Vegetation History and Archaeobotany (2018) 27:611–625
https://doi.org/10.1007/s00334-017-0661-8

ORIGINAL ARTICLE

Brewing beer in wine country? First archaeobotanical indications for beer making in Early and Middle Bronze Age Greece

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Received: 9 May 2017 / Accepted: 5 December 2017 / Published online: 30 December 2017

Abstract
This paper revisits and old question "Beer or wine?" as regards the potential alcoholic drinks consumed by prehistoric societies in southeastern Europe. Archaeobotanical remains of sprouted cereal grains as well as cereal fragments from the Bronze Age sites of Archondiko and Argissa on mainland Greece, presented here for the first time, provide strong indications for the making of something similar to beer in late 3rd millennium BC Greece, opening up a series of new questions about the recipes followed in this process and their origins. Beyond the recipes themselves, the paper highlights a range of available options as regards alcoholic drinks in Bronze Age Greece, beer and wine, offering thus a more detailed approach to preferences and possible identities reflected in the choice of alcoholic drink among prehistoric societies inhabiting the southernmost tip of the Balkan Peninsula, the Aegean and mainland Greece.

Keywords Bronze Age beer · Prehistoric Aegean · Archondiko · Argissa · Alcoholic drinks · Sprouted cereal grain · Ancient malt

Introduction

The origins of alcohol consumption by humans are probably related to primate dietary habits that include the consumption of fruits which are mature to a state of incipient natural fermentation (McGrew 2011; Hockings et al. 2015) and this might explain the universal indications of early alcohol production by human societies (Moore 1989; McGovern et al. 1995; Wang et al. 2016). The significance of alcoholic drinks among prehistoric societies has been the focus of much archaeological and anthropological discourse. Ethnographic work shows eloquently how alcohol is essential in many areas of social interaction (Dietler 2001; Arthur 2014). Alcohol has been considered, among other things, the trigger that led to cereal cultivation and domestication, as a response to a need for providing alcohol for feasting among hunter-gatherers (Hayden 2003; Dietrich et al. 2012; Hayden et al. 2013), a hypothesis originally raised in the 1950s by the pioneer researchers into the origins of agriculture, who, however, dismissed it as being highly unlikely (Braidwood 1953). Equally widespread is the association of alcohol with the emergence of elites and social stratification in many parts of the world; its consumption forms an essential part of rituals and feasting, contexts of social consumption where social roles are learnt and power relations forged (Moore 1989; Vencl 1994; Gorny 1995; Palmer 1995; Powell 1995; Sherratt 1987, 1995; Dietler 1996; Arnold 1999). Archaeobotany offers a reliable line of evidence that, given the right preservation conditions, could pin-point where and when alcoholic drinks began to be made. Other lines of evidence include pottery, pottery residue analysis, pictorial evidence and ancient texts from historic periods.

Prehistoric alcoholic drinks of the Old World include wine, beer and mead. Making wine would have been a rather straightforward procedure, similar to the alcohol fermented in mature fruit consumed by the distant hominid ancestors of modern humans: grape juice mixed with grape skins would suffice for alcoholic fermentation to take place as the sugars in the grape juice (or other fruit juice for that matter) would be used by wild yeasts naturally present on the grape skins (McGovern 2003; Sicard and Legras 2011). Wine therefore may have been the earliest alcoholic

Communicated by C. C. Bakels.

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beverage produced already from Palaeolithic times onwards (McGovern 2003). Beer making, on the other hand, requires the starch in the grain first to be changed to sugars which yeasts can then use to begin alcoholic fermentation (Samuel 1996); as this change can be achieved by the sprouting of cereal grain (malting) and the subsequent interruption of the process by roasting the grain, beer making must have needed more sophisticated know-how and equipment. It could even be argued that for brewing beer, wine making (McGovern 2003) and cereal domestication were prerequisite steps in the history of alcohol production.

Archaeological indications for wine making appear to be earlier than those for beer. Neolithic tartaric acid has been detected in pottery residues from 6th millennium Hadji Firuz tepe in Iran (McGovern et al. 1996), while in the second half of the 5th millennium BC, residue analysis from Areni cave in Armenia (Barnard et al. 2011) and integrated archaeobotanical and residue evidence from Dikili Tash in northern Greece (Garnier and Valamoti 2016), point to a wide geographical range of early wine-making, corresponding to areas overlapping with the natural distribution of wild grape vines in the Old World. Rather than searching for a single origin for grape vine use and wine making in prehistoric times, multiple origins appear as the most likely scenario in light of the archaeobotanical and residue analysis evidence, already suggested by McGovern for Palaeolithic hunter-gatherers (McGovern 2003). Ancient beer, or something similar, is detected in both textual as well as archaeobotanical evidence from Bronze Age contexts in Egypt and the Sumerian states (Samuel 1996; Bottéro 2004, for reviews of the Egyptian and Sumerian evidence for beer).The Egyptian records for beer are dated as early as the mid 4th millennium BC at Hierankopolis (Maksoud et al. 1994; Adamski and Rosińska-Balik 2014), while the Near Eastern ones are as early as 3200 BC (Damerow 2012). Textual evidence from historic periods in Greece clearly shows that beer was considered an alcoholic drink of foreign people, and barley wine a drink consumed by the Egyptians, Thracians, Phrygians and Armenians, in most cases drunk with the aid of a straw as reported by Archilochus and Xenophon (Nelson 2005).

Until now, archaeobotany confirms our image of Greek wine transcending centuries and millennia, connecting the prehistoric past to the present. There is ample archaeobotanical evidence consisting of grape pips and/or grape pressings from Neolithic and Bronze Age Greece, at times backed up by residue analysis of pottery containers (McGovern 2003; Tzedakis et al. 2008; Garnier and Valamoti 2016), which show that wine was produced and consumed both in the north and the south, in simple Neolithic villages and in grandiose palaces too (Fig. 1; Table 1).

Wine seems to have been the drink of the Late Bronze Age societies of the south of Greece and their elites, documented in Linear B texts, with separate ideograms for the

Fig. 1 Map of Greece showing Archondiko and Argissa where indications for beer making have been found, together with locations of sites with rich concentrations of grapes and/or grape pressings. Site numbers correspond to Table 1. Map prepared by N. Katsikaridis and T. Bekiaris

grape vine and wine as well as a honeyed variety of wine (Palmer 1995). Its centralised production, storage, distribution and ritualised consumption are also adequately documented for the Late Bronze Age (Palmer 1995; Wright 2004; Gauß et al. 2011). Partly an outcome of these later textual references and a stereotypical perception of the Mediterranean triad of "bread, oil and wine" have led to a widespread assumption that beer was not drunk in prehistoric Greece. Was this indeed the case? McGovern (2003) has questioned this widely held assumption for Bronze Age Minoan and Mycenaean southern Greece, on the grounds of residue analysis of pithoi, large pottery storage containers, from Myrtos-Phournou Koryphi. The scepticism about a widespread dominance of wine may be indeed justified, as our paper hopes to demonstrate, yet the chemical signature for beer detected by McGovern, calcium oxalates, can occur in other materials too, therefore on their own they provide weak indications for beer brewing (Michel et al. 1993; McGovern 2003). Suggestions for beer brewing and consumption among Bronze Age communities of Greece have also been put forward for terminal Early Bronze Age mainland Greece on the basis of particular pottery shapes and drinking sets (Rutter 2008). More recently, beer has been suggested as mentioned in Linear B texts (Weilhartner 2016).

This paper revisits and old question "*Bier oder Wein*?", "beer or wine?" (Kroll 1991), which was raised in connection with finds of rich concentrations of sprouted grains of einkorn, emmer and barley retrieved from middle Bronze Age (1700–1500 BC) Feudvar, Vojvodina, in former Yugoslavia, now Serbia. Archaeobotanical remains of sprouted

Table 1 Archaeobotanical finds from prehistoric Greece indicating intensive grape use (pure, numerous concentrations of grape pips) and possible wine-making (grape pressings consisting of grape skins and pips with grape skins attached)

Site	Period	Grape pips	Grape pressings	Context	Reference
1 Dikili Tash	Late Neolithic	6,000	X	Single context	Valamoti (2015)
2 Kastanas	Late Bronze Age	581		27 samples	Kroll (1979, 1983)
3 Toumba Thessalonikis	Late Bronze Age		X		Mangafa et al. (1998)
4 Lerna	Early Bronze Age	1,102		Single context	Hopf (1961, 1962a)
	Middle Bronze Age	313		Single context	Hopf (1961, 1962a)
5 P.O.T.A. Romanou	Early Bronze Age	3,400		Single context	Valamoti in preparation
6 Myrtos Pyrgos	Early Bronze Age		X		Renfrew (1972)
7 Monastiraki	Late Bronze Age	8,463	X		Fiorentino and Solinas (2006); Sarpaki (2012)

cereal grains as well as cereal fragments from Bronze Age Greece, presented here for the first time, provide strong indications for beer making in late 3rd millennium BC mainland Greece, opening up a series of new questions about the recipes followed in this process and their origins. Beyond the recipes themselves, the paper also discusses preferences and possible identities reflected in the choices of alcoholic drink among prehistoric societies inhabiting the southernmost tip of the Balkan Peninsula, the Aegean area and mainland Greece.

Materials and methods

Archondiko

Archondiko is a multi-period tell site which was occupied from the Neolithic through to the Iron Age, located in the region of western Macedonia in northern Greece (Fig. 1; Pilali-Papasteriou and Papaefthymiou-Papanthimou 2002; Papadopoulou et al. 2010). The finds discussed here originate from the Early Bronze Age, phase IV, dated to 2135–2020 BC (Papadopoulou et al. 2010). This phase has revealed a series of buildings, adjacent to each other and destroyed by fire, and hence preserving a rich inventory of structures, pottery and organic finds, including many archaeobotanical remains (Fig. 2). These include various cereals such as *Triticum monococcum* (einkorn), *T. dicoccum* (emmer), *T. spelta* (spelt wheat), *T. aestivum/durum* (free-threshing wheat) and *Hordeum* sp. (barley) which were found in dense, sometimes pure, concentrations indicating deliberate storage. Oil seeds like *Linum* (flax) and *Lallemantia* were stored in different locations inside the buildings (Valamoti et al. 2008a; Valamoti 2011a; Papanthimou et al. 2013); moreover, there is abundant evidence for preprocessed cereal grain from various contexts belonging to this phase (Valamoti 2002, 2011b; Valamoti et al. 2008b).

Archaeobotanical finds from the site were retrieved by flotation, using a variant of the Ankara machine (French 1971), with more than 2,000 soil samples being processed from the site using sieves with meshes of 1 mm and 300 µm, while a mesh of 1 mm retained the heavy residue during processing. The archaeobotanical finds from phase IV were collected from buildings A, C, D and E, while those discussed here come from buildings C and E, from areas around clay structures (Fig. 3; Table 2: flotation samples 1026, D16 and D14).

Argissa

Argissa Magoula is a multi-period tell site in Thessaly that lies on the northern bank of the river Peneus, just 4.5 km northeast of the city of Larissa (Fig. 1). Excavation of the site, a project of the German Archaeological Institute, was carried out in 1955, 1956 and 1958, under the direction of V. Milojčic et al. (1962). Its occupation spans the Early Neolithic through to the Late Bronze Age. The deposits discussed here are dated to the Middle Bronze Age, also known as Middle Helladic for mainland Greece, which falls at the end of the 3rd millennium BC and the beginning of the 2nd millennium BC (2100–1700 BC). The Middle Bronze Age deposits from Argissa consisted of long houses arranged almost parallel to each other, separated by very narrow streets. The archaeobotanical material presented here came from a burnt destruction layer in house 7B, one of the four long houses (7B, 10, 11, 12), with stone built walls and clay floors, which were sealed by a destruction layer and belong to phase 4 of the Middle Bronze Age occupation period. The interior of house 7B was equipped with two clay cists and three horseshoe shaped hearths. The archaeobotanical finds discussed here originated from a horseshoe shaped hearth, one of an agglomeration of three, inside house 7B, situated in the centre of the house (Fig. 4).

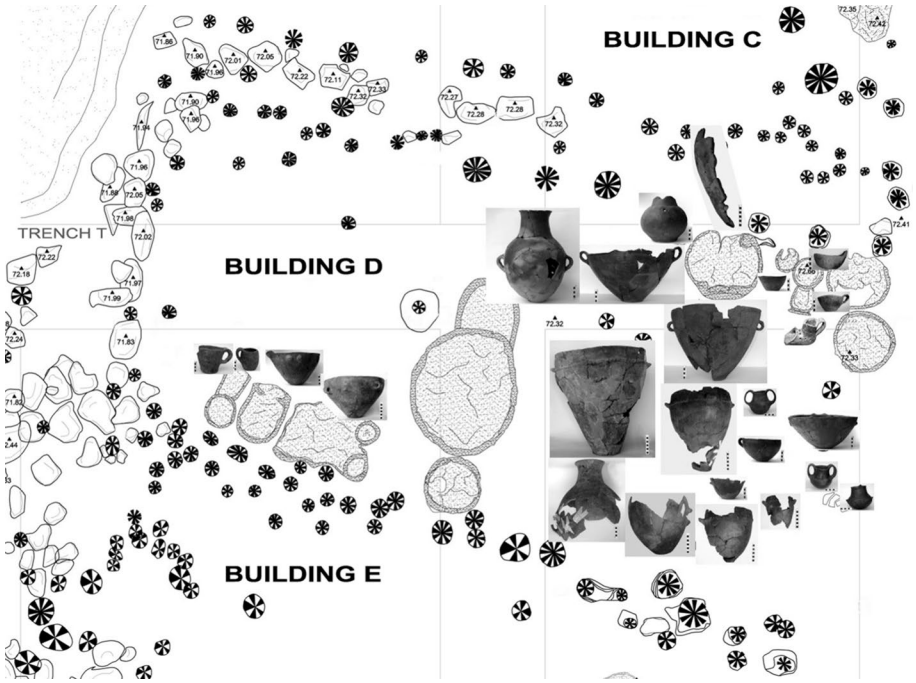

Fig. 2 The interior of House D at Archondiko, showing clay thermal structures and clay vessels in its interior (after Papanthimou et al. 2013)

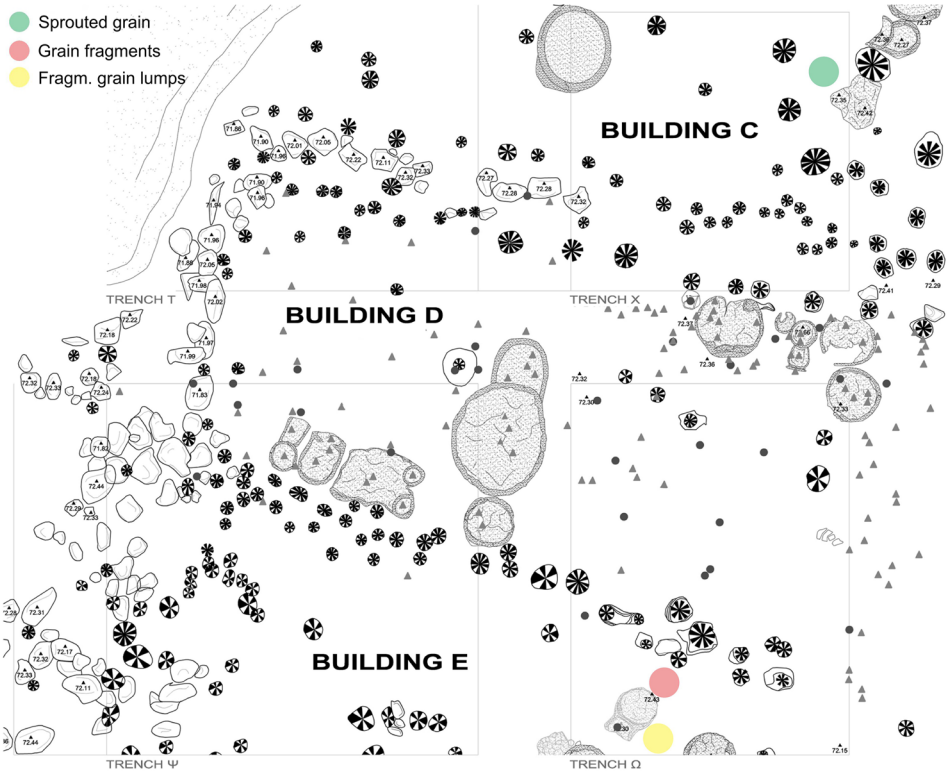

Fig. 3 Plan of Archondiko showing locations of archaeobotanical remains discussed in this paper: sprouted grain, ground cereal grain and cereal lumps

The archaeobotanical study of the material from the site was carried out by the late Maria Hopf and while part of the study has been published (Hopf 1962b), the archaeobotanical finds discussed here remained unpublished and are referred to in a report by Maria Hopf, archived at the Lower Saxony Institute for Historical Coastal Research in Wilhelmshaven, Germany. The archaeobotanical material from Argissa was collected on a judgemental, grab-sampling basis, whereby visible concentrations of grain were kept for study.

Table 2 Archaeobotanical finds from Archondiko and Argissa discussed in this paper

Site	*Archondiko*			*Argissa*	
Sample number	1026	Ω-Δ14	Ω-Δ16	XII-Γ2-3, 194/03/1	XII-Γ2-3, 194 02 B8/ XIII8
Fraction studied	> 1 mm	> 1 mm	> 1 mm	> 2 mm	> 2 mm
	1/1	1/1	1/1	1/1	1/4
Triticum cf. *monococcum* grains				1	6
Triticum cf. *dicoccum* grains				1	
T. monococcum sprouted grains				291	507
T. dicoccum sprouted grains				17	35
Triticum sp. sprouted grains	58			74	238
Hordeum sp. sprouted grains				17	16
Triticum/*Hordeum* sprouted grains	4			1	1
Triticum sp. indeterminate grain	66				
Cereal fragments		X			
Cereal lumps		X	X		
Linum usitatissimum	530				

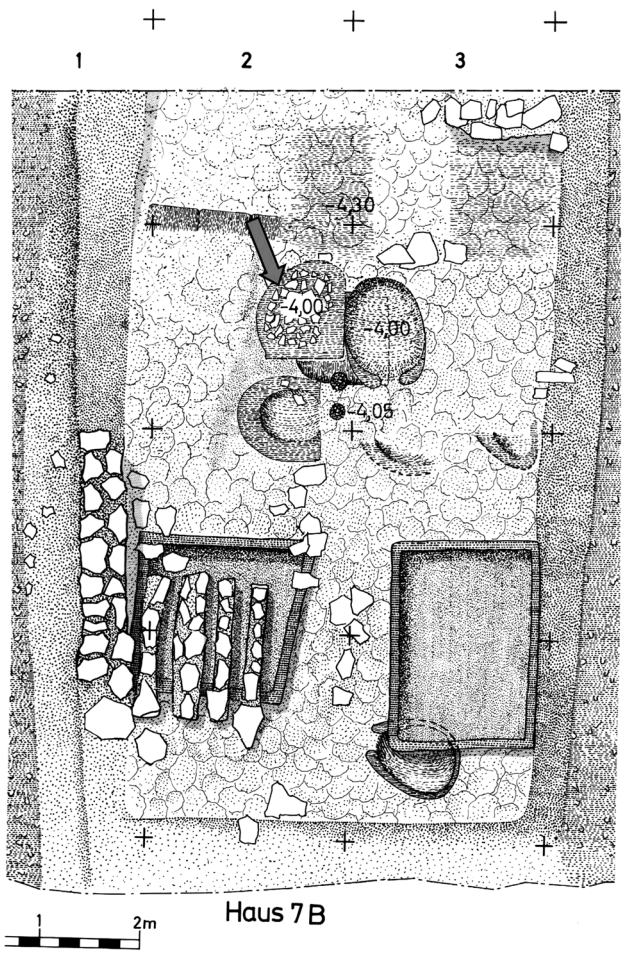

Fig. 4 Argissa, Middle Bronze Age, detail of house (Haus) 7B where thousands of sprouted cereal grains have been found (after Milojcic et al. 1962)

Results and interpretation

Archondiko

The archaeobotanical finds discussed here consist of cereal remains from the interior of the phase IV buildings C and E, retrieved in the following forms (Table 2): (a) a concentration of sprouted cereal grains (Fig. 5), (b) agglomerations of lumps of ground cereal fragments which had been broken prior to charring (Fig. 6a, sample D16; Valamoti 2002) and (c) ground cereal fragments broken prior to charring, mixed with smallish lumps (Fig. 6b, sample D14; Valamoti 2002). Sample D14 consisted of a total of 20 ml of charred fragments and small lumps, of which the majority, 12 ml in all, ranged between 1 and 2 mm, while 6 ml were between 300 μm and 1 mm. Variability in the proportions of lumps and fragments was observed between the two samples and they are currently under study as regards their spatial distribution in relation to the structures, as well as with the aid of scanning electron microscopy (SEM) for their particular structural characteristics; more material with similar characteristics of fragments and small lumps of fragments has been identified in building A, currently under study. The sprouted grains of wheat amounted 58 in total and were identified in a sample that also contained mainly a large number of poorly preserved and hence unidentified cereal grains together with *Linum*. The unidentified cereal grains were of a fragile appearance, perhaps a result of sprouting and heating during charring.

The fragments from Archondiko were identified as having been ground before charring due to the bulging surfaces observed on some of the fragments, a feature

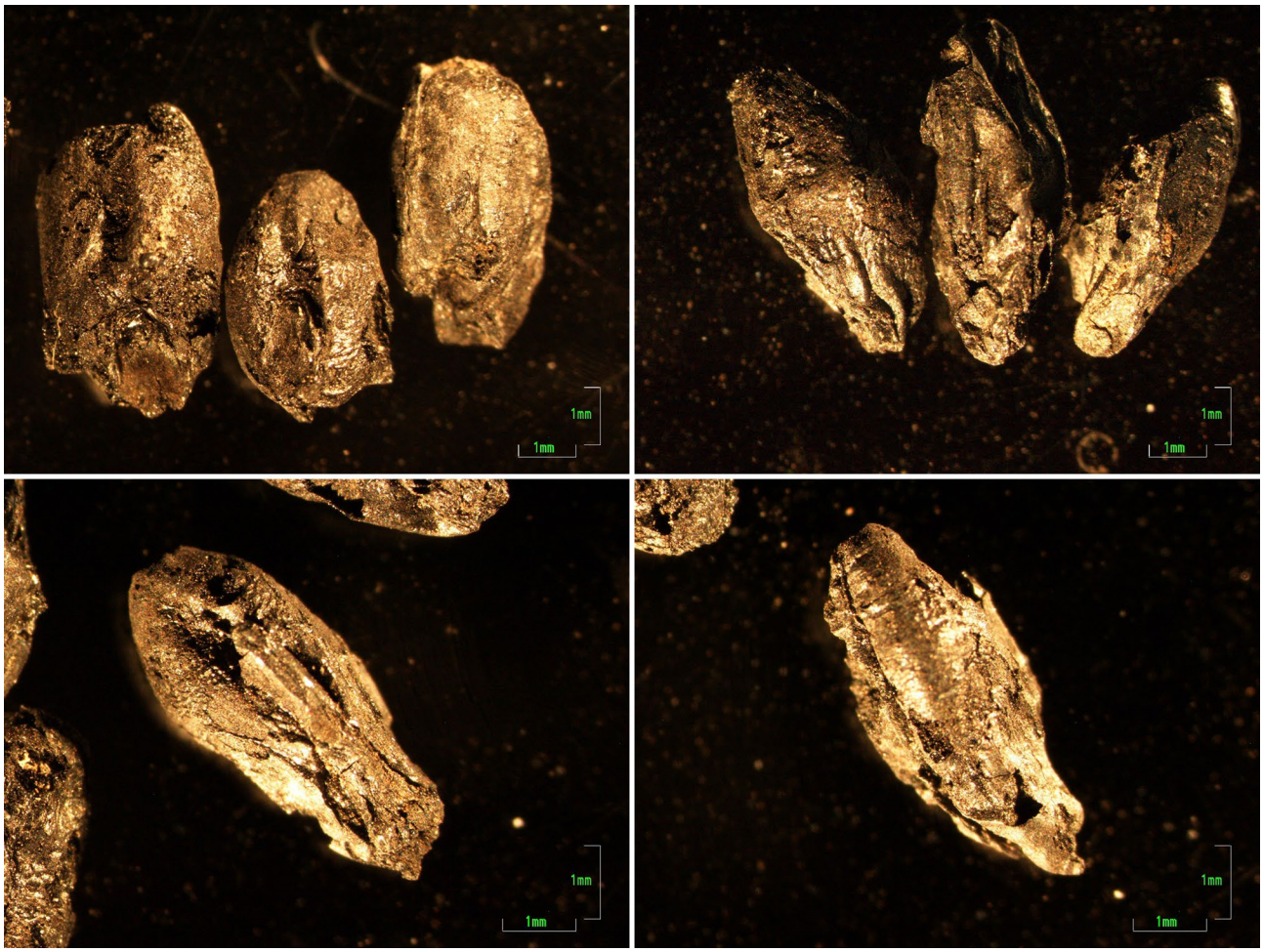

Fig. 5 Sprouted cereal grains from Archondiko

Fig. 6 Archondiko, **a** lumps of cereal fragments; **b** ground cereal fragments

considered to be indicative of cereal grain fragmentation before charring (Valamoti 2002). Further SEM work attempted to understand the processes involved in generating these fragments from Archondiko, comparing them to experimental specimens made by simple grinding and also grinding after boiling the cereal grain in water (Valamoti et al. 2008b). The patterns observed on the Archondiko fragment surfaces, however, did not match the experimental structures generated by boiling and due to the pilot nature of the 2008 study, it was not possible to disentangle the possible influence of charring on the structures observed in the archaeological specimens

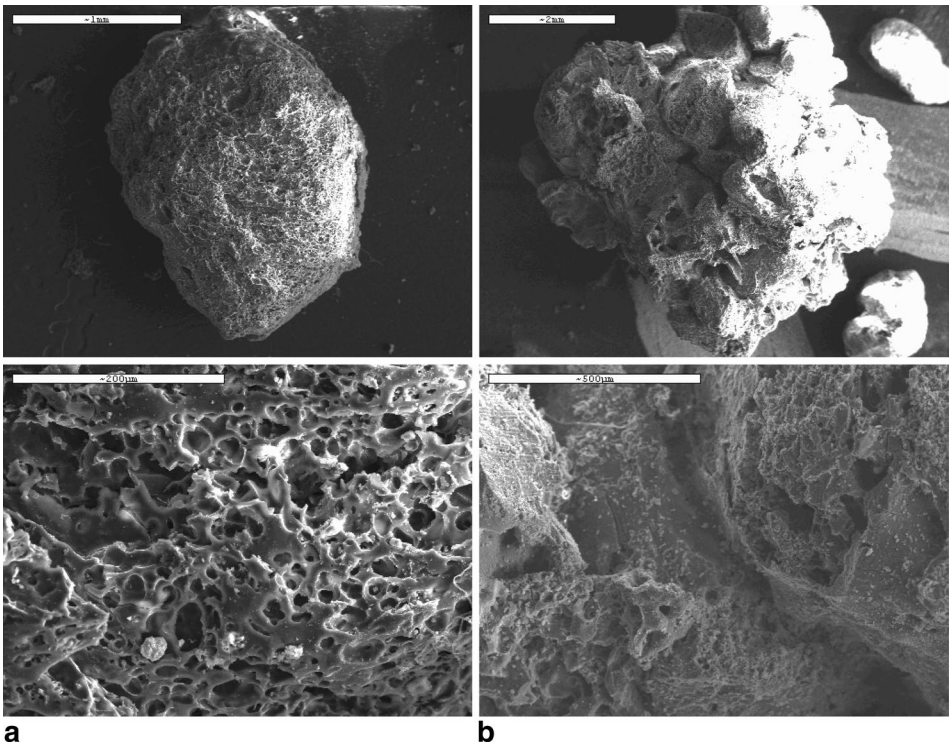

Fig. 7 SEM microphotographs showing structure of **a** cereal fragments; **b** a lump from Archondiko (after Valamoti et al. 2008b)

(Fig. 7a). Thus the processes underlying their creation remain little understood. In addition to these fragments, the same contexts provided lumps of fragments (Fig. 7b). These lumps and associated fragments from Archondiko were tentatively interpreted as corresponding to some form of pre-processed food, of the type of *kishk* and *tra chanas/tarhana/tarhonye*, which are dried pre-cooked and/or fermented food preparations combining cereals and milk in different forms, which are widespread in circum-Mediterranean countries and parts of central Europe and the Balkans, and they have a long storage life (Aubaille-Salenave 1994; Palmer 2002; Valamoti et al. 2008b; Valamoti 2011b). More such material from buildings A and E has been identified (Fig. 8a, b) and is currently under study by doctoral student Chryssa Petridou. Scanning electron microphotographs reveal the structure of these lumps: fragmented grains with chaff, free or adhering to the grain are visible. In one case these could further be identified to *Hordeum* (barley) (Valamoti et al. in preparation).

The sprouted grains identified at Archondiko are now raising alternative possibilities for the processes that may have led to the production of these cereal fragments and lumps of fragments there. The fragile sprouted grains are not mixed with robust, non-sprouted cereal grain, so it is unlikely that we are dealing with a few accidentally sprouted grains among a concentration of stored grain. The cereal fragments and lumps from Archondiko, combined with the recent identification of sprouted cereal grains from the same houses, may be pointing towards malt preparation for beer brewing, because these fragments potentially correspond to ground malt.

Argissa

The archaeobotanical remains from Argissa discussed here consist of at least 3,588 sprouted cereal grains that were identified to einkorn (2,319); a further 157 sprouted grains were identified as *T. dicoccum* (emmer) and 81 as *Hordeum* (barley) (Fig. 9; Table 2).

Unlike the relatively few sprouted grains from Archondiko, those from Argissa were found as a pure cache, were very numerous and in a much better preservation condition, being more solid and robust. Moreover, the furrow of each sprout formed a depression all along the length of the dorsal part of the grain, indicating that sprouting took place while the seeds were still in their husks. Although an accidentally generated cache of sprouted grains cannot be ruled out, the uniformity of the grains, which were all sprouted rather than only some of them, suggests that they had been deliberately sprouted. This suggestion has convincingly been put forward to interpret the sprouted cereal grains from Feudvar dated to 1700–1500 BC (Kroll 1991, 2016). If the grain

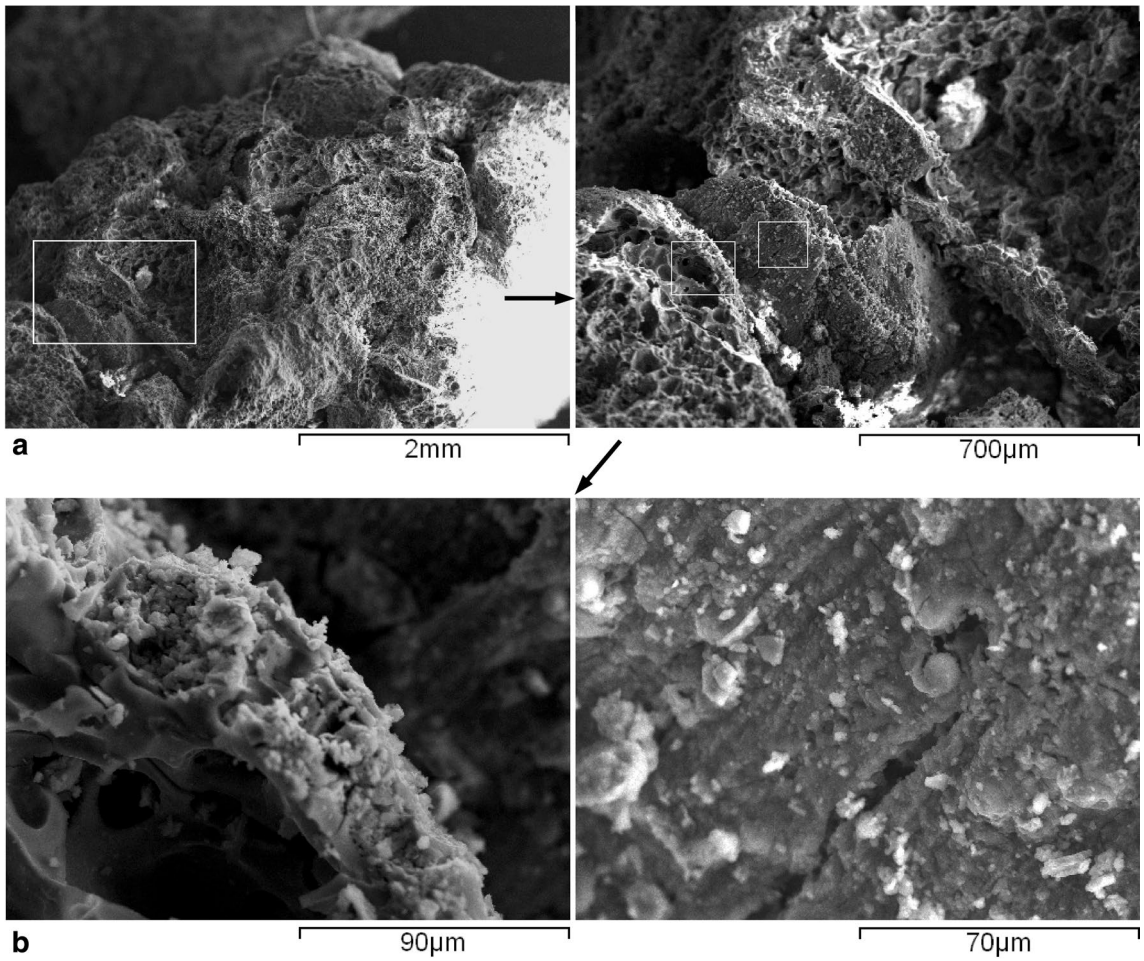

Fig. 8 Detail of cereal lump from Archondiko; **a** *Hordeum* aleurone layer; **b** *Hordeum* chaff (photo Ch. Petridou and L. Papadopoulou, identification A. Heiss)

Fig. 9 Sprouted cereal grains from Argissa, House 7B; **a** *Triticum monococcum* (einkorn); **b** *T. dicoccum* (emmer); **c** *Hordeum vulgare* (barley); scale bars = 1 mm

had sprouted accidentally, the sprouted grains would have been less numerous and mixed with non-sprouted grain. Following the argument of Helmut Kroll for the Feudvar remains, we interpret the Argissa sprouted grain as the remains of malt preparation.

Discussion

Bronze Age malting and beer brewing in the Aegean?

Based on our observations presented above, the finds of sprouted grain from both Archondiko and Argissa could be pointing to malting, while the cereal fragments and lumps from Archondiko might correspond to ingredients used in brewing beer. Sprouting of cereal grain for malt is the first step in beer making, a process that may take approximately 5 days (Stika 1996), followed by roasting of the sprouted grain which stops the process. These steps result in malt which in turn is a basic ingredient for brewing. The roasted malt is then coarsely ground and water added to make mash, which is mixed with more lukewarm water to make wort; this is allowed to stand, so that remaining starch is converted into sugars. Fermentation follows, in which the sugars in the malt are used by yeast which is present in the air or introduced with grapes or from other sources (McGovern 2003). Variations can occur as regards the grain used, the degree of roasting of the malt, the temperature of the wort and the forms in which the starchy ingredients for brewing were added to the mash (Stika 1996, 2011; Samuel 1996; Behre 1999; McGovern 2003; Zarnkow et al. 2011; Damerow 2012). After fermentation, the remaining cereal component, which consists mainly of chaff, is removed from the liquid and can be used as fodder or, based on recent studies, as food mixed with starchy ingredients (McCarthy et al. 2013; Buffington 2014). Based on the descriptions of the brewing steps, the type of archaeobotanical remains one might encounter in archaeological deposits could be (a) sprouted grains, roasted or not, (b) ground cereal grain potentially subject to various treatments such as sprouting, roasting, boiling, soaking or fermenting, (c) lumps of ground grain, potentially subject to various treatments, (d) chaff-rich residue, the remains of fermentation, called spent grain.

If the Archondiko fragments do correspond to ground malt, we still need to identify more accurately the exact procedures that led to these cereal fragments, as well as the cereal fragment lumps. Could they correspond to ground malt before the soaking process or a product of soaking ground malt and/or ground grain like mash before fermentation? It has been argued that malt mash could have been dried and stored to be used for brewing in the Sumerian kingdom, a product known under the name *titab* (Damerow 2012) and this seems to be the recipe of the experimental Late Bronze Age beer from Tall Bazi (Zarnkof et al. 2011). In light of the Tall Bazi beer making experiment (Zarnkow et al. 2006), the Archondiko lumps could correspond to beer mash that had been dried in the form of lumps in order to be used as a "starter" culture to introduce yeast into the wort of a later brew.

The lumps could not, however, correspond to residues of malt after fermentation (spent grain), which is used as a valuable fodder source and modern food admixture (McCarthy et al. 2013; Buffington 2014), as this would have been mainly chaff with hardly any grain mixed with it. We aim to explore this further through experimental replication. Of course malted grain could have been used to make a sweet-flavoured cereal-based food or drink, thus malt need not necessarily correspond to brewing (Stika 2011). Ground cereals, of course, could have been used in other ways, too, not only for brewing. Roasted and ground barley grain was a main ingredient of an ancient Greek food, known as *alphita*. Thus even if our evidence from Archondiko may point to beer, this does not exclude the possibility that the ground cereals had other uses too.

If the sprouted wheat and ground cereal or barley grain indeed represent snapshots of a beer making sequence at Archondiko, the sprouted wheat could have been the ingredient for the malt that would then be fermented, while the ground barley fragments could have been added to the wort to provide further starch. Mixing of malt with other starch sources, including gelatinised starch as is the case with bulgur, for example, has been suggested by various researchers for ancient brewing in the Near East and Egypt (Samuel 1996; Jennings et al. 2005; Zarnkow et al. 2011).

The preceding discussion raises a strong possibility that the ground cereals from Archondiko could correspond not

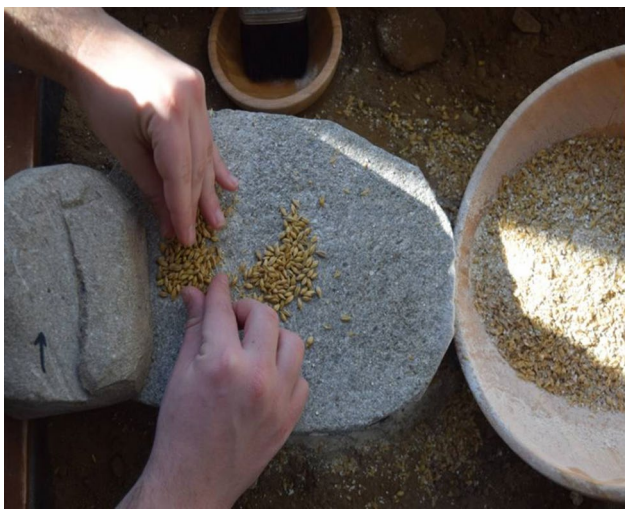

Fig. 10 Experimental grinding of malted *Hordeum* in the context of ERC PlantCult project

to pre-cooked cereals for long term storage but ground malt or ground cereal grain used as an ingredient for some type of brewing. At present we lack the full range of experimental malt to compare with the archaeobotanical finds from Archondiko, charred and uncharred. Therefore, our thorough examination of the three groups of finds and their spatial distribution at Archondiko could help identify the final product, possibly beer, and the processes involved in its production. Through the PlantCult project we aim to explore by experimentation the different steps that generated these fragments, informed by ethnography and ancient Greek texts. We plan a series of SEM imaging studies of comparative, experimentally made cereal based food products including malt, mash and wort, as well as commercial malt, ground with modern replicas of prehistoric stone grinding tools (Fig. 10). This material is currently under study with the aid of SEM studies, as part of the ERC PlantCult project. This work in progress aims to provide a means to determine whether malting generates distinctive diagnostic structures in sprouted and malted grain. Residue analysis of the large open mouthed pots, in particular the examination of any traces of the calcium oxalates also known as beer stone (Stika 2011) could potentially shed more light in this matter.

The archaeobotanical finds presented in the previous section offer the first strong indications for Bronze Age beer making in the Aegean region. Although further work is required to obtain a clearer picture of the different processes involved, we have indications of two of the steps involved in this beer making: (a) sprouting of the grain in the husk and (b) grinding of grain that could correspond to malt or simply ground unmalted grain intended to be used in a fermentation process. The likelihood of beer making at Argissa and Archondiko should alert us to search for suitable places on the sites which could have been used as malting floors where dampened grain could have been allowed to sprout, probably large, dark, damp surfaces; there may also have been places where the sprouted grain was roasted to produce malt and where this malted grain was ground. The various cooking installations excavated at both sites could have been used for roasting grain, especially some of them that could retain a large pan, which is indeed the case at both sites. At Archondiko, in particular, there is a wealth of information on the presence within the same buildings of structures that could have been used (a) for roasting sprouted grains (Papadopoulou 2010) and (b) for soaking ground malt in water at low temperatures. At Archondiko, the two-chamber structure seems to have been carefully constructed to maintain low temperatures in the rear chamber, possibly even below 100 °C (Papadopoulou 2010; Papadopoulou and Maniatis 2013). A temperature of around 70 °C is ideal for the preparation of the mash and the wort. Soaking of the wort could have taken place in the open jars placed in the rear chamber of the two chamber structure. Whether this complex structure was indeed intended for malting remains to be proven experimentally; work is in progress in the context of the PlantCult project.

Fig. 11 Cups from **a** Archondiko (courtesy of E. Voulgari and A. Papanthimou); **b** Argissa (after Milojcic et al. 1962)

If indeed an alcoholic drink was brewed from the sprouted cereal grains at Argissa and Archondiko, this might have been consumed in the specially designed cups found in very large numbers at both sites (Fig. 11). At Archondiko 30 two-handled cups of mainly kantharoid shape have been found in the phase IV houses (Fig. 11a), with capacities ranging between 0.1 and 1 l (E. Voulgari personal communication). At Argissa, the house of the Middle Bronze Age phase (2100–1700 BC) where sprouted barley was found (House 7) contained 45 cups out of a total of 67 found in the other contemporary houses (Fig. 11b), with capacities ranging from to 0.1 to 0.3 l, based on the published illustrations. This is a very large number indeed and suggests the drinking of something probably alcoholic that required a relatively small vessel; this may also have involved many participants, while the inhabitants of the house where most of the cups were found together with evidence for brewing, might have been the hosts. The similarity between the Argissa Middle Bronze Age cup shapes and those found at Archondiko is striking indeed, though the study of the Archondiko ones is in progress and direct comparisons are premature.

Aegean 'beer' in the wider context of prehistoric alcohol consumption in Europe

The finds interpreted here as corresponding to Bronze Age brewing, are roughly contemporary, covering the end of the 3rd millennium (Archondiko 2,135–2,020 cal BC) and the first part of the 2nd millennium BC (Argissa 2100–1700 BC), which, for mainland Greece, corresponds to the end of the Early Bronze Age and the Middle Bronze Age (Voutsaki 2010). The finds from Archondiko fall within the last century of the 3rd millennium, the end of the Early Bronze Age according to the excavators, while based on the periods according to Andreou et al. (1996) they belong to the Middle Bronze Age. Earlier suggestions for brewing in prehistoric Greece have been put forward on the basis of chemical analyses from two *pithoi* from Room 20 excavated at Early Bronze Age Myrtos-Phournou Koryphi, Crete (McGovern 2003), roughly contemporary with the mainland archaeobotanical finds from Argissa and Archondiko. The calcium oxalate detected in the residues from the Cretan vessels could equally represent foodstuffs or substances other than beer (McGovern 2003, p. 266; Tzedakis et al. 2008). The finds presented here, therefore, provide the first strong indications for brewing in the Aegean and mainland Greece at the end of the 3rd millennium BC and they lend further support to sporadic earlier suggestions for consumption of something similar to beer in the Aegean region during the Bronze Age.

Beer was the drink of ancient Babylonia, with ample evidence in cuneiform texts describing its preparation, its distribution in rations etc, while beer featured in songs and religious practice and ritual (Damerow 2012). Likewise, brewing is closely associated with Egypt, with early finds dating to the 4th millennium BC and associated with structures as well as remains of ingredients from different steps in the beer making process (Samuel 1996; Kubiak-Martens and Langer 2008; Adamski and Rosińska-Balik 2014). More recently brewing has been suggested for Late Bronze Age Syria (Zarnkow et al. 2006). At Tall Bazi in northern Syria, open mouthed ceramic vessels of large capacities (up to 200 l) have been found, from which residue analyses showed calcium oxalates present in these vessels, which were found in house interiors dated to the 13th–14th centuries BC and have been interpreted as brewing installations (Zarnkow et al. 2011). Beer brewing and consumption has been suggested for Bronze Age Cyprus on the basis of structural and artefact evidence including serving and drinking vessels (see Steel 2004 for a review of the evidence). More recently, indications for brewing in prehistoric Cyprus have consisted of structural evidence such as hearths as well as depictions on pottery of what appears to be brewing (Crewe and Hill 2012). At the site of Kissonerga-Skalia, Cyprus, an oven installation has been interpreted as a drying kiln, primarily for roasting malt or preparing malt cakes for making beer. This interpretation seems to be corroborated by "scenic compositions" related to brewing beer and baking bread found in tombs of the Early-Middle Cypriot Bronze Age.

Brewing was widely known in the eastern Mediterranean and the method might have been introduced to Greece from the east at least as early as the end of the 3rd millennium BC or even earlier, as is indicated by the contact networks through which exotic artefacts (Colburn 2008) and raw materials from the east reached Greece, for example the oil plant *Lallemantia* and tin bronzes (Valamoti and Jones 2010).

Indications for stylistic changes in pottery drinking vessels associated with serving and consuming alcoholic drinks have been found in assemblages dated to the end of the Early Bronze Age in southern Greece. Rutter (2008, 2017) observed this in the assemblages from Lerna and he tentatively suggested beer as an innovation introduced with the new drinking sets, based on the presence of multiple necked jars more suited to drinking with straws. These vessels are similar to the ones identified by Mellink (1969) from the region of Karatash in Turkey, for which beer drinking by using a straw has been considered as the most appropriate use. In this context it is of interest to note that the Archondiko cups cannot be used for drinking directly from the rim, as the liquid would spill off the lips (E. Voulgari pers. com.), so they might alternatively have been used for drinking with a straw.

The sprouted grains both at Argissa and Archondiko belong primarily to wheat. A similar predominance of sprouted wheat grain has been encountered at the slightly later site of Feudvar (Kroll 2016). This would suggest that brewing in Bronze Age southeastern Europe used wheat as a major ingredient. Barley was the main ingredient for Sumerian beer, and emmer wheat for Egyptian beer. In later periods in Hallstatt and La Tène Europe, barley malt seems to have been used (Bouby et al. 2011; Stika 2011). There may have been local as well as regional differences in beer making techniques. Already at the end of the 4th millennium BC, in proto-cuneiform texts (3200–3000 BC), nine types of beer are mentioned, while two cereal based ingredients were used together for making beer: one refers to coarsely ground cereal grain, probably barley, an ingredient encountered in other foodstuffs, and as something only used in beer making this therefore probably corresponded to malt (Damerow 2012). In mid 3rd millennium BC Mesopotamia, a large variety of beers is listed, characterised by colour (golden, dark, red), taste (sweet) and consistency (strained) while the use of wheat as well as barley is mentioned in beer making. At the end of the 3rd millennium BC large scale standardised beer production in breweries is mentioned, while textual evidence suggests the use of barley groats (hulled sometimes crushed grain) for brewing beer (Damerow 2012). At Archondiko, recent isotopic analyses carried out on cereal grains have

shown that some of the barley fields had received special care (Nitsch et al. 2017); it is therefore possible that these were used for growing high quality grain for beer, as has been speculated for Iron Age sites in southeastern Germany, on similar lines of evidence (Styring et al. 2017). As more indications for prehistoric beer making gradually emerge it would be interesting in the future to map the various main ingredients used for malt in different parts of the Old World, traditions that might reflect variability due to regional preferences and/or environmental conditions.

It is usually either wine or beer that have been closely linked to certain areas and civilisations of the past, leading to stereotypes as regards "wine cultures" and "beer cultures" of prehistoric Europe and western Asia widely prevailing in the archaeological literature (Sherratt 1995). Western, central Europe and the north Balkans in prehistoric times might be perceived as "beer cultures". This is corroborated by archaeobotanical finds from Feudvar in Serbia, Hochdorf in Germany and Roquepertuse in France (Kroll 1991; Stika 1996; Bouby et al. 2011). Further south, from the Danube to the Aegean area, the equivalent image we have is that wine was the alcoholic drink par excellence. Although the Aegean has been closely associated with wine according to various lines of evidence, archaeobotanical finds of pressed grapes, amphorae seals, later literary sources and residue analyses, the archaeobotanical remains presented in this paper indicate that besides wine, beer was also produced and consumed at some sites at least during the late 3rd and early 2nd millennium BC. If wine is an alcoholic drink with roots in the Neolithic of this region, what was the cultural context of beer making among prehistoric communities of the area? The Thessalian, Macedonian and Serbian finds correspond to a tradition of beer making that existed in certain parts of southeastern Europe, where wine was either not preferred or difficult to produce, perhaps in areas with few grapevines. Beer might have been a preferred drink, related to the cultural identities of beer-drinking peoples in the area discussed here. Alternatively, both drinks might have been available, reserved for different occasions and/or consumed by different people or on different occasions. Indeed, uneven access to beer and wine is mentioned in textual evidence for ancient Egypt and Mesopotamia. Sumerian texts, for example, make a clear distinction between wine, a drink reserved for the elites, imported to the empire through trading networks (Powell 1995; Bottero 2004), and beer, a drink that was consumed by elites and ordinary people in both ritual and other contexts. Similar associations are observed for Egypt (Joffe 1998). Compared to wine, for which grapes were only seasonally available, beer could have been produced on a regular basis throughout most of the year. This difference might have played a role in shaping a different status for the two alcoholic drinks. The date of the introduction of beer brewing in this part of Europe, the Aegean region, remains obscure at the moment as are the reasons why beer was later ostracised in the ancient Greek world as a barbarian drink. According to the archaeobotanical evidence presented here, the new drink is evidenced towards the end of the 3rd and the beginning of the 2nd millennium BC. In this context Rutter's (2017) suggestion that different cup shapes might have been associated with the consumption of distinct types of alcoholic drinks in Bronze Age Greece would be worth exploring further in light of the finds presented here. Cultural contacts with Anatolia shown by the archaeological records of parts of mainland Greece (Rutter 2008; Wiersma 2013, p. 225) might have introduced a new alcoholic drink familiar to inhabitants of lands to the east of Greece and the Aegean.

Conclusions

Our evidence shows that the stereotypical division between "wine cultures" and "beer cultures" is no longer valid for prehistoric southeastern Europe and the Aegean region. At least during the end of the 3rd millennium BC, two kinds of alcoholic drinks were available in our study area. This variability in a psychoactive substance such as alcohol, revealed by the archaeobotanical record, unfolds a range of potential distinctions related to food and drink preferences and status within and among different social groups inhabiting the region under study. There might also have been variability in the types of drinking vessels used and contexts of consumption.

Archaeobotany offers a valuable analytical tool to approach past food and drink, identity and contacts, contributing towards a detailed mapping of past practice. The finds presented here provide the earliest indications for beer making in Bronze Age southeastern Europe, dated to the end of the 3rd millennium BC and the beginning of the 2nd millennium BC and they form the first solid evidence reported for Bronze Age Greece. They correspond to pieces of a puzzle that had to wait for 56 years in the case of Argissa and 22 for Archondiko, to be pieced together and reveal the variability of choice as regards the potential alcoholic drinks that filled up the numerous cups encountered in Bronze Age southeastern Europe and the Aegean region. The archaeobotanical evidence for brewing from Bronze Age Greece presented here, shows that previous assumptions that wine was the main alcoholic drink there are probably out of date and the tentative earlier suggestions for beer consumption in the prehistoric Aegean are better founded than previously thought. Prehistoric Greece was wine country, no doubt, this is confirmed by archaeobotany, textual evidence and artefacts. But we have presented equally convincing evidence that beer was

also brewed. Beer might have been introduced at the end of the early Bronze Age as a result of contacts with the east, a possibility worth exploring further. We believe that continuation in our studies of the Archondiko finds, backed up by experimental replication, will allow a better understanding of Bronze Age brewing practices in southeastern Europe, among the earliest detected so far.

Acknowledgements Many thanks to the Archondiko excavators, A. Papanthimou and the late A. Pilali, for their support of the archaeobotanical study. I am deeply grateful to F. Bittmann and the Lower Saxony Institute for Historical Coastal Research in Wilhelmshaven, Germany, for making available the unpublished report by Maria Hopf and of her original material from Argissa, discussed in this paper. Prof. Harald Hauptmann kindly allowed reproduction of the Argissa House 7 in Fig. 4. Ch. Petridou helped with the Archondiko archaeobotanical material, T. Dimoula and E. Kalogiropoulou provided valuable assistance with the literature. E. Voulgari generously offered unpublished information on the Archondiko cups. A. Dimoula did the capacity calculations of the Argissa drinking cups using the software Pot_Utility1.05 developed by J.P. Thalmann in the project ARCANE, 2006 (http://www.arcane.uni-tuebingen.de). Helmut Kroll generously provided feedback on the archaeobotanical material from Feudvar. N. Katsikaridis and T. Bekiaris prepared Figs. 1 and 3. P. Lathiras and Chryssa Petridou helped with grinding experimental malt and with counting the sprouted cereal grains from Argissa. I. Ninou helped with editing parts of the text. I am also grateful to St. Andreou, S. Voutsaki, M. Nelsson, H.-P. Stika, K.-E. Behre, L. Crew, L. Steel, J. Jennings and J. Wang for help with the literature. Discussions over the years with D. Samuel and H.-P. Stika have been precious in shaping my ideas on prehistoric cereal foods. I am grateful to J. Rutter for his comments on an earlier version of this manuscript. V. Beer provided malt for generating the ground reference specimens. I am grateful to L. Papadopoulou and the SEM team of the Aristotle University of Thessaloniki for their help with the SEM photos presented in this paper. This work has been funded by the European Research Council project "PlantCult", Identifying the food cultures of ancient Europe, under the European Union Horizon 2020 research and innovation program (Grant Agreement No. 682529, Consolidator Grant 2016–2021). Background archaeobotanical work at Archondiko has been funded by the Institute of Aegean Prehistory (INSTAP), the British School at Athens and Μύλοι Θράκης (Thrace Flour Mills). I am also grateful to two anonymous reviewers for their very constructive comments.

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