TWO TRAJECTORIES IN THE NEOLITHIZATION OF EURASIA: POTTERY VERSUS AGRICULTURE (SPATIOTEMPORAL PATTERNS)

Yaroslav V Kuzmin

Institute of Geology & Mineralogy, Siberian Branch of the Russian Academy of Sciences, Novosibirsk 630090, Russia. Email: kuzmin@fulbrightmail.org.

ABSTRACT. Data on the emergence of pottery and agriculture in Eurasia were analyzed from the view of their spatiotemporal relationship. It was found that there are 2 major types of association between pottery and agriculture: 1) East Asian, with pottery as the main criterion of the Neolithization; and 2) Levantine, with agriculture as the phenomenon most closely related to the emergence of the Neolithic. Some regions of Eurasia have intermediate characteristics. The concept of a single area for pottery origin in eastern Eurasia and its subsequent spread to the west, still used by some scholars, is the revival of the old diffusionist paradigm and does not seem to advance the analysis of the Neolithization process. If the wheat/barley agriculture definitely originated in the Levantine "core" and spread toward Anatolia and central/western Europe, it is impossible to apply the same approach to pottery. The latest developments in chronology of the earliest ceramics in China, one of the key regions in the world in terms of the origin of pottery-making, are critically evaluated.

INTRODUCTION

The issues of Neolithization and the spatiotemporal features of the pottery/agriculture spread in Eurasia are among the most hotly debated in Old World archaeology (e.g. Jordan and Zvelebil 2009; Kuzmin et al. 2009; Hartz et al. 2011; Price and Bar-Yosef 2011). The term "Neolithic" was originally coined by Sir John Lubbock who indicated polished tools and to some extent pottery and agriculture as the main criteria of this period (Lubbock 1878). Later on, agriculture was accepted as the main benchmark of the Neolithic (e.g. Childe 1935:7). Discussion of this issue can be found in several sources, including Thomas (1993) and Kuzmin (2010a). As a result, there is an ambiguity with the definition of the term "Neolithic" in Eurasia: while in Levant and Europe it means first of all the presence of agriculture, in East Asia and adjacent regions pottery is the main criterion for the determination of the Neolithic (see discussion in Kuzmin 2010a,b). In order to understand the spatiotemporal relationship between pottery and agriculture in prehistoric Eurasia at the first degree of approximation, information about the timing of their appearance in key regions was collected and analyzed. This article presents the results of the study and its initial interpretations.

MATERIAL

Georeferenced data on the chronology for the appearance of agriculture (i.e. plant cultivation) and pottery were collected from published sources for Eurasia (Table 1). It should be emphasized that only regions with an early presence of both phenomena were selected, because in significant portions of northern Eurasia agriculture was introduced either quite late (in Bronze and Iron ages) or never practiced (see Figure 1). The values are expressed in calendar ages before present (cal BP) for the appearance of pottery (A_{pot}) and the invention/introduction of agriculture (A_{agr}); the difference between them is therefore $A_{pot–agr}$ (Table 1). After the GIS-based mapping, the localities with both A_{pot} and A_{agr}, and their $A_{pot–agr}$ values, were positioned, and isolines were generated for visualization by simple approximation between points.

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Table 1 Ages for appearance of pottery (A_{pot}), agriculture (A_{agr}), and their difference ($A_{pot-agr}$) for some regions in Eurasia, in calibrated yr ago (cal BP).[a]

Region	A_{pot}	A_{agr}	$A_{pot–agr}$	Reference
ASIA				
Japanese Islands	16,100	6000–4400	+10,100–11,700	Crawford (2011); Nakamura et al. (2001)
North China	12,000	10,000	+2000	Kuzmin (2006); Lu et al. (2009); Price and Bar-Yosef (2011)
South China	18,300	6000–3400	+12,300–14,900	Boaretto et al. (2009); Fuller et al. (2007b); Zhang and Hung (2010, 2012)
Korean Peninsula	7700	5500	+2200	Lee (2011)
Russian Far East (Primorye)	12,800	5300	+7500	Kuzmin et al. (2009)
Russian Far East (Amur River basin)	15,700	3200	+12,500	Kuzmin et al. (2005)
Transbaikal	13,400	3200	+10,200	Aseev (2003); Kuzmin and Vetrov (2007); Tsybiktarov (2003)
Trans-Urals and Western Siberia	8000	3300	+4700	Chairkina and Kosinskaia (2009); Ryabogina and Ivanov (2011)
Mainland Southeast Asia	6400–4500	4300	+200–2100	Higham (2002); Higham et al. (2011); Nguyen et al. (2004)
Island Southeast Asia (without New Guinea)	5000–3500	3500	+1500–0	Denham (2011); Paz (2005); Spriggs (2003)
New Guinea	6300	7000	–700	Denham (2011); Spriggs (2003)
Southwest Asia (Levant)	8000	11,500	–3500	Bar-Yosef (2001); Price and Bar-Yosef (2011)
Syria	8500	12,500	–4000	Akkermans and Schwartz (2003:102); Moore et al. (2000); Nesbitt (1999)
Anatolia	8500	8500	0	Özdoğan (2011)
Cyprus	6500	10,800	–4300	Manning et al. (2010); Peltenburg et al. (2001)
Central Asia (Turkmenistan)	7900	7900	0	Harris (2010)
Central Asia (Kazakhstan)	6600	4300	+2000	Mertz (2008); Frachetti et al. (2010)
Western India and Pakistan	7900	8900	–1000	Jarrige et al. (2006); Fuller and Rowlands (2011)
South India	5500	4500	+1000	Fuller (2011); Fuller et al. (2007a)
EUROPE				
The Balkans	9000–8500	9000–8500	0	Whittle (1996)
Bulgaria	8000	8000	0	Marinova (2007)
Ukraine and Moldavia	7700[b]	7300	+400	Lillie and Richards (2000); Yanushevich (1989)
Southern Russian Plain	7300	4200	+3100	Kremenetski (2003); Timofeev et al. (2004:76)
Southern Urals	8700	3700	+5000	Matyushin (2003); Hanks et al. (2007)
Eastern Russian Plain	8600–7700	3700	+4000–4900	Anthony (2007:142); Hanks et al. (2007); Zaitseva et al. (2009)
Central Russian Plain	7600	3600	+4000	Dolukhanov et al. (2009:248); Lebedeva (2005); Tsetlin (2008); Zaretskaya and Kostyliova (2008)
The Mediterranean region	8500	8500	0	Forenbaher and Miracle (2005)
Coasts of Spain and Portugal	7500–7000	7500–7000	0	Zilhão (2000)
Region of LBK pottery	7900–7500	7900–7500	0	Bonsall et al. (2004); Whittle (1996)
Low Countries	7500	6500	+1000	Price (2000)
British Isles	6000	6000	0	Brown (2007); Whittle (1996)

[a]Conversion of ^{14}C dates to calibrated ages follows IntCal09 curves (see Reimer et al. 2009), rounded to the next 100 yr.
[b]Reservoir-corrected (~500 yr); see Lillie et al. (2009).

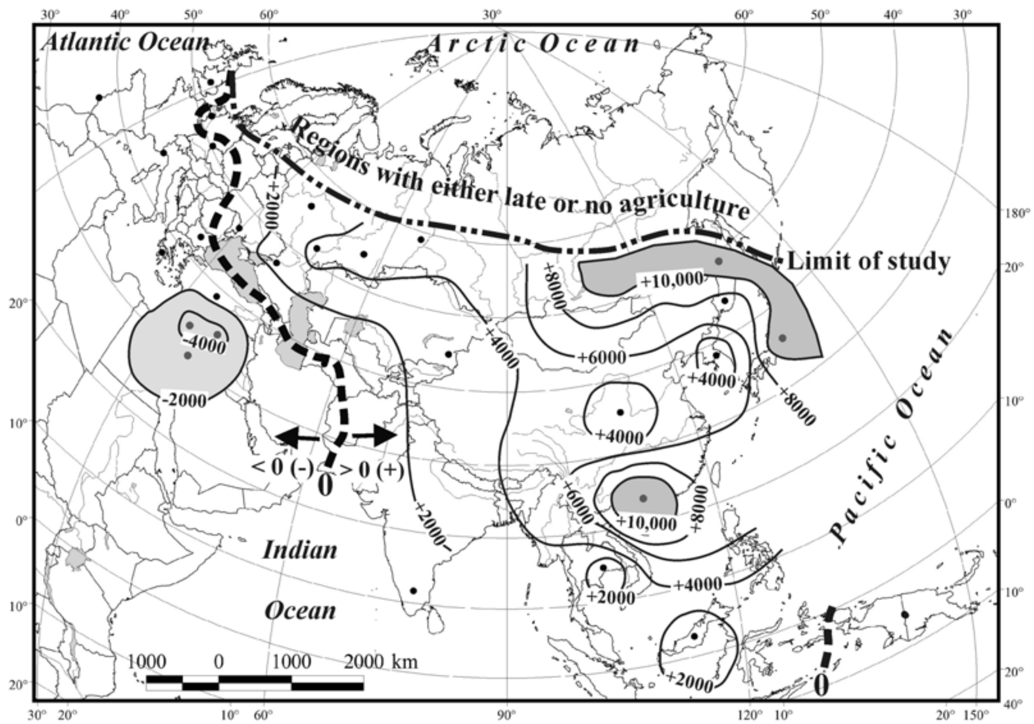

Figure 1 Isolines showing the temporal relationship between the appearance of pottery and agriculture ($A_{pot–agr}$) in Eurasia; key regions are indicated by dots, see original data in Table 1. Dark gray areas: the most positive $A_{pot–agr}$ values; light gray area: the most negative $A_{pot–agr}$ values.

RESULTS AND DISCUSSION

Relationship Between Appearances of Pottery and Agriculture in Eurasia

The spatiotemporal relationship between the 2 major criteria of Neolithization, pottery and agriculture, can be described as follows. For East Asia, the $A_{pot–agr}$ varies from about +13,000 to +2000 yr; the extremely large positive $A_{pot–agr}$ values for southern China, the Japanese Islands, and the Amur River basin of the Russian Far East are noteworthy (Figure 1). In mainland Southeast Asia, the value is about +200–2100 yr, while in island Southeast Asia it is about +1500–0 yr. In different parts of Siberia, the $A_{pot–agr}$ varies from +10,200 yr (Transbaikal) to +4700 yr (Trans-Urals and western Siberia). A similar trend is common for some parts of central Asia (Kazakhstan, +2000 yr) and southern India (+1000 yr). For eastern Europe, the $A_{pot–agr}$ values have the same pattern as East Asia: +3100 yr for the southern Russian Plain; +5000 yr for the southern Urals; +4900–4000 yr for the eastern Russian Plain (middle and lower courses of the Volga River); and +4000 yr for the central Russian Plain (Figure 1).

For the Near East, the $A_{pot–agr}$ values are always negative: about –3500 yr for the Levant; –4000 yr for Syria; and –4300 yr for Cyprus (Figure 1). Further west (and sometimes northeast), the $A_{pot–agr}$ is almost equal to zero because agriculture and pottery were brought together as a "Neolithic package." These regions include Anatolia and Turkmenistan in Asia; the Balkans and Bulgaria, the Mediterranean and Iberian coasts, the regions with LBK pottery (primarily Hungary, Croatia, Serbia, Austria, southern and central Germany, and the Czech Republic), and the British Isles, all in Europe.

There are slightly positive $A_{pot-agr}$ values for the Low Countries (northern France, Belgium, and the Netherlands: +1000 yr); and Ukraine and Moldavia (+400 yr). The situation for northern Europe (northern part of Germany and Poland, Denmark, and Fennoscandia) is more complicated and without a clear trend (e.g. Zvelebil 1998; Hartz et al. 2011), and should be the focus of future study.

Based on the data presented, 2 major trajectories in the Neolithization of Eurasia can be established. In most parts of Asia where pottery definitely preceded agriculture, the 'East Asian' scenario with positive $A_{pot-agr}$ values is common (Figure 2). In southwest Asia and central/western Europe, the 'Levantine' scenario with negative $A_{pot-agr}$ values prevails. Some parts of eastern Europe and central Asia (Turkmenistan) were also influenced by the Levantine agricultural core (Figure 2). A similar picture is presented by Fuller and Rowlands (2011:38–42) who plotted the chronology for the earliest pottery and agricultural complexes in Eurasia and northern Africa.

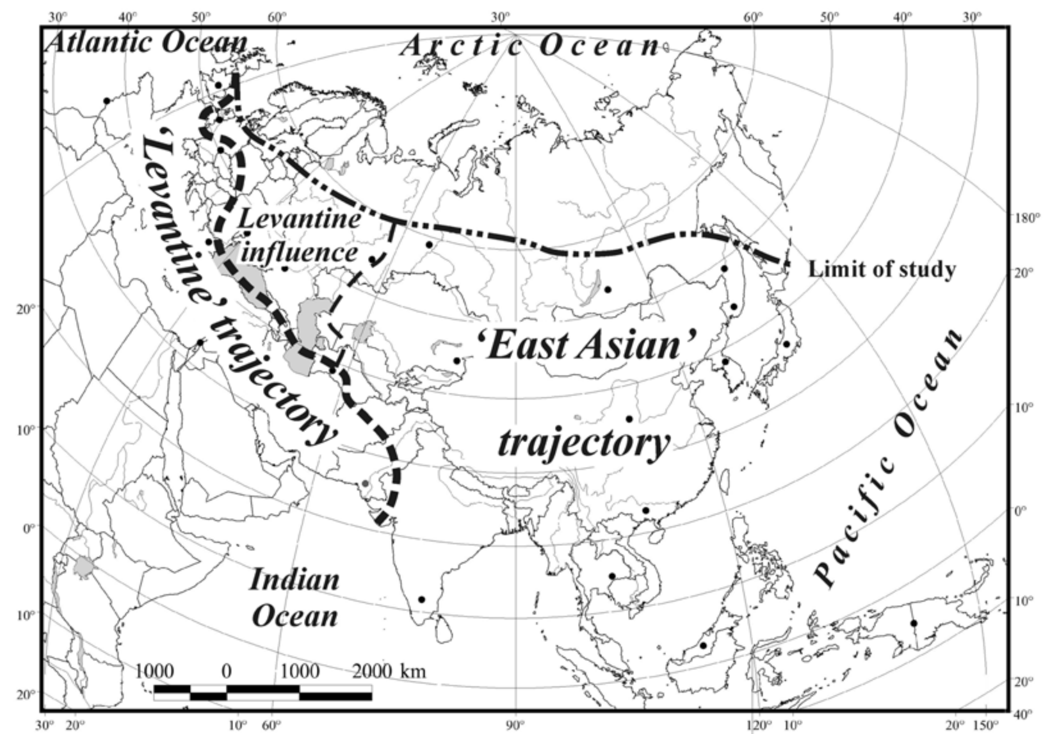

Figure 2 Location of regions belonging to 2 major trajectories in the Neolithization of Eurasia

When a spatiotemporal analysis for the appearance of pottery and agriculture in Eurasia is conducted, there should be no *a priori* assumptions in terms of the mechanism of pottery emergence and spread. While it is plausible to model the diffusion of wheat/barley-based agriculture from the Levantine 'core' to Asia Minor and Europe with the help of ^{14}C dates (e.g. Clark 1965; Gkiasta et al. 2003; Pinhasi et al. 2005; Russel 2004; see also the latest examples: Lemmen et al. 2011; Bocquet-Appel et al. 2012), the application of similar approach to pottery does not seem correct. It was repeatedly shown that the Childean diffusionist paradigm (e.g. Childe 1954:238–44) is unable to explain the appearance of several important cultural phenomena in Europe (e.g. Renfrew 1969:153, 1973; see also Trigger 2006:259–60).

Some scholars, however, still employ the diffusionist approach when attempting to understand the "roots" of eastern, central, and western European pottery, and continue to derive its origins from the eastern regions of Eurasia (e.g. Davison et al. 2006, 2007; Dolukhanov and Shukurov 2004; Dolukhanov et al. 2009; Piezonka 2011). In terms of eastern Europe, the localization of the "center" of origin for hunter-gatherer pottery in the middle course of the Volga River from where it spread throughout the Russian Plain (Davison et al. 2007:11, Figure 4f; see also Piezonka 2011; Hartz et al. 2012) is unproven by solid archaeological data (e.g. Tsetlin 2008; Vybornov 2008; Tsvetkova 2011). Before the genetic relationship between the early pottery types (Elshanka [Yelshanian] and Verkhnevolzhskaya [Upper Volga]) and the later ones (Narva, Valdai [Valday], and Serteya [Serteja]) is explicitly shown, any modeling would be unhelpful. Therefore, the use of the pottery origin concept in a single place and its subsequent dispersal in Eurasia (i.e. the process of Neolithization) is an oversimplification of cultural processes (see Kuzmin 2009:152; Kuzmin et al. 2009:892–4).

The Age of the Earliest Pottery in China (the Latest Developments)

Recently, Wu et al. (2012) published new data on the chronology of Xianrendong Cave in southern China. According to them, the ^{14}C age of the earliest pottery-bearing component of the Western Section is ~16,170–17,420 BP, and of the Eastern Section, ~16,100–17,460 BP. If true, these dates would make the pottery from Xianrendong significantly older compared to that from Yuchanyan Cave in the same large region, with associated ^{14}C dates of ~14,800 BP (Boaretto et al. 2009). However, some critical comments are necessary before acceptance of the pottery from Xianrendong Cave as the oldest in southern China in particular, and in the world in general.

The most complicated situation is still observed for the Western Section of Xianrendong where the disturbance of cultural layers and subsequent inversions in ^{14}C chronology were detected previously (MacNeish et al. 1998:39; see also Kuzmin 2006:365). Unfortunately, the new study by Wu et al. (2012) was unable to overcome the existing problems. First of all, no artifacts were collected during the cleaning up of the profiles at Xianrendong Cave (Wu et al. 2012:1697), and it is impossible to ascertain that the bone samples collected by Wu et al. (2012) are directly associated with the potsherds. This is in contrast to a previous study (MacNeish et al. 1998) when researchers conducted small-scale excavations and obtained reliable material for ^{14}C dating in direct association with the earliest pottery.

Second, the treatment of some ^{14}C dates obtained previously (see MacNeish et al. 1998; MacNeish 1999) seems to be biased. For example, the ^{14}C value of 12,530 ± 140 BP (BA95145) from Layer 3C1A, which was found to be the single reliable age estimate for this stratum (MacNeish et al. 1998: 39), is not included in the list of ^{14}C dates; the rest of the ^{14}C values from this layer are significantly older, ~14,240–16,340 BP (see Wu et al. 2012:1698–9, Table 1). Some other ^{14}C ages which do not fit the site's chronology are determined as outliers: ~15,180 BP from Layer 3C2; ~18,520 BP from Layer 3C1B; and ~12,420 BP from Layer 3B2 (Wu et al. 2012:1699). It should be mentioned that the ^{14}C values from layers 3C2 and 3B2 were generated on relatively large pieces of human bones (weight from 1.1 to 9.1 g; see MacNeish and Libby 1995:75), and discrepancies in their age relationship with the site's stratigraphy and other ^{14}C dates from these layers, in my opinion, show clearly the disturbed nature of cultural deposits at the Western Section as established previously (see MacNeish et al. 1998). Nevertheless, both this information and a critical evaluation of ^{14}C dates from Xianrendong Cave (Kuzmin 2006:365) were ignored by Wu et al. (2012).

Third, the micromorphological study of cultural deposits comprising the Eastern Section [Profile] of Xianrendong Cave resulted in the conclusion that "...it seems that most of the accumulation of the deposits in the Eastern Profile of the site do not represent in place human occupations or even occupation in this space" (Wu et al. 2012, Supplementary Material S2, p 21; see also Wu et al. 2012: 1698). This makes the series of ^{14}C dates from the Eastern Section very unreliable, and they should be rejected because they came from disturbed contexts and thus do not represent material for ^{14}C dating collected *in situ*.

Recently, Liu and Chang (2012) accepted the early age of pottery (~13,080 BP) from the Hutouliang site in northern China following Yasuda (2002), and claimed it as the earliest pottery-bearing complex in the region. They indicated that the ^{14}C date was obtained on the pottery itself (Liu and Chang 2012:50), but this seems to be a misreading of Yasuda's (2002:127) original information: "The date for the *pottery yielding stratum* from the Hutouliang is 13,080 ± 200 ^{14}C yr BP (16,300–14,700 cal. yrs. BP) (GrA-10460, Yasuda, unpublished)" (italics are mine). No record about the material dated exists in the archive of the AMS Laboratory of Groningen University (the Netherlands) where this ^{14}C value was measured (J van der Plicht, personal communication, 2005).

As noted before (Kuzmin 2006:366), this ^{14}C date is highly dubious and cannot be taken into account before more information is provided. No details about the stratigraphy of the Hutouliang site are given in the primary source (Guo and Li 2002). It is surprising that in this publication several pages are devoted to the Nanzhuangtou site with a pottery-associated ^{14}C date of ~10,200 BP, while the data on the Hutouliang site are given in a few paragraphs (see Guo and Li 2002:199). It is worth mentioning that the Hutouliang site consists of at least 9 localities (e.g. Gai and Wei 1977) ranging in ^{14}C age from ~10,690 to ~5625 BP, and without details of the site's provenance it is impossible to understand the validity of Yasuda's (2002) and Liu and Chang's (2012) conclusions. Unfortunately, Liu and Chang (2012) ignored a critical evaluation of the chronology for the Hutouliang site by Kuzmin (2006) as well as views expressed by Chinese archaeologists before (e.g. Zhao 1998) and after (e.g. Lu 2010) the announcement of the "early" pottery-related ^{14}C date from Hutouliang by Yasuda (2002).

Based on the evaluation of new data from China, it can be concluded that the disturbed nature of the Xianrendong Cave cultural layers does not allow us to accept the ^{14}C dates associated with the pottery older than ~15,000 BP, and most likely older than ~13,500 BP (e.g. MacNeish et al. 1998:39). MacNeish (1999:238) concluded that the earliest pottery phase Xian Ren in Jiangxi Province of China "…dates between 11,200 and 14,000 BP." The best-proven site in southern China with the oldest pottery is still Yuchanyan Cave, dated to ~14,800 BP (Boaretto et al. 2009; see review in Kuzmin 2010b). In northern China, the Nanzhuangtou site with an associated ^{14}C date of ~10,200 BP is the earliest reliable evidence of pottery-making (e.g. Wu and Zhao 2003:19; Kuzmin 2006).

CONCLUSION

It seems that the "agricultural" Neolithic has its origin in Levantine societies at ~11,500–12,500 cal BP, with a subsequent spread after ~9000 cal BP toward central/western Europe and some regions in central and south Asia. The "pottery" Neolithic is to a major extent an independent invention, with several "centers" for the emergence of pottery-making technologies identified after ~18,300 cal BP throughout Eurasia. Two main (and very different!) ways in the Neolithization process in Eurasia are therefore obvious (e.g. Kuzmin 2010a). Recently, Shelach (2012:1645) mentioned "... a fundamental difference in the socioeconomic development of the two regions [East Asia and Levant]." Probably, the clearer term for the pre-agriculture "Neolithic" complexes in East Asia would be "pottery-bearing hunter-gatherers" or the like, similar to the Jomon in Japan and Chulmun in Korea (e.g. Barnes 1999:71).

A further in-depth analysis of the pottery-agriculture relationship in Eurasia should be conducted after rigorous evaluation of the existing information and with non-biased viewpoints, in order not to "mix apples and oranges." The concept of "center(s)" for the origin and spread of pottery in non-agricultural societies of Eurasia contradicts the primary evidence.

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