Alcoholic drinks of prehistoric Europe

Exploring the archaeobotanical evidence from the Aegean to Central Europe in the context of ERC project PlantCult

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Summary

As a diachronic element of religious, ritual, healing and culinary traditions, wine has been the alcoholic drink associated with prehistoric societies of the Aegean and closely linked with ancient Greek civilisation, the cult of Dionysus and the symposium. Beer, on the other hand, has been associated with ancient Egypt and Mesopotamia, while in prehistoric Europe it are its continental areas, especially Central Europe that are considered “beer territory” in the relevant literature. Prehistoric communities around the northern shores of the Mediterranean, parts of the Balkans and Central Europe seem to have been familiar with the grapevine, yet it is only along the areas close to the Aegean shores that strong indications for prehistoric wine making are available. Artefactual evidence, archaeobotanical remains and chemical analyses indicate wine making since the Greek Neolithic, while Linear B texts make clear references to wine and Dionysus for the Aegean. Different wine types, wine-drinking and wine trade are frequently mentioned in ancient Greek literary sources. In this regional and cultural context, beer is hardly ever considered in the archaeological discourse, and for historic periods it is a drink of foreigners, despite the availability of cereal grains. Recent and old archaeobotanical evidence indicates beer making during the end of the 3rd mill. BC and the beginning of the 2nd mill. BC in Mainland Greece. The archaeobotanical finds consist of sprouted grains of cereals (wheat and barley) and ground cereal fragments that could correspond to ground malt. This recently identified pre-Celtic “beer” in a wine territory, has triggered an exploration of alcoholic drinks and identities from the Aegean to Central Europe, currently investigated within ERC funded project PlantCult (Grant Agreement no. 682529, Consolidator Grant 2016-2021), aided by scanning electron microscopy, experimental replication and residue analyses. In our paper we provide a thorough overview of archaeobotanical remains indicative of wine and beer making in our study area from a critical standpoint that calls for caution as regards previous interpretations of the available evidence.

Keywords: prehistoric Europe, ancient beer, ancient wine, mead, grape-pressings, malt
Zusammenfassung

The idea of alcoholic beverages holding a key position in social interaction is not new and it has been proposed even for hunter-gatherer societies (e.g., McGovern 2003; Dietrich et al. 2012). Despite the widely held association of alcoholic drinks with elites, however, this need not always have been the case as indications for wine making can be traced back to Neolithic communities organised on the basis of self-sufficiency (Valamoti 2017a). Alcoholic drinks, besides their association with Bronze Age and Iron Age elite emergence, have been closely linked to specific cultural identities existing in the past. In the literature different types of alcoholic drinks have been linked to identity formation, with beer and wine drinking cultures occurring in different parts of Europe, some better documented than others.

For prehistoric times and even later, Mediterranean regions are commonly associated with wine cultures, while regions in Central Europe further north are associated with beer cultures (Engs 1995; Brun 2004). In Central Europe wine corresponds to a luxury import intended for elite consumption/appropriation (Wells 1995; Arnold 1999; BEFIM different papers, this volume). In addition to these two alcoholic drinks, one could add mead, an alcoholic beverage prepared from honey. In the context of the ERC funded project PlantCult, we aim to explore the formation of culinary identities (cf. Valamoti 2017a) through specific choices of plant ingredients and plant food preparation. In the context of this general discourse on wine and beer cultures we aim to integrate published and new archaeobotanical, artefactual and textual evidence on alcoholic drinks from a large part of Europe starting from the Aegean and reaching Central Europe (Valamoti et al. 2017). This is work in progress and integrates plant remains, ingredients, food products and by-products such as the actual remains of the steps involved in the wine and beer making process. In addition, artefacts such as cooking facilities, cups and serving vessels, as well as iconographic evidence, experimentation and ancient texts are used to corroborate the archaeobotanical evidence.

The study area we are focusing on has been at the crossroads between East and West as well as South and North. Various cultural and consequently culinary influences have been in play since prehistoric times, manifested in the archaeological record through the formation of local culinary traditions and the introduction of new species and food technologies. In this paper we focus on archaeobotanical evidence related to alcohol production in our study area and present a brief overview of the state of the art together with new evidence that highlights the variability in culinary choice in prehistoric Europe, masked by generalised stereotypical assumptions.
Another line of evidence used to detect alcohol is residue analysis of ceramic vessels. These are considered here only for selected case studies, where archaeobotanical evidence indicative of alcohol production has been retrieved. Our overview excludes indications from residue analyses per se as the methodologies are still being developed (e.g. in the context of project BEFIM, this volume) and controversies often arise over the methods used for the detection of beer or wine through pottery residue analysis, resulting in an on-going debate (cf. McGovern et al. 1999; Mukhejee et al. 2007; Evershed 2008; Pecci et al. 2013; Garnier/Valamoti 2016; Mazow et al. 2014). Calcium oxalate crystals in vessels, for example, are often taken as an indication for beer making, as is the case for Pre-Pottery Neolithic Göbekli Tepe (Dietrich et al. 2012). These calcium oxalates, however, could have derived from other sources (there is a wide range of plant taxa containing calcium oxalate, cf. Bresinsky et al. 2008, 89-90) and for this reason it is pointed out that “... in Göbekli Tepe, the occurrence of beer making is not yet certain ...” (Dietrich et al. 2012, 688-689). Tartaric acid has always been associated with wine, ignoring other potential grape products like vinegar and grape syrup (cf. Valamoti et al. 2007) as well as other fruits containing tartaric acid/tartrate (e.g. Sorbus and Crataegus, see Altmeyer 2018). Residue analyses from vessels excavated in the 4100 BC Areni Cave in Armenia have yielded markers such as tartaric acid/tartrate (SG-16a) which have been interpreted as indications for wine (Barnard et al. 2011; McGovern et al. 2017) yet, although archaeobotanical

remains are mentioned in the publication, no such finds have been published that would corroborate the chemical results. Using residue analysis alone to positively identify prehistoric alcoholic drinks is, for the time being, quite controversial and inconclusive, generating at times doubts for certain identifications. Therefore, our overview relies heavily on the archaeobotanical remains that offer a reliable means to infer beer and wine production (Fig. 2).

Wine

Wine is the outcome of alcoholic fermentation occurring through contact of fruit juice with fruit skin, whereby wild yeasts on the skin start to produce alcohol (McGovern 2003; Sicard/Legras 2011). Various fruits can be used for wine making, and recently there have been claims for prehistoric wine making from Cornelian cherries (Bouby 2014, 159). Nevertheless, of all the potential fruit-wines, it is grape wine that has monopolised discussions on prehistoric societies of Europe. Numerous mixing, serving and consumption vessels such as cups, jugs, kraters among others, have been associated with wine consumption while amphorae have been the vessel par excellence associated with storage and trade of wine. For historic periods, for which plentiful ancient textual evidence as well as amphorae seals exist, wine trade in the Aegean and the Mediterranean in general is confirmed. For prehistoric periods, however, the most reliable evidence suggestive of wine making are the actual remains of its production, i. e. archaeobotanical remains of grape-pips, pressings and stalks. We therefore focus on these archaeobotanical remains which offer strong indications for wine making in prehistoric Europe. As wine can be produced from both wild and cultivated grapes (Singleton 1995) and given the presence of wild-looking pips among assemblages from historic periods in our study area (Pagnoux 2016; Pagnoux et al. 2015), we do not touch upon the issue of grapevine domestication in this paper, and instead focus on the indications for wine making irrespective of scale or context of production and consumption.

The grapevine is indigenous to a large part of Europe (Logothetis 1962), and pollen evidence since Palaeolithic times shows that it grew in refugia during the Pleistocene (e. g. at Tenaghi Philippon, Drama Basin, Eastern Macedonia: Wijmstra 1969). In Central Europe the archaeobotanical remains of grapevines consist of well dated finds of single pips from at least the Late Bronze Age (e. g. finds from Stillfried, Austria, early 1st mill. BC: Kohler-Schneider 2001; for old finds and old references with all their problematic dating cf. Berstch/Berstch 1947), and Vitis pollen in profiles from the region of Western Lake Constance in Southern Germany indicate a natural distribution of wild grapevine since the Holocene (Rösch 2016). During the Late Bronze and Early Iron Ages (approximately 1st mill. BC) Vitis pollen decreases in Central European pollen profiles, and this has convincingly been interpreted as an indication of the destruction of the natural habitats where wild grapevines grew (Rösch 2016). Although the grapevine is evidenced for prehistoric times in Central Europe, no concentrations of grape-pips or grape-pressings have been unearthed so far from prehistoric contexts. For the Late Bronze and Early Iron Ages, only a few grape-pips have been reported from recent excavations for both dry and waterlogged sites, thus reducing the chances of this being the outcome of taphonomic parameters (Stika/Heiss 2013). It seems therefore that the wild grapevines were growing as climbers on tall trees, such as ashes and oaks of flood plain stands, inaccessible to the Neolithic and Bronze Age people of Central Europe. The sporadic pips present at prehistoric sites of Central Europe could indicate a random collection/consumption of a few berries at the most. It is only when numerous grape-pips have been found in a rich dense concentration and/or grape-pressings that one can be sure for grape-juice extraction.
to which fermentation would be the immediate next step as fermentation begins almost immediately after the juice comes in contact with the grape skins. Thus in the absence of any evidence of intentional harvesting or processing of grape-pips from prehistoric Central Europe it is reasonable to assume that the grapevine was not harvested for wine production during prehistoric times in Central Europe. Very few grape-pips from Late Bronze and Early Iron Age contexts are discussed by colleagues as being cultivated following morphometric indices (Stillfried an der March: Kohler-Schneider 2001; Valais: Wick 2010; Sandberg-Roselberg; Kohler-Schneider et al. 2015). Definitively domesticated grape-pips regularly occur in Central European archaeological sites from the Roman period onwards (e.g. Stika 1996a). The first hints of large-scale grape wine production are reported from the Moselle Valley in Late Antiquity (König 1995; 1997) by finds of numerous grape-pips, skins and peduncles. Since then grape wine production was well adapted along the Rivers Rhine and Moselle (Jung/König 2010).

The available archaeobotanical record shows that further southeast on the Balkan Peninsula the grapevine occurred only sporadically (Marinova et al. 2013). Only two sites have yielded something more substantial than single occurrences or a few grape-pips: Mursalevo (Marinova et al. 2016) and Vinea (Dragana Filipovic, personal communication, pips observed by S. M. Valamoti during the Paris IWGP conference in 2016). At Mursalevo grape-pips have been found in a burnt layer as well as inside two houses totalling 132 pips, the first so far relatively rich concentration of grapevine from Bulgaria (Marinova et al. 2016). Still, for a site with burnt destruction layers the numbers of pips remain rather low and suggest a random harvest from the wild. The archaeobotanical evidence as regards grape-pip occurrences seems to have a northern geographic and temporal limit in the Balkans, being limited at the Danube at least in the 5th mill. BC as based on present evidence.

Further south, however, finds from prehistoric Greece show that grape-pips are ubiquitous: for Northern Greece, for example, there is hardly any site investigated archaeobotanically that has failed to yield grape-pips (Valamoti et al. 2015). Moreover, rich concentrations are often encountered at both Neolithic and Bronze Age sites (Valamoti 2015; Valamoti et al. 2015).

When one further examines the Vitis macrobotanical finds from the Aegean, the strong archaeobotanical signature for grape-juice extraction is impressive indeed compared to other regions, where wine making in early contexts has been suggested only on the basis of residue analyses. Neither in Iran, at the famous sites of Hadji Firuz and Godin Tepe, where tartaric acid has been detected in jars associated with wine storage, nor in Armenia, Georgia and the Caucasus, the widely assumed cradle of early viticulture, have any actual remains of grape-pips and grape-pressings been identified in rich concentrations (McGovern et al. 1996; 2017; McGovern 2009; Barnard et al. 2011).
This archaeobotanical evidence from Greece consists of charred grape-pressings (skins and skins attached to pips, occasionally peduncles) as well as rich concentrations of grape-pips. Mapping these occurrences shows clearly that there is a widespread distribution from the north to the south (cf. Fig. 2). Neolithic Greece has yielded a wealth of archaeobotanical finds indicative of juice extraction and most likely wine making. At the site of Dikili Tash, Eastern Macedonia, Northern Greece, more than 5000 grape-pips together with grape-pressings have come to light from the interior of a house that was destroyed by fire around 4300 BC (Fig. 3). At the same site, tartaric acid detected on the sherds of pots that contained grape juice and grape-pips, together with a wide range of pottery for serving and consuming liquids (Fig. 4), suggest that wine was produced and consumed at Dikili Tash (Garnier/Valamoti 2016).

Bronze Age grape-pressings have been reported from Crete at Myrtos (Renfrew 1972b) and Monastiraki (Fiorentino/Solinas 2006; Sarpakı 2012) and from Tounba Thessalonikis in Northern Greece (Mangafa et al. 1998). During the Iron Age, rich concentrations from the site of Karabournaki in Central Macedonia imply the

Figure 4: Wine-related pottery from Late Neolithic Dikili Tash: (a) jar that contained grape juice and grape-pressings in the process of fermentation (preserved height 62 cm) and (b) amphora with painted decoration found near a concentration of grape-pips (height 29 cm) (with kind permission of the excavators, © Ph. Collet/Ecole française d’Athènes).

Figure 5: Sub-Proto-geometric amphora from Karabournaki of local production (with kind permission of the excavators, © Karabournaki excavations archive).
continuation of a long tradition in wine making in Northern Greece as a whole. Moreover, at Karabournaki and neighbouring sites, special locally produced amphorae might have contained local wine (Fig. 5), the container acting perhaps as an indication for the content (Valamoti et al. 2018). Besides grape-pressings, several Bronze Age sites have yielded hundreds of grape-pips in concentrations of more than a hundred pips. Among those, the finds from Assiros Toumba (Mangafa et al. 1998) and Kastanas (Kroll 1985) in the north and those from Lerna (Hopf 1961; 1962) and P. O. T. A. Romanou (study in preparation by Valamoti et al.) in the Peloponnese stand out. These finds suggest proper harvest and not occasional picking of wild grapes by humans or animals. Although the lack of grape-skins and pressings does not allow great certitude for grape-juice extraction, it is possible that they are the outcome of this process, given the density and purity of the finds. The lack of grape-skins might be attributed to taphonomic factors. These early systematic harvests could have originated from cultivated grapevines in an incipient stage of domestication, whereby the morphological characteristics of domestication had not yet been developed (Valamoti 2015), as is the case with the Dikili Tash pips where the whole assemblage falls within the range of the wild grapevine (Mangafa/Kotsakis 1996). By the Late Bronze Age, however, it is clear that at Kastanas the grape-pips correspond to cultivated ones (Pagnoux 2016). Even in historic periods wild looking grape-pips occur, showing that even when grapevines are systematically cultivated, wild looking pips are still present (Pagnoux 2016). It has also been pointed out that wild grapevines were intentionally grown among vineyards in ancient Greece (Pagnoux 2016).

Sporadic harvesting is also indicated for circum-Mediterranean areas further west from our study area for the Neolithic and most of the Bronze Age. In Italy, for example, in Tuscany, the grapevine is present, but no indications for systematic harvesting have yet been found (Bellini et al. 2008). It is towards the end of the 2nd mill. BC that indications for grapevine cultivation are found in Sardinia (Ucchese et al. 2015) and some hundred years later in the Iberian Peninsula (Perez et al. 2017). Moving westwards from the core of our study area, to Iron Age Coudounou (5th cent. BC), Île de Martigues (4th cent. BC) and Le Castellan (2nd cent. BC) (cf. Fig. 2), assemblages consisting of pips, pedicels, and pressed grape-skins have been recovered from storage and domestic contexts (Marinval 1997; Bouby/Marinval 2001; Marty/Corso 2002) indicating the pressing of grapes for juice extraction and possible wine making, as was initially suggested and experimentally
tested on the basis of the Dikili Tash finds (Mangafa et al. 2001; Valamoti 2003). These consistently demonstrate the existence of local wine making, the outcome of influences of Greek colonies in the region (Roubey 2014: 180).

The impressive quantities of Neolithic and Bronze Age grape-pips indicate that while wild-looking, the grapes were harvested from systematically managed grapevines. These grapevines in the early stages of grapevine management might have grown on low trees or even been planted and cultivated in an incipient form of cultivation (Valamoti et al. 2007; Valamoti 2015). One can even envision the intentional growing of grapevines on trees, such as *Pyrus amygdaliformis*, also identified at the site of Dikili Tash as a systematically managed fruit tree due to the rich finds of wild pears only produced in quantity if the tree receives adequate sunlight (Valamoti 2015). The growth of grapevines on trees is a practice still witnessed nowadays, though not on a systematic scale in Greece (Fig. 6) and elsewhere (Roubey 2014).

This practice of cultivating grapevines as climbers on trees is known from ancient Greek under the name “ανάδενθρος” (anadendras), meaning a tree climber. In *Daphnis* and *Chloe* by Longus (2.1.4; Dalmeyda 1934) it is stated that on the island of Lesbos all the grapevines are growing low and not supported or climbing on trees. By contrast, their stems are expanding downwards and onto the land, like ivy (Πάνα γὰρ κατὰ τὴν Δέσθου ἢ ἀμπελὸς ταυτείνη, οὐ μετέχοις ὀὐδὲ ἀνάδενθρος, ἀλλὰ κατὰ τὰ κλήματα ἀποτείνουσα καὶ ὑπὲρ θητοὺς μεμενθέν), while detailed descriptions of how to manage climbing grapevines are present in *Geoponika* (3.1.1; 4.1.1-2; Beckh 1895). Even Linear B texts offer an association of a combined cultivation of climbing grapevines on fig trees (Pagnoux 2016 for a review of the relevant literature). In any case, it is only when different lines of evidence from well investigated sites point towards grape-juice extraction and fermentation that one can infer wine making from the archaeobotanical record. The archaeobotanical evidence for grapevine exploitation and wine making during the Neolithic and the Bronze Age in the PlantCult study area, as presented above, shows that, unlike Central Europe, where the grapevine was not systematically harvested or processed for juice extraction, grapes were systematically harvested and processed in the Aegean and Mainland Greece for their juice, with strong indications from contextual, artefactual and chemical evidence pointing towards wine making.

Thus different traditions are evidenced in the archaeobotanical record from our wider study area, with the Aegean and Mainland Greece standing out as a region, where viticulture and wine making had roots in the Neolithic.

**Beer**

Beer has been known as the drink of the big civilisations of the Near East, Sumerians and Egyptians, with many artefactual, pictorial and textual evidence confirming the widespread practice of beer making, both as a staple and ritual drink (McGovern 2009). Archaeobotanical evidence from Egypt provided a revolutionary means of looking into prehistoric beer making in Egypt (Samuel 1996a; 1996b; 2000; Samuel/Bolt 1995). Starch alterations in beer residues from Amarna clearly showed that starch granules had been affected by yeast attack, producing a pitted appearance (Samuel 1996a; 1996b). Another archaeobotanical indication for beer making lies among finds of sprouted cereal grain, an indication for malt production, i. e. the first step in beer brewing. Of course, one cannot be certain that the sprouted grains are always the outcome of malting for making beer. Sporadic sprouted grains can occur due to high moisture levels while in storage and therefore their presence might be accidental (Hopf 1981). For example, pits used for storage might contain charred sprouted grains because during storage, those in contact with the pit walls are likely to sprout until all oxygen in the pit is used up resulting in an airtight storage.
of the grain. When the pit is emptied and sterilised by burning, those sprouted grains adhering to the pit wall are very likely to become charred and end up in archaeobotanical assemblages. When, however, they are found in large, dense, evenly germinated and pure concentrations there is no doubt that we are dealing with an intentional process of malt production and the first step in beer making. Such finds from our study area have been identified from Bronze Age contexts in Serbia (Kroll 1991; 2016) and, more recently, Greece (Valamoti 2017b), where thousands of sprouted wheat and barley grains have been found. Two sites on Mainland Greece, Argissa and Archondiko, have yielded the earliest indications for beer making in South-Eastern Europe so far, consisting of sprouted cereal grain, mainly wheat (Fig. 7). They have been dated to the end of the 3rd and the beginning of the 2nd mill. BC, the period marking the transition from the Early to the Middle Bronze Age in Greece (Valamoti 2017b). The Serbian finds were found at the site of Feudvar and date to approximately 1900-1700 BC (Kroll 1991; 2016).

In addition to the above, more or less reliable finds from our study area, a recent overview of prehistoric finds of beer and bread in ancient Europe, the Near East and Egypt has been compiled and mapped (Rosenstock/Scheibner 2017). Although three examples of beer are mentioned in this publication for our study area (Rosenstock/Scheibner 2017, ID 5, 7 and 8), no single site of these three appears to have yielded convincing botanical macro-remains that could indicate beer production.

At the Neolithic site of Schernau (Bischheim Culture) in Southern Germany, a few carbonised germinated barley grains (38 items of Hordeum vulgare cf. var. nudum) in an assemblage of 658 ungerminated grains of div. Triticum taxa (einkorn, emmer, spelt and free-threshing wheat) are classified by the author (Hopf 1981) as waste, and she considers this an unlikely indicator for beer (contra Rosenstock/Scheibner 2017, ID 7, fig. 6 and tab. 1). The Neolithic site of Remseck-Aldingen (Schussenried Culture) yielded in one of several samples from pits, 345 badly preserved carbonised grains of mainly naked barley with hints of germination together with some ungerminated wheat grains as well as chaff and weed seeds; the archaeobotanist suggested unintended germination because of wet storage (Piening 2005), rather than intentional malting (contra Rosenstock/Scheibner 2017, ID 8, fig. 6 and tab. 1). For the Neolithic tell site of Ovčarovo in Bulgaria (Bailey 1996) storage, parching and grinding of cereals
are mentioned for House 59, but no hints of germination or malting are given (Rosenstock/Scheibner 2017, ID 5, fig. 6 and tab. 1).

Malt could have been used as food per se, therefore it may not be considered sufficient evidence for beer making. At both Argissa and Archondiko, however, numerous drinking cups have been identified (Fig. 8), which are additional artefactual evidence that points to some form of “special drink” produced and consumed there. In addition, complex cooking structures and vessels potentially suitable for drying malt and fermentation have been unearthed at both sites (Fig. 9); therefore brewing has been suggested as probably having been practiced (Valamoti 2017b). Whether they were indeed used for fermentation, remains to be further explored through experimentation in the context of project PlantCult.

Moving further north-west, finds of malt occur at a much later date. At the Early La Tène settlement site (5th–4th cent. BC) of Hochdorf an der Enz, distr. Ludwigsburg, close to Stuttgart (Stika 1996b; 2011a; 2011b; 2016) and at 5th-cent. BC (2nd Iron
Figure 9: Plan of the Middle Bronze Age house 7b, building horizon 4, at Argissa in Thessaly, where a large concentration of charred malt has been identified (© Vegetation History and Archaeobotany).

Age in France) Roquepertuse, Veloux, dépt. Bouches-du-Rhône, 15 km west of the modern city of Aix-en-Provence in South-Eastern France (Bouby et al. 2011) not only malt was found, but additionally features that could have been used as drying-kilns. In the case of the Roquepertuse house floor context, c. 100 obviously germinated barley grains were identified among more than 2000 badly preserved and mostly fragmented barley grains which may have been malt as well, close to a burnt clay fragment (Fig. 10). This can be reconstructed as a special kiln (Fig. 11). This type of oven structure fits well for drying green malt, but alternative functions cannot be entirely ruled out (Bouby et al. 2011).

In the Hochdorf/Enz settlement site several thousand grains of carbonised sprouted barley in a good state of preservation were found as a layer on the bottom of u-shaped ditches, where germination and the subsequent drying of the green malt could have been conducted (Fig. 12). At Hochdorf the context where the malted
barley was found, strongly suggests drying of malt. The sprouted grains were found in a dense layer among charcoal in several u-shaped ditches that have been considered to be drying kilns for malt. Although roasted malt could have been used for other foodstuffs, e. g. in bread making, the large amount of pure and evenly germinated malt would have been good for brewing nearly 1000 l of a 5 % alcohol beer which might have been used for drinking and feasting at the Late Hallstatt burial mound when, 150 years later, a ritual reuse of this “place of the old ancestors” occurred (Stika 2005; 2010; 2016). In its main burial chamber, the Late Hallstatt princely burial mound at Hochdorf itself may point at different drinks perhaps implied by the different shapes of containers used by the 6th-cent. BC elites of Central Europe, such as drinking horns (Fig. 13). Beer could have been one of these drinks, but has not yet been identified inside the burial chamber, where we have evidence for mead from the lion cauldron (Körber-Grohne 1985, see below).
Mead

In contrast to prehistoric indications for beer and wine, there is no botanical macro-remains signal for mead from excavations. In our research area in Southern Germany there are several Early Iron Age sites where the sediments and crusts in bronze vessels, pitchers, cauldrons and ladles have been analysed for botanical micro-remains, i.e. pollen preserved by the contact with copper ions. This is the case with the burials from Hochdorf (Körber-Grohne 1985), Glauberg (Rösch 1997; 1999), Heuneburg-Hohmichele (Rösch 1999; Rösch/Fischer 2016), Heuneburg-Speckhau (Rösch/Fischer 2016; Rösch in print).
and Niedererlbach (Rösch 2005). When a large amount of the pollen grains derive from bee-pollinated plants, we can think of hints for honey, sometimes confirmed by archaeo-
chemical evidence of beeswax (e.g. Hochdorf/Enz: Haas 1985). This might suggest that the vessels contained mead or a liquid sweetened with honey. Mead or a preparation for fer-
menting mead can be assumed when the honey content in the liquid was high, as was the case with the Hochdorf lion cauldron (Vorwohl 1985). To be absolutely sure of hav-
ing found mead, archaeo-chemical fermentation markers should be analysed, which is the case in the on-going research of the BEFIM project.

Human coprolites from the Early Iron Age salt mines at the Dürrnberg Mountain, Austria, have been analysed palynologically and showed a pollen spectrum dominated by insect-pollinated taxa with a significantly high value of Filipendula ulmaria (meadowsweet), which points at the consumption of honey (Moe/Oeggl 2014). These finds of Filipendula ulmaria pollen have been further interpreted as strong indications of mead production, because the flowers of meadowsweet are known as traditional additives for spicing mead (Moe/Oeggl 2014). Although mead could have been a source of meadowsweet pollen, the identification of mead per se would require additional lines of evidence such as fermentation indicators deriving from chemical Organic Residue Analyses of special vessels used for production and/or storage.

Alcoholic drinks of prehistoric Europe: Future work in the context of ERC project PlantCult

As our brief overview has shown, indications for alcohol production in prehistoric Europe are dispersed and, with few exceptions, hardly integrated with other lines of evidence. Our PlantCult approach aims to rectify this by taking into consideration a wide range of evidence explored in a contextual way. This is, for example, the case with the sites of Archondiko and Dikili Tash in Northern Greece. At Archondiko, the archaeobotanical indications for sprouted wheat have been examined together with the pots and cooking installations from the site, while for later periods textual evidence provides insights into a period spatially and temporally much closer to the prehistoric finds than to our modern ethnographic records. Moreover, the excellent preservation conditions at Archondiko allow for the experimental reconstruction of brewing, for which work is under way in the context of the project. At Dikili Tash, finds indicating wine making are closely examined by the PlantCult team as regards the archaeobotanical indications for wine making, the related ceramic vessels and their spatial distribution. For Greece markers indicating wear of the interior surfaces of jars at sites where wine or beer making is evidenced will be explored as relevant ethnographic literature shows that fermentation leaves distinct erosion patterns on jar surfaces (Arthur 2014). Such lines of evidence could then be compared to and integrated with the results of the on-going BEFIM project.

In PlantCult we aim to incorporate evidence from installations, grinding equipment, pots and actual remains of plant foods related to alcoholic production in order to obtain a better understanding of the processes and contexts of production and consumption. In this respect, experimentation holds a key position in our methodological approach. It will be used as a tool that will enable us to detect those distinctive features that may be particular to beer making and wine making, allowing a secure identification of the processes in the archaeobotanical record in both macro- and micro-remains.

Experimentation is being developed at two levels. Grain/seed is generated from different known stages of beer and wine making and is then examined under a scanning electron microscope (SEM) in charred and uncharred conditions and then compared to the archaeological remains that indicate sprouted grain from Argissa and Archondiko in Greece and from Hochdorf in Germany (Fig. 14). This corresponds to work in progress by PlantCult PhD student Chryssa Petridou and postdoctoral researcher Marian Berihuete Azorin.
The information on all morphological characteristics induced by the beer making process will be entered into a database accessible to other scientists, who deal with similar material. In addition, replication of brewing on the basis of facilities and jars found at Argissa and Archondiko will yield further comparative material. For Central Europe similar work is already in progress by project BEFIM. The various residues generated each time in each step will be observed in order to see the potential remains that would survive in the archaeological record. In our approach, archaeological contexts play an important role in order to better understand the processes underlying alcohol production and consumption.

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