Research Article

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Distribution of Organic-Tempered Pottery in Southeast Europe and the Near East: A Complex Picture. The Case of Northern Greece

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Abstract: Organic-tempered pottery is considered characteristic for the early pottery assemblages in most parts of Southwest Asia and Southeast Europe. The aim of the present paper is to explore: (a) the chronological consistency of this practice, i.e. is it always related to the early assemblages and how intensively was it employed by the various communities? and (b) is its use related to vessel type, surface treatment etc. and how does this change in time and space? In order to address these questions we explore the distribution patterns of this practice in this large geographical area, based on published information, since the appearance of pottery in the Near East until the early sixth millennium in Southeast Europe. Moreover, in the case of the Early Neolithic in Greece, new data is presented on the appearance and distribution of organic-tempered pottery within the assemblages of six newly studied sites in northern Greece, spanning the second half of the seventh millennium BC and the beginning of the sixth millennium BC. The emerging picture indicates that the cultural practice of organic tempering was available in all of this area for almost a millennium, although the significations may have not remained unaltered, and variably embraced by the various Neolithic communities. As such, this study offers insights into the complex process of neolithisation, and at the same time contextualizes the appearance of organic-tempering in northern Greece, which includes some of the earliest Neolithic sites in Europe.

Keywords: organic-tempered pottery, neolithisation, Early Neolithic pottery, Greek Neolithic

1 Introduction

Organic-tempered pottery refers to the deliberate technological act of adding plant-derived material (such as chaff, straw, and dung) to the clay during paste preparation. In archaeological contexts, it is recognised through the existence of macroscopic and microscopic plant remains (phytoliths) and characteristic voids distributed within the fabric of fired vessels. As a practice, it is considered a trademark for early pottery

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assemblages in most parts of Southwest Asia and Southeast Europe. Based on published information, the present article explores the presence of the practice over a large geographical area and time period, from the appearance of pottery in the Near East until the first century of the sixth millennium in the Early Neolithic Balkans. Still, it does not aim at an exhaustive catalogue of all the sites where organic-tempered pottery was reported in the Near East, Anatolia, Southeast Europe, and Greece. Instead, it seeks to trace that practice's persistence, often considered primaeval and transferred as an integral part of the Neolithic "package" – though in recurrent later instalments – to Europe.

Understandably, the finer details of this large geographic and temporal span are lost in the wide-ranging approach adopted here. For this missing variability, which is recognisable only from close examination, we turn to the detailed deep analysis of the ceramic assemblages of six newly studied sites in northern Greece, spanning the second half of the seventh millennium BCE to the beginning of the sixth millennium BCE. As they are among the earliest Neolithic sites in Europe, they offer valuable insights into the complex process of neolithisation of the region. Therefore, they are excellent examples to contextualise the appearance of organic tempering in northern Greece as a part of this major transformation. We will see that organic tempering of pottery – at least in these sites – is a phenomenon far from uniform, pointing to the multifaceted character of the process of adapting the Neolithic way of life to novel environmental and social conditions.

A perception of organic tempering as a transferrable and transmissible technological behaviour does not seem to accord with the story told by the Early Neolithic sites in northern Greece. Neither can it serve as a token for the spread and migration of people since techniques can be copied easily, among other things. By contrast, if we perceive organic tempering as one of the choices open to Early Neolithic communities, we focus on the actual practice itself, not as a proxy for a supra community event but as an embedded part of their daily life. Of course, the same can also hold for all the sites of this vast horizon, but an analysis to a comparable level will require a tremendous amount of joint effort.

The discussion, therefore, moves along the following axes of questioning. Firstly, is this practice chronologically consistent and is it always related to the earliest assemblages? Secondly, how does it correlate with other parameters of pottery? Finally, how intensively did the various communities employ it? It is evident that the first question bears on the question of the transit of the Neolithic from Anatolia to Europe, while the second and third deal with how the various groups incorporated this technological tradition in their communities of practice.

Finally, a note before embarking on the distribution of organic-tempered pottery in SW Asia and SE Europe: the overview, based on bibliography, is by no means meant to be an exhaustive account. Instead, it is an outline aiming to highlight different patterns in the use of vegetal tempering. Furthermore, not all the data presented here are of equal detail. The information may vary from a presence/absence account to detailed analytical approaches, while the chronology issue, both relative and absolute, makes fine synchronisation a challenge (e.g. Campbell, 2007; Reingruber, 2020). For both these reasons, reliable statistical estimates are not possible.

2 Organic Temper. Bibliographical Review

2.1 Southwest Asia

The generalised adoption of ceramics in SW Asia was preceded by a phase of experimentation, which is attested to at a few disparate sites, for the moment, across a very wide area (Fletcher, Baird, Spataro, & Fairbairn, 2017; Le Mière & Picon, 1998; Tsuneki, 2017, for a discussion see Nieuwenhuyse & Campbell, 2017). Two recent excavations have pushed back the appearance of an incipient pottery production to the 9th millennium. The one is Boncuklu Höyük on the Konya plain (Figure 1(9)), dated to 8300–7800 BC, that yielded a few rudimentary pottery sherds, some of which contained vegetal matter interpreted either as temper or inadvertent inclusions, while others are bone tempered (Fletcher et al., 2017; Spataro, Fletcher,

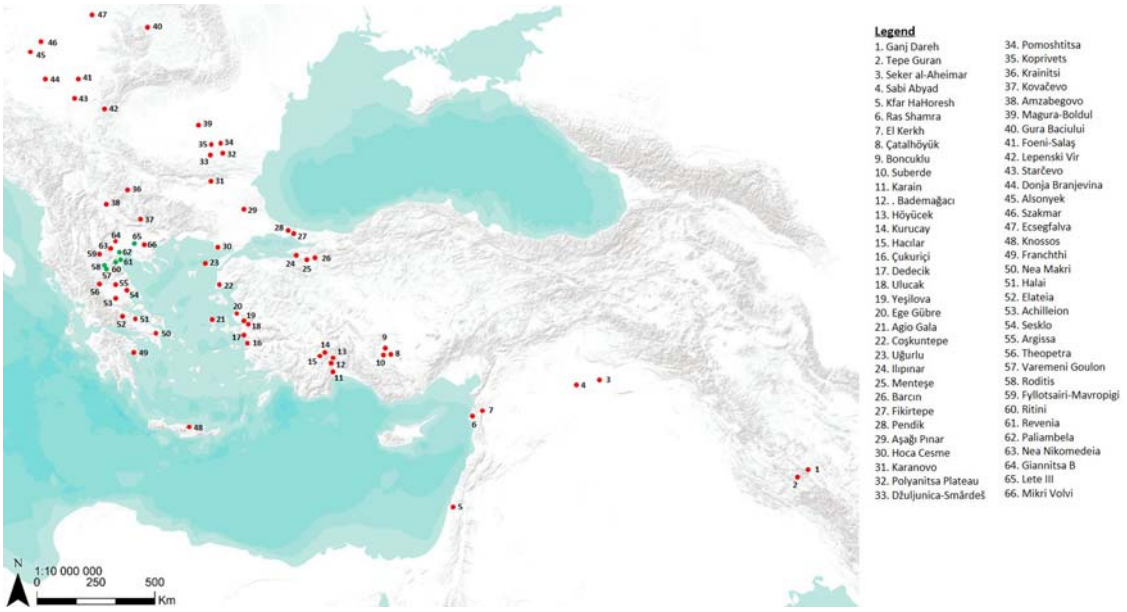

Figure 1: Map of sites mentioned or indicative of the appearance of pottery. The sites in green indicate the new sites presented here. Sources: Esri, USGS, NOAA. The map was created by F. Stefanou and T. Papadakou.

Cartwright, & Baird, 2017).[1] The other site is Kfar Hahoresh in Israel (8750–7500 BC) (Figure 1(5)), where low-fired pottery was produced in small quantities throughout the stratigraphic sequence, containing animal dung (Biton, Goren, & Goring-Morris, 2014). The earliest pottery from Ganj Dareh in Iran may also belong to this horizon and is tempered with organic materials (Aurenche, Galet, Régagnon-Caroline, & Évin, 2001; Smith, 1990) (Figure 1(1)).

Apart from these early examples, the appearance of an early pottery production is dated to the end of the 8th millennium and becomes widespread at the beginning of the 7th millennium over a vast geographical area which includes the Zagros mountain range, northern Levant, and southeastern and central Anatolia (Aurenche et al., 2001; Le Mière, 2009; Le Mière & Picon, 1998; Nieuwenhuyse, Akkermans, & van der Plicht, 2010; Nishiaki & Le Mière, 2005; Tsuneki, Nieuwenhuyse, & Campbell, 2017) (Figure 1). The earliest horizon is documented in few sites, apart from those already mentioned, such as Tepe Guran in Zagros, Ras Shamra and Tell el-Kerkh in northern Syria, and Çatalhöyük in SE Turkey (Figure 1(2 and 6–8)). This initial pottery production is small in scale and characterised by the simplicity of forms and contains organic admixtures often in large quantities. However, and despite the small size of the assemblages, there appears to be a certain degree of variability in the manner this practice is embraced. For example, in Tell el-Kerkh, where organic-tempered vessels appear from the beginning and are heavily tempered, this pottery comprises, in fact, only a portion of the assemblage (Tsuneki & Miyake, 1996). In Çatalhöyük, the earliest pottery is mostly organic tempered, while the quantities of temper may vary significantly (Last, 2005), and the use of vegetal temper is linked to the specific clay source used for the early pottery production (Doherty & Tarkan, 2013, also see discussion in Doherty, 2020).

During the first centuries of the seventh millennium, there is a significant increase in the number of sites using pottery, especially in northern Mesopotamia. Although organic tempering is the most common practice, at some sites, in northern Mesopotamia and the northern Levant, it has been noted that the very first pottery contains no organic temper at all (Le Mière, 2017). Such sites are, for example, Tell Seker al-Aheimar (Nishiaki & Le Mière, 2005) and Tell Sabi Abyad I (Nieuwenhuyse et al., 2010) (Figure 1(3 and 4)), in northern Mesopotamia, where these initial, and few, mineral-tempered vessels are quickly substituted by organic-tempered vessels which thereafter dominate the assemblages for a long time (for a discussion, see

1 Although doubts have been expressed on the intentional firing of the Boncuklu pottery (Doherty, 2020, p. 18).

articles in the study by Tsuneki et al., 2017). Interestingly, the first attempts to add organic temper are done on vessels with mineral inclusions/temper, and in the study of Seker al-Aheimar, the vegetal parts are described as sparse and quite large (Le Mière, 2009). To make things more complex, in northwestern Syria, in sites previously using organic temper, such as the aforementioned Ras Shamra and Tell el-Kerkh, in this period, mineral-tempered pottery dominates the assemblages (Le Mière, 2009). Similarly, in Çatalhöyük, organic-tempered pottery declines in numbers towards the mid-seventh millennium (Last, 2005).

Organic-tempered pottery of this period (mid-seventh millennium) is often referred to as Standard or Coarse Ware; however, as Cruells and Nieuwenhuyse (2004) point out, there is great variability in the technology, shape, and surface treatment of these vessels. There is one type of vessel that is exclusively organic tempered, the "husking tray", as it is called, presumably related to seed cleaning (de-husking) or bread making (Balossi Restelli & Mori, 2014).

Towards the end of the seventh millennium, the production of organic-tempered pottery decreases significantly, but it does not disappear, and it is generally excluded from the painted pottery (Cruells & Nieuwenhuyse, 2004; Le Mière, 2009; Le Mière & Picon, 1998; Vandiver, 1987), as well as for cooking vessels which now become more prolific, as exemplified in Sabi Abyad (Nieuwenhuyse et al., 2010). However, in Çatalhöyük, there is a renewed interest in this practice, which is interpreted not as a revival of an old technique but as experimentation (Last, 2005).

Up to this point, the information on the botanical composition of the organic temper is rather scarce. Some researchers consider the possibility that at least some of the organic-tempered pottery is constructed with animal dung, based on the smaller size of the plant particles (Cruells & Nieuwenhuyse, 2004; Le Mière, 2009); however, only in the case of Kfar HaHoresh, this practice has been proven (Biton et al., 2014 and see above). In Çatalhöyük, Akça et al. (2009) found phytoliths and pollen from reeds, and Fairbairn, Near, and Martinoli (2005) identified mostly monocot stems, as well as some seeds (cereal grains and lentils) and glumes, and they report that one sherd was tempered mainly with cereal grains (pp. 147–148, Table 8.4). An interesting, and related, fact observed in several ceramic assemblages is that the quantity of the temper may vary considerably among contemporaneous vessels within settlements (e.g. Last, 2005; Vandiver, 1987), and moreover, the size of the vegetal particles appears to decrease over the course of time in some sites (Last, 2005; Le Mière, 2009).

Although the geographical distribution of pre-pottery Neolithic is yet rather unclear, possibly also owing to geological factors which may hinder the visibility of ancient surfaces in many parts of Turkey (Özdoğan, 2005), and in the rest of Anatolia, recent research has revealed Neolithic phases without pottery or clay artefacts, and the earliest of which are established in the first half of the seventh millennium BCE (for a discussion on absolute dates and the lithic industry of these sites, see Guilbeau, Kayacan, Altlnbilek-Algül, Erdogu, & Çevik, 2019). The renowned sites of the Anatolian Lakes region (Figure 1(11–15)), and especially Hacılar, have been extensively used to pinpoint interactions between Anatolia and the west, Greece and the Balkans specifically (e.g. Mellaart, 1960; for a discussion, see Brami & Heyd, 2011). Interestingly, in none of these sites was organic tempering employed (Çilingiroğlu, 2012, pp. 90–109; Mellaart, 1970, pp. 101, 142–144).

At the eastern Aegean coast, the site of Ulucak offers important insights into this issue (Figure 1(18)). After an initial phase without pottery, the first pottery on-site (early level V, approximately mid-seventh millennium), small in quantity and simple in shapes, contains only mineral inclusions (Çevik & Vuruskan, 2020). In the late level V and level IV, which cover the second half of the seventh millennium and the beginning of the sixth millennium BCE (Çilingiroğlu, 2012, pp. 16–18; Thissen, 2010), the pottery is predominantly red slipped. In the earliest level V (Vb), approximately 14% of the assemblage, in all wares and types, contain vegetal temper, while, contrary to the chronological trend observed further east, in the subsequent level IV, organic-tempered pottery comprises 63% of the assemblage (IVb) (Çilingiroğlu, 2012). The situation in other sites in the wider Izmir area demonstrates that this feature is rather idiosyncratic, and it has been suggested that it may have some chronological correlation (Figure 1(16–21)). Specifically, the pottery assemblages of Ege Gübre and Çukuriçi Höyük organic temper is absent (Çilingiroğlu, 2012, pp. 78–85). At the site Agio Gala on Chios island (Hood, 1981, pp. 14, 29), pottery does contain organic temper, and in Yeşilova (Derin, 2011), a pattern similar to that of Ulucak is observed, and the earliest phases contain no organic-tempered vessels, while the latest do. Similarly, at Dedecik-Heybelitepe, the earliest

pottery does not contain organic temper, while this practice is attested to at the later, Chalcolithic, levels (Herling, Kasper, Lichter, & Meriç, 2008).

In northwest Turkey, a picture of complexity and variety is outlined. Along the southern and eastern coast of the Sea of Marmara, Neolithic habitation starts shortly after the mid-seventh millennium, and it appears to be an area where different traditions converge (Karul, 2017; Özdoğan, 2011) (Figure 1(24–28)). This cultural horizon is called Fikirtepe, and aside from any chronological or morphological differences, the pottery assemblages from this area share the general absence of organic tempering. In many, such as Barcın (de Groot, Thissen, Özbal, & Gerritsen, 2017) and Menteşe (Roodenberg, van As, Jacobs, & Wijnen, 2003, p. 29), it is altogether absent. Organic-tempered pottery appears in small quantities in Pendik (Çilingiroğlu, 2012, p. 133), as well as in the earliest level of Ilıpınar (6000 BCE) only to disappear in the following levels (Thissen, 2001). Organic tempering also appears in a specific vessel type in the eponymous Fikirtepe site, a large and shallow oval vessel, while it is otherwise absent from the pottery assemblage (Özdoğan, 2013).

In the area of Troas, at Coşkuntepe, the pottery, characterised by red slipped surfaces, is not organic tempered (Takaoğlu, 2005), and similarly, at the site of Uğurlu on Gokceada island (Imbroz), organic tempering is almost entirely absent (Erdogu, 2014) (Figure 1(22 and 23)).

2.2 Southeast Europe

In Bulgarian and Turkish Thrace, habitation begins towards the end of the seventh millennium[2] (Figure 1(29–31)), and although there are differences, a general trend towards red slipped surfaces and white on red painted decoration can be observed. Organic temper is not the main feature of these assemblages. For example, in Hoca Çeşme, it is altogether absent, while in Karanovo I, organic tempering, although rare, is present in all or most wares, and it is reported that the temper size increases in time (Nikolov, 1997, p. 111). From the Greek part of Thrace, we don't have excavated contexts dating as early, as of yet.[3]

In the southern Balkans, organic temper was indeed used with variable intensity in the early assemblages (beginning between 6200 and 6100 BC). For example, in the middle Struma valley, in Kovačevo (Figure 1(37)), organic temper is observed in 17% of pottery and is mostly linked to large storage vessels (Salanova, 2009, p. 23). Interestingly, in the neighbouring site of Ilindentsi, a small fraction of the pottery assemblage is tempered with vegetal materials in varying quantities, while the temper, or its quantity, is not related to specific wares, shapes, or clays (Dzhanfezova, Doherty, & Grębska-Kulow, 2020). In Anzabegovo, in the southern part of North Macedonia (Figure 1(38)), organic tempering is common in phases I–III and especially in phase I, including the painted wares, while the quantity of the added temper appears to vary (Mock, 1976).

However, it is to the North of this area where organic-tempered pottery becomes almost synonymous with pottery in the early phases (6100–6000 BC and onwards, Figure 1), and this trend includes the various expressions of the Neolithic.

Specifically, in Bulgaria (Figure 1(32–36)), organic tempering is the norm, and the quantities of the temper are often abundant, already since the uncertain early monochrome horizon (e.g. de Groot, 2019; Krauss et al., 2014; Stefanova, 1996). In Džuljunica-Smărdeš, where approximately 75% of painted pottery is organic tempered, Dzhanfezova, Doherty, and Elenski (2014) note that organic temper is added to common ceramic fabrics, also used without temper, in varying amounts and express doubts that the very small amounts added in some cases would alter the physical properties of the vessels. Moreover, in the rest of the assemblage, the percentage of organic-tempered pottery is even higher, and apparently, the same clay preparation is employed in both decorated and plain pottery (de Groot, 2019).

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2 The chronological issue of the appearance of the Neolithic in the area is rather complex, see Özdoğan (2013), Thissen (2005), Thissen and Reingruber (2017, pp. 129, 131).

3 Recent core sampling in the area indicates the presence of Early Neolithic is dated to as far back as 6400 BC; however, no archaeological deposits have been excavated yet (Ammerman et al., 2008).

The central and northern Balkans, including the Great Hungarian plain, in the early phases of the Neolithic are characterised by the Starčevo-Criş and closely related Körös pottery (Figure 1(39–47)). The almost contemporaneous appearance of Neolithic settlements after approximately 6100 BC in this vast area has been interpreted as a rapid population expansion involving mostly the Balkan riverine network (Biagi, Shennan, & Spataro, 2005; Krauss, Marinova, De Brue, & Weninger, 2017). Despite the typological variation, pottery technology has been described as rather uniform, whereby potters use mainly non-calcareous clays and abundant organic temper (Biagi et al., 2005; Spataro, 2008; Spataro & Meadows, 2013). The example of Hungary is of particular interest (Figure 1(45–47)), as researchers have delved into the matter of organic temper characterisation, thus constructing a methodological and interpretative approach based on phytolith identification in petrographic thin sections (Kreiter, Peto, & Pánczél, 2013; Kreiter et al., 2014; Pető & Vrydaghs, 2016; Starnini & Szakmány, 2009). According to their findings, in pottery and other clay artefacts, the main botanical component of temper comes from cereals, primarily glumes, and this is interpreted as a close link between pottery construction and agricultural activities. Cereals (wheat and barley) have also been reported from the Starčevo and Criş sites (Biagi & Spataro, 2005; Spataro, 2008; Spataro & Meadows, 2013). All types of vessels and wares are commonly tempered with organic materials, and organic-tempered pottery is sometimes reported to amount to more than 90% of these early assemblages (e.g. in Blagotin, Serbia, Vuković, 2004, pp. 87–88). Within the technological landscape of the Balkans, various researchers point out a variability in the quantities of temper, among sites (Manson, 1995), within the same site and the same type of vessels (Dzhanfezova et al., 2014; Kreiter et al., 2013) or a difference between plain and painted pottery (less/finer temper and/or less frequently used) (e.g. Stefanova, 1996). Contrary to what appears to be a "standard recipe" in the Balkan Early Neolithic, in the adjacent and largely contemporaneous impresso pottery of the Adriatic coast, organic temper is absent from the assemblages (Spataro, 2011; Spataro & Meadows, 2013).

Turning to the south, in the Greek region, we encounter a great variation regarding the use of organic temper; however, it doesn't play a prominent role in any of the assemblages, anywhere in the region.

The earliest Neolithic habitation is Knossos (shortly after 7000 BC, Douka, Efstratiou, Hald, Henriksen, & Karetsou, 2017) (Figure 1(48)), in Crete, where indeed organic tempering is documented in low numbers and in relation to two fabrics that are commonly used without temper (Tomkins, 2001). In the Peloponnese and central Greece (Figure 1(49–52)), the Neolithic starts generally much later, at the end of the seventh millennium, with the exception of Franchthi, and there is no mention of organic tempering (e.g. Phelps, 2004). The same absence of organic temper is observed in the earlier Neolithic pottery of the Franchthi assemblage (Vitelli, 1993).

In Thessaly, the beginning of the Neolithic is dated to 6600/6500 BC (Dimoula, 2014, Table 2.1; Maniatis, 2014; Reingruber, 2017; Reingruber & Thissen, 2005, 2009) (Figure 1(53–56)). Although quantified data are not available, we know that organic tempering was employed from the beginning, as we encounter it in various assemblages, but it had never been particularly popular during the Early Neolithic (Dimoula, 2014, p. 254; 2017). As in other areas that we examined, here as well the quantities of the added material vary greatly. For example, in Achilleion the addition of organic temper had been noticed and verified by petrography since phase Ia, but it was never a central feature, despite the fact that it occurs in various wares, including some of the rare white kaolin vessels (Dimoula, 2014, pp. 161–190, 2017; Winn & Shimabuku, 1989). In Sesklo, small quantities were noticed macroscopically in some sherds, and it was verified by petrography (Dimoula, 2014, pp. 117–159; Wijnen, 1981). In the Larisa plain, neighbouring sites exhibit great similarity in pottery morphology and construction, and in some assemblages, petrographic analysis confirmed the existence of organic temper, while at others, like Argissa and Otzaki, it was inconclusive (Dimoula, 2014, pp. 196–272).

In western Macedonia (Figure 1(59 and 63–64)), a similar situation of a low and variable interest in this technique is noted despite a scarcity of quantified published data. Specifically, in Nea Nikomedeia, it is reported that 1–2% of the assemblage contains fine organic inclusions, in all wares and types except painted pottery (Youni, 1996, p. 78). For Giannitsa B, it is mentioned that some impresso vessels are organic tempered (Chrysostomou, 1994). Further North, in the site Fyllotsairi-Mavropigi, one of the earliest in the

region[4], organic temper is used in abundance, and it is encountered in all wares and shapes; however, it is very frequent in impresso vessels, while rarer in painted pottery. A correlation between vessel size and temper size/quantity is reported (Bonga, 2017, 2020).

3 EN Northern Greece: New Data

3.1 Methods

The ceramic assemblages of six new sites in central and western Macedonia were studied in detail (Figure 1(57, 58, 60–62, and 65)), offering insights into the position of the practice of organic tempering within the local pottery technologies, as well as quantified data The pottery assemblages were studied in the framework of the Thales-Exploring research programme[5] using the following methodology: Initially, all the sherds were studied in three main aspects: surface treatment and colour (e.g. burnished brown, painted red on beige), general shape (open, closed, or unknown), and quantity of inclusions (mineral and/or organic) in the ceramic fabric based on macroscopic examination (fine, medium, and coarse). Taphonomic observations as well as joining of sherds also take place at this stage. For the specific phases of the six sites presented here, a total of 110,000 sherds were examined and recorded through this process.

In the next step, the sherds that offer further information on typology (rims, bases, handles, and big fragments), decoration (motifs, techniques), technology (building techniques, etc.), and use (sooting clouds, etc.) were further studied in detail in a subsample. During this second step of the analysis, the inclusions/temper of the ceramic fabric were determined in broad categories (rock fragments, mica, shells, vegetal), with the help of a stereoscope and the collaboration of petrography specialists.

All the sherds that contained vegetal temper recognised at this second stage were studied as a further separate subset with the aim to determine the frequency of such pottery within the assemblage and the characteristics of the particular vessels. To minimise the possibility that the selection strategy employed in defining the second-stage subsample was skewing our results (as decoration or use might), the frequencies of the vegetal-tempered sherds were counted separately as to the whole of the subsample, the rims, and the bases, thus producing a range for the percentage of the vegetal tempered pottery (Table 1)[6].

The identification of the vegetal inclusions as deliberate temper, as opposed to inadvertent inclusions, was based on their relatively even distribution in the matrix and their often common orientation. Moreover, on a microscopic level, the phytoliths embedded in the clay matrix are generally interpreted as natural inclusions (not found in the present material), whereas the existence of empty pores surrounding the plant remains is evidence of burnt plant parts (deliberately added or not) (as shown in Figure 5) (Pető & Vrydaghs, 2016). Sherds containing isolated plant fragments, such as roots, seeds, and others, were not recorded as organic tempered. More importantly, the petrographic analysis conducted on a large number of

4 6590/6450 and 6200/6010 BC (Karamitrou-Mentesidi et al., 2013; Karamitrou-Mentessidi, Efstratiou, Kaczanowska, & Kozłowski, 2015; Maniatis, 2014).

5 The study of the ceramic assemblages was conducted in the framework of the THALES-Exploring research programme "Exploitation of resources in the Neolithic period in northern Greece. Material culture and environment." (PI Prof. K. Kotsakis). This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) – Research Funding Program: Thales. Investing in knowledge society through the European Social Fund. The study of the organic-tempered pottery is part of the first author's PhD research (organic-tempered pottery in the early phases of the Neolithic in northern Greece, 2021).

6 An exception was made for the two sites of the Kozani area, Roditis, and Varemeni Goulon, where the organic-tempered pottery was found in very low amounts. In this case, all sherds of the assemblage were isolated and studied, not just the ones encountered in the subsample which was studied in detail in the second step of the pottery analysis (see above and Table 1).

Table 1: Percentage of organic-tempered pottery in each phase of each site

Site	Phase	% of the detailed studied sample	% of rims only	% of bases only	% on the total of the assemblage	% Range	% Mean
Paliambela	EN	37.5	38.8	38.1	—	37.5–38.8	38.1
Paliambela	EN/MN	26	27	32.7	—	26–32.7	28..6
Revenia	EN	7.3	8.9	5.4	—	5.4–8.9	7.2
Revenia	EN/MN	8.7	8.7	8.7	—	8.7	8.7
Ritini	EN/MN	4.4	3	5.7	—	3–5.7	4.4
Lete III	EN/MN	5.1	4.9	4.9	—	4.9–5.1	5
Roditis	EN/MN	—	—	—	0.9	0.9	0.9
Varemeni Goulon	EN/MN	—	—	—	0.7	0.7	0.7

samples[7] corroborated the interpretation of these inclusions as a deliberate technological act (Dimoula, pers. comm.; Saridaki, 2019; Saridaki, Kotsakis, Urem-Kotsou, Papadakou, & Papaioannou, 2019). The methodology employed to identify the botanical composition of the temper included the examination of phytoliths (microscopic plant remains) in petrographic thin sections (Figure 5) and the examination of manually extracted botanical material from sherds under the scanning electron microscope (SEM) and will be presented elsewhere in detail, as well as the results of the study (Papadakou, 2021).

3.2 Results

Two neighbouring sites of this group of six have yielded absolute dates to the mid-seventh millennium or even earlier, Paliambela Kolindros (Maniatis, 2014; Maniatis, Kotsakis, & Halstead, 2015) and Revenia (Maniatis & Adaktylou, 2021) in Pieria (Figure 1(61 and 62)). At this stage, both sites are flat-extended with several pits, some of which represent living areas, according to the excavators (Revenia: Besios, Athanasiadou, Noulas, & Christakou-Tolia, 2005; Paliambela: Kotsakis & Halstead, in press). The bulk of pottery examined for this period can be safely attributed to the period approximately 6400–6200 BC, while some pottery may derive from earlier contexts. Given this difficulty combined with the fact that no technological differentiation is observed, it is treated here collectively. These early assemblages are generally simple in forms, mostly medium-sized open bowls, with well burnished, rarely slipped, surfaces, while decoration, painted and later impresso, is scarce (Papadakou, 2010; Papadakou, Urem-Kotsou, & Kotsakis, 2015; Papaioannou, 2010; Urem-Kotsou et al., 2017; Urem-Kotsou, Papaioannou, Papadakou, Saridaki, & Intze, 2014; Urem-Kotsou, Papaioannou, Silva, Adaktylou, & Besios, 2015). As it can be seen in Table 1, organic tempering is quite popular in Paliambela Kolindros (approximately 38% of the assemblage), which is the highest amount of organic-tempered pottery recorded in the region so far. Organic temper in Paliambela Kolindros is used in all wares and types, permeating all other parameters of pottery. By contrast, in Revenia, the percentage is significantly lower (approximately 7.2%) and organic tempering is linked to the construction of medium-sized burnished brown/beige bowls, which form the bulk of the assemblage (Figure 2). The absence of temper from much less frequent types (e.g. hole-mouthed) or wares (such as the very rare decorated sherds) is difficult to assess; it is clear, however, that this practice concerns the most common vessels on site. In both sites, the quantity of the added temper varies from vessel to vessel, but none of them are heavily tempered.

The following period, approximately 6200–5900 BC (the end of the Early Neolithic), is in general better documented in the archaeological record. Six sites dating to this period are presented here (Figure 1(57, 58,

7 From the specific phases of these six sites, 33 thin sections contained identifiable phytoliths and were studied for their botanical composition; however, a larger number of petrographic thin sections were characterised as organic tempered, based on the pore morphology, during petrographic analysis.

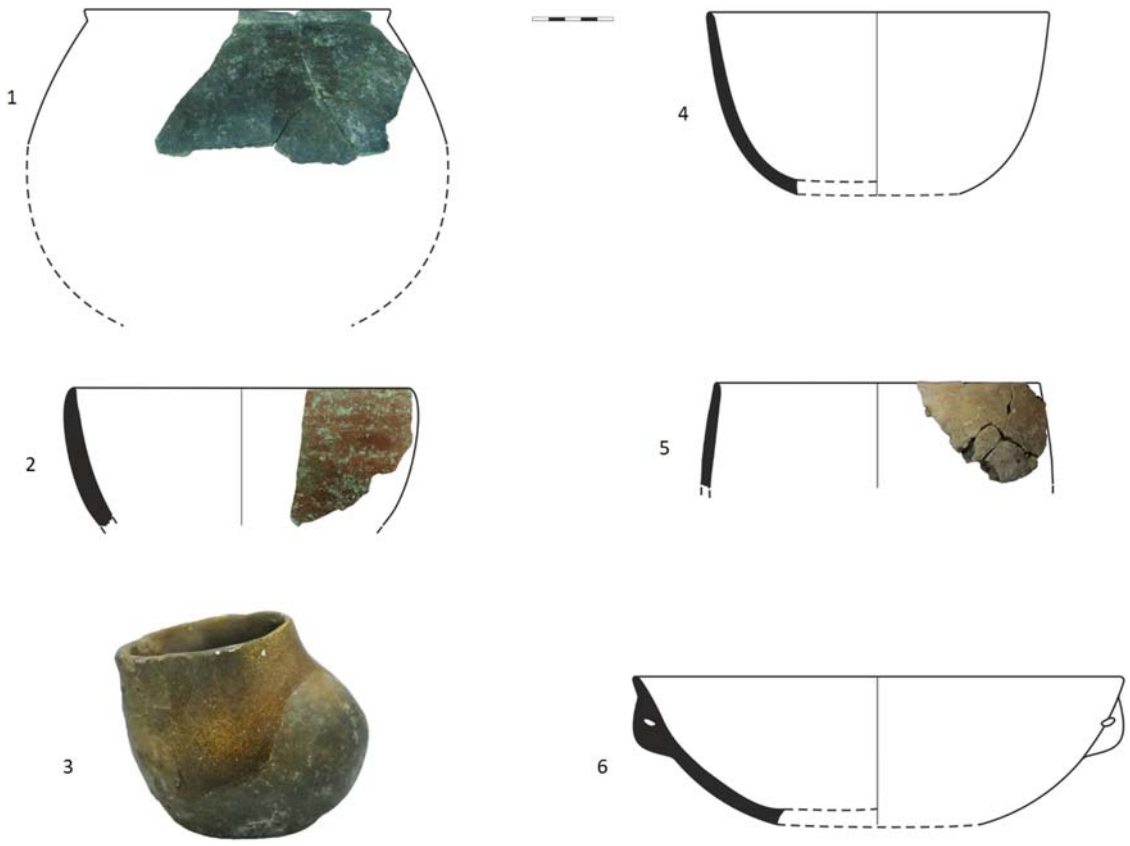

Figure 2: Organic-tempered vessels from the early phases of the Early Neolithic. (1–3) Paliambela Kolindros, (4–6) Revenia. Archive of the THALES-Exploring programme.

60–62, and 65)). Paliambela Kolindros and Revenia in Pieria continue from the previous phase as flat settlements with pits; however, at the end of this period and onward, rectangular houses appear in Paliambela, as well as ditches that surround the settlement (or part of it) (Halstead & Kotsakis, 2006; Maniatis et al., 2015), whereas the severely eroded late phase of Revenia hints at the existence of architectural features such as houses on ground level (postholes as well as great quantities of burnt architectural clay) (Besios, Adaktylou, Athanasiadou, Noulas, & Christakou-Tolia, 2005). The other sites are as follows: Ritini in Pieria, where part of the plan of a rectangular building with an exterior cobbled area has been excavated, as well as a large adjacent pit, interpreted as clay extraction area (Besios et al., 2005); Lete III in the Langadas basin, with semisubterranean houses equipped with hearths (Tzanavari, Kotsos, & Gioura, 2004); and two sites in Kozani western Macedonia, Varemeni Goulon, a tell spanning the Early and Middle Neolithic, and Roditis, dated to the end of the seventh millennium, which appears to be a low mound. However, only a small part at the edge of the settlement has been investigated, with areas interpreted as working spaces (Chondrogianni-Metoki, 2004, 2009). For a discussion on the shifts in architecture and the allocation of living space during this period, see the study by Kotsakis (2014, 2018, 2019).

The preference for well-burnished surfaces and medium-sized open forms continue from the previous period, while this period is characterised by an increase in red-slipped and painted vessels in most sites. The sites of Pieria and Kozani share more similarities, in terms of pottery morphology and decoration, among them as well as with Thessaly, specifically the preference for spherical and hemispherical forms, composite bases (ring and discoid), and few rounded pierced lugs, while the decoration, limited in amount, consists mainly of painted red on the burnished surface (usually beige or brown) and secondarily of impresso decoration (Urem-Kotsou et al., 2017, also see Urem-Kotsou et al., 2014 where the individual character of each site is described in more detail and the sites are compared). Lete III, on the other hand, is stylistically further apart, with more elongated rather than spherical forms, flat bases, and tubular

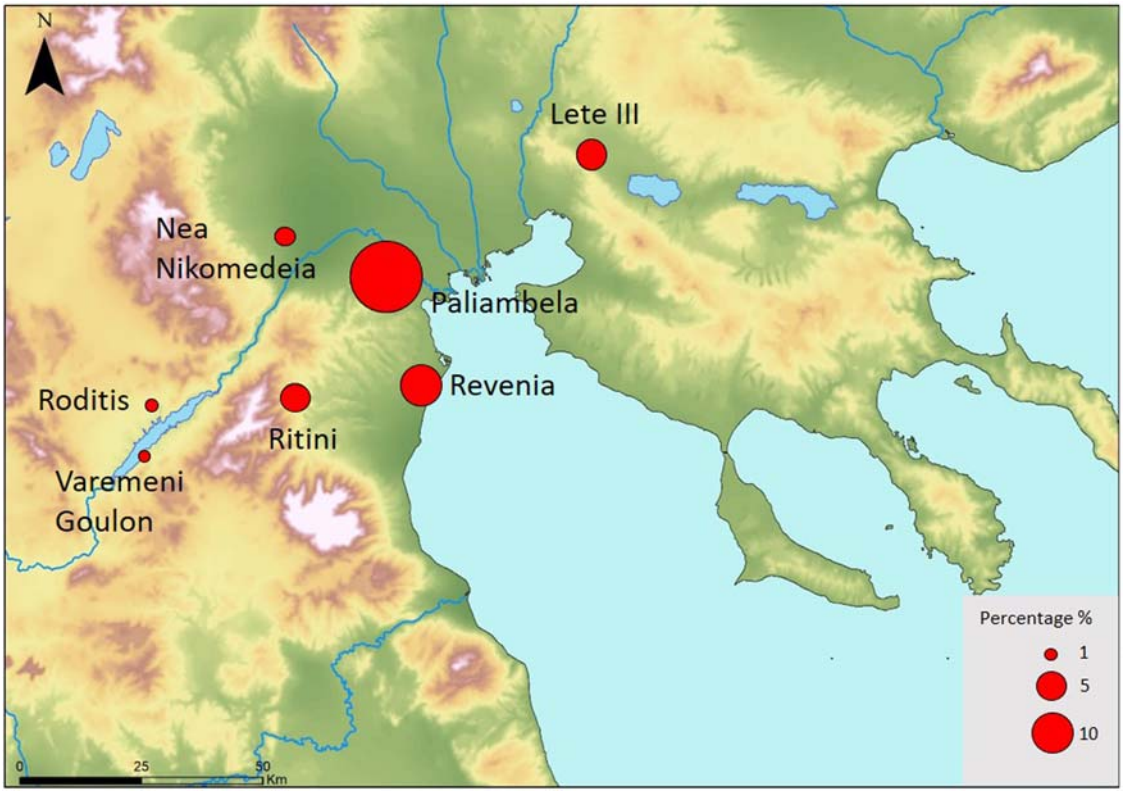

Figure 3: Map showing the sites discussed by percentage of organic-tempered pottery within the assemblage. Nea Nikomedeia is included here for reference, the percentage (1–2%) is given by Youni, 1996, p. 78. The map was created by F. Stefanou and T. Papadakou.

lugs, painted decoration with white on red slip and plastic decoration, while impresso is absent (Urem-Kotsou et al., 2014), and possibly at the very end of the chronological sequence examined here.[8] Moreover, cooking (Urem-Kotsou, 2018; Whelton, Roffet-Salque, Kotsakis, Urem-Kotsou, & Evershed, 2018) and large storage vessels (Urem-Kotsou, 2017) appear in some sites, and closed vessels, with or without neck, are more numerous (Urem-Kotsou et al., 2014, 2017).[9] In Figure 3, the discrepancy in the intensity of organic-tempering among sites is evident. In Paliambela Kolindros, although decreased, the percentage of organic-tempered pottery is quite high (approximately 28%), whereas in Revenia, it has remained unaltered. In the neighbouring site of Ritini, as well as in Lete III further north, approximately 5% of the assemblage is organic-tempered (Table 1). In contrast, the sites of Kozani exhibit a very low interest in this practice, and such pottery amounts to slightly less than 1% in each site. The quantity of temper is in most cases low at all sites, and we encounter heavily tempered vessels only very rarely[10] (Table 1).

Regarding the distribution patterns of organic-tempered pottery in wares and types in this period, we note the following:

8 Although no absolute dates are available yet, Dimoula, Pentedeka, and Filis (2014) propose a relative chronological horizon between 6000 and 5500 BC for the neighbouring and very similar, in terms of the ceramic assemblage, site of Lete I.

9 For more detailed studies and comparisons for the sites of Pieria, see Intze, 2011; Papadakou, 2010; Papadakou et al., 2015; Papaioannou, 2010; Saridaki et al., 2019; Silva, 2011; Urem-Kotsou et al., 2014. For the results of petrographic analyses and discussion, see Saridaki, 2019; Saridaki et al., 2019.

10 During the macroscopic examination of pottery, the density of inclusions was empirically characterised as low/medium/high. Petrographic analysis has determined that only in rare cases the organic temper was as high as 10–15%, while in most samples, it was lower than 10% (Dimoula, pers. comm.; Saridaki, 2019; Saridaki et al., 2019).

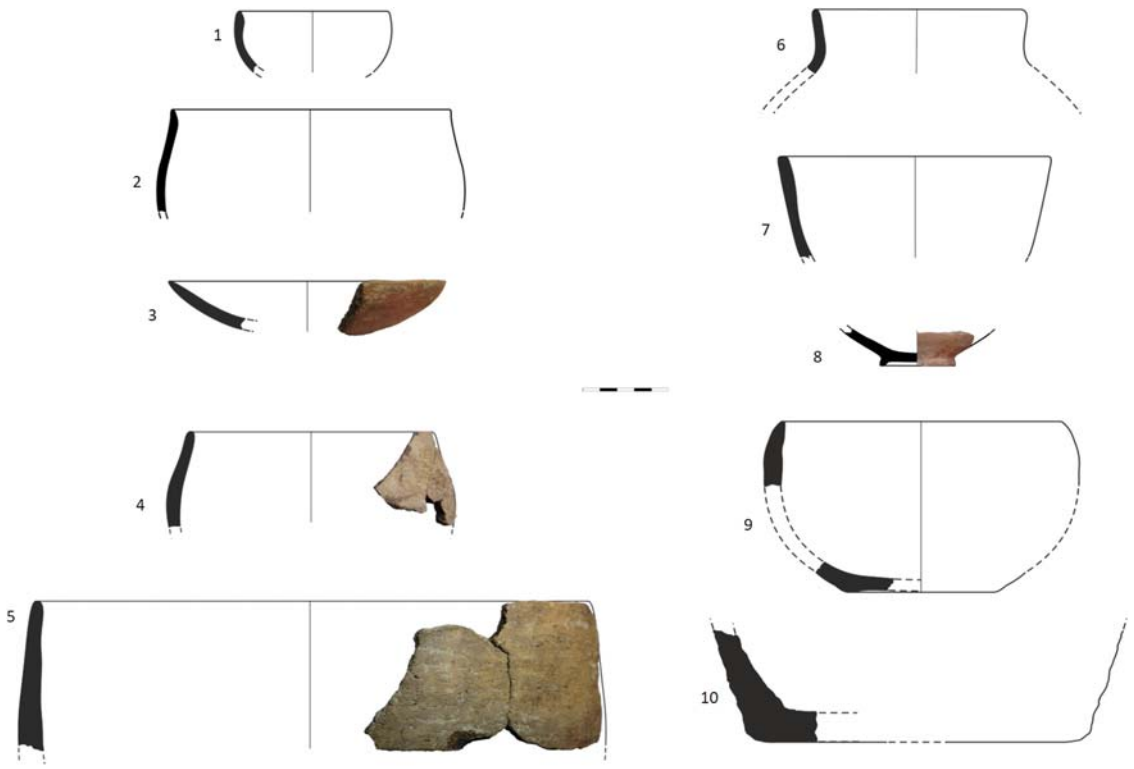

Figure 4: Organic-tempered vessels from the end of the Early Neolithic. (1 and 2) Revenia, (3 and 4) Roditis, (5) Lete III, (6–8) Ritini, (9 and 10) Paliambela Kolindros. Archive of the THALES-Exploring programme.

1. In all sites, organic tempering is linked to the most common types and wares, the majority of which are the burnished brown/beige or red-slipped bowls, but not restricted to them (Figure 4). Moreover, petrographic analysis has revealed that the clay used to produce these vessels is the most commonly used overall at all sites (Dimoula, pers. com.; Saridaki, 2019).[11] Interestingly, organic temper has also been detected in more rare fabrics or vessels considered imported from neighbouring areas (Saridaki, 2019).
2. Decorated pottery is treated differently between sites. In Paliambela Kolindros, Revenia and Ritini painted and impresso pottery is routinely tempered with organic materials (Figure 4(8)). On the contrary, in Lete III, painted pottery is never tempered, while plastic decorated vessels, the other major decorated ware, may be tempered. In Roditis, painted pottery is not tempered, while some impresso sherds do contain organic temper, and in Varemeni Goulon, the reverse was observed. It must be noted, however, that both sites yielded very low amounts of decorated pottery.
3. Closed vessels, with or without neck, appear or become progressively more popular in most assemblages of this period (end of EN-beginning of MN), presumably used for liquids, although open forms continue to dominate the assemblages. Apparently, organic temper was not preferred for their construction in most sites, except Paliambela Kolindros and Revenia, from where we have some examples.
4. The existence of cooking vessels has been verified for this period in Ritini, Lete III, and Varemeni Goulon (Urem-Kotsou, 2018; Whelton et al., 2018). These vessels are not made with organic temper. One exception from Lete III may involve a vessel in secondary use (red-slipped bowl), and, either way, this exemplifies that these categories were probably not impermeable. On the contrary, some of the large storage vessels, not found in all settlements, were made with organic temper (Figure 4(10)).

11 Dr N. Saridaki has conducted petrographic analysis on pottery from the sites: Paliambela, Revenia, Ritini, Roditis, and Varemeni Goulon for her PhD dissertation in the framework of THALES-Exploring research programme (Saridaki, 2019) and Dr A. Dimoula on the ceramic assemblage of Lete III (unpublished).

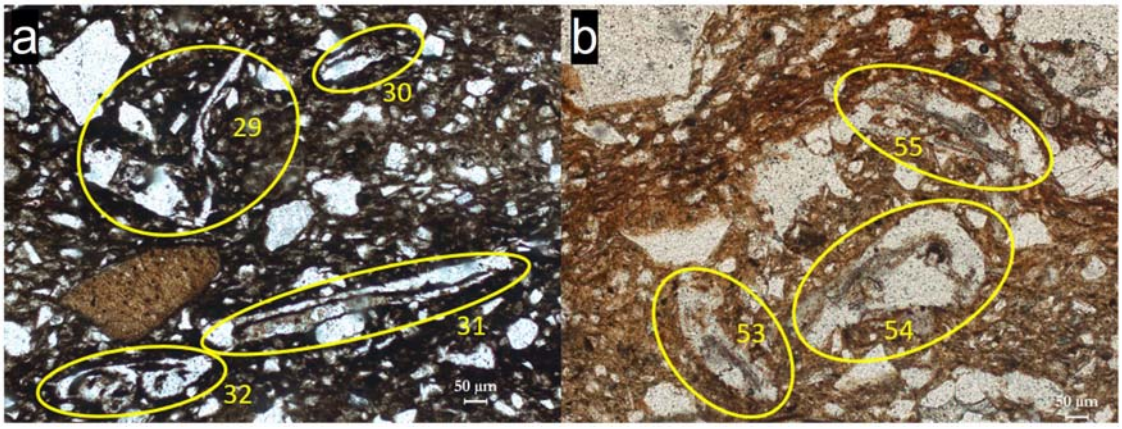

Figure 5: Thin sections of organic-tempered sherds from (a) Revenia and (b) Paliambela Kolindros under a petrographic microscope in ppl, showing different degrees of oxidation. The numbered areas contain plant remains and were examined in detail.

Regarding the botanical composition of the temper, diachronically the samples of the microscopic study were mostly dominated by grass glume phytoliths, sometimes identified as cereals. In several instances, the glume phytoliths were accompanied by significant amounts of polyhedral phytoliths, found predominantly in dicot leaves. Given the paucity in grass stem phytoliths, we may presume that these remains represent the byproduct of household food preparation, such as cereal glumes and legume leaves/lobes, or other leafy plant foods. Other interpretations are of course plausible. The possibility of the addition of dung cannot be excluded, although no feacal spherulites were identified and perhaps more grass stem remains would be expected in such a case. Although differences do exist among sites, they are not very pronounced, and given the primarily qualitative character of the analysis, the range of the practices employed may be wider (Papadakou, 2021).

To sum up, during the Early Neolithic in the sites presented here, organic tempering was not a very popular practice, and the variable percentages tell a story of local preferences. Paliambela Kolindros appears to stand out throughout the chronological sequence examined here, not only among the sites in question but also in the Greek region in general, in both the amounts of organic-tempered pottery and the fact that this practice usually permeates all wares and types, while at the opposite end, the sites of Kozani rarely employ such techniques. The temper appears to be closely related to the agricultural production and, perhaps, in many cases with food preparation.

4 Discussion

In this brief overview, we saw that although organic-tempered pottery is linked to the earliest appearance of pottery, other "histories" also occurred, whereby organic-tempered pottery was not the first pottery on-site (e.g. Sabi Abyad) or re-emerged after a period of decline, perhaps in a new context (Çatalhöyük), or even found its production intensified at a time when other sites veered away from it (Ulucak). As a general observation, organic-tempering appears less associated with painted pottery and, especially, cooking vessels; however, this is by no means true to the same extent everywhere. For the most part, when organic temper is widely used, it crosscuts all or most other parameters of pottery, while when it is not, we often encounter specific types of vessels associated with it.

Furthermore, the distribution of organic-tempered pottery appears "patchy" over this large area, even in neighbouring and/or contemporaneous sites or regions, including the differential intensity of the practice. An exception to this is the Balkan Neolithic, where it appears as the norm or standard "recipe." However, we should note that even in these assemblages, pottery without organic admixtures also exists,

in variable proportions, suggesting that other options were also available and employed. As regards the origins of the Balkan Neolithic pottery technology, given that in all the probable routes of neolithisation, namely, northwest Anatolia, Thrace, and northern Greece, organic tempering does not play a prominent role in local traditions, it follows that this practice is not necessarily "inherited" with the pottery craft itself, but it is a local or regional interpretation, a choice fitting to the general concepts of these first Neolithic communities.

Whether this divergence in the frequency of organic temper serves a practical technological purpose, possibly related to some properties of the local clays in the North, could be the object of a focused, specialised technological analysis that goes beyond the scope of the research presented here. However, in the case of the northern Greek sites presented here, which have been systematically examined, most organic-tempered vessels are common vessels, regular in construction and appearance, clearly showing that this practice was not reserved for "special" vessels, at least in ways that archaeological research can recognise them as such, including contexts of use and discard. Furthermore, there is no association of organic tempering with a particular type of clay, which excludes the technological parameter as an exclusive interpretation, at least in these sites. However, in most sites presented here, organic temper is avoided in the construction of certain wares or types (e.g. painted or closed vessels), although each assemblage has its own peculiarities, which it may share with other sites in a micro-region or not, except for cooking vessels which were consistently constructed without organic temper. According to the available published data and the new data presented herein, in both Macedonia (Greece) and Thessaly, a similar situation can be observed, where the practice of tempering is indeed employed in many if not most sites, but organic-tempered pottery amounts to only a small fraction of the assemblages and appears to vary in quantity from site to site.

It would be interesting to note that there appears to be a link between food and vegetal temper, much as in the clay is "fed" the human food and becomes a vessel. This tentative relationship, however, is not a "literal" one, as we've noticed the general trend of not adding organic materials in cooking vessels, but rather a conceptual one. The often-mentioned interpretation of vegetal-tempered pottery (and often pottery in general) as a seasonal technology is based on the premise that abundant such material (chaff and straw) would be available after the harvest (e.g. Fuller, Stevens, & McClatchie, 2014; Kreiter et al., 2013), as well as on the fact that pottery would be constructed during the hotter months, in order for it to dry. While the merits of making pottery during the hotter and drier season are many and obvious, the tempering material itself (including dung and other plant-derived mixtures) could be stored all year round to be used when needed, for various purposes. Therefore, a direct seasonal relationship cannot, in our opinion, be proven solely by the presence of organic temper, especially in the case of northern Greece where such vessels are a minority within the assemblages. Nonetheless, temporality may indeed have been central in this practice, as we shall present later.

The key facts presented earlier regarding the organic-tempered pottery in northern Greece can be summarised as such: the practice concerns only a small fraction of the assemblages, which may vary considerably; the majority of the organic-tempered vessels are common in shape and surface treatment (as in types and wares routinely used without organic temper), and the same clay sources are used as the ones used for the construction of the rest of the pottery; the botanical composition of the temper shows strong links to the agricultural production and, perhaps, especially to household-based food preparation; the quantity of the added temper is generally low, and in most cases, it is doubtful that it would change the physical properties of the vessel significantly (weight, porosity, etc.), an observation mentioned by other researchers as well in the wider region. With these in mind, there are two broad lines of interpretation for EN northern Greece, not mutually exclusive, in which this practice can be viewed: (a) this practice may have involved certain lineages of potters, traditions, rituals, and ideas pertaining to certain communities of practice (Lave & Wenger, 1991) and/or (b) this practice may have been dictated by temporality, employed in certain hallmarks in the year (including the harvest) or in the community's or a person's life, in order to commemorate or refer to an event, past or future, or providing certain significations, thus constituting a material metaphor of the plant world within the clay pot.

5 Conclusions

Organic-tempered pottery shows much more variability than imagined by the mainstream view. The brief overview presented here indicated variable ways of producing such pottery (regarding the temper source) and variable choices for incorporating this technology into the ceramic assemblages. Hence, it would be misleading to treat this technological aspect of pottery as one single technique, always and everywhere; if nothing else, it is difficult to envisage that a given practice and its signification would remain unaltered for over a millennium in such a vast area.

From this respect, the organic temper can only have limited value for supporting arguments for the smooth and constant wave of Neolithic expansion, implicit in many relevant narratives and often visually expressed in the appropriate maps. Invariably, on a closer inspection of the data, the variance observed is incompatible with this simple normalising model. The apparent conclusion from reviewing the data is that organic tempered pottery is neither consistent nor coeval to serve as a helpful hallmark of the Neolithic expansion.

Studying the Early Neolithic Greek sites reveals an equally variable picture at the beginning of the Neolithic period in Europe. Organic-tempered pottery is not a popular choice everywhere, and differences are noted even in neighbouring sites. Decorated pottery never gets organic temper in some sites; others use it invariably. Closed shapes and cooking pots are again treated variably from site to site. The fact is that regularity exists inside the community, not in the region. This stark difference should be no surprise – material culture results from the community's dynamic decisions and cultural choices rather than copying some imported blueprint. In the past, in such a case, one would try to connect it to an origin further to the East with a similar treatment of organic temper in pots. However, this exercise assumes that the significance of organic tempering is just its technological presence. It misrepresents the meaning that every technological act acquires once it becomes part of material culture.

Of course, the specific practice was available, and it remained part of the broader cultural concepts for a very long time. Tempering pottery with organic materials was one of the available options out of a pool of possibilities and technical knowledge from where communities draw and express their own views and innovate further. Individual potters variably embraced this technique, and in this variability, we can perhaps trace the complex social practices and networks involved, the shaping of communities of practice, the histories, traditions and genealogies, assimilation in new communities, etc.

These different patterns show that although neolithisation was a process that eventually took over to become a *modus vivendi*, in the finer aspects of it, we get a glimpse of the idiosyncratic and multifaceted reinterpretations that weave the fabric of these first centuries of the Neolithic in Europe.

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