying (Valamoti 2004), no other such finds have been reported until now from prehistoric Greece. The whole figs that have been found in some quantity at sites such as Rachmani and Sternes (see

above) had probably been stored after drying, a practice still surviving in parts of Greece even today. Wild pears have been found whole and in halves at Dikili Tash, though the halving could have been the result of postdepositional processes. Ethnographic accounts from Crete report the use of a herbal infusion into which pear halves were soaked before drying, the whole process aiming to the better preservation of the fruit (Valamoti 2009). Similar uses of herbs for the preservation of stored plant food have been reported from various parts of Greece, a practice sometimes routed in Antiquity (Panagiotakopulu *et al.* 1995).

Crushing and Grinding

Fruits and seeds could have been crushed or ground in order to extract their juice or to reduce them to small particles for further processing.

Remains of charred crushed grapes (fig. 5) have been encountered at a few sites in Greece: Final Neolithic Dikili Tash (Macedonia in Northern Greece, Valamoti *et al.* 2007), Early Bronze Age Myrtos (Crete, J. Renfrew 1972), Late Bronze Age Toumba Thessalonikis (Macedonia in Northern Greece, Andreou and Kotsakis 1997). These finds consist of grape pips surrounded by skins, loose skins and seeds and have been experimentally shown to correspond to the remains of pressed grapes (Mangafa *et al.* 1998). Obviously this process aimed to the extraction of grape juice, an interesting ingredient for various potential recipes that will be discussed in the following section.

Grinding or crushing, depending on whether grinding or pounding equipment was used, could have been applied to oil-rich seeds such as linseed, poppy seed, Lallemantia seed etc. in order to facilitate the extraction of oil. For oil to be edible, especially in the case of linseed, the crushed seed pulp should be mixed with cold water, from which the oil floating on the surface would be collected by various means (Serpico and White 2000). Although several concentrations of seeds of oil plants have been identified in the archaeobotanical record of Greece, no indications for crushing exist, in the form of pressed seed cake for example. Olives are of course the major oil-producing plant in modern Greece and other circum-Mediterranean countries, yet for prehistoric times, on present evidence from Greece, although attested from the end of the Neolithic, they are mainly present in the Bronze Age and in the southern parts of Greece in particular. A unique find of minuscule broken olive stones comes from Chamalevri in Crete identified from a late 3rd millennium B.C. context (Sarpaki 1999b). Although this find may imply crushing of olives for oil extraction, it must be pointed out that olive stone fragments are not a necessary by-product of olive oil extraction as other extraction means could have been used which leave the stones intact (cf. Adam-Veleni and Mangafa 1996).

Cereal grain could be eaten whole or ground, coarsely or finely. For the Neolithic of Greece there are no archaeobotanical remains that could correspond to ground grain while such finds are known from the site of Kapitan Dimitrievo in Neolithic Bulgaria (Marinova 2006). Whether this is a result of different preferences in cereal food consumption practices between the two regions of the Balkan peninsula or whether it is an artefact of preservation and recovery of archaeobotanical remains from Greece it is difficult to tell. Grinding could have been carried out using grinding stones, which constitute a common find of prehistoric sites of the area. Analyses of a number of grinding stones, however, coupled with experimental and ethnoarchaeological evidence, suggest that at least in some Greek Neolithic sites (e.g. Franchthi Cave) such tools may have not been used routinely for grain grinding and that they were rather used for grinding other types of material (see Runnels 1988; Stroulia in press). Wooden equipment, not usually preserved at Greek sites, might have also been used for breaking the grains.

Ground cereals have been unearthed in rich, pure concentrations at Early Bronze Age sites of northern Greece (Valamoti 2002). Small fragments of wheat grain, ranging between 0.5 and 2 mm, probably of einkorn, were found in a pot located in a house destroyed by fire at the settlement of Mesimeriani Toumba, dated to the end of the 3rd millennium B.C. (Grammenos and Kotsos 2002). Fragments of barley grain were found at the site of Archondiko (Papanthimou-Papaefthymiou and Pilali-Papasteriou 1997), again in a rich concentration inside a house destroyed by fire, dated between 2100-1900 B.C. These barley fragments were found loose but also in conglomerations. It is far from clear, however, whether these conglomerations had been formed in prehistory as part of a processing sequence or whether they are the artefact of charring (Valamoti 2002; Valamoti et al. 2008). In both cases, the loose fragments demonstrated a swollen cut surface which was experimentally demonstrated to be the result of grinding of cereal grain prior to charring (Valamoti 2002). It is therefore certain that these fragments were generated in prehistoric times as the result of grinding rather than accidentally induced by post-depositional processes. Of a later date are the various finds of ground cereal grain from Akrotiri at Santorini, where the presence of coarsely ground barley grain and also of cereal and pulse flour are reported (Sarpaki 2001). The barley fragment photographed from Akrotiri does not demonstrate the smooth, slightly swollen surface observed on the Archondiko and Mesimeriani fragments. It has a rather 'shredded' appearance and this may be the outcome of differential preservation conditions or processing or a combination of both.

'Recipes' of Neolithic and Bronze Age Greece

What is a recipe in the context of our discussion? The Concise Oxford Dictionary (1995) and a website provide an idea of what people commonly understand as a recipe. According to the first, a recipe is a statement of the ingredients and procedure required for preparing cooked food. The website gives a similar explanation of the meaning of the word: 'a recipe is a set of instructions used for preparing and producing a certain food, dish, or drink. The purpose of a recipe is to have a precise record of the ingredients used, the amounts needed, and the way they are combined'. Analysing further the term, the website explanation includes the recipe name, the list of ingredients, the amount of ingredients, the preparation instructions and variations on a recipe. Anyone who loves cooking can appreciate the 'variations' part to which one could improvise. Which of these aspects of a recipe can be gleaned from the archaeobotanical record of Greece? The available evidence is quite promising in this respect although of course the information gained is fragmentary, requiring input from imagination, culinary intuition and the ethnographic record. As for the 'recipe names' these are gone for good, together with the small talk that went on during food preparation, the excitement or exhaustion that might have accompanied their preparation. Yet, we do use modern words to approach what we think is the recipe hidden inside the heated to blackness remains of prehistoric plant food ingredients and 'recipe' fragments.

The range of ingredients of plant and animal origin available to the prehistoric inhabitants of Greece has been well documented (e.g. Valamoti 2003; Valamoti 2009; Theodoropoulou 2007; Halstead 2007). The way these ingredients were combined is totally lacking, of course, and the relevant information provided by chemical analysis of pots is equally ambiguous as it is far from clear whether the different elements/ingredients detected in the pots were added for single recipes or separately for different dishes. Although some information is available as regards cooking installations of the Neolithic and the Bronze Age (e.g. Prevost-Demarkar 2002, 2003; Papadopoulou and Prevost-Demarkar 2007; Papaefthymiou et al. 2007), no systematic study integrating the available ingredients and the cooking potential of the installations is available as yet. We should not forget, of course, that cooking can also take place on or in hot ashes without the need for special installations (cf Avitsur 1977), leaving little in terms of material remains indicative of this specific activity. Turning to the plant food components that form the theme of this paper, the archaeobotanical evidence from Greece has yielded some interesting information as regards the processing of cereals and grapes. This information although preliminary at present, is quite promising.



6. - Ground cereal grains (probably of einkorn) from end of 3rd millennium B.C. Mesimeriani Toumba, after Valamoti 2009.

Cereals

The finds of ground cereals discussed in the post harvest processing section may actually lead us to snapshots of prehistoric 'recipes', albeit with many missing parts. The fragments from Mesimeriani Toumba (fig. 6), an Early Bronze Age site, demonstrated a shiny surface which, on the basis of preliminary experimental charring of wheat treated with hot water, was interpreted as an indication of boiling of the grain in some liquid (Valamoti 2002). Further investigation of these fragments with scanning electron microscopy and their comparison with specimens generated under controlled experimental conditions suggested that these grains had probably been subject to boiling prior to grinding (Valamoti et al. 2008). Boiling of cereal grain, mainly emmer or durum wheat, and its subsequent grinding (after the boiled grain has dried in the sun) is a common practice in many circummediterranean countries (e.g. Abdalla 1990; Bayram 2000; Rivera-Nuñez and Obon de Castro 1989; Palmer 2002; Valamoti and Anastasaki 2007). In this way, wheat grain can be stored and consumed piecemeal throughout the year, constituting an ingredient easily transformed to a nutritious cooked dish: by mere soaking in hot water or very brief boiling. It can be eaten plain, sweet or salty, with vegetables, pulses and meat in various combinations, replacing rice in traditional cuisines of the region. The boiled, ground and stored einkorn seeds, captured in the flames that destroyed a house some 4000 years ago (2100-1900 B.C.), probably correspond to such an early preparation. This preparation is in fact an ingredient for a dish. It does, however, correspond at the same time to a 'recipe' as specific ingredients are used and cooked together. We lack of course the specific quantities used, we do not know if water was the boiling liquid or perhaps milk. Yet, it is as close to a recipe as we can get for prehistoric Greece, using archaeobotanical data.

Another Early Bronze Age site from northern Greece, Archondiko, has also produced intriguing finds

that may correspond to some form of food, this time consisting of barley (Valamoti 2002; Valamoti et al. 2008). This find has already been discussed in relation to grinding. It is as yet unknown whether it had been treated in a way similar to those of Mesimeriani, i.e. boiled in water or milk. The starch structure of the fragments examined by SEM is not diagnostic of any treatment. An additional intriguing feature of the Archondiko fragments is that many form lumps. At present it has not been possible to determine whether the lumps were formed originally as part of a specific recipe or whether they are the artefact of charring which could also have caused fusing of the fragments. If the charred lumps are intentional, they would correspond to some early form of boiling cereals and drying them in lumps for piecemeal consumption throughout the year, know as trachanas (Greek), tarhana (Turkish) and kishk (Arabic) (Palmer 2002; Aubaille-Sallenave 1994; Valamoti and Anastasaki 2007). In the modern ethnographic examples, the ground grain is boiled in milk or sour milk and sun-dried in the form of lumps, combining seasonally available ingredients such as wheat and milk and turning them into a highly nutritious, easy to cook ingredient. The Archondiko fragments are currently being examined further in order to decipher the processing 'history' behind them with its potential culinary interest.

Lumps similar to those found at Archondiko, apparently consisting of grain fragments, have been found at the northern Greek sites of Armenochori (Valamoti unpublished) and Angelochori (Valamoti in press) as well as at sites in Bulgaria (Marinova personal communication) and they present a challenge for future investigation of the procedures of their formation.

Grapes

Leaving cereals and turning to fruit, the grape-pressings that have been found in various Neolithic and Bronze Age contexts from Greece suggest another ingredient that is closely connected to a series of 'recipes'. Grape juice called '*mustos*' ($\mu o \dot{\nu} \sigma \tau o \zeta$, in Greek) begins its fermentation as soon as it is extracted due to fungal activity initiated by contact of the Saccharomyces cerevisiae present on the grape skins with the juice (e.g. Mc-Govern 2003). It can be consumed fresh, as such, or mixed with flour into a sweet desert, like moustalevria, still prepared in Greece today (e.g. Psilakis and Psilakis 2001). It can also be transformed into vinegar that can be used, among other things, for preserving fruit and vegetables, or reduced by simmering into a thick syrup called *petimezi* ($\pi\epsilon\tau\iota\mu\epsilon\zeta\iota$), which can be used throughout the year as a sweetener (Delatola-Foskolou 2006)². Last, but not least, wine could have been the end product of yet another possible 'recipe' using grape juice, alternative to the rest but highly potent and much discussed in the context of prehistoric elite emergence in the Aegean. Yet, again, we lack the necessary evidence that could point to whether the prehistoric grape pressings from Greece are the by-products of preparing a desert, a sweetener, a sour preservative or an intoxicating beverage.

Concluding remarks

Archaeobotanical research in Greece has revealed a wealth of potential ingredients that could have been used individually or in combination for the preparation of prehistoric dishes. The preceding presentation of the plant species that were available to the prehistoric inhabitants of northern Greece reveals a wide range of cereal and pulse species, as well as fruits, nuts, medicinal and aromatic plants that could have been used in food recipes of the Neolithic and the Bronze Age. The ingredients seem to increase in variety over the course of the Bronze Age and this is probably the result of a more intensive and complex network of contacts between communities of the period. As noted by several scholars, cereals combined with pulses must have constituted the main elements of prehistoric meals (C. Renfrew 1972; Halstead 1981; Sarpaki 1992) and we could further add that the different species of pulses may have added variety to cereal-based dishes, consisting mainly of the glume wheats and barley (e.g. Valamoti 2003).

The archaeobotanical investigation of prehistoric diet in the Aegean has covered significant ground, yet a great deal of further research, integrating in particular the elements of 'prehistoric cuisine' such as ingredients, processing tools, cooking equipment and installations, serving and eating gadgets is much needed. Even more challenging is the context of food consumption. A few special contexts that have been unearthed by recent archaeological research have been related to food and drink consumption during feasting, religious and funerary rituals (e.g. Wright 2004; Hamilakis 2008; Pappa et al. 2004; Koukouli-Chrysanthaki 2007). The consumption of special dishes prepared particularly for feasting occasions on marked days of the annual calendar or of the life cycle of a person is very well documented ethnographically. Although meat and alcohol consumption in such contexts often usually attract the attention of archaeologists, other plant products and foods were probably involved. A wealth of such examples exists in the archaeobotanical and ethnographic record: boiled wheat is prepared and offered in relation to funerary rituals in modern southeastern Europe and ancient Greece (Psilakis and Psilakis 2001; Mesnil and Popova 2002; Megafoudi 2006b), pomegranates, pine nuts, garlic and other plants were burnt as sacrificial or funerary offerings in Classical and Hellenistic times (Megaloudi 2005; Megaloudi et al. 2007), and a specially prepared grass-pea stew, consumed on certain religious celebrations in Spain (PeñaChocarro and Zapata- Peña 1999). The consumption of cracked wheat and bulgur, elements of prehistoric meals emerging among the archaeological debris of prehistoric sites in Greece, is a tradition still alive in modern Greece, in daily, festive and ritual meals alike (Psilakis and Psilakis 2001). Archaeobotanical research, a powerful tool towards the investigation of 'cuisine' of prehistoric societies in Greece, is revealing not only a wide range of available plant ingredients but also staples (cereals) and 'diet enhancers' (aromatic plants, grape juice products such as *petimezi* and wine), the consumption of which would have marked ordinary days and special events of the Neolithic and the Bronze Age in Greece.

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Notes

¹ See also Zohary and Hopf 2000 and Nesbitt 2003 for a discussion on the origins of spelt.

² As a Cretan 80 year old told me in the summer of 2008, in the past honey was available in small quantities only and *petimezi* was their main sweetener.

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