Old World Ceramic Origins and Behavioral Contexts from the Late Pleistocene to Mid-Holocene: Unresolved and New Problems

One of the early major concepts known as “the Neolithic Revolution” suggested that right after climate change at the end of the last Ice Age, pottery was adopted with a sudden explosion of new behaviors and technologies: farming, sedentism, and grinding stones (Childe, 1936). Evidence came from the Middle East, northern Africa, and Europe. Nevertheless, after many decades of research, development of new dating techniques, and site discoveries, it is clear that pottery appeared in distinct contexts from varied climatic and environmental, technological, subsistence, and mobility contexts and timing. For example, in the New World, the earliest dates associated with pottery in South America reported from the lower Amazon (ca. 8000–7000 cal BP) and lowland Colombia (ca. 7000-5800 cal BP) are suggested to have been adopted by foragers with decreased mobility (Oliver, 2008; Oyuela-Caycedo and Bonzani, 2005) and in Central America, by egalitarian farmers who also foraged and fished, around 5500-3300 cal BP (Iizuka, 2013, 2017, 2021). These adoptions occurred at the onset and during the mid-Holocene. On the other hand, in the Old World, the adoption of pottery vessels occurred much earlier in the late Pleistocene with the first evidence coming from East and Northeast Asia, incorporated by hunter-gatherers in distinct environmental contexts (Buvit and Terry, 2011; Morisaki and Natsuki, 2017). For this reason, we have not reached a consensus on conditions and causes of why people adopted pottery. As there are obvious gaps in knowledge in all locations due to discrete research intensities and histories, and difficulty in accessing important reports and papers written in different languages, exchange of information across traditional boundaries is required to critically evaluate the worldwide emergence of ceramics. In this special issue, we focus particularly on tackling long-debated problems and newly emerging issues related to the origins of ceramics in the Old World. We introduce new case studies and critical reviews of existing work from a variety of regions: Europe, Southwest Asia, Africa, and East, Northeast, and Southeast Asia, extending to Micronesia. We first outline debates and problems, some relevant worldwide, then introduce these issues as addressed by each contributing author outlining the main arguments of each contribution.

The reconstruction of accurate geochronology is critical for intra- and inter-regional behavioral understanding related to the origins of ceramics. In East and Northeast Asia, with the first appearance of pottery in the late Pleistocene, there are regions and sites with contested dates. According to the most recent AMS-14C dates, South China yields the earliest dated sites, ca. 20,000–17,000 cal BP (Boaretto et al., 2009; Cohen et al., 2017; Wu et al., 2012), and new field studies and results reiterate the strength of those AMS-14C ages (Patania et al., 2019a, 2019b, 2019h). However, because of the microbotanical remains of semi-domesticated and domesticated rice associated with pottery, deposited materials prone to diagenesis in the karstic cave environment, and thermoluminescence dates on pottery reported from earlier studies, also potentially suggest dates closer to the Holocene (Iizuka, 2018; Lu, 2010; Yanshina and Sobolev, 2018; Zhang, 2002; Zhao, 1998). In the Transbaikal region of Russia, various radiocarbon dates and more recent AMS-14C dates obtained directly from carbonized encrustation on pottery fall within ca.14,000–12,900 cal BP (Buvit et al., 2003; Hommel et al., 2017; Konstantinov, 1994; Razgildeeva et al., 2013; Tsydenova et al., 2017). Nevertheless, those who observe wide regional stratigraphic relations suggest ca. 7000-6000 years ago during the Atlantic Optimum (Konstantinov, 1994, 2016). In the Russian Far East, pottery was present as early as 16,000 cal BP (Buvit and Terry, 2011; Hashizume et al., 2016, 2017) and more confidently by 14,000 cal BP (Iizuka, 2018) but compressed stratigraphy makes it difficult to comprehend the fine chronology (Kuzmin, 2006). In Honshu Island of Japan, the Odaiyamamoto I site is often used as one of the main yardsticks to assess the timing of the appearance of pottery, but it has also been suggested for a reassessment due to some anomalous dates (Iizuka, 2018). Without the confirmation of geochronology, debated problems such as absence and presence of diffusion (Jordan et al., 2016; Kuzmin, 2013; Sato and Natsuki, 2017; Jordan and Zebelevil, 2009; Yanshina, 2019) related to the appearance of pottery cannot be adequately assessed. Without accurate geochronology, it is difficult to place subsistence practices, residential mobility, and climatic and environmental conditions in the pottery adoption context.

Use of the first pottery is an aspect that is of critical importance. In the past decade, there is a significant increase in studies reconstructing early pottery use, a fundamental aspect in our understanding pottery adoption, with molecular and/or stable isotope methods on residue and carbonized encrustation on pottery in a variety of regions with early ceramics in the Old World (e.g., Craig et al., 2013; Dunne et al., 2016; Kunikita et al., 2013; Lucquin et al., 2018; Shoda et al., 2020). This is a great contribution. Note, however, that geochronological evaluation plays a key role in placing those first functions into behavioral and paleoenvironmental contexts.

Furthermore, the first ceramics found worldwide were not vessels, but figurines and pellets made during the Upper Paleolithic in Central Europe, 32,000–27,000 cal BP (Farbstein and Davies, 2017; Iizuka, 2018; Svoboda et al., 2015; Vandiver et al., 1989). The earliest vessels did not appear until thousands of years later in East Asia by ca. 16,000–15,000 cal BP. The nature of ceramic making behavior, context, and these gaps require research attention. Although correlations of global climatic conditions in the late Pleistocene and the adoption of


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Pottery have been presented (e.g., Craig et al., 2013; Morisaki and Natsuki, 2017), a variety of other local and regional environmental and ecological conditions and their relations to the first pottery uses (e.g., Iizuka and Izuo, 2017; Janz, 2016) are also critical. Likewise, the adoption of pottery and the timing of the appearance of a broad-spectrum diet (e.g., Iizuka, 2018; Janz, 2016), and assessments of the absence and presence of domesticated plants and animals is crucial. Some areas had the co-existence of ceramic using and non-ceramic using foragers and sites. Their relations have remained unclear. The early concept of the “Neolithic Revolution” has weight in referencing Southwestern Asia with the first vessels adopted by farmers (Gibbs and Jordan, 2016; Zeder, 2009), but the updated holistic comparative reviews on the timing, context, and regional variability centered on pottery are uncommonly presented in international journals. Furthermore, detailed reconstruction of ceramic production processes, and circulation patterns to reconstitute performance characteristics and infer intended functions (e.g., Schiffer, 1995, 2011, 2013), especially with archaeological approaches, are not common for late Pleistocene ceramics.

Finally, the delayed adoption of pottery is another issue under explored. For example, in the Korean Peninsula and northeastern Mongolia, although surrounding regions have late Pleistocene radiocarbon dates associated with pottery, ceramics are reported and suggested from the early to mid-Holocene (Iizuka, 2018; Kuzmin, 2014; Sefériades, 2004). In a related manner, the mechanism of early adoption of pottery with sustained uses that continued for thousands of years despite other newly emerging behaviors (Lucquin et al., 2018) requires explanation. Delayed adoption also occurred in previously uninhabited regions, and in areas with inhabitants that had distinct pottery characteristics and economy, or places without pottery use prior to the migration of hunter-gatherers and food producers with the technology (e.g., Combé, 2009; Fitzhugh et al., 2011; Gjesfeld, 2016); however, the nature and mechanisms of its adoption, invention processes, and uses have remained unexplored in some regions.

Below we introduce papers in this volume that examine these debates and problems, listed in geochronological order by region for each issue outlined above: Europe, East Asia, Northeast Asia, northern Africa, and Southwest Asia, and delayed adoption cases of East Asia, eastern Africa, and Micronesia.

Vandiver’s (2022, this volume) paper presents the earliest ceramic technology worldwide found in the Eurasian Upper Paleolithic and addresses the later appearance of vessel technology through a materials science perspective, all rare contributions for this time period. It compares distinct technologies while providing analytical results on ceramic and raw material properties and ceramic production processes, as well as inferences on performance characteristics and the early ceramic producers’ intentions. The author critically reviews studies from the Eurasian Upper Paleolithic with special attention to figurines and pellets of the Gravettian context from central Europe ca. 32,000–27,000 cal BP. Based on evidence of abundant broken figurines with thermal shock, their likely purpose is interpreted as intentional repetition and transmission of the production behaviors for non-utilitarian symbolic uses involving fire. Additionally, studies on a figurine from Siberia, and a bowl-shaped lamp from the southern Urals are provided. The author also redefines “ceramics” from the current engineering perspective to include clay and pigmented clay particle processing to create drawings at Lascaux Cave, thus re-evaluating the beginning of ceramic making. By providing early pottery vessel technology from the Russian Far East and South Siberia, the author suggests that constructing thin walls of a large pot requires more care than creating a figurine. As the author writes, the earliest ceramics across Eurasia were not pottery vessels for food preparation, which provides critical insights about symbolic functions to archaeologists pursuing subsistence and behavioral changes examining tools and artifacts in late Pleistocene societies.

Moving to the earliest reported ceramic vessels, Feng and Wang’s (2022, this volume) contribution focuses on several of the major debates surrounding the earliest ceramic vessels in South China, evaluating the chronological record, lack of domesticated plant use and “broad spectrum foraging”, and behavioral changes contained therein. They adopt an AMS-based geochronology and reveal a complex pattern of early pottery use directly after the Last Glacial Maximum (LGM), by ca. 20,000 cal BP, prior to the earliest reliably dated domesticated plants (after ca. 10,000 cal BP). First, the authors evaluate the context of radiometric dates associated with the earliest pottery bearing layers and carbonized encrustation on pottery, adopting nine early ceramic sites. These sites represent the totality of sites excavated and dated in South China, clarifying information presented in English language publications. They also provide summaries of artifacts, features, and fauna associated with each layer, another important contribution of this paper, which are then used to evaluate changing behavioral strategies. They conclude that as pottery was integrated after 20,000 cal BP, residential mobility decreased, and a “broad-spectrum diet” was adopted including higher percentages of small animals and freshwater snail in faunal assemblages. The authors suggest ceramic vessels were possibly used to boil mollusks, while several other technologies emerged including polished stone tools, this process wild grains and tubers present in occupations, as well as shell knives. Since these changes occurred throughout the entire late Pleistocene, the authors argue that the emergence of pottery was not tied to climatic cooling or warming events, rather a shift in subsistence behavior after the LGM by hunter-gatherer populations who migrated south during the LGM. Within this new geographic and climatic environment, these foragers shifted to longer and more stable occupational strategies that relied more heavily on localized resources including small-sized mammals, mollusks, and plants resulting in adoption of new subsistence technologies including polished stone tools, shell knives, and pottery.

As the chronological, technological, and behavioral relations between aceramic and ceramic-bearing hunter-gatherer sites during the late Pleistocene in the Japanese archipelago has been unclear, Natsuki’s (2022, this volume) case from Hokkaido addresses these problems by investigating the correspondence between climate and behavioral variability and changes. The author distinguishes between a terminal Upper Paleolithic (UP) technocomplex, ca. 16,000–11,500 cal BP, and two Incipient Jomon technocomplexes, ca. 15,000–13,000 cal BP, from Hokkaido based on differences in lithic composition and technology, with a particular focus on flaking patterns and the absence or presence of pottery. The author suggests the appearance and disappearance of the Incipient Jomon technocomplexes and probable technological inheritance by comparing them with climatic periods and adaptation. The author infers that the Incipient Jomon people adapted to warmer conditions, migrating in and out of Hokkaido from northern Honshu, between the late Glacial Warm and the early Holocene. The cold adapted UP people’s technological, and probable populational persistence into the Holocene and their mixture with the re-arriving Jomon, resulted in the early Initial Jomon technocomplex. It also indirectly contributes to the debate of the first Americans, as similarities of UP lithic assemblages of Hokkaido to the first American sites have recently been proposed (Buvit et al., 2022; Davis and Madsen, 2020; Davis et al., 2019; Watters, 2019).

Morisaki’s (2022, this volume) paper critically reviews the process and possible adaptive reasons for the appearance of pottery in the Japanese archipelago. First, the author compares the paleoclimatic chronozones with the AMS date-based timing of the appearance of pottery by region, including Hokkaido. Different from Natsuki (2022, this volume), the author excludes that pottery appeared in a late Oldest Dryas suggesting that the adoption occurred from Hokkaido to southwestern Japan regardless of the ecological variability. Unlike earlier suggestions of pottery adoption by foragers corresponding to resource change at the onset of the Holocene (Hayashi, 2004; Kondo, 1965; Watanabe, 1968), the author’s findings on the minor level of production and use in the Oldest Dryas serves to show a more complex process. The second and main point of the paper, however, is the critical response to recent studies based on residue and carbonized encrustation
on pottery in the Japanese archipelago indicating heavy aquatic resource use during the Incipient (Craig et al., 2013) and Initial Jomon (Lucquin et al., 2016, 2018) at site levels and/or cross-regionally, interpreted as the main catalyst for the adoption of pottery. The author highlights other evidence that indicates a more varied process. In an example from the Maedakochi site of east-central Japan, pottery and early sedentism did occur in the context of aquatic resource abundance. However, in southern Kyushu of southern Japan, stable isotope ratios of carbonized encrustations on pottery from the Oujiyama site suggests plant and animal products (Kudo, 2014), while the Sankakuyama I site with groundstone artifacts for plant food processing suggests a broad-spectrum diet. Therefore, different from the aquatic hypothesis, the author infers aquatic and plant-rich potentially distinct subsistence and regional contexts related to the adoption of pottery.

Unlike the approaches by Natsuki (2022, this volume) and Morisaki (2022, this volume), Nakazawa et al. (2022, this volume) work on the problems dealing with multi-site issues of late Glacial Japan, ca. 16,000–11,000 cal BP. The authors examine technological transmission of pottery through a distance decay model (Shennan et al., 2015; Lycett, 2019). With the Odaiyamamoto I site as the donor site, they examine radiocarbon dates and pottery decorative techniques. Vertical (chronological) and horizontal (spatial) distances from the donor site to the recipient sites, which are expected to decrease, are evaluated against cases of a single wave of diffusion. The results suggest that radiocarbon dates and pottery decorative techniques do not necessarily follow the established pottery style-based relative chronology. Also, no Late Glacial sites’ sample size effects were found, indicating that pottery frequency does not affect the cultural diffusion evaluation. Also, as time progressed, sherd frequency relative to lithics increased suggesting that the usefulness of pottery technology over others were weighed more heavily over time and that pottery technology, with multiple potential regional donors (e.g., convergence), was transmitted by travel and exchange networks. Furthermore, tests on cultural diffusion did not account for the emergence and widespread adoption of pottery. Although the exact antiquity of pottery from the Odaiyamamoto I site, and additionally, Fukui Cave site, used for the study has been questioned (Iizuka, 2018), this research has implications for the debate on diffusion and invention of Old World pottery (Jordan et al., 2016; Jordan and Zvelebil, 2009).

Iizuka et al. (2022, this volume) source pottery samples from the Incipient Jomon of the Sankakuyama I site, on Tanegashima Island of southern Kyushu in southern Japan, associated with the layer below Satsuma tephras confidently dated to ca. 12,800 cal BP. Pottery dates are 14,000/13,500–12,800 cal BP, from the Balling/Allerød. These secure geochronological conditions exist region-wide here and strengthens the authors’ pottery sourcing, which is also among the first from the late Pleistocene. Building on earlier visual and stereoscopic analysis inferring production processes and performance characteristics (e.g., Schiffer, 2011, 2013) and inferences on sources, this study reconstructs the production and circulation patterns of pottery with petrography and microprobe analysis. The results suggest that people had a high degree of sedentism and occasionally engaged in exchange of goods contained within ceramic vessels, or possibly the vessels themselves. Results also suggest that pottery adoption corresponds with a rise in sea level, and the low level of inter-island exchange of pottery occurred to buffer risks to maintain contacts with people on other island(s) and distant locations. However, the circulation of light flake tools at much higher proportions requires future explanations. Based on results of pottery, even though Tanegashima Island was an ecotone with abundance, it is inferred that there were mid-to long-term risks (e.g., Fitzhugh et al., 2011; Gjesfjeld and Phillips, 2013) associated with habitation here. This paper provides an important contribution to pottery origins debates by reconstructing late Pleistocene pottery involving economy with exchange and relations between mobility and sedentism of foragers from the present-day subtrigons with archaeometric techniques and a context of a regionally firm geochronology.

The next set of papers are situated in the Transbaikal and Russian Far East regions of Siberia, in which focus is on chronology and behavioral changes associated with early ceramic vessels. Unlike other regions in Northeast Asia, including the Russian Far East and Japan, early pottery in the Transbaikal region is less understood in terms of timing and because this period is represented by fewer and more geochronologically problematic sites (Iizuka, 2018). Thus, responses to debates about cultural contacts and the origins of ceramic vessels in the region are inhibited. Although stratigraphic sequences tend to be well-established chronologically, some radiometric dates point to late Pleistocene occupations (ca. 14,000–12,000 cal BP) while others yield distinct Holocene ages, and there are age-depth reversals at some sites (Buñi et al., 2003; Hommel et al., 2017; Konstantinov, 1994; Razgildeeva et al., 2013; Tsydenova et al., 2017). With these results, while those following radiocarbon dates argue for a late Pleistocene occupation (Hommel et al., 2017; Razgilgeeva et al., 2013; Tsydenova et al., 2022, this volume; Tsydenova et al., 2017), Konstantinov (2016, 1994) argues that the early ceramics are from the warm period of the Atlantic Optimum, ca. 7000–6000 years ago, observing stratigraphic layers from which they are found.

Directly addressing these problems, Tsydenova et al. (2022, this volume) present new stratigraphic, radiocarbon, and palynological data from the Krasnaya Gorka site, situated on the shore of Lake Bol’shoi Eravnoe. AMS-14C ages were obtained from charred remains on pottery, hearth charcoal, and charred bones from cultural layer 2 (the earliest pottery bearing layer) indicating occupation between 13,700 and 10,500 cal BP. The authors maintain that these latest AMS-14C ages might be more reliable than the previously reported dates that were taken from smaller sample sizes and suggest that their results do not support the hypothesis of the Atlantic Optimum-origins of pottery. Additionally, pollen analysis corroborates these ages placing cultural layer 2 occupation within the warming period associated with the Allerod interstadial (14,500 to 12,500 cal BP), then a marked cooling period of the Younger Dryas (12,500 to 11,700 cal BP) occurred after this occupation. The authors also report carbon and nitrogen isotope ratios of charred remains of pottery indicating the possibility that mammals and fish were cooked in ceramic vessels. These are the first reported stable isotope studies on carbonized encrustations on ceramics from the region and suggest possible similarities to studies on pottery from the Russian Far East (Shoda et al., 2020; Yanshina and Kovalenko, 2022, this volume) that were used to cook ruminants (Middle Amur) and salmonoid species (Lower Amur).

Iizuka et al. (2022, this volume) directly address whether the earliest ceramic layer 9 at the Studene 1 site in the Transbaikal region of Siberia represents an occupation during the late Glacial (e.g., Taymir Warm period of the Sartan Glacial, 12,000–10,800 cal BP) or a delayed manifestation of the Holocene Atlantic Optimum (e.g., 6500–5500 cal BP) (Razgildeeva et al., 2013; Konstantinov, 1994, 2016). The authors focus on inconsistencies in the radiocarbon and paleoenvironmental reconstruction records using stratigraphic analysis of soil formation marker horizons combining recent geoarchaeological studies of sediments, including soil chemistry, granulometric, and carbon isotope analysis, review of the pollen record, and evaluation of 36 radiocarbon ages. Within the pottery bearing level, the authors report age reversals relative to site stratigraphy, then reevaluate the interpretation of layers that represent soil formation and possible cryogenic processes that might account for these reversals, but confirm that neither are factors. Furthermore, review of published pollen records does not elucidate the problem of climate at the site during occupation of layer 9 because they provide contradictory evidence. Finally, the authors suggest the discrepancies in radiocarbon ages are due to a carbon reservoir effect from melting alpine glaciers inundating and depositing old carbon with sedimentation at Studene 1 layer 9, thus deposits may return inconsistent ages. Although the authors do not provide conclusive evaluation of whether the earliest pottery from this site represents a late Pleistocene (15,000–12,000 cal BP) or Holocene phenomenon from the Atlantic Optimum (8800–5500 years ago) (Bazarov et al., 1982; Konstantinov,
sedentism and inferred diets, are exposed. In the Transbaikal, settlement in both regions, however subtleties of intensification, including amounts of food along riverine systems, possibly including land mammals/un-mobility increased in early ceramic sites likely to increase encounter rates. Lower Amur River sites were occupied to extract, cook and possibly store and Russian Far East regions as the first adoption of ceramic vessel technology was incorporated into behavioral systems. The author bases comparisons on archaeological data including site location, features present, faunal assemblages, types of organic and stone tools, and symbolic representations of aceramic and ceramic-bearing sites of each region. These comparisons highlight the overall adoption of pottery use at some sites as a method to intensify extraction of resources already heavily in foraging diets in both regions, however subtleties of intensification, including amounts of sedentism and inferred diets, are exposed. In the Transbaikal, settlement mobility increased in early ceramic sites likely to increase encounter rates with food along riverine systems, possibly including land mammals/un-gulates and fish. New evidence presented by Tsydenova et al. (2022, this volume) corroborate these conclusions. In the Russian Far East, sedentism and ground stone tools increased. Previous isotope studies reveal that the Middle Amur ceramic sites used early pottery to cook ruminants, while Lower Amur River sites were occupied to extract, cook and possibly store salmon, other anadromous fish, and C3 plants (Hashizume et al., 2016; Kunikita et al., 2013; Shevkomud and Kuzmin, 2009; Shoda et al., 2020) possibly *Juglan mandshurica* Maxim (Kuzmin, 2003). Furthermore, the author highlights the overlapping nature of sites with and without ceramic technology in each region, that may represent the ephemeral incorporation of a new technological feature into a larger system that includes some occupations where ceramic technology was utilized and others where it was not. This study contributes to the understanding of foragers’ response to climatic fluctuations with diet breadth and subsistence adaptation which included the use of pottery technology.

In the Russian Far East, Yanshina and Kovalenko (2022, this volume) evaluate radiocarbon chronologies, characterize early use of, and assess possible contact between early ceramic sites attributed to hunting-gathering-fishing groups of the Osipovka (Lower Amur River basin) and Gromatukha (Middle Amur River basin) culture complexes. They provide information rarely presented in English language journals including a distribution map with an estimated 95 early pottery sites identified from the Russian Far East. They conclude that Osipovka and Gromatukha complexes are roughly coeval dating 16,200 to 10,700 cal BP, then compare pottery paste composition, vessel forms, forming techniques, surface treatment, and decoration of Osipovka and Gromatukha pottery from major sites in order to both build chronologies documenting changes in construction sequences within each cultural complex, as well as provide comparisons between them. Compiling this data with geographical site distributions and other archaeological materials present, the authors argue that the Gromatukha and Osipovka cultural complexes represent distinct cultural entities that created and used ceramic vessels under different historical and behavioral circumstances, with little overlap in pottery forming techniques. The authors also note that the Osipovka culture exhibited more “Neolithic” type features, such as more permanent dwellings, arrowheads, and ground adzes, during and after the Younger Dryas, and were aggregated around productive regions at the confluence of rivers. The authors and River Basin researchers of practice to manage this time of resource stress. The description of technological variability through the analysis of production processes of early ceramics are among the contributions of this paper.

Several North African cases of early pottery use through chemical and isotopic methods are presented by Dunne (2022, this volume). From Libya, the author introduces examples from Takkaroki with the adoption of pottery in the early Holocene by people who were mainly hunter-gatherers (Late Acacus, ca. 10,200–8000 cal BP), but who may have had access to sheep/goat and cattle or co-existed with herders (Biagetti and di Lernia, 2007), and from the subsequent pastoral herder period (ca. 8300–4650 cal BP). Other studies include pottery from Uan Afuda adopted by Epilpaleolithic foragers (Late Acacus, ca. 8900-8500 cal BP), Early Neolithic Cardium impressed pottery from the Moroccan Rif area with evidence of domesticated sheep, goat, and plants, Early Neolithic B and C (ca. 7100-6600 cal BP) pottery from Ifri Oudadane, and Hassi Ouzzenga pottery from ca. 7600 cal BP. From all of these contexts, evidence of use includes plant processing in conjunction with signatures of meat or dairy products, however plant signatures are often masked by those of meat. The author suggests the importance of combining molecular and isotopic data with contextual archaeological data and ethnobotanical information for the interpretation of use. The author emphasizes the importance of the plant cooking function of early pottery, which facilitated their detoxication and consumption. This paper presents valuable insights concerning the interconnectedness of pottery adoption with a broad-spectrum diet.

Gibbs (2022, this volume) critically reviews the chronology, technology, and function of ceramics from Southwest Asia in the context of their adoption. This is the heartland of the concept of “Neolithic Revolution” (Childe, 1936) where a holistic review from a pottery angle has been awaited in an international journal. The author suggests that this concept still applies at some level related to domesticates and pottery, but at a finer scale with no revolutionary change observed, and that the timing and inter- and intra-regional variability should be weighed. For example, pottery emerged in the context of a gradual adoption of farming, with some cases of hunting continuing to the Late Neolithic. Some level of residential mobility and pottery transportation or exchange is also observed at some communities of the Late Neolithic. Adopting Campbell (2017), the author especially focuses on the chronology, technology, and function, viewing pottery adoption as processes and stages in a long-term experimentation. The first stage was unfired clay for construction and clay containers, and portable, fired clay figurines and tokens during the pre-Pottery Neolithic from Anatolia, Levant, and the Zagros Mountains between 10,500 and 9000 cal BP (8500–7000 BC). The second stage is an appearance of continuous, small scale fired-clay container productions around 9000 cal BP (7000 BC) in Upper Mesopotamia, northern Levant and Anatolia. The third stage is larger scale production with Zagros pottery appearing prior to 9000 cal BP (7000 BC), followed by the southern Levant, debatably associated with an 8.2 ka cooling event (Gibbs, 2022, this volume). Widespread adoption was delayed further in the eastern desert of Jordan and Cyprus, with the latter as late as 7000 cal BP (5000 BC). The third stage is also when stylistic variability appears. Without residue studies, vessel forms indicate that the third stage has probable increased functions associated with cooking and symbolism, referring to Arthur (1994, 2009) and Hodder (2012), and to cooking, serving, and storing. Additionally, the author introduces a perspective that as pottery in Southwest Asia can also be considered to have emerged as a relatively sophisticated technology, there are inferences about technological diffusion from East Asia (Gibbs and Jordan, 2013; Jordan and Zvelebil, 2009) and North Africa (Jordan et al., 2016). Nevertheless, based on the presence of an experimental stage in Southwest Asia, Gibbs (2022, this volume) suggests that technological and typological evidence is required to support these dispersal arguments.

Another related enigma mentioned earlier that requires attention is the delayed appearance of pottery during the early to mid-Holocene in the Korean Peninsula. Kim and Seong (2022, this volume) investigate this theme focusing on South Korea. The authors argue that although considerable fieldwork yielding quality research has been conducted in South Korea, late Pleistocene sites bearing pottery have not been encountered. They hypothesize that the scarcity of sites is due to the drastic population decline following the end of the LGM, ca. 26,500–19,000 cal BP (Clark et al., 2009) continuing into the early Holocene (ca. 8200 cal BP). After this time, pottery suddenly appears on the eastern and southern coasts. To test their hypothesis, they examine the summed
probability distribution of radiocarbon dates by critically assessing and selecting reliable radiocarbon dates. Results support the hypothesis on population decline, prompting the authors to explain these results in the context of climate change and layout the process as follows. During the LGM, northern East Asia experienced a population decline (e.g., Barton et al., 2007; d’Alpoim Guedes et al., 2016) but with climatic amelioration after the LGM, and after the onset of the Holocene, foragers may have occupied favorable environments in Northeast Asia. Although they withheld the Younger Dryas in the populated areas elsewhere, the cooling event around 8200 cal BP may have prompted the re-population of the Korean Peninsula. They suggest the similarities of pottery and lithic assemblages indicate the possibility of migration by the maritime Rudnaya and proto-Boisman of Primorye (Kim, 2014; Lim, 2017) who had previous links to pottery producing Amur inhabitants. As the authors suggest, future tests of their hypothesis on population influx should include the Primorye and other surrounding regions. This article addresses not only the delayed appearance of pottery, but also puts population movement and climate into this discussion.

The work of Guan et al. (2022, this volume) assesses the function of early pottery in a later context from the Weijiawopu site in northern China (Inner Mongolia), through residue analysis of micro-botanical fossils from Hongshan culture pottery dating to 6500-5500 cal BP. This study centers on flat-based conical ceramic use, a vessel form that originated in the earliest Neolithic time period (Xinglongwa) with both ceramics and domesticated foods, providing an analogy for the earliest function of these vessels because food residue analysis is lacking from these earlier sites. Weijiawopu is a large Neolithic settlement with numerous semi-subterranean pit-houses, pottery, and ground and flaked stones. Large ring trenches indicate a complex residential spatial organization (Guan et al., 2022, this volume). Vessels possibly held wild and domesticated forms of millet seeds (Panicum, Setaria, Echinochloa, Fagopyrum esculentum), wild tubers (Dioscorea), beans, and wild nuts. These starch grains do not indicate any sort of processing such as cooking or grinding, therefore the authors conclude that the vessels were used for food storage. Furthermore, all types of starch grains are found from various vessels, therefore they did not exhibit separate functions based on forms. Millet was domesticated before 7000 cal BP indicating that vessels were used for both agricultural storage, and the storage of wild plant foods including tuber, nuts, and wild forms of millet. Therefore, subsistence practices in this region, even long after the initial use of pottery, were a mixture of agricultural staples and hunting and gathering wild resources, most likely from semi-permanent settlements. This study addresses the first uses of pottery in the region while investigating the subtle changes in pottery use about 5000 years after its initial adoption in North China around the Pleistocene-Holocene boundary, despite the occupational intensity at Weijiawopu and agricultural supplementation to diets in the Hongshan culture. This is a case of pottery use without evident long-term functional variation in spite of other behavioral changes.

A case from Eastern Africa, by Grillo et al. (2022, this volume), deals with another delayed adoption of vessel technology. There, after the adoption of ceramics by hunter-gatherer-fishers in the early Holocene, highly decorative Nderit ware (Pastoral Neolithic: ca. 5000-1200 cal BP) appeared much later. This pottery emerged with either pastoralists who moved into northwestern Kenya from southern Sudan/Ethiopia, or local foragers who began herding through contacts with these groups (Grillo et al., 2022, this volume). This pottery is associated with monumental architecture. The Nderit ware, like the Southern African Lapa Lireccion pottery and stone beads (Goldstein, 2019; Hildebrandt et al., 2018; Sawchuk et al., 2019). This period of shifting to food production likely corresponds to drastic environmental changes to the arid period ca. 5000 years ago. The paper provides comprehensive critical reviews of changing archaeological conceptualization of the Nderit ware, evaluation of sites, regions, chronology, technology, and variability, and infers subsistence strategies and group relations, as well as intends to reconstruct human behaviors with ceramic life history (Grillo et al., 2022, this volume). Great quantities of pottery are found at “pillar sites,” the communal cemeteries, where Nderit ware is often highly decorated, and in varied forms, and with some milk and meat signatures assessed through residue analysis. Interpretation of pottery function may be for communal ceremonial activities; however, the authors are cautious about defining this function suggesting that it may relate to the establishment of relations with local forager communities due to the uncertainties of drastic environmental change. This study provides an insightful picture of how environmental factors may have influenced behavioral shifts to food producers/pastoralists with pottery during the mid-Holocene in Eastern Africa, later than in North Africa (Dunne et al., 2022, this volume).

Although the earliest AMS dates for pottery vessel technology in the world are reported from South China, dates for early pottery off the coast of Taiwan and its relation to South China are rarely discussed. Furthermore, migration of people toward Island Southeast Asia and the Pacific and their pottery origins have not been included in the Eurasian ceramic origins debate. Swete-Kelly and Winter (2022, this volume) introduce a case with pottery producing people who migrated to the Mariana Islands. As an extension of the “Out of Taiwan” model (Bellwood, 2005) and dispersal of pottery, with migration starting ca. 4000 years ago, people from northern Philippines are suggested to have had close connection to the eastern Marianas, and the Marianas to the Bis-mark Archipelago, with additional inferences (Hung et al., 2011) based on stylistic grounds of pottery (and language). This study takes a more systematic approach analyzing different steps in the production processes to test the hypothesis through comparisons of northern Philippines and Marianas pottery including clays and temper, vessel manufacturing method, forms and sizes, surface treatments, and firing conditions. Results suggest that pottery was made locally in both regions, rejecting the possibility of ceramic adoption through direct migration. However, due to the wide-regional maritime adaptation in the South China Sea and western Pacific (e.g., Solheim, 2006), some stylistic commonalities in pottery are observed as making up the “Island Southeast Asia cultural sphere.” This research addresses problems on the mechanisms and timing of delayed Holocene adoption of pottery in the context of newly occupied islands, through examination of the pottery production processes.

The papers in this volume critically responding to traditional and new debates and problems highlight the diverse circumstances under which early ceramics were first added to the behavioral organization of human groups in the Old World: timing, process, and in responses to changing climatic conditions, social and physical environments, ways of getting and processing foods, and associated technology. There are common aspects we can suggest within all of this variability. The first ceramic technologies appearing during the Upper Paleolithic, prior to the adoption of vessels, were not for food processing, but were likely used for symbolic purposes. In places where pottery vessels appeared in the late Pleistocene, vessels were used in the context of broadening diets within different environmental conditions. Distinct trajectories of the Holocene adoption and use of early pottery is observed with migration, contact, continued broad-spectrum diet with or without access to domesticated food, and ranging anywhere between a hunter-gatherer (fishers) and food producer spectrum. We expect these papers to provide valuable insights into new avenues of research, broadening our future understanding of this far-reaching technological invention and adoption processes.

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