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Soil, Hands, and Heads: An Ethnoarchaeological Study on Local Preconditions of Pottery Production in the Wei River Valley (Northern China)

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ABSTRACT

This study combines an analysis of archaeological remains, geographic background, and ethnoarchaeological research to gain insights into preconditions and processes of pottery making in northern China during the Yangshao period (5000–3000 BCE). Previous research on Neolithic ceramics from this region focused on typochronology while ethnoarchaeological research has largely been limited to southern China, where geology, geomorphology, and thus resource availability are entirely different. In this study, for the first time we connect ethnographic research in northern China with an analysis of local archaeological ceramics and raw material sources to gain insight into patterns of raw material choice, ceramic production and distribution, and their connection with geographic preconditions. In this fashion, we are able to show that potters, both past and present, systematically sought out suitable raw material and worked close to abundant water and clay resources and major routes of distribution. Standardization is shown to be a problematic concept as ceramic measurements may vary even in large-scale specialized production, but clay recipes and procedures may be standardized. It also becomes clear that in recent times, migrating or travelling potters are responsible for the spread of ceramic production techniques and types. Similar processes may have taken place in the past as well.

1. Introduction

As they are ubiquitous in the material record, ceramics have long been a major concern of archaeological research. To gain further insight into processes of ceramic production and related sociocultural issues, it has become common to refer to ethnographic data and to conduct ethnoarchaeological studies (e.g., Arnold, 1985, 2015; Kramer, 1985a; Longacre, 1991; Skibo, 1992; Stanislawski, 1978). In research on the Chinese Neolithic, where ceramics are abundant, radiocarbon dates few, and chronological schemes only partially formed, ceramic analysis is of crucial importance to establish relative and absolute dates of archaeological finds, but ethnoarchaeological explorations relating to ceramic production have so far been limited. The few existent ethnoarchaeological studies focus on the origin of ceramic production or details of ceramic technology (e.g., Fu, 2011; Li Yangsong, 1959; Wang, 2008), but they rarely discuss greater social, economic, or cultural issues. (For rare exceptions, consult Underhill, 2003 and Hung Ling-yu's unpublished research.) Furthermore, they do not consider local resource availability, mostly because ethnoarchaeological studies are usually conducted amongst the ethnic minorities in Southwest China, while archaeological research on ceramic production is concentrated on the Central Plains and northern China in a completely different environment. The only ethnoarchaeological study conducted so far in the Central Plains did not connect the ethnographic with the archaeological data, so the conclusions remain ethnosociological rather than archaeological (Guo and Wang, 2014). For ceramic production, the availability of resources—and thus the local geology and geomorphology—is vital; thus examples from southern China—though valuable for insights into production organization and social components—have their limitations. The results of ethnoarchaeological research done in southern China are thus quoted and considered throughout this paper, but in terms of raw material availability and choice, the local ethnoarchaeological research presented here provides crucial new insights.

This study combines an analysis of archaeological remains with ethnoarchaeological work and an overview of the environmental and social background of both to gain insights into preconditions and processes of pottery making in the Wei River valley in northern China during

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the Yangshao period (5000–3000 BCE). This choice of research topic was sparked by ongoing fieldwork at the middle Yangshao site of Yangguanzhai, Gaoling County, Shaanxi Province. Here, over a decade of excavations brought to light a large number of kilns, ceramic debris, and refuse pits, indicating that the site may have served as a ceramic production centre (Shaanxi, 2009; Shaanxisheng 2009). Stylistically, the ceramics have been dated to the Miaodigou (4000–3500 BCE) and Banpo IV (3400–2900 BCE) periods, while recent radiocarbon dates reflect an occupation period of less than 500 years, from circa 3600 to circa 3100 BCE (Ye et al., 2017). Nevertheless, the deposits at Yangguanzhai are thick and show intensive occupation, mostly in the form of large numbers of refuse pits, many of them 1–2 m in diameter, up to 3 m deep, and filled with layers upon layers of ceramic sherds, suggesting intensive consumption necessitating intensive production.

Prior to this discovery, it had been assumed that most Yangshao-period ceramic production took place on a household level, without elite involvement or supra-local distribution networks (Underhill, 2002:132–33, 182–86), and a study of ceramic material from Dongguang has confirmed this assumption, at least for the Yuanqu Basin during the mid-fourth millennium. However, the large amount of ceramics found 350 km farther west at Yangguanzhai, and at a slightly later date, forces us to reconsider this assessment. Furthermore, it prompts a number of specific questions:

1 How was ceramic production organized at the site?
2 How far were the wares distributed?
3 How did the site fit into the ancient landscape, both natural and sociocultural?
4 Why was it only in use for a relatively short period of time compared with other Neolithic sites in northern China?

To answer these questions, it is crucial to consider the nature of ceramic technology, potential organizational patterns of production and distribution, and the reflection of both in the archaeological record. As van der Leeuw (1977) has pointed out, several aspects of the production process are key in understanding the organization of production, most importantly (1) the distribution of raw materials, (2) the nature of the technology, and (3) the training and skills required. Further aspects mentioned by Costin (1991):(3) are (4) the nature and level of the demand (both actual and as perceived and acted upon by the potter) and (5) the logistics of distribution. We furthermore would like to add (6) the relations between potters in a given region in terms of access to raw materials and customers/distribution networks. In both its archaeological and ethnoarchaeological parts, the present study will thus emphasize the natural and social environment—that is, the local preconditions of ceramic production.

In the following sections, we first introduce the local environment shared by potters past and present and then discuss the site of Yangguanzhai, focusing on evidence for ceramic production but also placing this particular craft within its economic, social, and cultural context. We then provide a preliminary analysis of the archaeological material, aiming to understand the nature and organization of ceramic production at Yangguanzhai. As the site is still undergoing excavations and the finds have not been fully published, all results are preliminary, but they are sufficient to inform our ethnoarchaeological work. In that part of our research, we focus on aspects of ceramic production that can be identified archaeologically and help in answering our core questions, but we also record other details that may be of use for future research on ceramic production both in China and other parts of the world. The present paper thus contributes to our understanding of the organization and local and regional integration of ceramic production during the Yangshao period in general and at Yangguanzhai in particular. It also provides a body of ethnographic material for future studies and a case study of how both types of evidence can be connected with each other and with information on the natural and social environment.

2. The environment shared by potters past and present

It is crucial to detail the nature of the regional environment to understand underlying reasons for location choices made by present potters and how these may have been related to choices made by potters in the past. The geographic data under consideration here encompass geomorphology, climate, and access to resources such as water, clay, and wood or other types of fuel. The Wei River valley, in which the site of Yangguanzhai is located, is one of the focal points of early cultural development in China. The Wei River originates in the Niaoshu Mountains in Gansu and continues over a distance of 818 km with a drainage area of 135,000 km^2 before it flows into the Yellow River valley (Fig. 1). The Jing River, a tributary of the Wei River, is the watercourse closest to Yangguanzhai. It is 455.1 km long, it has a drainage basin of 45,000 km^2, and its flow varies significantly throughout the year. At present, Yangguanzhai is located about 1 km north of the northern riverbank.

Both the Wei River and its tributaries carry heavy silt loads and have changed their courses many times, with floods occurring at least biannually (Huang et al., 2012; Shuilibu, 1979:248; Wang Qing, 1993). As Zhang et al. (2007:772) pointed out, in this region the choice of location for Neolithic settlements always “reflects a balanced relationship between the need of humans to use the river and the need to avoid the river flood.” Indeed, Neolithic sites are densely distributed throughout the Wei and Yellow River valleys and are mostly located in close proximity to the rivers but not directly on the riverbanks (Guojia and Shaanxisheng, 1998) (Fig. 2).

Paleoclimatic research shows a Mid-Holocene Climatic Optimum between 8500 and 2100 cal. BC with temperatures of around 3 °C above the current average, more than 600 mm annual precipitation, and subtropical forests covering at least part of the Wei River valley (Winkler and Wang, 1993). At irregular intervals, changes in monsoonal patterns led to either droughts or marked wet periods (An et al., 2000). Such an event of environmental deterioration around 4000–3000 cal. BC—at the onset of the Miaodigou phase and around the time of the establishment of Yangguanzhai—may have been one of the factors behind shifts in settlement patterns and various cultural changes (Dai, 2006; Huang et al., 2002; Liu and Chen, 2012:34, 169). The archaeological record of this period shows a rapid population increase in Shaanxi and Shanxi, while Henan was sparsely inhabited (Henansheng and Guojia, 1991; Shaanxi, 2009), likely due to the high precipitation and expanding lakes in the region that made the establishment of large settlements impossible (Liu, 2004:26). An abrupt cooling during the third millennium BC freed those areas of their water cover, while monsoonal evergreen forest gave way to coniferous and herbaceous plants (Yi et al., 2003). At that point, population densities in the present-day Henan and Shandong regions reached a peak, but population numbers in the alluvial plains of central Shaanxi declined (Liu, 2004:27, 221–22). Considering the dates and overall local trends, the establishment of the settlement of Yangguanzhai and its subsequent discontinuation may both be connected with these environmental changes. It has also been suggested that flooding events may have been a reason for the abandonment of the site (Hu, 2017; Ye and Hein, 2020).

3. The archaeological context

3.1. Yangguanzhai and Yangshao

The site of Yangguanzhai was discovered in 2004 in connection with the expansion of industrial areas in Gaoling County, about 25 km north of Xi’an. When subsequent excavations brought to light an anthropogenic trench, it was interpreted as a moat, making Yangguanzhai one of the earliest moated sites in China. Yangguanzhai was thus designated one of the most important archaeological finds of 2008 and has been under excavation since (Fig. 3). So far, only preliminary reports have been published (Hu et al., 2011; Shaanxi, 2009; Wang and Lee, 2010).

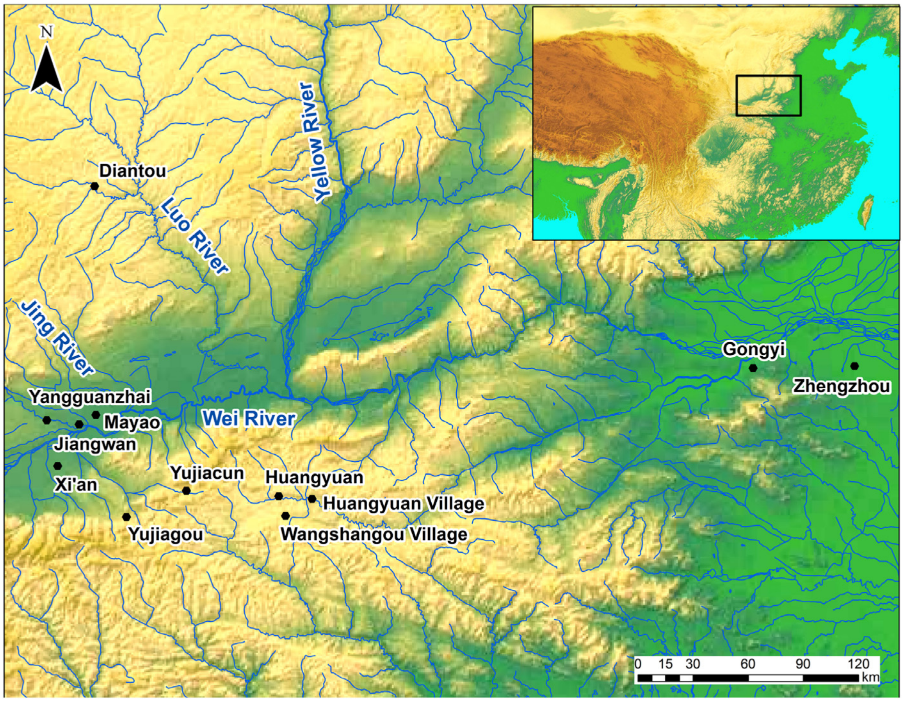

Fig. 1. The Wei River and its tributaries with all locales mentioned in the text.

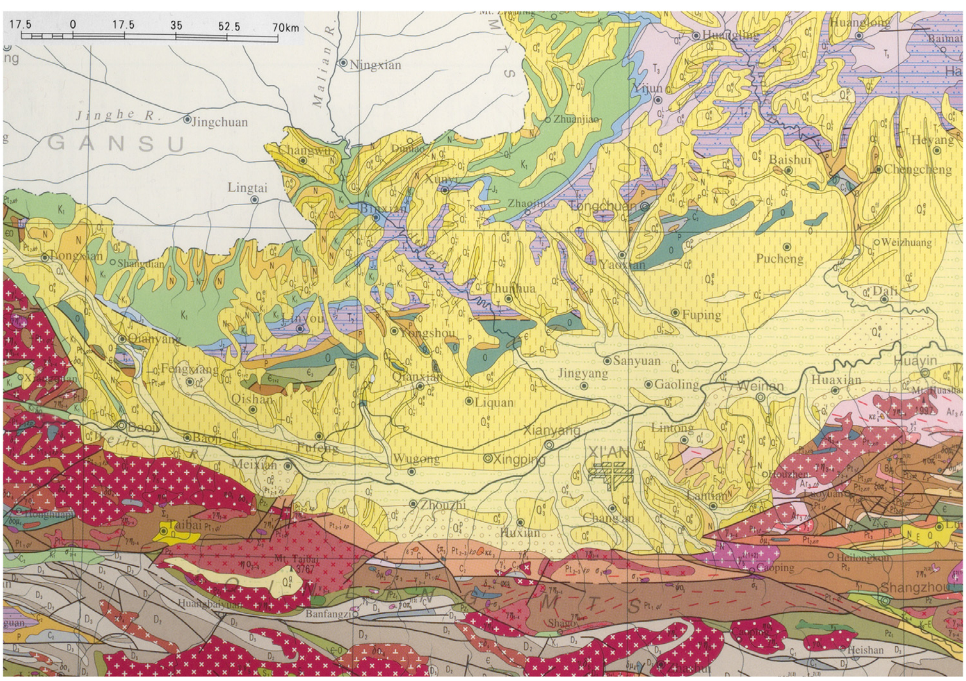

Fig. 2. Geology of the Wei River valley (Compilation Committee of Geological Atlas of China, 2002:318–19). The yellow areas are loess overlaying a varied geology, including Tertiary, Cretaceous, Jurassic, and Triassic deposits of sandstone, mudstone, and limestone, as well as small amounts of Silurian shale, schist, and siltstone, and granite and quartz diorite deposits.

Up to the present, excavations have revealed 56 houses, 861 refuse pits, 23 pottery kilns, 41 child burials, two ditches, and one water reservoir (Zhang, 2014). The object finds comprise considerable amounts of ceramics (more than 7000 objects have been reconstituted, but disassociated sherds make up the majority of the material); some stone and bone tools; various ornaments made of stone, ceramic, bone, and shell (353 stone objects, 303 bone objects, 16 shell objects); and animal bones and botanical remains of both domesticated and wild species, indicating a mixed form of subsistence (Zhang et al., 2010). The site occupies an area of about 80 ha, of which about 1.8 ha have been excavated (Hu et al., 2011; Shaanxi, 2009; Shaanxisheng, 2011; Wang and Lee, 2010).

The moat is 1945 m long, has a depth of 2–4 m, and encircles 24 ha, accessible through a single entrance. The moat is often interpreted as protective, but recent geomorphological research has shown that it served as a place to deposit trash; the more refuse came to rest in the moat, the narrower it became, reducing any possible protective function (Fox, 2014). Another option is that at least for some time, the moat served as a reservoir for water, a resource crucial for ceramic production, but was later filled with refuse.

Based on ceramic typology, Yangguanzhai has been dated to middle to late Yangshao (Hu et al., 2011). Yangshao is characterized by painted pottery (amphorae, jars, and bowls with black painted design) accompanied by corded ware and undecorated vessels (Wu et al., 1983;

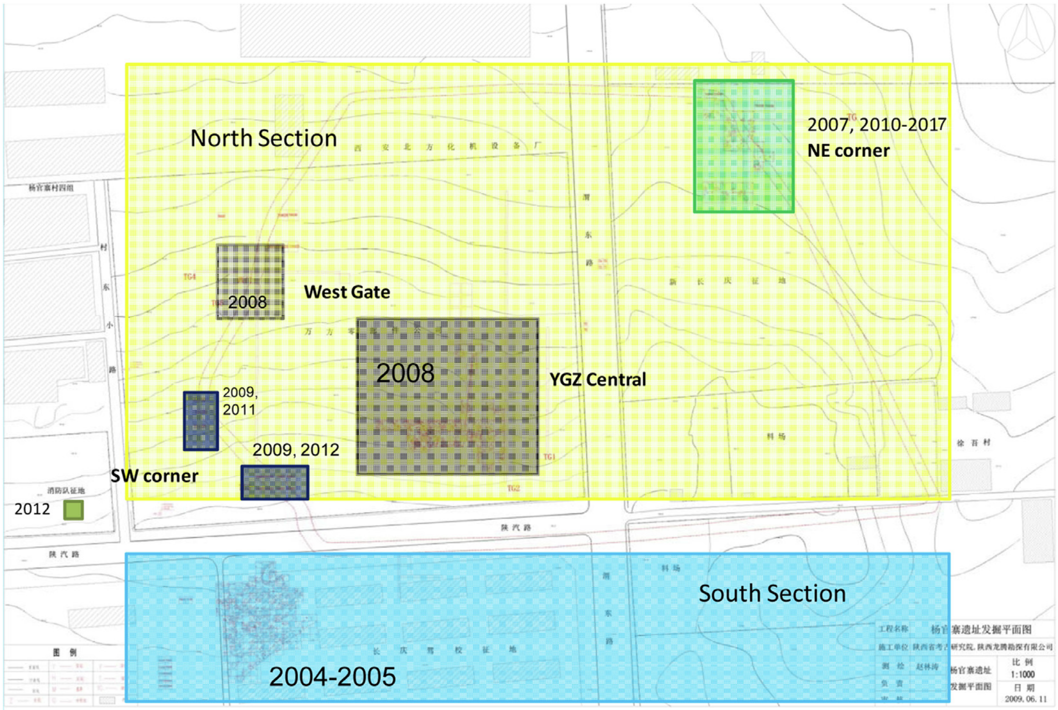

Fig. 3. Excavated areas at the site of Yangguanzhai.

Yan, 1989). Yangshao culture remains are commonly structured into three phases: the early period or Banpo phase (5000–4000 BCE); the middle or Miaodigou phase (4000–3500 BCE), which saw a wide expansion of Yangshao material culture and is represented by the site of Xipo; and the late phase (3500–3000 BCE), which saw the emergence of a more complex settlement system and the first rammed-earth structures (Dai, 2006: 3–7; Liu and Chen, 2012:169–212).

The northern part of the site of Yangguanzhai is dominated by Miaodigou-type ceramics, while Banpo IV remains are especially common in the southwest. However, these later remains also appear in most other parts of the settlement, indicating that it expanded in size (Fig. 4). Recent radiocarbon dates suggest that the site spans less than 500 years (circa 3600–3100 BCE) (Ye et al. 2017), much shorter than most other Yangshao sites (e.g., Yan, 1989), with an abrupt discontinuation of settlement activity after the significant expansion during Banpo IV.

While the ceramic assemblage and some of the house structures observed at Yangguanzhai are similar to those of other middle Neolithic sites in northern China, there are striking differences in settlement size and layout. Yangshao settlements have been described in detail elsewhere, as has the evolution of Yangshao village organization (Peterson and Shelach, 2012). Yangguanzhai is considerably larger than earlier settlements in the Wei River valley, which usually measure about 5–6 ha. Middle Yangshao sites in western Henan can measure up to 40–90 ha, but they differ in structure from Yangguanzhai. They tend to consist of house clusters organized around a central plaza, with cemeteries and—rather limited—production facilities located outside the ditches, while at Yangguanzhai, ceramic production facilities are numerous and located within the ditches. Furthermore, according to the current state of excavation, there seems to be no clear organizational principle between the arrangement of buildings within the site. Outside Yangguanzhai, for the late Yangshao period, a few regional centers of up to 100 ha in size, with large central public buildings, can be distinguished from a number of medium-size central places, some of them surrounded by rammed-earth walls, and a large number of smaller sites (Liu, 2004:162–68; Liu and Chen, 2012:189–97).

Fig. 4. Miaodigou-phase (4000–3500 BCE) and Banpo IV–phase (3500–3000 BCE) ceramics from Yangguanzhai.

The exact place of Yangguanzhai within this emerging settlement hierarchy is still unclear. It is remarkable that the site is very large and moated, but the features near the moat do not follow any coherent organizational pattern. The houses are small round structures with postholes and a hearth, similar to the roundhouses at other Yangshao-period sites. On both sides of the moat, clusters of house remains have been observed; they are associated with kilns, child burials, and a large number of refuse pits. The southern part of the site outside of the moat revealed a row of cave dwellings, likewise associated with ceramic kilns, storage pits, and refuse pits but aligned in an orderly row, showing some organization that the earlier part of the site is missing (Fig. 5).

The proportions of stone tools and faunal and floral remains are low for a settlement site (Hu et al., 2011; Zhang et al., 2010), and—as will be demonstrated below—the number of refuse pits, wasters, and kilns reflects ceramic production on a scale that surpasses the needs of a single settlement. Based on this evidence, we argue that Yangguanzhai may have been a ceramic production centre, a hypothesis that is considered below in light of archaeological and ethnographic evidence.

3.2. The ceramics of Yangguanzhai: range of wares and chronology

As the site of Yangguanzhai is under continued excavation and the material found so far still awaits publication, at present statements about the spectrum of ceramic forms and quality are preliminary. For the current paper, descriptions are based on the 54 vessels described in detail in the preliminary excavation report and the 39 vessels and 10,299 sherds recovered from the 14 layers of the single refuse pit H85 during excavations conducted by our team in four seasons between 2012 and 2015. The ceramic types are summarized in Tables 1 and 2.

Nearly 60% of all ceramics are decorated; surprisingly, this applies particularly to the coarse ware, both reddish and grey varieties, while the grey fine ware tends to be undecorated, as is more than half of the reddish fine ware (Table 3; Fig. 6). However, the majority of reddish fine ware is burnished, so some surface enhancement has been applied to them as well. All painted ceramics were likewise burnished, but vessels carrying other types of surface treatment were not.

The main types of decoration observed are coarse and fine corded ware, appliqué bands, painted geometric decoration, whirl patterns, and fingernail impressions (Table 4; Fig. 7). The overwhelming majority of decoration on coarse ware consists of cord impressions, mostly the coarse variety; fine cord marks appear mostly on grey and more rarely reddish fine ware. Appliqué bands are less common, occurring only on ceramics fired in an oxidizing atmosphere, mostly on fine ware. Black painted decoration is always connected with red burnished fine ware. All other types of decoration are more common on fine reddish ware than on ware that is coarse or grey in color.

As far as ceramic forms are concerned (Fig. 4), the available data are too limited to suggest percentages for the relative frequency of different forms, but the most common forms seem to be:

1 Bowl forms mostly executed in reddish fine ware, high fired, highly burnished, and sometimes adorned with geometric ornamental bands executed in black paint on the upper third of the vessel surface
2 high pointed-bottom or more rarely flat-bottom flasks covered in corded ware patterns and executed in reddish or grey fine ware
3 Urns, including tall urns with straight bodies and urns with large openings and small bottoms, mostly made of burnished grey fine ware and some made of coarse grey ware with corded ware decoration
4 Various jar forms executed in coarse ware and sometimes with appliqué bands or flanges on the shoulder, possibly meant to help in handling the vessel

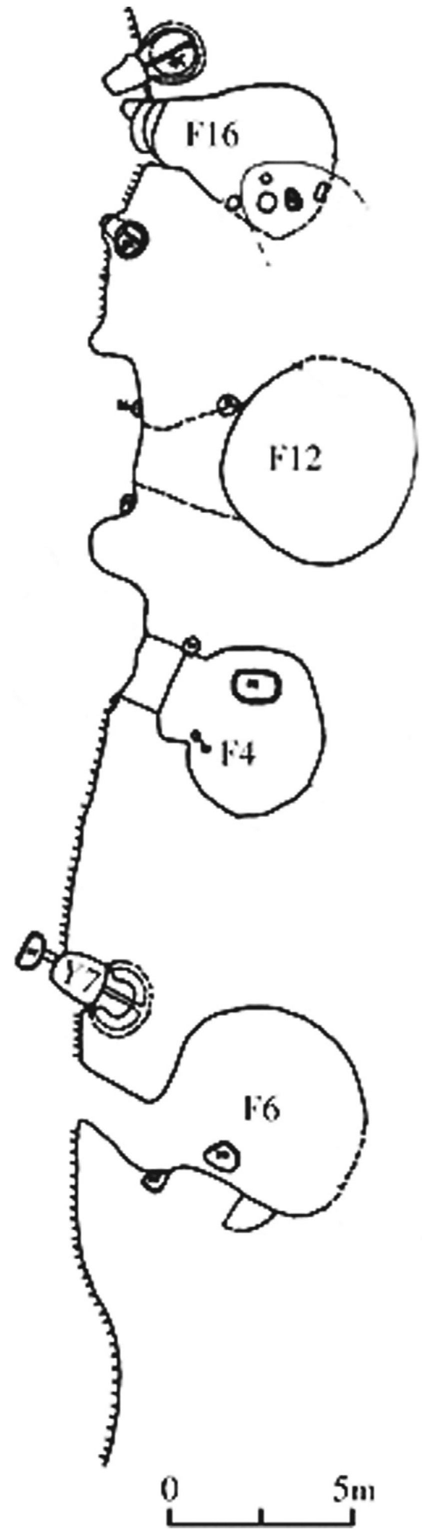

Fig. 5. Plan of the excavated features in the southern part of Yangguanzhai (after Shaanxisheng, 2011: Fig. 17).

Table 1
Ceramic Color and Quality of Finds from H85 Calculated by Number of Sherds.

	Fine Ware		Coarse Ware		All	
	Sherd Number	Percentage	Sherd Number	Percentage	Sherd Number	Percentage
Red	3680	52.1	1447	45.3	5127	49.9
Orange	1777	25.1	7	0.2	1784	17.4
Brown	523	7.4	240	7.5	763	7.4
Grey	1089	15.4	1503	47.0	2592	25.3
Sum	*7069*	*100.0*	*3197*	*100.0*	*10,266*	*100.0*

Table 2
Ceramic Colour and Quality of Finds from H85 Calculated by Weight of Ceramic Sherds.

	Fine Ware		Coarse Ware		All	
	Weight	Percentage	Weight	Percentage	Weight	Percentage
Red	50,244	49.3	32,097	48.4	82,341	48.9
Orange	30,778	30.2	880	1.3	31,658	18.8
Brown	5138	5.0	4550	6.9	9688	5.8
Grey	15,790	15.5	28,822	43.4	44,612	26.5
Sum	*101,950*	*100.0*	*66,349*	*100.0*	*168,299*	*100.0*

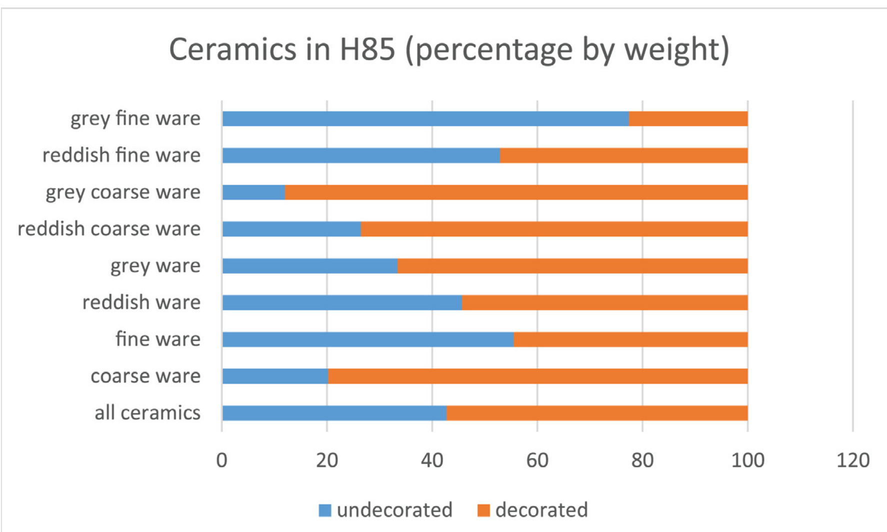

Fig. 6. Percentage of decorated and undecorated ceramics in H85 based on ceramic weight.

Table 3
Percentage of Decorated and Undecorated Ceramics in H85 Calculated by Ceramic Weight.

	Undecorated	Decorated
All ceramics	42.7	57.3
Coarse ware	20.2	79.8
Fine ware	55.5	44.5
Reddish ware	45.7	54.3
Grey ware	33.4	66.6
Reddish coarse ware	26.5	73.5
Grey coarse ware	12.0	88.0
Reddish fine ware	52.9	47.1
Grey fine ware	77.4	22.6

Other vessel types, such as lids, goblets, and vessel stands, are rare. Other pottery objects include rings, perforated knives produced from ceramic sherds, spindle whorls, and a potential potter's wheel.

Chronologically speaking, the earlier layers ascribed to the Miaodigou phase are dominated by fine ware, mostly in reddish color, but coarse ware is common too, both reddish and grey. Decorative patterns include coarse and fine corded ware as major decorative programs. Other patterns include various types of incisions, impressions, and appliqué bands, as well as geometric and more rarely zoomorphic motifs applied in black color onto reddish ceramic bodies. The geometric motifs mainly consist of dots, curved lines, and triangles, mostly arranged in bands running around the shoulder of the fine ware basins or bowls. Amphorae with cord design are also common; lids, stove models, and ceramic knives, rings, and spindle whorls are rare. The later-phase layers holding Banpo-style ceramic material are similar in ceramic quality and color, but grey ware becomes more common. Similar to the previous phase, a considerable number of ceramics are undecorated and the others show similar decorative patterns apart from painted ware, which seems to be lacking. Instead, three-dimensionally protruding animal or human faces appear in small numbers. The form spectrum is similar to the earlier phase, but the amphorae are somewhat wider, leading to a stouter appearance, and they lack the double-folded rim typical for Miaodigou amphorae. Ceramic knives and rings increase in number.

3.3. *Organization of production at Yangguanzhai*

3.3.1. *Material evidence of production techniques*

Material evidence of production processes at Yangguanzhai comprises kilns, tools, wasters, and finished products. The fine ware ceramics were made without adding temper. The coarse ware vessels have sandy inclusions consisting of irregular sharp-edged crystals of up to

Table 4
Percentage of Various Types of Decoration by Percentage of Decorated Ceramics Calculated by Weight in Grams.

	Reddish Coarse Ware	Grey Coarse Ware	Reddish Fine Ware	Grey Fine Ware	Coarse Ware	Fine Ware	Reddish Ware	Grey Ware	All
Corded ware	83.1	87.4	14.0	1.6	85.1	13.0	39.4	74.8	49.5
Fine corded ware	16.4	11.6	53.3	97.9	14.1	57.0	39.7	24.2	35.3
Appliqué band	0.4	0.0	13.1	0.0	0.2	12.0	8.5	0.0	6.1
Painted pottery	0.0	0.0	8.6	0.0	0.0	7.9	5.4	0.0	3.9
Whirl pattern	0.0	1.1	6.6	0.0	0.5	6.0	4.2	0.9	3.3
Fingertip impressions	0.2	0.0	4.4	0.5	0.1	4.1	2.9	0.1	2.1

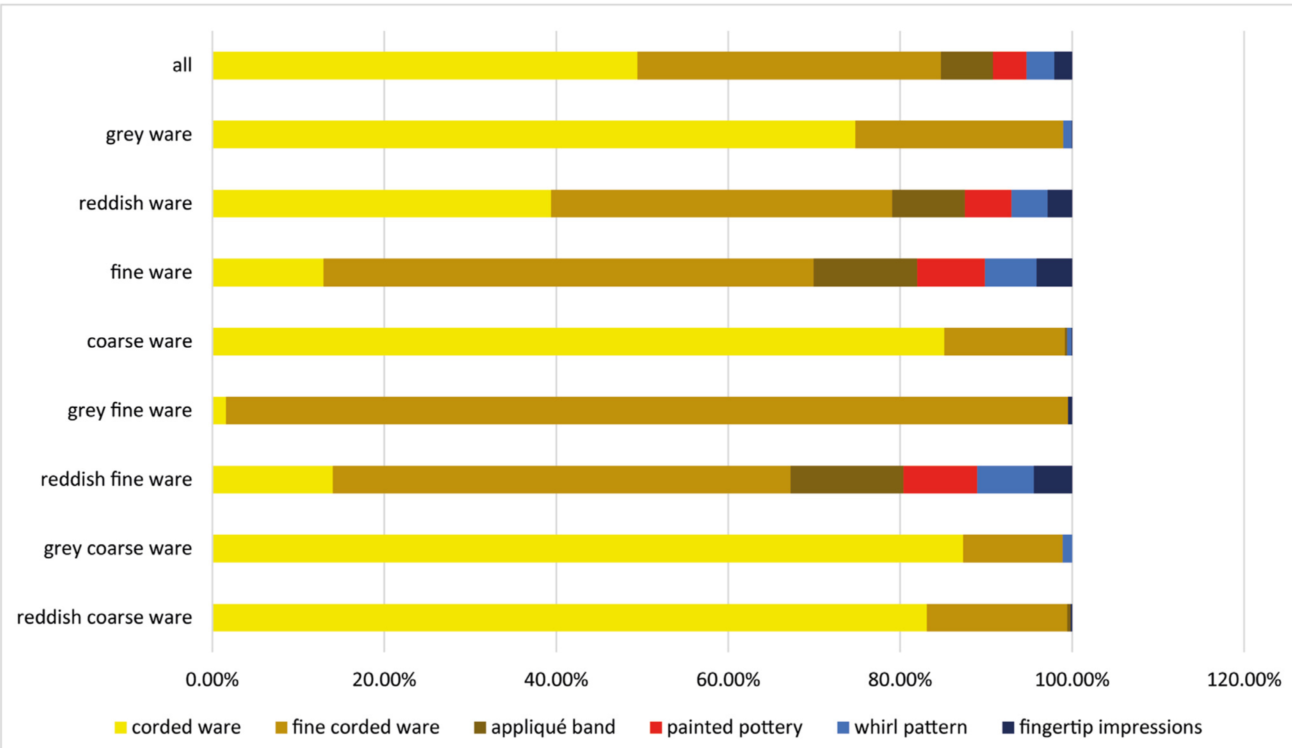

Fig. 7. Main decoration types at Yangguanzhai by ceramic quality.

0.2 mm diameter, suggesting intentional tempering. On occasion, grog may have been added, a question that will have to be approached in future petrographic studies.

The vessels seem to have been produced by hand: there are coiling ridges and finger impressions on pointed-bottom amphorae. In the case of fine ware vessels, parallel ridges outside combine with finger marks inside, indicating finishing on a slow wheel. An object generally interpreted as a potter's wheel is made of red coarse ware and consists of a plate of 36.8 cm diameter with a protruding disk-shaped platform of 13.8 cm diameter rising to a height of 8.4 cm, with holes along the wall making it easier to turn the plate by hand (Fig. 8). There is no evidence for the use of fast wheels.

Tools potentially used in ceramic production include ceramic rings and ceramic knives with or without perforations (Fig. 9). Experimental studies have shown that similar objects from Banpo could have been employed in cutting millet or processing hides (Wang and Wang, 1999). The knives found at Yangguanzhai did not show any traces of use-wear, so they cannot have been used on millet or hides; a use in ceramic production, which is unlikely to leave any clear traces, thus seems more plausible. There are also various types of scrapers, paddles, and flat or pointed tools made of ceramic, bone, or stone; all of these could have been multipurpose tools used for various tasks, including vessel forming and decorating. The ridged rings may be bracelets or decoration tools.

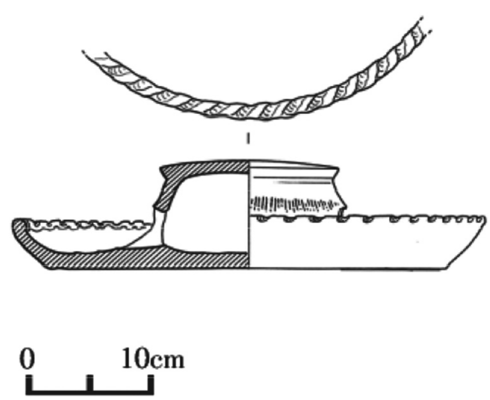

Fig. 8. Potential potter's wheel from Yangguanzhai.

In terms of firing, the site held both horizontal and vertical updraft kilns with firing chambers of usually 1–1.3 m in diameter and around 0.6 m in height, with a firing box of slightly smaller dimensions (Fig. 10). In vertical kilns, the firing chamber is located directly above the fire box; in horizontal kilns, a short sloped firing pathway runs between firing chamber and box, creating a draft that would have created higher temperatures. Some of the kilns have a dome-shaped ceiling and could be

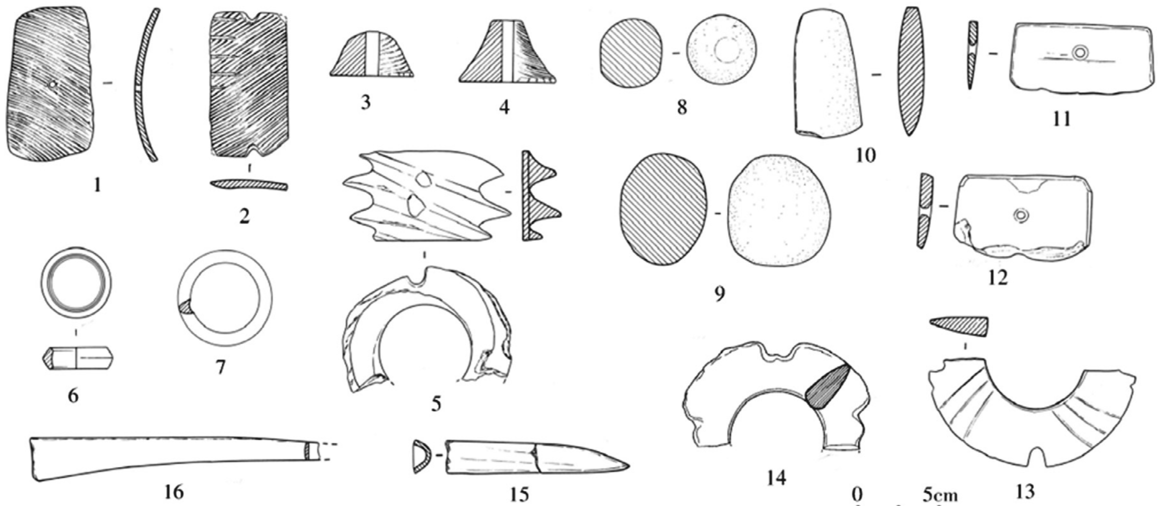

Fig. 9. Miaodigou-phase tools from Yangguanzhai: (1–2) ceramic knives; (3–4) ceramic spindle whorls; (5–7) ceramic rings; (8–9) stone balls; (10) stone axe; (11–12) stone knives; (13–14) stone rings; (15) bone awl; (16) bone spatula (after Shaanxisheng, 2011: Fig. 16).

Fig. 10. Top, left to right: Vertical updraft kiln Y9, roundhouse feature F16, and kiln Y10 in the southern part of Yangguanzhai. Bottom: Horizontal updraft kiln Y4 in the northeast corner of Yangguanzhai.

sealed sufficiently to create a reducing atmosphere and temperatures at the higher end of the Yangshao average of 730 to 1050 °C (Li Jiazhi et al., 1996; Li et al., 2011). Recent excavations have also brought to light a large horizontal kiln of 4.5–5 m total length, the largest kiln found so far at Yangguanzhai. In addition to these more sophisticated kilns, pits lined with sintered material indicate pit firing, producing an oxidizing firing atmosphere and lower temperatures. Recent refiring experiments have shown that the majority of vessels were fired at temperatures of 600 to 800 °C, but a considerable number were fired at up to 1100 °C and a few vessels were fired at below 600 °C (Deibel et al., 2017), which would fit with the use of the three different types of "kilns" just described.

The majority of ceramic vessels are red, but grey ceramics also appear, indicating the existence of kilns that could create a reducing atmosphere. Previously it was assumed that the Yangshao updraft kilns could produce only an oxidizing atmosphere and that only changes in kiln structure during the Longshan period (2800–200 BCE) allowed for firing dark wares (Li and Guo, 1988:49–53). The discovery of grey pottery at Yangguanzhai thus changes our understanding of the development of firing technology in northern China.

A few deformed vessels clearly identifiable as wasters have been recovered from the site, but they have not been systematically recorded and it is unknown how prominent they are in the assemblage. It is clear, however, that large refuse pits filled to the rim with ceramic sherds are plentiful, suggesting that these remains might be wasters rather than the results of breakage due to wear and tear in everyday usage. The dark deposits in the moat were originally interpreted as ash remains from the kilns as well, but recent analysis has shown that they largely consist of charred plant and animal remains; they are thus traces of normal household activities rather than intensive ceramic production (Fox, 2014). The nature of similar blackened remains in the ash pits is unclear, and it is uncertain whether ceramic production even leads to the accumulation of considerable ash remains. Here our ethnographic studies provide further insights (see below).

3.3.2. Production organization and specialization

In the archaeological context, organization of production is usually discussed in terms of craft specialization. Specialization is often visualized along a sliding scale, from nonspecialized (nearly as many producers as consumers) to highly specialized, where single producers or production units supply a whole settlement or region with wares (Dai 2006; Rice, 2015; Underhill, 2002). Scholars have suggested a range of different terms for various degrees of specialization, most of them having household and factory production at opposite ends (e.g., van der Leeuw, 1977). However, as Rice (2015) has pointed out, there are many different kinds of specialization, including site, resource, and producer specialization. Building on her work, Flad and Hruby (2008) have suggested distinguishing between producer and product specialization, with product specialization being the more encompassing approach, implying "regular exchange of functionally different products amongst nondependents" (Flad and Hruby, 2008:4); they see producer specialization as a subset of product specialization that "involves the added implication that exchange is necessary for the producer's livelihood" (5). Their approach and the other contributions in the same volume (Hruby et al., 2008) are aimed at inferring social organization and mechanisms of control over the production process (that is, attached versus independent), a very common aim in archaeological studies on technology. In our present paper, however, we focus on organization of production and its embeddedness in the local environment. Organization of production is multidimensional and shaped by a number of different factors. In a model developed Costin (2001), the major factors are (1) context of production (the degree of elite sponsorship, ranging from independent to attached), (2) concentration (dispersed to nucleated), (3) scale (kiln-based to factory), and (4) intensity (part-time to full-time) (Costin, 2001:Fig. 1.4). Archaeologically observable aspects of production are mainly concentration (the geographic organization of production), scale (the number of individuals/workshops involved in production and the amount and range of products), and intensity (amount of time spent on production activities). All these factors are also observable ethnographically and are thus a focus of our research.

Intensity of production in the sense of producer specialization is often assessed based on the level of standardization of the ceramic products (e.g., Arnold, 2000; Arnold and Nieves, 1992; Rice, 1981; Sinopoli, 1988). Standardization means that "the craft is carried out by individuals utilizing a limited range of materials and somewhat formalized or routinized techniques," producing standardized ceramics that reflect "little heterogeneity in composition and appearance within each category of pottery" (Arnold and Nieves, 1992:93).

Previous ethnoarchaeological work on product uniformity has shown that only individual measures (often rims), relations between measurements (for example, height-to-width ratio), or combined measurements (such as volume) tend to be uniform and that vessels may be uniform within one production batch but differ substantially between batches even if made by the same potter (Arnold and Nieves, 1992; Underhill, 2003). In the case of archaeological material, it is in most cases impossible to distinguish between different batches or the work of different potters. Also, products made over many years if not decades may end up in the same context, so we are faced with a cross section of products potentially made by many hands over several years or even decades.

For statistical relevance, it is furthermore important that at least 30 vessels of each type be compared. But in our case of a settlement site, sherds are significantly more common than complete vessels, and we had access to only 141 vessels of 13 different form types that belong to two different time periods, 43 coming from Banpo IV layers and 97 from Miaodigou layers (Appendix 1). The majority (about 76%) are fine ware and a similarly large majority (about 73%) were fired in an oxidizing atmosphere. Each vessel type is represented by three to 25 objects, which is not sufficient for complex statistics such as *F* test or ANOVA. Instead, we conducted basic descriptive statistics and calculated the coefficient of variation, which has been shown to be a more reliable reflection of variability/uniformity than the standard deviation, as the former is ascertained in relation to the mean (Arnold and Nieves, 1992:106–7; Longacre et al., 1988). To account for the unevenness in vessel numbers, we focused on object types represented by a large number of vessels, such as closed bowls (25 items), open bowls (21 items), basins (15 items), pointed-bottom amphorae (21 items), and round-bodied jars (18). The trends described below are indeed even more pronounced with these types than with types represented by fewer than 10 vessels, suggesting that our results are relatively robust.

We considered only the types represented by four or more vessels, with a special emphasis on types with 15 or more samples, and showed their measurements in graphs and through numerically displayed descriptive statistics, both together and by period (Appendix I; Figs. 11 and 12). These analyses show that wall thickness and vessel proportions (rim/height) are remarkably homogenous within each type and to a lesser extent between types. Considering that the vessels come from a wide range of different batches and are unlikely to all have been made by the same potter, this evenness suggests considerable routine and shared forming practices amongst a community of potters, practices that were transmitted over many generations.

For bowls (53 items) and basins (15 items), bottom diameter and height also show little variation; the same applies to the bottom diameters of most jar types (40 items). This contrasts with our ethnographic observations and those made by Underhill (2003) during her research at Guizhou, where potters estimated vessel diameter by hand measurements but did not check bottom diameters or height. In case of the Yangguanzhai material, the potters seem to have checked height or bottom diameter and then adjusted the other dimensions and proportions by sight rather than considering rim diameters. For the narrow-mouthed amphorae (represented by 21 items), however, rim diameters are remarkably homogenous even between vessels of different heights. For these vessels, which were likely used for pouring out liquid, ease of handling in this task may have been the main concern. The varying rim diameters combined with an even height for bowls/basins, on the other hand, may have had the aim of improving stackability and spacing when filling the kiln with vessels of even height. Overall, it seems that both production process and customer needs influenced the choice of measurements that potters paid attention to.

In general, absolute measurements may thus not be a reliable indicator for standardization or other forms of systematization in ceramic production. What is standardized for Yangguanzhai ceramics is the building process for the amphorae, for instance, which have been made in three sections followed by a remodeling and drawing out of the lip. Ceramic tools may also have been unified, as suggested by the increasing ubiquity of ceramic knives, tools likely used in shaping the amphora walls into their characteristic curved shape. Clay recipes also seem to have been standardized, as the homogeneity of the clay bodies and the results of geochemical and petrographic analyses suggest (Deibel et al., 2017; Hein, 2018). Given the shared clay recipes, forming techniques, and tools, there was a common understanding of how ceramics were to be made. Although the vessel sizes and exact measurements may vary, the production process was thus apparently regularized—though not necessarily regulated from above—in a form not reflected in absolute vessel measurements.

Besides standardization, there is a trend toward intensification of production reflected in the increasing number of kilns, specialized tools, and potential wasters, which are more numerous amongst Banpo IV than amongst Miaodigou remains. In comparison with other Yangshao-period sites, kilns and refuse pits are particularly numerous at Yangguanzhai. The house-to-kiln ratio is 2:1 or at maximum 4:1 if some of the ash pits were repurposed dwellings, while Banpo, for example, has a ratio of 7:1, and at Jiangzhai there is one kiln for every 40 houses.

In terms of labor organization, the Banpo IV remains in the southern part of the site provide some evidence. Here, pottery kilns, refuse pits, and cave dwellings are aligned in a row next to the escarpment, with the three types of features alternating, resembling differently shaped beads on a thread. These structures were carefully planned and the kilns were used simultaneously, indicating large-scale production at least during the latter phase of the site. There are no indicators for a separation of labor in a factory-style, assembly-style production lines, nor for specialization of certain kilns or workshops in one specific vessel form or style. Instead, current evidence suggests a holistic form of production with at most limited division of labor. For ceramic production, it is of course

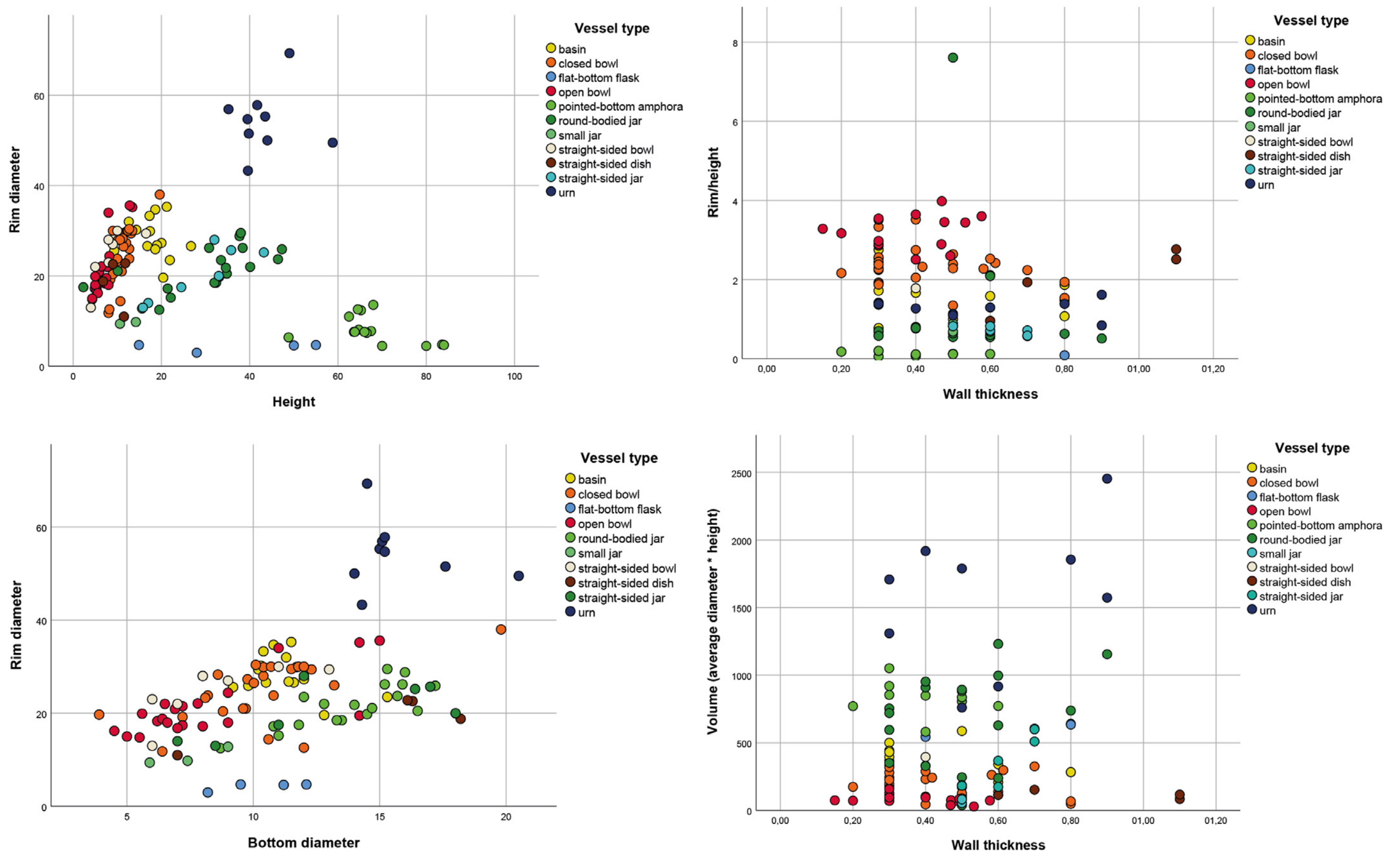

Fig. 11. Graphs of main measurements of ceramics from Yangguanzhai by vessel type. Number of items: basins: 15; closed bowls: 25; flat-bottom flasks: 4; open bowls: 21; pointed-bottom amphorae: 21; round-bodied jars: 18; small jars: 4; straight-sided bowls: 7; straight-sided dishes: 4; straight-sided jars: 7; urns: 9.

impossible to tell from the archaeological record if the same individual sourced, prepared, shaped, polished, painted, and fired the clay or if several people were involved, each doing one of these tasks only, but the arrangement of several contemporary kilns and workshops right next to each other, with largely identical layouts and wasters, shows that there was not one large centrally organized workshop but several units working independently. Nevertheless, ceramic production at Yangguanzhai and its organization went far beyond household-level manufacturing of items only for immediate kin. It's also unclear whether the potters were entirely dependent on their products to make a livelihood, or whether they worked full-time or only during specific times or seasons. Findings from the Yangguanzhai cemetery and ongoing research into bone pathologies might provide further insights into repetitive motions and thus specialization in specific tasks by some individuals.

3.4. Preliminary conclusions and open questions

The archaeological evidence just described indicates a relatively high and increasing intensity and regularization of ceramic production, as reflected in numbers of production facilities, products, wasters, and specialized tools, and the appearance of a workshop area. What is less clear is the degree of specialization of both site and potters, the range and mechanisms of product dissemination, the relations of potters to each other, the relations of site and production facilities to the local environment, and the reasons the site was abandoned both as a production locale and a settlement. While the question of the range of product dissemination for Yangguanzhai will require comparative chemical and petrographic analysis on archaeological and geological samples from a range of contemporary sites in the Wei River valley and beyond (a long-term project that is currently under way), ethnographic information can provide valuable insights into some of the behavioral questions. Our ethnoarchaeological research, likewise conducted on the Loess Plateau of northern China, therefore focused on the following factors:

1 Location choice
2 Raw material choice and procurement
3 Organization of production, including
   a labor organization
   b Intensity of production
   c Degree of specialization
   d Production hierarchies and their relation to social hierarchies
4 Organization of dissemination
5 Relations between potters, including
   a Arrangement of access to raw material
   b Relative access to markets and customers
   c Patterns of learning, teaching, and labor division

While pursuing these topics, we paid particular attention to traces the underlying behaviors would have left in the archaeological record, observing, for instance, differences and similarities in production techniques and raw material choice, workshop layout and location, and object measurements and other characteristics.

4. Ethnographic research: potters in the Wei River Valley

4.1. Ethnoarchaeological research and ceramic production

Since its emergence in 1900, the term *ethnoarchaeology* has been used in various ways that fall into two categories: the use of ethnographic studies in analogy and theory building in archaeology (or ethnographic analogy; Kent, 1987) and "the ethnographic study of living cultures from archaeological perspectives," likewise with the aim of building analo-

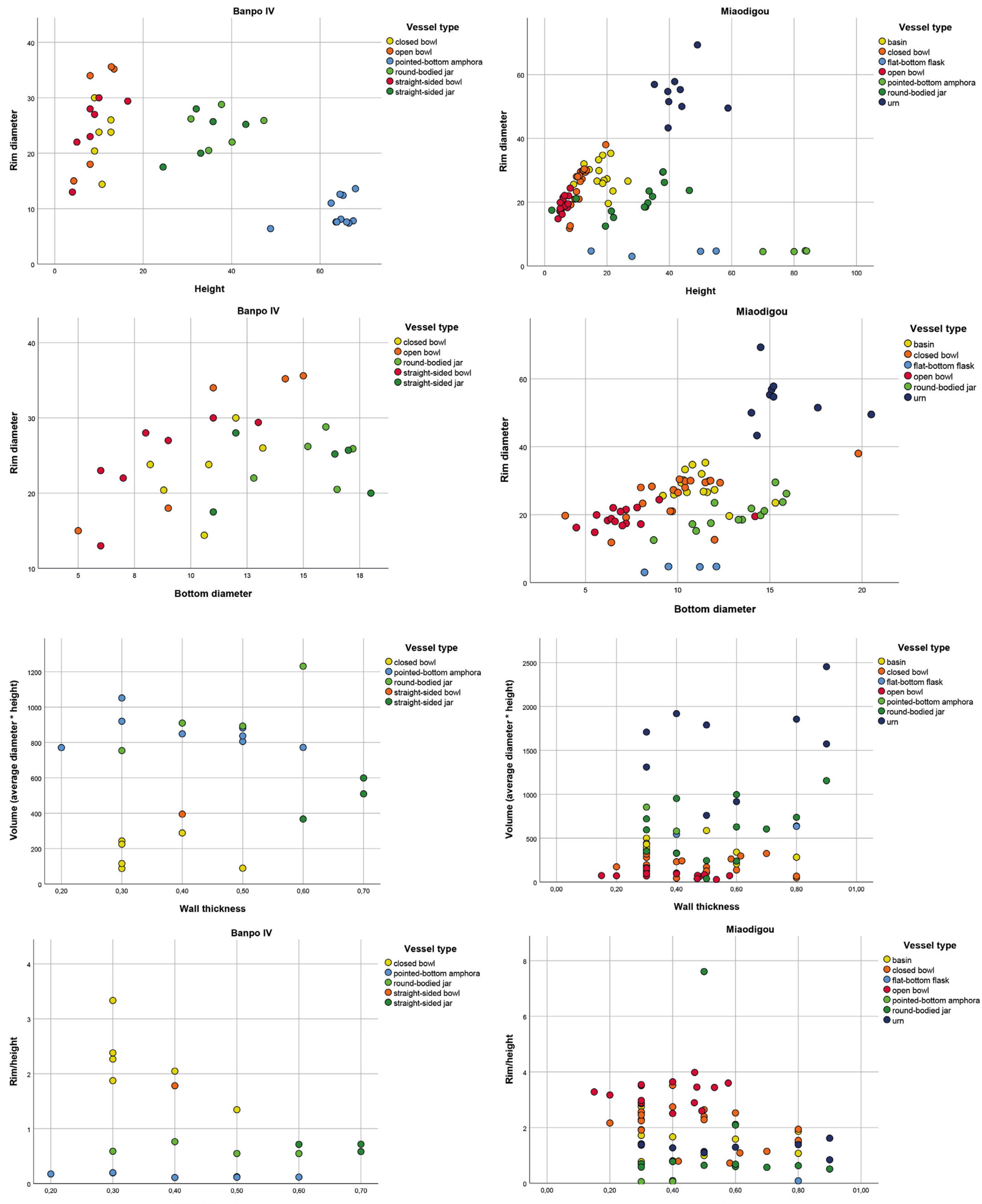

Fig. 12. Graphs of main measurements of ceramics from Yangguanzhai by vessel type and period. Left side: Banpo IV (number of items: closed bowls: 6; pointed-bottom amphorae: 11; round-bodied jars: 5; straight-sided bowls: 7; straight-sided jars: 5). Right side: Miaodigou (number of items: basins: 15; closed bowls: 19; flat-bottom flasks: 4; open bowls: 15; pointed-bottom amphorae: 10; round-bodied jars: 15; urns: 9).

gies but based on ethnographic research by archaeologists (David and Kramer, 2001:2).

The use of analogy in archaeology has a long history that can be traced back to the rapid expansion of ethnographic studies during the colonial period in the nineteenth century, when in a great wave of enthusiasm, prehistoric people were equated with "modern primitives" (Wylie, 1985). Although it is now generally agreed that such direct equations are not permissible, there is still no consensus as to how ethnographic material can be employed in archaeological research.[2] Some scholars argue that there is too much diversity in human behavior for such intercultural comparisons (Clark, 1951); others hold that the uneven nature of the archaeological record makes any simple and direct readings of the past from the present inevitably flawed (Heider, 1969), with some even suggesting that analogy should be abandoned as a method of interpreting archaeological data (Gould, 1980:x). As several scholars have pointed out, however, explanation in archaeology is necessarily based on analogy, and conscious, explicit analogies are less problematic than inferences based on so-called common sense (e.g., Ascher, 1961; Chang, 1967:109; Wylie, 1985).

Following Ascher (1961) and Willey and Phillips (1958), who suggest choosing case studies from similar environments, for this study we sought out potters living in the vicinity of the archaeological site in question. We are not proposing a direct historical approach, however, which would suggest local continuity, as has been done in other parts of China (e.g., Liang and Zhang, 1983). Instead we focus on general questions of human–environment interaction—in this case especially the influence of local geology on ceramic production—and the social embeddedness of ceramic production.

Although paying attention to geographic factors, we are not suggesting that human behavior is completely determined by the natural environment, as early processualist theories would have it. Nor are we trying to establish general rules of human behavior in the sense of middle-range theories (e.g., Raab and Goodyear, 1984). Instead, we explore the range of possible responses to the local environment by potters past and present through the double lens of archaeological and ethnoarchaeological research. Economically speaking, modern-day potters are in a situation fundamentally different from Neolithic groups, but similar material and environmental preconditions may elicit similar—or noticeably different—responses in technological choices. Thus both differences and similarities have to be observed carefully, not only between archaeological and ethnographic *comparanda*, as Wylie (1985) pointed out, but also between different modern-day potters living in the same environment.

Within ethnoarchaeology, ceramic research is especially well developed, exploring issues of technological and stylistic change (Hardin and Mills, 2000; Stark and Longacre, 1983), production processes and organization (Arnold, 2008), function (Skibo, 2013), and especially standardization and specialization (Arnold, 2000; Kramer, 1985b; Roux, 2015; Underhill, 2003), the latter topic being of great importance for archaeological research on social change and complexity.

In China, ethnoarchaeological work has concentrated on the so-called ethnic minorities in southern China (Fu, 2011; Li, 1959; Yao, 2004). The general assumption is that these groups are more "primeval" (*yuanshi*) and their way of life and ceramic production are thus closer to past practices than those of "more developed" groups (e.g., Fu, 2011; Wang, 2006; Wu Chumin, 1994). Consequently, some scholars connect the present-day groups directly with local prehistoric groups, aiming to reconstruct the origins and development of pottery production over time (Huang, 2008; Yang, 2002). The issues with this semi-colonialist attitude toward groups perceived as "primitive" have been discussed in great detail and do not need to be repeated here (see, e.g., Ascher, 1961; Schrire, 1984; Wylie, 1985).

These studies have their merits, as they record technological details that may be useful for future research (Li, 1998; Luan et al., 1992; Yu, 2015), but they do not provide further interpretation. A remarkable exception is Wang Ningsheng's (2003) study on the Dai people of Yunnan, in which he discusses issues of organization of production and exchange, and expression of identity. Anne Underhill's (2003) ethnoarchaeological study on ceramic production in Guizhou goes one step further by making general suggestions on the relationship between degree of vessel uniformity, intensity of production, and various social factors. However, neither Underhill nor Wang apply their inferences to archaeological material. In our study, we connect our ethnoarchaeological observations with an analysis of local archaeological material sharing the same natural environment, in particular the same access to raw materials needed in ceramic production. Overall, our study thus focuses on two major aspects of location choice:

1 Location choice in relation to various resources, transportation routes, and marketplaces
2 Arrangements between different potters in terms of access to raw material and customers

We follow Underhill's (2003) example of exploring spatial arrangements of ceramic production and their connection with intensification, specialization, and various social pressures. Additionally, we consider patterns of learning and teaching as well as labor division in relation to social status. The traces that these patterns of behavior may leave in the archaeological record are discussed, and the insights are applied to the archaeological material from Yangguanzhai.

4.2. The case studies

To ensure similarity in natural environment, we searched for potters in Guanzhong. Due to the influx of cheap, factory-produced goods over the last few decades, in the immediate vicinity, nonindustrial ceramic production ceased in the early 2000s. We found three retired potters: Zhao Delin (1933–2012) at Gaoling Jiangwang Village, his nephew Zhao Zhiwu (b. 1955) at Lantian Yujiagou Village, and Ding Xicai (b. circa 1940) in Mayao Village. At the time of the interviews, two of them were over 70 and one was in his 50 s; between them, they had knowledge of local developments spanning more than 50 years.

About 150 km southeast of Yangguanzhai, we found three active potters and heard about a fourth who had passed away recently. Two of the active potters, Hao Maichang (b. 1961) and Zhang Junwen (b. 1962), live in Wangshangou, Jing Village, Luonan County. The third potter, Huang Huiwa (b. circa 1943), lives in Huangyuan, which is also in Luonan. The deceased potter lived in Huangyuan Village, about 30 km east of Huangyuan (Fig. 1). At Wangshangou, there used to be a potter called Yang Cunhua (b. 1937), who was interviewed by a reporter in 2014 (Xin Xibu, 2014) but has passed away since. Zhang's father, who is over 90, was a potter but was not active or responsive to questions, so accounts of his family rely on his son's views. Two potters in another production team in Luonan, You Jiayu (b. 1936) and his son, You Zhanhu (b. 1969), in Tang Village, were interviewed by a magazine in June 2017 (Lüxing, 2017). We learned about their existence only after our fieldwork but plan to visit them in the future.

Since so few potters are left and most are of advanced age and considering terminating production within the next few years, we decided to conduct as much work as possible, but we could not spend several months in the field as is advisable for ethnographic work. We conducted several interviews in the summers of 2010–2013 and 2016, and in May 2017, making audio and video recordings, making notes and drawings, and taking photos. Additionally, we visited former production sites and observed and recorded remainders of kilns, tools, and ceramic products. Following Costin's (2000:377–78) suggestions for ethnoarchaeological

[2] For a detailed history of ethnoarchaeology, consult David and Kramer, 2001. For overviews on the history of ceramic ethnoarchaeology, consult Arnold, 1985; Arnold et al., 1991; Kramer, 1985a; and Longacre, 1991. For discussions on analogy in archaeology, consult Ascher, 1961; Fischer, 1990; and Wylie, 1985.

research, we describe the production process as fully as possible and anchor it in its historical contexts.

Through observations on finished objects and debris, raw material sources, and production facilities, we link these ethnographic observations to the archaeological material, considering parallels as well as differences. The main connecting factors between the two contexts are the involvement in ceramic production and the shared environment.

An overview of our observations is provided in a table (Table 5) for easy comparison and as reference. The table is structured into the main rubrics of (1) historical background, (2) materials, (3) tools and installations, (4) spatial arrangement, (5) production process, (6) organization of production and training, (7) dissemination. This is the structure we follow below where we also provide summaries for each rubric.

4.3. Historical background: origins, migrations, and location choice

Remarkably, all potters in this study are connected with outside production traditions, mostly Henan. Henan Gongyi was already famous for its ceramic production in the Tang period (AD 618–907), owing to its high-quality kaolin deposits (An and Li, 1997; Henansheng, 2000; Henansheng et al., 2005; Li, 1957; Liao 2012). In late Qing times and again in 1942, some potters fled from Gongyi to Shaanxi, trying to escape famine (Gongyishi, 2012; Zhang Gaofeng, 1943). During the second wave, Zhao Delin's father decided to move to Yehu Yujiagou Village in Lantian, Shaanxi Province, finding refuge with former neighbors from Gongyi. As there was not enough land, Zhao Delin's father learned how to make clay basins in Gongyi tradition, relying on a contact network with his former county-men, as it is typical for new immigrants. Soon the village became too small for the father and his four sons, who were all active potters. In 1949 Zhao Delin and one of his older brothers were sent out to search for a new suitable place of settlement and ceramic production. At Jiangwang Village in Gaoling County, they discovered a clay deposit and brought some material back to Lantian for experimental firing. As the results were good, they decided to relocate to Jiangwang, acquiring clay-rich land by the Jing River. They thus gained access to the two main resources for ceramic production, clay and water, and fuel was plentiful in the form of grain stalks from local farmers.

Similar migrations took place in the opposite direction in the 1930s, 1940s, and 1960s, with potters moving from Henan to Shaanxi, fleeing hunger and finding new clay sources and markets for their products (Guo and Wang, 2014). Considering their specialized skills, potters may have been more willing to move and had an easier time settling in a new locale than peasants who relied on access to land for their subsistence. Ethnographic evidence from northern China also suggests the presence of itinerant potters—that is, those who travelled a considerable part of the year to make ceramics in places without a local potter (Wang Weilin, personal communication, 2015). This ease of movement for potters applies especially on the Loess Plateau, where suitable raw material abounds, while places with less ideal material may require adjustments in technology.

The Zhangs migrated in a similar fashion, albeit in the late 1890s, likewise from Henan. They scouted out suitable clay in Wangshangou Village, Luonan, a village of 40 to 60 inhabitants, where they remained the main potting family until the 1950s. In 1958 the country was reorganized into people's communes consisting of farm collectives of 4000 to 20,000 households each. The communes controlled all production and resources, with cadres assigning work, which was paid for in work points instead of money (Dubois and Li, 2016; Guo and Wang, 2014). The communes were divided into production brigades that had to fulfill certain quotas. With the establishment of a ceramic production brigade at Wangshangou, the village grew to several hundred inhabitants, more people were trained as potters, and by the 1970s at least 10 potters were working side by side and having their wares distributed widely through the commune.

In the 1970s, the new household responsibility system was implemented, making leaders of production units responsible for their success, while individuals were allowed to sell any products beyond the quota on the free market (Tilt, 2008). As there was hardly any surplus in agriculture, pottery became the sole source of cash income at Wangshangou, leading to an increase in intensity of production.

With the land reforms of 1982–1985, the communes were replaced by townships and the production units were dissolved (Tilt, 2008). The potters now became individual entrepreneurs but had to pay a fee for usage of the kilns, until they became owners of their kilns again in the late 1980s. At that point, there were four production teams with altogether seven potters: two Zhangs (first two brothers, then father and son), a Hao father and son, two brothers named Yang Xicai and Yang Qunhua, and Yang Wa working on his own. All of them were students of one of the Zhangs, working in the Henan tradition, although the Haos and Yangs were from local families.

Mayao had a pottery production centre run by a group of potters from Gongyi as well. Not all migrants from Henan were potters, though. Ding Xicai, an educated man who fled from Henan during a famine in 1960, worked at Mayao as an accountant. In 1965 he was accused of manipulating accounts and sentenced to manual labor in the Mayao kilns. In 1980 Ding took over the communal kiln and became an independent entrepreneur. He was thus not responsible for the location choice of the kiln but maintained an older local practice established by his fellow county-men, continuing their tradition.

The only potter we encountered who was not related to Henan tradition is Huang in Huangyuan. Here, pottery production started when the production brigade asked a potter from Shandong to build a kiln and teach the locals, amongst them Huang, for a year. Similar stories of planned moving of potters are known from Henan (Guo and Wang, 2014), likely all in the hope of providing additional income besides agriculture.[3] There happened to be a suitable clay outcrop at the village edge, and that is where the Shandong potter built the kiln, a locale still used by Huang.

4.4. Raw materials, tools, installations, and their arrangement

The clay used by the potters at Gaoling, Lantian, and Mayao comes from the Quaternary red clay deposit described above. This deposit is wedged between layers of loess and is easily visible on the riverbanks (Fig. 13). The Zhaos and Ding mined the clay right next to a cliff, where it was easy to access. In addition to pure clay, the Zhaos used mixed clay–loess deposits that they had to levigate. Zhang and Hao mine the clay from a red clay deposit close to the topsoil between their workshops. This source has been used since the 1950s and has thus shrunk from a sloping mound to a sunken area, revealing less ideal material below. There is another outcrop by the road, but it is farther from the workshops and the potters do not use it. Hao estimates that the old deposit has enough material for another 10 years of production, so he sees no need to change his source or method of material processing by digging into less ideal material.

Worldwide, potters usually find their material within less than 5 km of the place where they produce the vessels, and large-scale production often happens on top of clay deposits (Arnold, 2017). If potters buy the

[3] At the time, pottery production was one of the few permissible forms of *fuye*, "sideline production" (as opposed to agricultural production [*nongye shengchan* 農業生産]), and was the only chance to make money in Wangshangou. Sideline production was a key issue for government agricultural policy. Allowing peasants to engage in free enterprises such as pottery to make money on the side had been criticized as "taking the capitalism road" by the extreme left wing of the Chinese Communist Party during the 1950s and also in the Chinese Republic. Yet being forced to focus completely on agricultural activities led the agricultural population (80%–90% of the Chinese population at the time) into poverty or extreme poverty. The government thus allowed sideline production to alleviate poverty (Lin, 1987).

Table 5
Overview of Ethnographic Information on Modern-Day Ceramic Production.

Potter	Zhao Delin (1933–2012)	Zhao Zhiwu (born 1955)	Ding Xicai (born ~1940)	Hao Maichang (born 1961)	Zhang Junwen (born 1962) and father (older than 90)	Yang Xicai and Yang Qunhua (brothers; deceased)	Yang Wa (deceased)	Huang Huiwa (born ~1943)	Yang Cunhua (1937–?)	You Jiayu (born 1936) and You Zhanhu (born 1969)
Source of information	interviews 2010–13 and 2016	interviews 2010–13 and 2016	interviews 2010–13 and 2016	interviews 2010–13 and 2016	interviews 2016–17	hearsay	hearsay	interviews 2016–17	*Xin* Xibu, 2014	Lüxing, 2017
BACKGROUND										
Location	Gaoling Jiangwang	Lantian Yujiagou	Lantian Mayao	Luonan Wangshangou	Luonan Wangshangou	Luonan Wangshangou	Luonan Wangshangou	Luonan Huangyuan	Luonan Wangshangou	Luonan Tangcun
Origin and migration history	Henan Gongyi (famine) -> Shaanxi Lantian Yujiagou (too many potters) -> Gaoling Jiangwan	Henan Gongyi (famine) -> Shaanxi Lantian Yujiagou	Henan Zhengzhou (famine) -> Mayao	local	Henan Zhangjiagou (famine in great-grandfather's generation)	local	local	local but learned from Shandong potter	local	local
MATERIALS										
Raw material	Quaternary red clay deposit	Quaternary red clay deposit	Quaternary red clay deposit	calcium-rich fine red clay deposit without large inclusions	calcium-rich fine red clay deposit without large inclusions	calcium-rich fine red clay deposit without large inclusions	calcium-rich fine red clay deposit without large inclusions	calcium-rich fine red clay deposit without large inclusions	calcium-rich fine red clay deposit without large inclusions	coarse clay
Clay storage	as clay bricks in caves	as clay bricks in caves	as clay bricks in caves	as clay bricks under tarpaulin	as clay bricks under tarpaulin	unclear	unclear	as clay bricks under tarpaulin with ash between them	unclear	unclear
Temper	no	no	no	no	no	no	no	no	no	yes
Fuel	firewood	firewood	bituminous coal	firewood; 3000 jin per kiln	firewood, 5000–6000 jin per kiln	unclear	unclear	firewood; 1000 jin per kiln	unclear	unclear
TOOLS AND INSTALLATIONS										
Kiln type	updraft kiln cut in cliff	updraft kiln cut in cliff	updraft kiln cut in cliff	updraft kiln built into shallow terraces using adobe bricks and mud–straw mix	updraft kiln built into shallow terraces using adobe bricks and mud–straw mix	updraft kiln built into shallow terraces using adobe bricks and mud–straw mix	updraft kiln built into shallow terraces using adobe bricks and mud–straw mix	updraft kiln on village edge	updraft kiln built into shallow terraces using adobe bricks and mud–straw mix	updraft kiln
Kiln building	team of 4 men built them in 1–2 days	team of 4 men built them in 1–2 days	considerable amount of work; getting help from outside	built last one at 17 by himself	built several kilns himself with help; not sure how long it took	unclear	unclear	had kiln built by his teacher	unclear	unclear
Kiln usage	20+ years with annual repairs	20+ years with annual repairs	20+ years with annual repairs	20+ years with annual repairs	20+ years with annual repairs	20+ years with annual repairs	20+ years with annual repairs	40+ years with annual repairs	20+ years with annual repairs	unclear
Specialized workshop	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Wheel	intermediate between kick and electric wheel run by two people	intermediate between kick and electric wheel run by two people	weighted wooden wheel	weighted wooden wheel, 1.7 m diameter, c. 70 kg; usable for 30+ years if oiled regularly	weighted wooden wheel, 1.8 m diameter, c. 70 kg; usable for 30+ years if oiled regularly	weighted wheel	weighted wheel	weighted wooden wheel, 1.7 m diameter, c. 70 kg; usable for 30+ years if oiled regularly	weighted wheel	weighted wooden wheel
Tools	repurposed kitchen tools; wooden molds for ornaments	repurposed kitchen tools; wooden molds for ornaments	repurposed kitchen tools; wooden molds for ornaments	meat cleavers, milling stones, half-moon-shaped clay knives, wire, wooden beaters, peelers, sticks for decoration	meat cleavers, milling stones, half-moon-shaped clay knives, wire, wooden beaters, peelers, sticks for decoration	unclear	unclear	meat cleavers, milling stones, half-moon-shaped clay knives, wire, wooden beaters, peelers, sticks for decoration	unclear	half-moon-shaped clay knives, wire, other tools

(*continued on next page*)

Table 5 (*continued*)

Potter	Zhao Delin (1933–2012)	Zhao Zhiwu (born 1955)	Ding Xicai (born ~1940)	Hao Maichang (born 1961)	Zhang Junwen (born 1962) and father (older than 90)	Yang Xicai and Yang Qunhua (brothers; deceased)	Yang Wa (deceased)	Huang Huiwa (born ~1943)	Yang Cunhua (1937–?)	You Jiayu (born 1936) and You Zhanhu (born 1969)
SPATIAL ARRANGEMENT										
Kiln location	at distance from settlement	at distance from settlement	at back of house at village edge	several hundred meters to house	several hundred meters to house	several hundred meters to house	several hundred meters to house	right by house	several hundred meters to house	right by house
Housing	at distance from kiln	at distance from kiln	less than 50 m from workshop	less than 50 m from workshop	less than 50 m from workshop	less than 50 m from workshop	less than 50 m from workshop	less than 50 m from workshop	less than 50 m from workshop	unclear
Clay source	right by kiln	right by kiln	right by kiln	a few hundred meters from kiln	a few hundred meters from kiln	a few hundred meters from kiln	a few hundred meters from kiln	a few hundred meters from kiln, but collected by others for pay	a few hundred meters from kiln	unclear
Water source	river next to kiln	river next to kiln	well in front of the house	well at several hundred meters distance	well several hundred meters distance	well at several hundred meters distance	well at several hundred meters distance	well at several hundred meters distance	well at several hundred meters distance	unclear
Fuel storage	next to kiln	next to kiln	unclear	next to kiln	next to kiln	unclear	unclear	next to kiln	unclear	unclear
Vessel storage	in caves (mostly not necessary)	in caves (mostly not necessary)	mostly not necessary	previously not necessary; now special storage facilities	in workshop and house, but little			in workshop and house		
PRODUCTION PROCESS										
Preparation	drying, picking out inclusions, levigation for lower-quality material, kneading	drying, picking out inclusions, levigation for lower-quality material, kneading	drying, picking out inclusions, levigation for lower-quality material, kneading	drying, picking out inclusions, treading with water, kneading	drying, picking out inclusions, treading with water, kneading	unclear	unclear	drying, picking out inclusions, treading with water, kneading	unclear	unclear
Forming	thrown on electric wheel	thrown on electric wheel	thrown on wheel moved at varying speeds by feet and/or stick	coiling or throwing on wheel moved at varying speeds by feet and/or stick	coiling or throwing on wheel moved at varying speeds by feet and/or stick	coiling or throwing	coiling or throwing	throwing on wheel moved at varying speeds by feet and/or stick	coiling or throwing	unclear
ornaments	moulded	moulded	moulded	moulded or impressed	moulded or impressed	unclear	unclear	moulded or impressed	unclear	unclear
Drying	in sun, turning them	in sun, turning them	in sun, turning them	in workshop on shelves and floor	in workshop on shelves and floor	unclear	unclear	in workshop on shelves and floor	unclear	unclear
Kiln preparation	stacking by size	stacking by size	stacking by size	stacking by size	stacking by size	stacking by size	stacking by size	stacking by size; ash between vessels to prevent sticking	unclear	saggars
Number of items per kiln	300–400	300–400	400	previously 300–400, now 400–500	previously 300–400, now 400–500	300–400	300–400	300	300–400	unclear
Firing time	24 h to 3 days	24 h to 3 days	24 h to 3 days	24 h	24 h	24 h	24 h	6–7 h	24 h	24 h

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Table 5 (*continued*)

Potter	Zhao Delin (1933–2012)	Zhao Zhiwu (born 1955)	Ding Xicai (born ~1940)	Hao Maichang (born 1961)	Zhang Junwen (born 1962) and father (older than 90)	Yang Xicai and Yang Qunhua (brothers; deceased)	Yang Wa (deceased)	Huang Huiwa (born ~1943)	Yang Cunhua (1937–?)	You Jiayu (born 1936) and You Zhanhu (born 1969)
ORGANIZATION										
Learning	learned from father who learned from fellow county-men after move	learned from father who learned from brother (Zhao Delin's father)	clerk forced to work as manual laborer in pottery kiln; learned for himself and became independent	learned from father who learned from Zhang (father); started at 18; trained 1 year	family tradition; started at 17; trained 1 year	learned from Zhang (father)	learned from Zhang (father)	learned from itinerant potter; 1-year training	learned from Zhang (father)	learned from father as teenager
Training	own son (discontinued)	own son (discontinued)	no	no	trained 7–8 people but unsuccessfully; not his own children	unclear	unclear	trained 7–8 people, not his own children	unclear	trained son
Division of labor	4–5 helpers; labor division between brothers (lower level/higher level)	4–5 helpers; labor division between brothers (lower level/higher level)	used to be conscripted laborer; later wife doing some of the unskilled labor	wife doing much of the unskilled labor	work in equal team; other family members helping with unskilled labor	unclear	unclear	wife doing much of the unskilled labor; children help at times	worked alone with help from family	work in team, slight hierarchy
Intensity of production	full-time until late 1990s	full-time until late 1990s	full-time until late 1990s	full-time except for breaks for family matters; wife plants small vegetable patch	full-time; some agriculture taken care of by family	unclear	unclear	full-time for Huang; wife does agricultural work on the side	unclear	full-time
DISSEMINATION										
Production focus	utilitarian grey wares	utilitarian grey wares	dark grey decorative fish basins	utilitarian grey wares, now burial vessels	utilitarian grey and red wares, now burial vessels	utilitarian grey wares	utilitarian grey wares	utilitarian grey wares and burial vessels	utilitarian grey wares	*shaguo* casseroles
Road access	right by road network	right by road network	right by road network	several hundred meters to road	several hundred meters to road	several hundred meters to road	several hundred meters to road	by road	several hundred meters to road	by road
Distance to other kilns	at least 20 km	at least 20 km	at least 20 km	in line of kilns run by up to 8 different teams of potters	in line of kilns run by up to 8 different teams of potters	in line of kilns run by up to 8 different teams of potters	in line of kilns run by up to 8 different teams of potters		in line of kilns run by up to 8 different teams of potters	unclear
Sale	through middlemen, then through production brigade, then through middlemen again	through middlemen, then through production brigade, then through middlemen again	through middlemen, then through production brigade, then through middlemen again	previously through production brigade, then shops in town, now middlemen	previously through production brigade, then shops in town, now middlemen	unclear	unclear	middlemen	unclear	unclear
Max. range of sale	8–10 km	8–10 km	30–70 km	10–30 km	10–30 km	unclear	unclear	10–15 km	unclear	unclear
Price per item	unclear but much less than Ding	unclear but much less than Ding	40–50 RMB in 1980s	1.2 RMB in 1980s; now 20–30 RMB	20–30 RMB (sell for 50–60 in town)	unclear	unclear	20 RMB	unclear	10 RMB
Fee to production unit	unclear	unclear	500 RMB in 1980s	200–300 RMB in 1980s	200–300 RMB in 1980s	200–300 RMB in 1980s	200–300 RMB in 1980s	unclear	unclear	unclear
Fuel price	free	free	1200 RMB/ton in early 2000s	unclear	1000 RMB worth of firewood for 1 kiln (100 RMB per load)	unclear	unclear	preferred pine 20 RMB for 100 jin	unclear	unclear

Fig. 13. Clay deposits at Mayao (top) and Wangshangou (bottom).

clay, the range may be wider (Guo and Wang, 2014). Huang does not dig clay himself, even though the source is only a couple hundred meters from his workshop. Instead, he buys a fine clay with few inclusions and gets it delivered to his house. None of this clay needs levigation. Only the Zhaos levigated their lower-quality materials, so they needed significantly more water than the other potters, which explains their choice to work close to a water course.

Even in production without levigation, large amounts of water are needed according to the potters. The water is transported in buckets and stored in large urns, depending on the distance to the water source. Hao estimates that for one batch of clay, he needed to go 30 times back and forth, carrying two buckets of 15 L each time, resulting in 900 L, so it is no accident that all the workshops and kilns were or are very close to a river or well.

Both clay and fuel are stored near the kiln, but the latter comes from varying distances and with various qualities. In times of large-scale production of utilitarian wares with the support of many helpers, the Zhaos went for the cheapest possible fuel, wheat and millet stalks, which burnt quickly and unevenly and had to be restocked often. At the same time, Ding Xicai, working alone and specializing in decorative basins, invested in bituminous coal, which allowed him to attain black, shiny surfaces and control the firing temperature without refueling. Taking an intermediate route, all currently active potters prefer wood, if possible of high quality, which fires more evenly. Since the early 2000s, it has become difficult to buy firewood, this being a dying business (Underhill, 2003:212), and soon the sale may cease, leaving the potters to collect their own twigs and other low-quality material. The choice of firing material is thus determined by considerations of cost, availability, and the quality and price of the resultant products.

Similar considerations determine the choice of tools. Most tools are expedient: repurposed kitchen utensils, nondescript sticks, wire, or millstones. Nearly identical tools are used in Henan (Guo and Wang, 2014). The only specialized tools are wooden molds or stamps for ornaments,[4] wheels to produce serrated rims, peelers to thin the vessels in the leather-hard stage, and half-moon-shaped perforated clay knives used to shape vessels during throwing (Fig. 14). The latter implements are basically identical with tools found at Yangguanzhai, but the repurposed or expedient tools would be difficult to connect to ceramic production found archaeologically.

Easier to identify in terms of function—but usually made of organic material—are the wheels. Most potters we encountered use wheels of wood or rattan, sometimes recycling old cart wheels (Fig. 14). The rattan wheels were covered with a mixture of mud and animal hair to add the necessary weight to throw large basins. The wheels have diameters of 1.7–1.8 m, weighing around 70 kg. Such a wheel is spun by the potter himself using a stick or a stick and feet. This wheel type is remarkably similar in all workshops we visited and is also known from Henan (Guo and Wang, 2014). They run smoothly and are hard-wearing, lasting 30 years or more; none of the potters considered an electric wheel. Only the Zhaos used a more complex wheel moved by an assistant. It consists of two parts: the wheel itself and a spinning apparatus linked to the wheel by a belt. One person sat at the spinning apparatus keeping up the motion while the other formed the vessel on the wheel (Fig. 15). For the Zhaos' high level of output with several assistants, such a half-automated wheel was a useful construction, while current potters working alone for dwindling numbers of clients have no need for a more efficient wheel.

The kilns we observed were similar in structure: updraft kilns consisting of a fire box below and a dome-shaped firing chamber above with a horseshoe-shaped cross section and a half-oval hole connecting both parts (Figs. 16–18). The dimensions were similar, too, with fire box heights of 0.8–1.5 m, firing chamber heights of 2–3 m, and maximum diameters of 2–3 m. While the kilns in Luonan were all built into shallow terraces using adobe bricks and a mixture of mud and straw, the one in Jingwang was constructed in the courtyard of a building and the kilns in Gaoling were cut directly into the cliff. The cliff kilns were particularly easy and quick to build while the freestanding varieties took more time and effort but were more flexible in location, though more prone to damage. When repaired regularly, they could nevertheless last for 30 years or more.

The choice of kiln type—cut into a cliff or freestanding—of course is determined by the potter's location relative to raw materials, living quarters, and road networks. All potters seem to have taken great care to have their kilns close to transportation networks, helping with dissemination of products. Not all are close to their living quarters though. Where cliff faces were chosen, the rich clay outcrops next to a water source, with ready-made walls to cut kilns and storage caves into, seemed more attractive than locales in the village. Such cliff faces near a road network are not available in Luonan, and here clay outcrops on the village edge provided a great alternative for building living quarters, workshops, and storage facilities close to the road and community. This also means closeness to the support every potter needs: unskilled

[4] In one case, Hao and Zhang used a seal provided by a customer to be impressed onto the vessels he ordered. This is a unique case of potters using a specialized implement they did not produce or choose themselves. The seal impressions read *Mutang chunse* 穆堂春色 ("Spring Scenery of Mu Hall"), potentially referring to the name Hall (*tanghao* 堂號), a personal name or a family lineage reference. Or the impression might contain an incorrect character for *mu*暮 ("twilight") and would therefore mean "Spring Scenery of Twilight Hall." The potters do not know the meaning either, and we were not able to ask the customer directly, so the meaning remains obscure—much like the meaning of decorations on prehistoric ceramic vessels.

Fig. 14. Wheel and tools used by Hao.

labor and food provisions. It also provided access to wells located at the village edge.

The potters have specialized workshops, with tiny windows, the wheel placed by the door to let in light, tools on the wall behind, a water basin right by the wheel, and drying space on the floor and/or shelves. The clay, already homogenized and formed into bricks, is stored outside the workshop under a tarpaulin or in a cave so that it will stay moist. The working of the clay takes place in front of the workshop, so there is some empty flat space. The kiln is only 20–100 m away, with fuel stacked at the side (Fig. 19).

Most of the potters do not have extended storage but leave their wares in the kilns until they are picked up by customers. If necessary, a few wares are stored in workshop or house. In 2016 Hao decided to build dedicated storage facilities because his business had been slowing down and he was afraid the wares would be spoiled by rain. Specialized storage facilities found archaeologically may thus not be a sign of high output or a flourishing business but a sign of a time lag between production and dissemination. Large buildings could of course be used for drying before firing rather than storage, but ethnographic evidence suggests that items are usually dried on all available surfaces in living and working spaces (e.g., Underhill, 2003). To our knowledge, the construction of buildings entirely dedicated to drying has not been reported.

4.5. Production: process and actors

The main steps in the production process are raw material preparation, forming, drying, retouching/decorating, further drying, stacking the kiln, firing, and emptying the kiln. In all locales, after retrieval, the clay is dried and crushed, with the removal of large inclusions by hand. The next steps are mixing the clay with water and homogenizing it, mostly by trampling it with bare feet. Then the clay is cut into brick-shaped portions and stored in a way that keeps it humid. Before a vessel is formed, the stored clay is homogenized further by hand. The potter kneads 30–40 kg at a time, sometimes on a large millstone with ridges or other surfaces that provide resistance.

None of the potters use temper because they say that would make the vessels crack during the firing process. This may be a particularity of the clay they use, for temper is employed by most potters worldwide and can be observed with local Neolithic ceramics as well. The issue may also be one of terminology. In other parts of the world, scholars have found that the concept of temper—non-clay material that is deliberately added to alter the behavior of the clay—is not shared by all potters but that many simply mix clay of different qualities to attain the desired result (Arnold, 2000, 2017). Such mixing could not be observed with the modern-day potters in Shaanxi, but the possibility has to be kept in mind for the archaeological material.

Techniques used in vessel construction are coiling and wheel-throwing. Most small jars and basins are manufactured on a wheel. The potter centers a lump of clay on the wheel and produces a hole in the centre. Then he draws up the vessel walls by placing one hand on its inside and the other on the outside (Fig. 20). The lip is made by pressing the fingers together at the rim while the wheel is turning. We saw the wheel in motion only at Hao's workshop and noticed that he uses the wheel at different speeds. First he uses his feet to kick the wheel, maintaining a constant but slow speed for centering. Before drawing up the walls, he speeds up the wheel by using a stick. When making the rim or doing further adjustments to the form, he uses his feet only, resulting in a slower speed. A large basin made from around 9 kg of clay takes Hao 12 min to make. Large storage vessels take longer and are often manufactured in several stages, combining throwing and coiling. Once the vessels have dried to the leather-hard stage, the potters thin the walls using a metal peeler and incise them or apply decoration formed in separate molds or by hand.

The vessels are preferably dried outside if weather permits or in the large workshops. As Underhill (2003:261) pointed out, drying is a part of the production process that is largely hidden from archaeologists, but

Fig. 15. Wheel-spinning apparatus and wheel used by Ding Xicai.

it is very stressful and space-consuming, especially with high production intensity. The size of workshops, if identified archaeologically, may thus serve as an indicator for intensity of production.

For firing, the vessels are stacked by size—the smallest inside, the largest outside, the heaviest at the bottom, the lightest on top—sometimes with ash sprinkled between the vessels to prevent sticking. Only the Yous, who produce small casseroles, use saggars. The plant matter is bundled and packed tight to create a steady fire. The fire is started at a low temperature, warming the wares slowly to let the remaining moisture in the clay evaporate before the temperature is increased. After one hour of firing, the kiln is sealed with adobe bricks, leaving only a small hole for observing the color.

Firing times vary widely by kiln, fuel, number of wares, and desired result. The numbers range from six or seven hours to three days, with 300 to 500 vessels fired at a time. A great deal of experience and alertness is needed to fire the ceramics successfully, as humidity and other weather conditions, type of fuel, dryness of wares and fuel, and many other factors have to be taken into account when deciding on timing, the amount of fuel added, and the closing and opening of the kilns.

The intensity of production varies widely depending on demand, season, and family situation. During the winter, when the wares cannot dry easily, production often ceases for a while. During the harvest, the whole family, including the potter, focuses on the fields. When there are weddings or funerals, there may be breaks in production. During the time of the production brigade, the potters worked very long hours and did not have to engage in agriculture, but in recent years, with demand dwindling, the potters rely on their fields again, making them less specialized.

As Feinman (1999) showed, monolithic models for craft specialization, with clearly distinguishable types from household production to large-scale industry, do not fit well with reality. Intensity of production especially varies widely; within a community of specialized potters, there can be considerable variation in intensity of production between individuals or even between years for the same individual, calling into question common archaeological categories such as part-time or full-time production (Underhill, 2003:227). Female potters especially are under scheduling pressure, with child-rearing and household responsibilities, causing them to spend less time on pottery production when their children are small (Arnold, 1993; Costin, 2000; Underhill, 2003). Male potters have more time to devote to potting when their children are grown and take over the farmwork (Underhill, 2003).

Interestingly, beyond a certain number of years of experience, skill level does not increase or decrease dramatically, even if the intensity of production is scaled back from 11 to three months a year, for instance (Underhill, 2003:263). It is therefore difficult to infer intensity of production from vessel uniformity, especially in an archaeological site where assemblages are a mixture of the products of many potters and years. Furthermore, standardization may not be a high priority if consumers do not demand it. In the case of our ethnographic research, for instance, one potter argued that customers noticed the evenness of vessel sizing in one batch only when vessels stood side by side in the store. They regarded homogeneity as an indicator of high skill but were not too concerned about differences between vessels they bought several years apart. As has likewise become clear from our ethnographic research, some potters use measuring aids to achieve a higher level of standardization, while other potters in the same community may not, regardless of what the customers are looking for.

What is likewise difficult to assess is the status of potters. While the helpers—be they family members or hired help—are hardly ever mentioned, indicating their relatively low prestige, the prestige of the potters themselves seems to vary between locations. Most potters seem to be proud of their trade, speaking with regret of the unwillingness of the younger generation to continue the trade. Surprisingly, Guo and Wang (2014) report that in Henan Beihoucun, people did not like the trade and the arduous labor it involved. The authors assume that people will always prefer agricultural work, as it directly brings food to the table (Guo and Wang, 2014:277). However, agricultural work is strenuous too, has to be done outside in every weather, and does not have a high financial yield. Agriculture is thus not naturally preferable to potting, at least not as long as there is a market for the products. After all, the children of the potters are abandoning the craft not to concentrate on agriculture but to work in cities, where they can make more money with physically less strenuous work. Potters thus seem to have a status equal to or even higher than normal peasants, but dwindling demand forces them to abandon their craft and not transmit it to the next generation.

4.6. Division of labor, teaching, and learning

In all workshops, there was a clear division between skilled and unskilled labor, and people engaged in more or less physically strenuous parts of the production process differed in social standing. In Gaoling and Lantian, occasionally helpers were hired, especially during the height of production of utilitarian wares. In Luonan, on the other hand, most of the unskilled labor is done by family members; wives do much of the work, especially in one-potter workshops with no brother or son present. This reliance of potters on their families and/or the wider community for help with nonspecialist tasks, or in freeing them from subsistence work or family obligations, is often overlooked in ethnographic

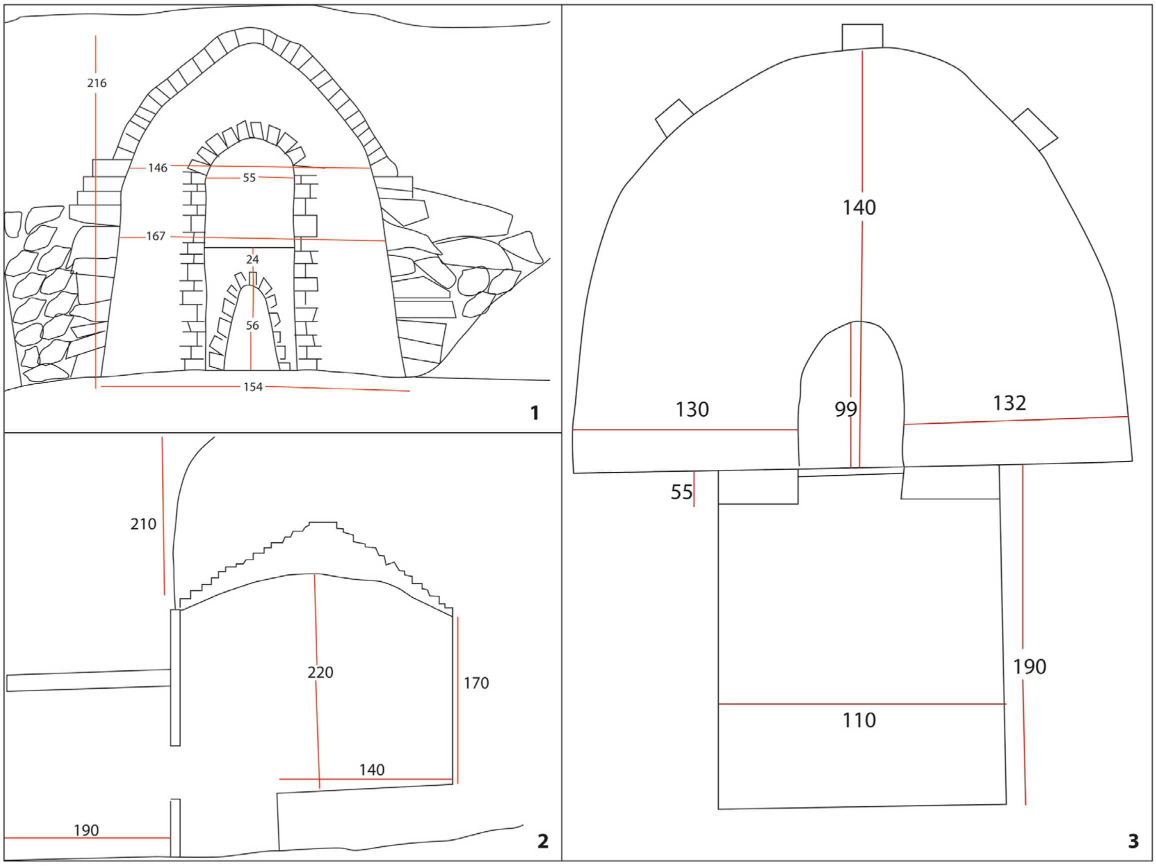

Fig. 16. Drawings of Hao's kiln at Wangshangou.

research and is entirely invisible archaeologically. Individual potters say they are working "alone" even though their wives do much of the heavy work, and when demand is high, other family members help. Indeed, where specialized pottery production exists, "It takes a whole family to produce vessels, not simply the individual who shapes the vessels" (Underhill, 2003:207).

In all locales, there was a clear hierarchy, with the unskilled helpers being overlooked, the vessel forming done by the older team member (brother or father), and the heavy labor done by the younger team member. In most teams, the younger learned the throwing, however, and later took over that part of the production process, but in the case of the Zhaos, the younger brother and his son permanently stayed unskilled laborers and were never taught the craft.

In contrast, in Luonan, the craft was transmitted across families, but the production unit nevertheless remained the individual household. Even after collectivization, the main potters in a workshop were members of the same family, and people from other families were trained for only a year or two before working independently in their own workshops. The story of how outsiders were trained in the craft is told differently by the different parties involved, though. Hao says that his father agreed to be trained because Zhang's workshop could no longer meet the market demand alone. Zhang says that his father employed Hao's father to help him financially when Hao's mother died. Whatever the social circumstances, it was clearly necessary to have a larger number of potters to produce at the level of a specialized production brigade like the one of Wangshangou during the 1970s, and not just Hao's father was trained by the Zhao family but at least four more individuals, who then worked in their own workshops and kilns while their products were sold through the brigade. Similarly, at Huangyuan, the itinerant potter trained a number of locals, who in turn trained people without any family connections.

All potters report starting to learn the trade after finishing their schooling, around 15 to 18 years of age. The training was often indirect, through observation rather than teaching, but they nevertheless learned the craft fully within a year. If taught by their father, they often did most of the physically taxing parts of the work, such as preparing the clay and loading the kiln, for a number of years before being allowed to do the forming and then taking over when the father became old. In most cases, not all siblings learned—only the one who would take over the business. The others turned to other professions or moved away. Which child became the potter seems to have been relatively random. In several cases, it was the one who happened to be the right age when his father felt that he needed help. It was always the male children though. The girls were expected to be engaged in domestic duties instead.

The shortness of the period of apprenticeship—usually only a year or even less—is surprising. It can be assumed that most of the potters observed their fathers and potentially experimented with clay in a playful way from an early age, so a year of full-time studying might have been enough for them but may not have sufficed for somebody completely new to the craft. Huang succeeded in learning the craft from an itinerant potter within a year, but many of those who learned with him seem to have been less successful. Indeed, he and other potters complain that it was difficult to train outsiders, likely because they did not have childhood exposure to the process and required systematic training rather than learning by imitation.

As to the current generation, most of the potters decided not to train their children but rather to send them to the city to work. Only the You family from Tang Village continues the tradition. Nevertheless, You Zhanhu's son, who is now 24, is in the city working, for the *shaguo* casseroles they make sell for only 10 RMB a piece, a very low rate of return for very hard work, with increasingly less demand.

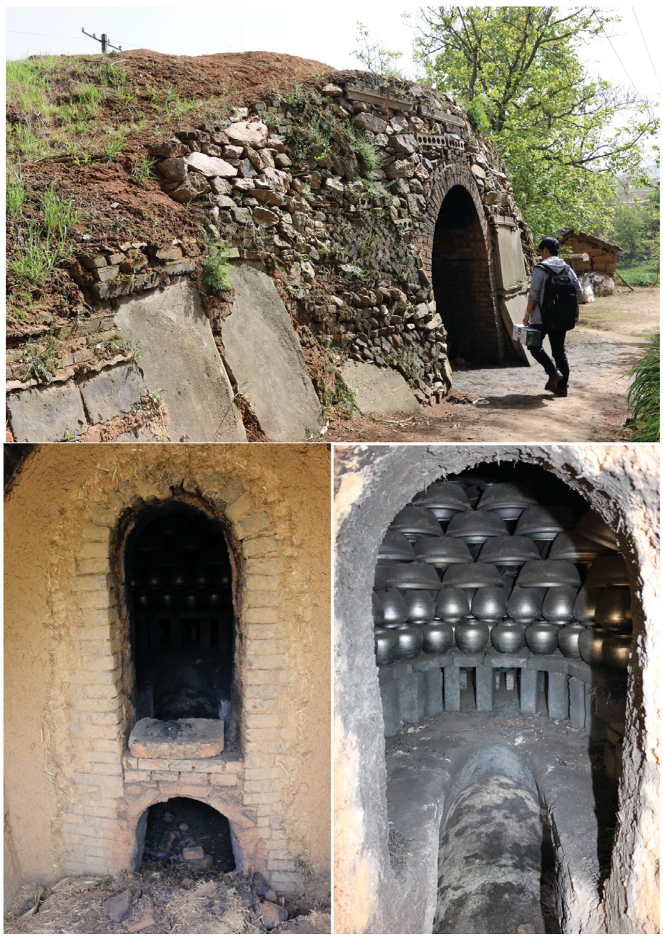

Fig. 17. Zhang's kiln, newly reopened after firing.

Fig. 18. Top: Huang's kiln. Bottom: kilns on the riverbank at Jiangwan Village.

4.7. Product range, dissemination, and finances

While the *shaguo* casseroles are made only by the Yous, the products of all other potters we interviewed are remarkably similar, even though one was trained by a Shandong potter and the others worked in the Henan tradition. The reasons for choosing specific vessel forms are more related to local demands than to the potting tradition in the place of origin. Locals seem to have demanded untempered grey-black wares of similar wall thickness and quality used for storage and serving vessels but never for cooking pots. Zhang produced red wares once when a customer ordered red basins in various shapes for bonsai—clearly not an order to serve local demands but something to be sold in a large city—but he has not done so in a while, and his neighbor, Hao, does not know how to make red wares.

The main products are various types of jars for food storage and water transportation, ranging in size from 15 to 100 cm in height; basins of various sizes used for fermentation and everyday purposes; and large fish and flower basins of about 50 cm in height and up to 1 m in diameter (Fig. 21).[5] While the Zhaos made only nondecorative kitchen and storage wares, Ding Xicai was known for his beautiful fish basins and flowerpots with fish and water lily decoration and floral ornaments. In Luonan, only simple decoration such as impressed flowers is common.

During the peak of production, from the mid-1970s to the late 1990s, in all locales, the whole range of vessels was made in great number, but now household items have been replaced by cheaper industrially made containers. Production in Gaoling and Lantian ceased in the early 2000s, but potters in Luonan started specializing in funerary goods, basins in three sizes (rim diameters of 29–44 cm, heights of 10–14 cm), and jars in two sizes (heights of 10–20 cm, diameters of 11–15 cm) with knobbed lids, ordered by a customer who said they were meant to hold tea leaves but more likely meant to serve as cremation urns (Fig. 21).

In Danfeng County, Shangluo, where some of the Wangshangou products are sold, a set of one jar and one basin is used in burials. At Wangshangou, jars with yeast in them were smashed on the coffin before entombment to express the wish that the deceased and the descendants would *fa* ("rise")—that is, prosper. Similar practices exist in Henan. In recent years, plastic buckets have replaced the ceramic at Wangshangou, so the potters have difficulties selling their wares.

In terms of product standardization, the potters do not use scales; they estimate the amount of clay needed by eye and by hand. Hao uses a stick to measure and adjust the rim diameter of his basins, so one would expect uniformity in diameter but some variation in other measurements. Interestingly, Hao's products do not vary much in weight, while the variation in overall measurements is high and diameters vary significantly, especially for the basins, even though he applies the measuring stick (Fig. 22; Appendix 2). The greatest variation in all measurements occurs for large basins, with standard deviations of 0.52–0.88, ranges of 1.4–2.1, and coefficients of variation (CVs) of up to 0.19. Considering that the vessels are hand-thrown and no precise measurements are applied, however, the products are fairly uniform in shape. Zhang's products are even more homogenous. The jars vary the most, with stan-

[5] As production has ceased and hardly any vessels were available for inspection, it was not possible to produce a fine typology or distinguish clearly between different production traditions. It is clear that similar vessels such as those made by Ding and the Zhaos are still being produced in Henan (especially the fish basins), but to ascertain the closeness of the relationship between these ceramic traditions, further comparative research is needed.

Fig. 19. Spatial arrangement of production locales at Wangshangou (top) and Huangyuan (bottom).

dard deviations of 0.05–0.69, ranges of 0.12–1.36, and CVs of 0.01–0.06—lower in variation than most of Hao's wares. To the naked eye, the greater homogeneity in measurements of Zhang's wares is noticeable, and the potters claim they can distinguish their wares clearly. As they are working together on some orders, the lack of homogeneity does not seem to bother their customers greatly. Also, Hao's ability to form much larger vessels speaks of great skill and not lack thereof, so the greater heterogeneity of his wares may simply be a lack of care rather than lack of ability.

As to dissemination, sales are arranged in two main ways: through middlemen/the production brigade or by several potters banding together to organize transportation and sale in larger towns. Prior to collectivization, middlemen sold the products on commission, carrying them around villages on poles or in carts. The remaining items were brought to markets that took place every 10 days. The middlemen settled payments with the potters once or twice a year, usually on the fifth day of the fifth month and the eighth day of the twelve month of the lunar calendar, dates that are used to pay debts in other businesses as well. The sales territory covered about 8–10 km around each kiln—an area with about 1000 households.[6] Only Ding's large decorative basins were sold in farther-off large cities, Xi'an and Xianyang.

[6] Sun Zhouyong's survey on ceramic production in the western part of the Guanzhong region furnished a similar number for the radius of ceramic distribution (Sun Zhouyong, personal communication, May 2010).

Fig. 20. Production stages of Hao throwing a vessel.

After the collectivization of 1958, the production brigades took over dissemination and the potters received fixed work points in turn. One large basin would fetch three work points at 1 RMB per work point, while peasants would only get 2–4 *fen* per work point (100 fen to 1 RMB). During the collective period, an able-bodied man usually made 10 work points a day, a woman maybe 6–8 (Ye Wa, personal communication, 2017). The potters fired every 10 days, with 15 to 20 kilns per workshop per year and each kiln holding 300 to 500 items, depending on size. At the time, Hao was making more than 4000 work units a year, while people doing other types of labor got a maximum of 3650, so potting was a lucrative business. It was also less risky and more specialized. Dissemination was done by the production brigade, which opened a shop in the county capital, but some items were also sold directly in the village itself.

During the de-collectivization of the 1980s, all potters signed contracts with their production units and became the owners of the kilns in which they worked. Every year, they paid a certain fee to the production unit, ranging around 200 to 300 RMB. Ding Xicai paid more—500 RMB in the 1980s, at a time when 0.5 kg of corn could be bought at 6–7 *fen*—but he made a profit since his decorative wares sold at a much higher price, 40–50 RBM per basin instead of the 1.2 RMB that utilitarian wares fetched. At that time, he sold through middlemen again. At Wangshangou and in many other places (Guo and Wang, 2014:244), after de-collectivization, three to six potters would band together to transport their vessels to the market in Jingcun, a nearby township, but soon middlemen took over, and since the 1990s, the potters have mainly been working on commission. The middlemen now come with their own vehicles, usually taking a full kiln load of 200 to 400 vessels, paying 20 to 30 RMB per vessel and selling them for 50 to 60 RMB.

The products of Hao and Zhang are basically identical, but each has his own network of buyers; sometimes they split the work when a buyer wants a large load fast. Such orders are rare, though, for over the last two years, sales have deteriorated. For many years, the potters sold their large basins for 30 RMB and small ones for 20 RMB, but now there is an unknown person selling basins for 20 RMB and 15 RMB, respectively (probably over the internet), and doing home delivery. The Wangshangou potters thus are under pressure, and 2017 was already the third year they had trouble selling. Demand was high from 1980 to 2000 but diminished significantly afterward due to the influx of cheap, factory-made items. Additionally, changes in lifestyle led to a change in demand. Villagers still plant vegetables, but they no longer process grains—they buy them in stores. There is thus no longer a need for large numbers of ceramic storage vessels. Ding and the Zhaos did not adapt their products quickly enough, so they had to close their kilns. They may also not have had the option to switch to funerary wares, as the proximity to the urban centers of Xi'an and Xianyang—and thus government control—meant a stricter enforcement of the government-prescribed practice of cremation that does not require funerary basins. In Luonan, however, inhumation is still common and ceramics continue to be used in rituals surrounding the grave. Nevertheless, even here ceramics are replaced by plastic.

Fig. 21. Vessels made by modern potters: (1) vessels made by the Zhaos; (2–4) vessels made by Hao; (5–6) vessels made by Zhang.

5. Connecting archaeological and ethnographic evidence

5.1. Possible traces in the material record

Modern production processes would leave material traces, including kilns, production tools, wasters, ash from firing, and ceramic products and their distribution, as well as the depletion of clay sources, creating large depressions in the ground, and the construction of wells close to workshops. Deforestation due to high demands for fuel would be visible but would not be attributable to ceramic production on a household level; only industrial-scale production would have such an effect. The kilns would be evident if they were ever excavated, but production tools would be difficult to identify, as the potters sometimes used utensils originally made for a different purpose. Remarkably, there is a great similarity in form between modern tools for vessel shaping and the half-moon-shaped perforated ceramic "knives" found at Yangguanzhai and other Yangshao sites. Some of the bone and stone tools that may have been used for ceramic decoration are also similar to their modern counterparts. It is difficult to be sure about the purpose of these, though; they may have been multipurpose in the past as they are in the present. Potters' wheels might appear in the archaeological record, but only if organic material was preserved and not repurposed as fuel.

The waste products are more problematic. The amount of ash produced in firing was negligible and was mostly dumped outside, where it was soon spread by wind and rain. Zhang kept the charcoal bits left by firing in a chest and used them as fire starters for household cooking. Huang spread ash between the items to be fired to keep them from sticking together. The amounts were very small to begin with though. Each firing produces fractured pots, but these can often be mended. In Luonan, we could not observe many broken pieces. Nevertheless, Ding reported once having lost a whole kiln full of products because his customers rushed him to fire the vessels, even though the damp weather had prevented them from drying sufficiently. The Zhaos also remember instances when firing went wrong. The loss rates seem to vary greatly. The same would likely have applied in the past, especially in periods when no coal was available for firing and the heat of the fuel would have been more uneven.

The volume of wasters found in the archaeological record can thus not be translated directly into the level of production intensity. As Feinman (1999) has shown, large amounts of wasters can occur with household-level production, so the large number of broken vessels at Yangguanzhai does not necessarily mean centrally organized (that is, prescriptive, following Franklin's (1999) terminology), possibly attached, assembly-line, factory-style production. Instead, they could have been the result of high-intensity, partially or fully independent, holistic production. Nevertheless, the presence of designated areas for ceramic production as we see them in the later phase of Yangguanzhai indicates that production went considerably beyond the household level but was likely still holistic and partially or fully independent rather than attached. In such a scenario, one would also expect a designated dumping ground for wasters close by, but this does not have to be the case. Present-day potters have no specific place to dump wasters; they place them in the closest abandoned pit or ditch together with other trash. In the archaeological record, such a process would result in random areas with ceramic waste and ash at short and medium distances from kilns, likely intermingled with other refuse, as can be seen in depressions and pits all over Yangguanzhai.

As far as the ceramic products themselves are concerned, careful analysis of ceramic types might allow for the differentiation of regional form traditions as well as individual kilns and family traditions or even individual potters, although the latter differences would be very subtle. What is remarkable is that ceramic forms, decorations, and even color are influenced by customer demands more than by the traditions the potters were trained in. The market thus decides in this case, but technical details, such as the way vessels are formed, likely depend on the training and abilities of the individual potter. Throwing large vessels completely on the wheel is difficult. Some potters master it while others opt for coil-building techniques or don't make large vessels at all. Uniformity of vessels is thus a tricky measurement, as larger vessels are more difficult to throw and control in their dimensions, and would probably have been thrown only by extremely skilled potters. At the same time, skilled potters may not have taken particular care to make vessels of uniform size if their customers did not demand it; the vessels may have just turned out more or less the same due to the routine the potter developed. Future research on vessel uniformity should therefore take into account not only the level of specialization and production intensity but also issues of skill and customer demand. Such research of course must keep in mind that modern concepts of market determinism are not applicable to premodern, let alone prehistoric, studies. Therefore, different models and concepts have to be considered or developed. Furthermore, as far as standardization studies are concerned, in the case of archaeological material, it is impossible to distinguish between the work of different potters, let alone different batches they produced. It is therefore not surprising that the coefficient of variation for the archaeological ceramics is much higher than that for the ethnographically observed batches, as are all other measurements of variation. The standards for what can be seen as relatively homogenous thus have to be significantly different between ethnographic case studies with known product–producer–batch connections and archaeological material where no such certainty exists.

If the material is levigated or not, if the vessels are dried indoors or outside in the sun, what kind of fuel is used, and how long the firing takes all depend partially on available raw material and also on how the potters were trained and what the clients demand (red or grey wares, fast or slow delivery, beauty or practicality). A complex analysis

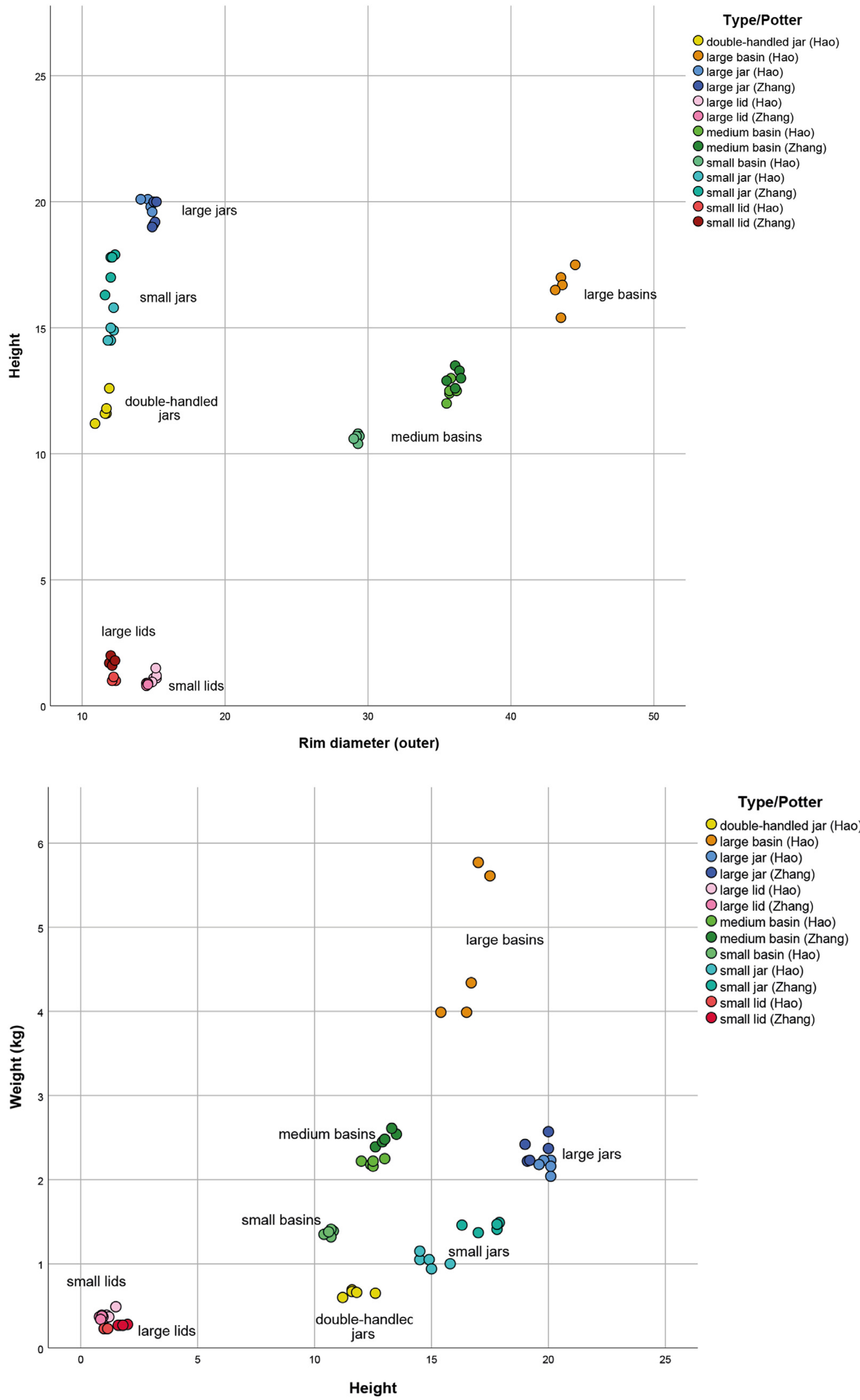

Fig. 22. Measurements of vessels made by modern potters.

considering various factors, including resources, environment, marketplace, production organization, and even political, social, and familial aspects, is thus necessary to understand past and present processes and conditions of ceramic production.

5.2. Discussion: comparison of pottery production past and present

There are many commonalities but also differences between pottery production past and present in the Gaoling area. Prehistoric and modern-day potters chose the same type of clay from the various kinds locally available (Hein, 2018), indicating that they had a similar understanding of the characteristics of suitable raw material for ceramic production. They settled in similar locations that would allow them easy access to raw materials and that guaranteed a water source near the kilns. Furthermore, the kilns were very similar in construction and the firing procedure would have been similar, but the temperatures reached in modern-day kilns are higher, especially if coal is used. Additionally, the range of ceramic forms was not the same, and the customer base and economic preconditions were vastly different. Nevertheless, the shared location preferences, clay choices, and kiln structures allow for further comparisons of the two bodies of evidence. After all, both groups of potters would have had to grapple with similar issues concerning clay preparation and ceramic firing, and therefore to a certain extent labor organization. These parallels, aided by the results of comparative material analysis, enable us to use the ethnographic material to reconsider the hypotheses raised at the beginning of this study.

The ceramics found at Yangguanzhai were likely produced using nearby clay and water resources. Ethnographic evidence indicates that much water is needed in ceramic production and that potters will search out places with easy access to both water and clay to build their kilns. They will furthermore likely test the available raw material before deciding to settle near a specific clay source. This evidence, combined with the specific location of Yangguanzhai and the large number of ceramic sherds and kilns, indicates that the site may have been chosen deliberately to allow easy access to clay and water for ceramic production.

Access to major trade routes may also have been a consideration when choosing Yangguanzhai as a settlement location, and this is a big concern with modern potters. Yangguanzhai is close to the Jing and the Wei rivers, which might have been routes of transportation as well.

The updraft kilns at Yangguanzhai are very similar to those used by the modern potters, and the presence of grey as well as red ceramics shows that these kilns did allow for controlling the firing atmosphere and producing both reducing and oxidizing environments at will. Our ethnographic research has shown that such kilns produced hardly any ash but usually some broken products. Sometimes even a whole kiln full would be unusable. It is therefore not surprising that Yangguanzhai did not contain any significant ash deposits while the large number of ceramic sherds may indicate high-output production.

Our ethnographic research suggests that at least in modern times—meaning the 1950s to the 1990s, prior to plastic and cheap industrial-made porcelain becoming widely available and skewing the data in comparison to prehistoric conditions—a distance of at least 7–10 km between workshops made them profitable. Considering that the modern-day population density is likely greater than it was in prehistoric times, the number of kilns and the amount of ceramic refuse at Yangguanzhai seem to exceed what is needed to supply even a large settlement.

The uniformity of the vessels and their large number make it clear that production was specialized, but it is not entirely clear if it was organized on a near-industrial level or continued on a household basis. Considering the placement of several kilns next to each other with probable workshop buildings nearby (strikingly similar to the situation at Wangshangou brought about by an intensification of potting during the time of the production brigade), it is likely that the dissemination was jointly organized, although not necessarily by a higher-level authority.

Once the excavated material has been published, a large-scale statistical evaluation of vessel numbers and measurements can help determine the degree of specialization and the amount of output over time. As the analysis of a limited number of ceramics presented above has shown, such research promises to be very fruitful. Combined with stylistic analyses, these data may permit the identification of various production traditions. At this point, it is already clear that at least a subsegment of the population of Yangguanzhai focused on pottery making. As pottery production includes physically demanding processes that can be done by unskilled laborers, such as raw material extraction and clay preparation, and tasks such as vessel forming that can only be done by a skilled potter, it is reasonable to assume that some labor division existed in the past as well. This form of labor division may in turn have led to a certain level of hierarchy. However, such details of social organization are difficult to ascertain from settlement material alone. Here, the newly discovered cemetery at Yangguanzhai promises to furnish new insights.

Further evidence may be gained from an analysis of the tools found at Yangguanzhai. Even though their use in ceramic production would likely not have left traces on the tools themselves, use-wear and residue analysis could determine if these implements were used in abrasive activities. Even if they were, they may still have been used in ceramic production also, making them multipurpose tools. Ethnographic evidence shows that tools made for other purposes may be employed in forming vessels as well. Further typological analysis and comparison with tool sets used by potters in various parts of the world, combined with experimental studies, would help us judge the potential usefulness of the tools at Yangguanzhai in ceramic production.

Considering the overall evidence, it seems that the neatly aligned kilns, cave dwellings, and pits dating to Banpo IV were used in specialized ceramic production, but it is currently unclear if Yangguanzhai was indeed a ceramic production centre. The lack of internal organization and large central buildings inside the moat marks the site as different from any other large settlements found so far, indicating that it lacked any central administrative function, so ceramic production may have occurred on the household level. However, at Wangshangou, once a well-organized collective production team, the buildings do not reflect such a central organization. In fact, the facilities previously used by the collective are now used by individual potters, showing that the same buildings and spatial layout may serve a wide range of different production systems. Furthermore, our ethnographic research has shown that the presence of large storage facilities has two possible explanations: large production output or a sluggish market with products waiting for customers for a long time and thus needing to be stored. A major issue with the comparison between past and present is of course that market determinism is a modern trend and the ethnographically observed potters' responses to market needs cannot directly be applied to the archaeological material.

Nevertheless, the presence of a large number of kilns throughout the Yangguanzhai site suggests that ceramic production was of considerable importance and produced a large output, likely supplying a vast areas. In a next step, it is therefore necessary to conduct comparative analysis of ceramic forms and composition amongst middle Neolithic sites in the Wei River valley and beyond to ascertain the range of distribution of ceramics from Yangguanzhai.

6. Conclusions

Of the questions asked in the beginning—How did the site fit into the ancient landscape? How was ceramic production organized at the site? How far were the wares distributed? Why was the site in use for only a relatively short period of time—our study was able make progress in finding answers to some of them. The combination of archaeological material from Yangguanzhai, ethnoarchaeological data from Gaoling County, and information on the local natural and social environment has allowed us to shed light on the organization of prehistoric ceramic production and its embeddedness in the local environment, in particular in terms of resource availability. The results show that the modern-day kilns and the site of Yangguanzhai are located in similar microenvironments and that potters in the past and present showed preferences for similar locations in terms of access to necessary resources and routes of product dissemination and built similar kilns. Both groups therefore had to grapple with similar issues in ceramic production, thus allowing for further comparisons between the two bodies of data, enabling us to use the modern ethnographic data to throw light on preconditions and processes of ceramic production during the Neolithic. It has become clear that our hypothesis that ceramic production was of central importance to the site and likely intensified during Banpo IV seems tenable. The site location was likely chosen because of its proximity to abundant clay resources, water, and probably routes of transportation for product dissemination.

This study has also provided a few general insights into processes of ceramic production and their potential material correlates. It has become clear that potters rely markedly on other people for help with various tasks in the production process, a fact that is often overlooked in archaeological research and theoretical discussions on the organization of ceramic production. The combination of archaeological and ethnographic data has furthermore shown that absolute measurements are a problematic proxy for standardization and intensification of ceramic production (e.g., Underhill, 2003). Potters may check only one measurement (such as rims) or may strive for uniformity only within a batch but not between batches, or they may simply rely on their sense of the proportions or weight of the piece of clay they are choosing for a specific vessel type. Important factors influencing variability in vessel measurements are not only level of specialization and production intensity but also individual skill and customer demand, issues that need to be taken into account in future research. A major problem with such endeavors remains that archaeological assemblages consist of many batches of ceramics produced by many different potters, batches that cannot be split apart, thus making it difficult to investigate individual skill and standardization in non-factory-style production. Instead of measurements, intensification and centralization of production are more likely to be reflected in standardization of clay recipes, tool sets, and production procedures, as is visible in the material from Yangguanzhai. Individual specialization and the social embeddedness of ceramic production at the site require further research. At present, it is already clear that this is not a case of attached, assembly-line-style production. However, given the considerable number of kilns and products, it is also clear that production at the site went far beyond seasonal household-level work. Further evidence for centralized production can be expected to be found in an increase in the number and geographic spread of products from Yangguanzhai, but comparative research with ceramic material from other contemporary sites is needed to test this hypothesis.

Another aspect that needs further consideration is mechanisms of spread of ceramic forms or styles aside from direct trade of finished products. As our ethnoarchaeological research has shown, migrating or travelling potters seem to have been responsible for the spread of technology and forms in modern China; similar processes may have taken place in the past as well. To gain further insights into this matter, large-scale comparative research between Yangguanzhai and other contemporary sites in the Wei River valley and beyond is necessary. Such research will help answer the question of the embeddedness of the site in the sociocultural landscape at the time. Additionally, further environmental research is needed to test the hypothesis proposed and preliminarily tested here that the site was abandoned due to environmental changes and flooding events. Such research is already under way at the China University of Geoscience.

Although much remains to be done, this study clearly shows that the combination of archaeological material, geographic information, ethnographic research, and material analysis in the same region can greatly enhance our understanding of prehistoric ceramic production. Similar analysis conducted at other Yangshao-period sites, combined with comparative studies of evidence for ceramic production and material analyses in the Wei River valley and beyond, might thus go far in elucidating the scale and organization of ceramic production in middle Neolithic northern China.

Acknowledgments and Remarks

This research is based on seven years (2010–2017) of collaborative fieldwork at the Yangguanzhai site on the northern outskirts of Xi'an in Gaoling County, Shaanxi, China. The work was jointly conducted by the Shaanxi Provincial Institute of Archaeology, Northwestern University, and the UCLA Cotsen Institute of Archaeology, while the Institute for Field Research provided organizational support. A notable aspect of the project was the joint training of Western and Chinese students of archaeology, with the objective of cross-training and broadening the intellectual perspectives of all students.

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Appendices

Appendix 1. Measurements for Complete Vessels from Yangguanzhai and Their Statistical Evaluation, Both Together and Separate by Time Period (Miaodigou and Banpo IV)

Vessel Type	Find Number	Period	Rim Diameter	Widest Diameter	Bottom Diameter	Height	Wall Thickness	Rim/Height	Average Diameter	Volume (Average Diameter * Height)	Ceramic Quality	Decoration
closed bowl	H769:1	Miaodigou	21	22.6	9.7	11	0.3	1.9	17.8	195.4	red fine ware	undecorated
closed bowl	H640:2	Miaodigou	21	23.2	9.6	9.7	0.2	2.2	17.9	174.0	red fine ware	undecorated
closed bowl	H534:1	Banpo IV	23.8	25.4	8.2	12.7	0.3	1.9	19.1	243.0	red fine ware	burnished
closed bowl	H540:1	Miaodigou	28	29.6	10.4	10.2	0.4	2.7	22.7	231.2	red fine ware	burnished
closed bowl	H627:1	Miaodigou	19.2	19.4	7.2	8.4	0.3	2.3	15.3	128.2	red fine ware	burnished
closed bowl	W13:3	Miaodigou	29.5	32	11.5	11.5	0.3	2.6	24.3	279.8	orange fine ware	undecorated
closed bowl	H181:1	Banpo IV	26	29	13.2	12.7	0.4	2.0	22.7	288.7	orange fine ware	undecorated
closed bowl	H776③:103	Miaodigou	29.4	31.6	12.3	13.1	0.3	2.2	24.4	320.1	red fine ware	undecorated
closed bowl	H228:14	Miaodigou	38	40.2	19.8	19.6	0.8	1.9	32.7	640.3	red fine ware	undecorated
closed bowl	G8–2②:60	Miaodigou	27.287	28.635	9.77	12	0.582	0.7	21.9	262.8	red fine ware	undecorated
closed bowl	G8–2②:8	Miaodigou	26.5	27.181	10.021	11.4	0.418	0.8	21.2	242.1	orange fine ware	slipped
closed bowl	G8–2②:53	Miaodigou	30	31.156	11.78	13.4	0.7	1.1	24.3	325.8	red fine ware	painted
closed bowl	G8–2③:59	Miaodigou	29.9		10.4	12.2	0.3	2.5	13.4	163.9	red fine ware	undecorated
closed bowl	G8–2③:54	Miaodigou	30	31.279	10.7	12.4	0.614	1.1	24.0	297.5	red fine ware	painted
closed bowl	G8–2③:80	Miaodigou	30.4		10.1	12.7	0.5	2.4	13.5	171.5	red fine ware	undecorated
closed bowl	G8–2①:29	Miaodigou	19.7		3.9	5.6	0.4	3.5	7.9	44.1	red fine ware	undecorated
closed bowl	G8–2③:64	Miaodigou	28.3		8.6	11.2	0.6	2.5	12.3	137.8	brown fine ware	painted and burnished
closed bowl	H766③:83	Miaodigou	23.3		8.1	10.2	0.5	2.3	10.5	106.8	red fine ware	painted and burnished
closed bowl	H776⑤:41	Miaodigou	28		8	10.6	0.5	2.6	12.0	127.2	red fine ware	painted and burnished
closed bowl	H776②:4	Miaodigou	11.8		6.4	8	0.8	1.5	6.1	48.5	red fine ware	undecorated
closed bowl	H776:67	Miaodigou	12.6		12	8.2	0.8	1.5	8.2	67.2	red fine ware	undecorated
closed bowl	H492:1	Banpo IV	14.4		10.6	10.7	0.5	1.3	8.3	89.2	red coarse ware	flangen
closed bowl	H402:7	Banpo IV	20.4		8.8	9	0.3	2.3	9.7	87.6	red fine ware	undecorated
closed bowl	H402:14	Banpo IV	23.8		10.8	10	0.3	2.4	11.5	115.3	red fine ware	undecorated
closed bowl	H85.8.5	Banpo IV	30	33	12	9	0.3	3.3	25.0	225.0	red fine ware	undecorated
open bowl	H573:10	Miaodigou	22	20.6	6.5	7.7	0.3	2.9	16.4	126.0	orange fine ware	slipped
open bowl	H776:25	Miaodigou	18.3	17.6	6.2	7.3	0.4	2.5	14.0	102.4	orange fine ware	undecorated
open bowl	H776③:74	Miaodigou	21.5	19.6	7.2	5.9	0.4	3.6	16.1	95.0	orange fine ware	undecorated
open bowl	H776:15	Miaodigou	18.8	19.4	6.4	6.5	0.3	2.9	14.9	96.6	grey fine ware	undecorated
open bowl	H776④:13	Miaodigou	17.4	17.4	7.2	5.3	0.15	3.3	14.0	74.2	red fine ware	undecorated
open bowl	H776④:52	Miaodigou	24.4	24.4	9	8.2	0.3	3.0	19.3	158.0	orange fine ware	undecorated
open bowl	H776⑤:45	Miaodigou	17.2	17.2	8	4.9	0.3	3.5	14.1	69.3	grey fine ware	undecorated
open bowl	H776:51	Miaodigou	16.8	16.8	7	5.3	0.2	3.2	13.5	71.7	orange fine ware	incisions
open bowl	H384:1	Miaodigou	20.9	20.9	6.9	5.9	0.3	3.5	16.2	95.8	orange fine ware	slipped
open bowl	G8–1③:28	Miaodigou	22.1		7.8	6.4	0.477	3.5	10.0	63.8	red fine ware	undecorated
open bowl	H785:6	Miaodigou	18	19	6.6	5	0.577	3.6	14.5	72.7	red fine ware	undecorated
open bowl	G8–4:1	Miaodigou	19.9	19.9	5.6	5	0.47	4.0	15.1	75.7	red fine ware	undecorated
open bowl	G8–1①a:1	Miaodigou	14.8		5.5	4.3	0.533	3.4	6.8	29.1	red fine ware	undecorated
open bowl	H95:2	Miaodigou	16.2		4.5	5.6	0.469	2.9	6.9	38.6	brown fine ware	undecorated
open bowl	H785:37	Miaodigou	19.5		14.2	7.5	0.493	2.6	11.2	84.3	red fine ware	undecorated
open bowl	H402:12	Banpo IV	35.2	35.2	14.2	13.4		2.6	28.2	377.9	grey fine ware	undecorated
open bowl	H402:22	Banpo IV	35.6	35.6	15	12.8		2.8	28.7	367.8	grey fine ware	undecorated
open bowl	H1.3.1	Banpo IV	18	18					12.0		red fine ware	undecorated
open bowl	H85.13.27	Banpo IV	15	15	5	4.3		3.5	11.7	50.2	red fine ware	burnished
open bowl	H85.13.30	Banpo IV	34	34	11	8		4.3	26.3	210.7	brown fine ware	undecorated
open bowl	H85.8.25	Banpo IV	18	18	9	8		2.3	15.0	120.0	red fine ware	burnished
straight-sided bowl	H144:5	Banpo IV	29.4	29.4	13	16.5	0.4	1.8	23.9	394.9	brown fine ware	undecorated
straight-sided bowl	H85.13.28	Banpo IV	23	23	6	8		2.9	17.3	138.7	red fine ware	undecorated
straight-sided bowl	H85.8.7	Banpo IV	13	13	6	4		3.3	10.7	42.7	red medium coarse ware	undecorated
straight-sided bowl	H85.8.8	Banpo IV	27	28	9	9		3.0	21.3	192.0	red fine ware	undecorated

Appendix 1. (Cont.)

Vessel Type	Find Number	Period	Rim Diameter	Widest Diameter	Bottom Diameter	Height	Wall Thickness	Rim/Height	Average Diameter	Volume (Average Diameter * Height)	Ceramic Quality	Decoration
straight-sided bowl	H85.8.16	Banpo IV	22	25	7	5		4.4	18.0	90.0	brown fine ware	burnished
straight-sided bowl	H85.8.10	Banpo IV	28	25	8	8		3.5	20.3	162.7	brown fine ware	burnished
straight-sided bowl	H85.8.11	Banpo IV	30	32	11	10		3.0	24.3	243.3	brown fine ware	burnished
basin	H886②:7	Miaodigou	35.3		11.5	21.2	0.4	1.7	15.6	330.7	red fine ware	painted and burnished
basin	G8–2②:40	Miaodigou	34.7		10.8	18.6	0.8	1.9	15.2	282.1	red fine ware	painted and burnished
basin	G8–2③:12	Miaodigou	26.6		10.5	16.8	0.6	1.6	12.4	207.8	red fine ware	painted and burnished
basin	H776:26	Miaodigou	25.6	24	9.2	9.3	0.3	2.8	19.6	182.3	red fine ware	undecorated
basin	H776⑤:27	Miaodigou	32	35	11.3	12.6	0.3	2.5	26.1	328.9	red fine ware	painted
basin	W1:2	Miaodigou	30.2	31	10.3	14.3	0.6	2.1	23.8	340.8	red fine ware	painted
basin	H577:7	Miaodigou	27.3	15.5	12	20	0.3	1.4	18.3	365.3	red fine ware	painted
basin	H776③:39	Miaodigou	33.3	31	10.4	17.3	0.3	1.9	24.9	430.8	brown fine ware	painted
basin	G8–2②:40	Miaodigou	29.4		10.2	37.9	0.3	0.8	13.2	500.3	red fine ware	painted
basin	H320:1	Miaodigou	26.6	27.8	11.6	26.7	0.5	1.0	22.0	587.4	red fine ware	painted
basin	H370:7	Miaodigou	26.8	31.6	11.4	19	0.3	1.4	23.3	442.1	red fine ware	painted
basin	G8–2④:147	Miaodigou	25.9	28.1	9.8	18.6	0.3	1.4	21.3	395.6	red fine ware	painted
basin	G8–2④:7	Miaodigou	29.9	32.8	11.7	17.4	0.3	1.7	24.8	431.5	red fine ware	painted
basin	G8–2②:21	Miaodigou	19.6		12.8	20.4		1.0	10.8	220.3	grey fine ware	burnished
basin	H776:28	Miaodigou	23.5		15.3	21.9	0.8	1.1	12.9	283.2	grey fine ware	burnished
straight-sided dish	G8–2⑤:26	Miaodigou	18.8		18.2	6.8	1.1	2.8	12.3	83.9	red fine ware	undecorated
straight-sided dish	H402:16	Banpo IV	11	11.7	7	11.5	0.6	1.0	9.9	113.9	brown coarse ware	undecorated
straight-sided dish	G8–2①:6	Miaodigou	22.6		16.3	9	1.1	2.5	13.0	116.7	red fine ware	undecorated
straight-sided dish	G8–2③:51	Miaodigou	22.8		16.1	11.8	0.7	1.9	13.0	153.0	red fine ware	undecorated
flat-bottom flask	H776:92	Miaodigou	4.6	16.8	11.2	50	0.4	0.1	10.9	543.3	red fine ware	fine corded ware
flat-bottom flask	G8–2②:32	Miaodigou	4.7	17.8	12.1	55	0.8	0.1	11.5	634.3	grey fine ware	fine corded ware
flat-bottom flask	G8–2④:59	Miaodigou	3	11.6	8.2	28		0.1	7.6	212.8	red fine ware	fine corded ware
flat-bottom flask	H547:6	Miaodigou	4.7		9.5	14.9		0.3	4.7	70.5	red fine ware	undecorated
pointed-bottom amphora	W18:1	Miaodigou	4.5			80		0.1	1.5	120.0	red fine ware	fine corded ware
pointed-bottom amphora	W13:1	Miaodigou	4.8			83.6		0.1	1.6	133.8	red fine ware	fine corded ware
pointed-bottom amphora	H402:32	Banpo IV	12.4			65.2		0.2	4.1	269.5	grey fine ware	corded ware
pointed-bottom amphora	H402:28	Banpo IV	6.4			48.8		0.1	2.1	104.1	red fine ware	fine corded ware
pointed-bottom amphora	G8–2④:43	Miaodigou	4.5	20.4		70	0.4	0.1	8.3	581.0	red fine ware	incisions
pointed-bottom amphora	W13:1	Miaodigou	4.7	25.8		84	0.3	0.1	10.2	854.0	grey fine ware	incisions
pointed-bottom amphora	G8–2④:139	Miaodigou	4.5	21.5			0.5				orange fine ware	slipped, incisions
pointed-bottom amphora	H274:5	Miaodigou	4.5	23.7			0.5				orange fine ware	slipped, incisions
pointed-bottom amphora	T0211④	Miaodigou	4.8	25.7			0.5				red fine ware	incisions
pointed-bottom amphora	W12:2	Miaodigou	4.9	23.5			0.5				grey fine ware	incisions
pointed-bottom amphora	T2008④	Miaodigou	4.6	26.5			0.5				grey fine ware	incisions
pointed-bottom amphora	W28:1	Miaodigou	4.2	25.8			0.4				grey fine ware	incisions
pointed-bottom amphora	H580:10	Banpo IV	11	26		62.5	0.2	0.2	12.3	770.8	red fine ware	slipped, incisions, appliqué band
pointed-bottom amphora	H402:21	Banpo IV	12.6	30.2		64.5	0.3	0.2	14.3	920.2	grey fine ware	incisions, flangen
pointed-bottom amphora	H402:25	Banpo IV	13.6	32.8		68	0.3	0.2	15.5	1051.7	orange fine ware	incisions
pointed-bottom amphora	H402:19	Banpo IV	7.6	30.4		63.6	0.5	0.1	12.7	805.6	grey fine ware	incisions
pointed-bottom amphora	H402:20	Banpo IV	8.1	30.7		64.7	0.5	0.1	12.9	836.8	grey fine ware	incisions, flangen
pointed-bottom amphora	H402:31	Banpo IV	7.8	31.4		67.5	0.5	0.1	13.1	882.0	grey fine ware	incisions, flangen
pointed-bottom amphora	H402:26	Banpo IV	7.4	30.9		66.5	0.4	0.1	12.8	849.0	grey fine ware	incisions, flangen
pointed-bottom amphora	H402:27	Banpo IV	7.6	31.8		66		0.1	13.1	866.8	grey fine ware	incisions, flangen
pointed-bottom amphora	H402:33	Banpo IV	7.6	28.7		63.8	0.6	0.1	12.1	772.0	grey fine ware	appliqué, incisions
goblet	H776④:6	Miaodigou	20				1.0		6.7		grey fine ware	burnished
goblet	H776③:21	Miaodigou	20		8.5	24	0.7	0.8	9.5	228.0	grey fine ware	burnished
goblet	H773.6:44	Miaodigou	17		5.8	24.1	0.7	0.7	7.6	183.2	grey fine ware	burnished

Appendix 1. (Cont.)

Vessel Type	Find Number	Period	Rim Diameter	Widest Diameter	Bottom Diameter	Height	Wall Thickness	Rim/Height	Average Diameter	Volume (Average Diameter * Height)	Ceramic Quality	Decoration
straight-sided jar	H25:24	Banpo IV	25.7		17	35.8	0.7	0.7	14.2	509.6	brown fine ware	undecorated
straight-sided jar	H85.13.29	Banpo IV	28	23	12	32		0.9	21.0	672.0	brown fine ware	undecorated
straight-sided jar	H85.8.22	Banpo IV	20	24	18	33		0.6	20.7	682.0	grey coarse ware	corded ware
straight-sided jar	H785:31	Miaodigou	14	11.2	7	17	0.5	0.8	10.7	182.5	brown coarse ware	appliqué, corded ware
straight-sided jar	H589:3	Banpo IV	25.2		16.4	43.2	0.7	0.6	13.9	599.0	red coarse ware	impressions, flangen
straight-sided jar	H776:84	Banpo IV	17.5	16.5	11	24.5	0.6	0.7	15.0	367.5	brown coarse ware	crossed corded ware, flangen
straight-sided jar	H776:86	Miaodigou	13	11.5	8.5	15.8	0.6	0.8	11.0	173.8	red coarse ware	corded ware
round-bodied jar	H247:13	Banpo IV	22	32	12.8	40.1	0.5	0.5	22.3	892.9	brown medium coarse ware	coarse corded ware
round-bodied jar	H402:35	Banpo IV	26.2		15.2	30.8		0.9	13.8	425.0	red coarse ware	appliqué band, flangen
round-bodied jar	G8–2③:91	Miaodigou	17.2	18	10.8	21.4	0.4	0.8	15.3	328.1	grey coarse ware	coarse corded ware
round-bodied jar	H580:2	Banpo IV	28.8	27.6	16	37.7	0.4	0.8	24.1	909.8	grey coarse ware	incisions, flangen
round-bodied jar	H784:13	Miaodigou	29.5	30.4	15.3	38	0.4	0.8	25.1	952.5	brown medium coarse ware	corded ware, flangen
round-bodied jar	H800:5	Banpo IV	20.5	28	16.5	34.8	0.3	0.6	21.7	754.0	red coarse ware	appliqué, corded ware, basket ware
round-bodied jar	W17:1	Banpo IV	25.9	35	17.2	47.3	0.6	0.5	26.0	1231.4	red coarse ware	crossed corded ware, flangen
round-bodied jar	H776④:33	Miaodigou	18.5	24	13.5	32.4	0.7	0.6	18.7	604.8	brown coarse ware	coarse corded ware
round-bodied jar	H841:3	Miaodigou	19.8	22.7	14.5	33.1	0.6	0.6	19.0	628.9	red coarse ware	corded ware, crossed corded ware, appliqué band
round-bodied jar	H621:1	Miaodigou	12.5	16.5	8.7	19.5	0.5	0.6	12.6	245.1	red coarse ware	crossed corded ware
round-bodied jar	H621:9	Miaodigou	15.2	21.5	11	22.1	0.3	0.7	15.9	351.4	brown coarse ware	coarse corded ware
round-bodied jar	H764:1	Miaodigou	17.5	20.2	11.8	2.3	0.5	7.6	16.5	38.0	red coarse ware	coarse corded ware
round-bodied jar	H776:23	Miaodigou	23.5	29	12	33.5	0.3	0.7	21.5	720.3	grey coarse ware	corded ware
round-bodied jar	H784:40	Miaodigou	18.5	24	13.3	32	0.3	0.6	18.6	595.2	brown coarse ware	corded ware
round-bodied jar	W16:2	Miaodigou	23.7	35.3	15.7	46.4	0.9	0.5	24.9	1155.4	red coarse ware	corded ware
round-bodied jar	G8–2③:152	Miaodigou	26.2	35.8	15.9	38.4	0.6	0.7	26.0	997.1	black coarse ware	coarse corded ware
round-bodied jar	W4:2	Miaodigou	21.8	28.2	14	34.6	0.8	0.6	21.3	738.1	red coarse ware	corded ware
round-bodied jar	W10:1	Miaodigou	21.1	35	14.7	10.1	0.6	2.1	23.6	238.4	red coarse ware	corded ware
small jar	H79:2	Banpo IV	11	11.7	7	11.5	0.6	1.0	9.9	113.9	brown coarse ware	corded ware
small jar	H234:1	Banpo IV	9.4		5.9	10.6	0.5	0.9	5.1	54.1	grey fine ware	coarse corded ware
small jar	H776.6:15	Miaodigou	9.8		7.4	14.2	0.5	0.7	5.7	81.4	red coarse ware	coarse corded ware
small jar	H776③:96	Miaodigou	12.8	14	9	15.6	0.5	0.8	11.9	186.2	grey coarse ware	coarse corded ware
straight-necked jar	G8–2③:156	Miaodigou	28.6	35.4	16.2	38		0.8	26.7	1015.9	brown coarse ware	coarse corded ware
straight-necked jar	G8–2③:152	Miaodigou	25.5	34.3	15.2	46		0.6	25.0	1150.0	brown coarse ware	coarse corded ware
urn	H776③:49	Miaodigou	50	58	14	44	0.5	1.1	40.7	1789.3	grey fine ware	burnished
urn	H816:2	Miaodigou	69.3	20.8	14.5	49	0.3	1.4	34.9	1708.5	grey fine ware	undecorated
urn	G8–2③:33	Miaodigou	55.3	62	15	43.5	0.4	1.3	44.1	1918.4	grey coarse ware	burnished
urn	G8–2④:48	Miaodigou	54.7	29.6	15.2	39.5	0.3	1.4	33.2	1310.1	grey medium coarse ware	burnished
urn	H836:10	Miaodigou	56.9	62.1	15.1	35.2	0.9	1.6	44.7	1573.4	grey fine ware	undecorated
urn	H310:10	Miaodigou	49.5	55.2	20.5	58.8	0.9	0.8	41.7	2453.9	grey fine ware	undecorated
urn	G8–2③:39	Miaodigou	57.8	60.5	15.2	41.7	0.8	1.4	44.5	1855.7	grey fine ware	burnished
urn	G8–2④:34	Miaodigou	51.5		17.6	39.8	0.6	1.3	23.0	916.7	grey medium coarse ware	burnished
urn	H766:142	Miaodigou	43.3		14.3	39.6	0.5	1.1	19.2	760.3	grey fine ware	burnished

Appendix 1. (Cont.)

Closed bowl	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)
Average	24.89	28.88	10.15	11.02	0.46	2.07	17.07	200.51
Standard error	1.25	1.39	0.58	0.52	0.04	0.14	1.41	25.16
Median	26.50	29.30	10.10	11.00	0.40	2.24	17.77	173.95
Modus	30.00		10.40	12.70	0.30			
Standard deviation	6.24	5.19	2.88	2.60	0.18	0.71	7.04	125.79
Standard variance	38.95	26.95	8.28	6.78	0.03	0.50	49.57	15,824.35
Kurtosis	0.16	0.84	4.91	4.27	−0.56	−0.07	−0.85	5.14
Skewness	−0.47	0.17	1.14	1.09	0.72	−0.13	0.22	1.73
Range	26.20	20.80	15.90	14.00	0.60	2.80	26.60	596.21
Minimum	11.80	19.40	3.90	5.60	0.20	0.72	6.07	44.05
Maximum	38.00	40.20	19.80	19.60	0.80	3.52	32.67	640.27
Quantity	25.00	14.00	25.00	25.00	25.00	25.00	25.00	25.00
Coefficient of variation (95.0%)	2.58	3.00	1.19	1.07	0.07	0.29	2.91	51.93

Open bowl	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)
Average	21.12	21.68	8.14	6.87	0.38	3.19	15.48	118.98
Standard error	1.37	1.61	0.69	0.55	0.03	0.12	1.30	21.46
Median	18.80	19.40	7.10	6.15	0.40	3.23	14.53	89.62
Modus	18.00	18.00	7.20	5.90	0.30			
Standard deviation	6.26	6.65	3.11	2.47	0.12	0.52	5.95	95.99
Standard variance	39.13	44.25	9.65	6.12	0.02	0.27	35.37	9213.29
Kurtosis	1.59	0.90	0.64	2.66	−0.86	−0.48	1.03	3.75
Skewness	1.60	1.51	1.27	1.66	−0.18	0.14	1.07	2.07
Range	20.80	20.60	10.50	9.10	0.43	2.00	21.97	348.78
Minimum	14.80	15.00	4.50	4.30	0.15	2.25	6.77	29.10
Maximum	35.60	35.60	15.00	13.40	0.58	4.25	28.73	377.88
Quantity	21.00	17.00	20.00	20.00	15.00	20.00	21.00	20.00
Coefficient of variation (95.0%)	2.85	3.42	1.45	1.16	0.07	0.24	2.71	44.92

Appendix 1. (Cont.)

Straight-sided bowl	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)
Average	24.6	27.5	8.6	8.6	0.4	3.1	16.3	146.3
Standard error	2.3	1.7	1.0	1.5	0.0	0.3	2.5	31.6
Median	27.0	26.5	8.0	8.0	0.4	3.0	18.0	162.7
Modus		25.0	6.0	8.0		3.0		
Standard deviation	6.0	3.3	2.6	4.1		0.8	6.5	83.5
Standard variance	35.6	11.0	7.0	16.6		0.6	42.8	6980.4
Kurtosis	1.9	0.0	−0.4	2.2		1.9	−1.1	−1.6
Skewness	−1.4	1.1	0.8	1.2		−0.1	−0.5	−0.2
Range	17.0	7.0	7.0	12.5		2.6	18.0	218.0
Minimum	13.0	25.0	6.0	4.0	0.4	1.8	6.3	25.3
Maximum	30.0	32.0	13.0	16.5	0.4	4.4	24.3	243.3
Quantity	7.0	4.0	7.0	7.0	1.0	7.0	7.0	7.0
Coefficient of variation (95.0%)	5.5	5.3	2.4	3.8		0.7	6.1	77.3

Basin	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)
Average	28.45	28.53	11.25	19.47	0.44	1.61	18.94	355.27
Standard error	1.11	1.95	0.38	1.69	0.05	0.15	1.35	29.08
Median	27.30	31.00	11.30	18.60	0.30	1.58	19.60	340.82
Modus	26.60	31.00		18.60	0.30			
Standard deviation	4.28	5.84	1.45	6.53	0.19	0.57	5.23	112.64
Standard variance	18.32	34.09	2.11	42.66	0.04	0.32	27.38	12,688.02
Kurtosis	−0.06	2.69	3.60	4.20	−0.18	−0.17	−1.56	−0.20
Skewness	−0.14	−1.53	1.49	1.51	1.11	0.54	−0.17	0.32
Range	15.70	19.50	6.10	28.60	0.50	1.98	15.30	405.12
Minimum	19.60	15.50	9.20	9.30	0.30	0.78	10.80	182.28
Maximum	35.30	35.00	15.30	37.90	0.80	2.75	26.10	587.40
Quantity	15.00	9.00	15.00	15.00	14.00	15.00	15.00	15.00
Coefficient of variation (95.0%)	2.37	4.49	0.80	3.62	0.11	0.32	2.90	62.38

Appendix 1. (Cont.)

Straight-sided dish	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)
Average	18.80	11.70	14.40	9.78	0.88	2.04	12.04	116.86
Standard error	2.76	0.00	2.51	1.17	0.13	0.40	0.73	14.15
Median	20.70	11.70	16.20	10.25	0.90	2.22	12.65	115.28
Modus					1.10		12.97	
Standard deviation	5.52		5.02	2.35	0.26	0.80	1.46	28.31
Standard variance	30.43		25.23	5.51	0.07	0.64	2.13	801.41
Kurtosis	1.50		3.40	−2.04	−5.29	0.21	3.07	1.51
Skewness	−1.41		−1.78	−0.69	−0.12	−1.02	−1.76	0.33
Range	11.80	0.00	11.20	5.00	0.50	1.81	3.07	69.14
Minimum	11.00	11.70	7.00	6.80	0.60	0.96	9.90	83.87
Maximum	22.80	11.70	18.20	11.80	1.10	2.76	12.97	153.01
Quantity	4.00	1.00	4.00	4.00	4.00	4.00	4.00	4.00
Coefficient of variation (95.0%)	8.78		7.99	3.73	0.42	1.28	2.32	45.05

Flat-bottomed flask	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)
Average	4.3	15.4	10.3	37.0	0.6	0.2	8.7	365.2
Standard error	0.4	1.9	0.9	9.4	0.2	0.1	1.6	133.6
Median	4.7	16.8	10.4	39.0	0.6	0.1	9.2	378.1
Mode	4.7							
Standard deviation	0.8	3.3	1.7	18.8	0.3	0.1	3.1	267.2
Sample variance	0.7	11.1	3.0	354.1	0.1	0.0	9.9	71,407.5
Kurtosis	3.9		−2.4	−3.4		3.9	−2.1	−4.1
Skewness	−2.0	−1.6	−0.2	−0.3		2.0	−0.6	−0.1
Range	1.7	6.2	3.9	40.1	0.4	0.2	6.8	563.8
Minimum	3.0	11.6	8.2	14.9	0.4	0.1	4.7	70.5
Maximum	4.7	17.8	12.1	55.0	0.8	0.3	11.5	634.3
Quantity	4.0	3.0	4.0	4.0	2.0	4.0	4.0	4.0
Coefficient of variation (95.0%)	1.3	8.3	2.8	29.9	2.5	0.2	5.0	425.2

Appendix 1. (Cont.)

Pointed-bottom amphora	**Rim diameter**	**Widest diameter**	**Bottom diameter**	**Height**	**Wall thickness**	**Rim/height**	**Average diameter**	**Volume (average diameter * height)**
Average	7.05	27.40			0.43	0.12	9.77	654.49
Standard error	0.66	0.92		2.31	0.03	0.01	1.28	84.51
Median	6.40	26.50		66.00	0.50	0.12	12.33	805.60
Mode	4.50	25.80			0.50			
Standard deviation	3.01	3.79		8.95	0.11	0.05	4.94	327.29
Sample variance	9.07	14.36		80.04	0.01		24.41	107,118.76
Kurtosis	−0.04	−1.03		1.10	−0.21	−1.00	−0.90	−0.81
Skewness	1.05	−0.31		0.28	−0.72	0.19	−0.87	−0.91
Range	9.40	12.40		35.20	0.40	0.14	13.97	947.63
Minimum	4.20	20.40		48.80	0.20	0.06	1.50	104.11
Maximum	13.60	32.80		84.00	0.60	0.20	15.47	1051.73
Quantity	21.00	17.00		15.00	16.00	15.00	15.00	15.00
Coefficient of variation (95.0%)	1.37	1.95		4.95	0.06	0.03	2.74	181.25

Straight-sided jar	**Rim diameter**	**Widest diameter**	**Bottom diameter**	**Height**	**Wall thickness**	**Rim/height**	**Average diameter**	**Volume (average diameter * height)**
Average	20.49	17.24	12.84	28.76	0.62	0.73	15.21	455.19
Standard error	2.25	2.73	1.64	3.81	0.04	0.04	1.57	82.14
Median	20.00	16.50	12.00	32.00	0.60	0.72	14.23	509.55
Mode					0.70			
Standard deviation	5.96	6.10	4.35	10.09	0.08	0.11	4.16	217.31
Sample variance	35.52	37.21	18.94	101.83	0.01	0.01	17.31	47,224.24
Kurtosis	−1.92	−2.94	−1.89	−1.17	−0.61	−1.54	−1.15	−1.81
Skewness	−0.05	0.17	−0.10	−0.09	−0.51	−0.24	0.61	−0.41
Range	15.00	12.80	11.00	27.40	0.20	0.29	10.27	508.20
Minimum	13.00	11.20	7.00	15.80	0.50	0.58	10.73	173.80
Maximum	28.00	24.00	18.00	43.20	0.70	0.88	21.00	682.00
Quantity	7.00	5.00	7.00	7.00	5.00	7.00	7.00	7.00
Coefficient of variation (95.0%)	5.51	7.57	4.02	9.33	0.10	0.10	3.85	200.98

Appendix 1. (Cont.)

Round-bodied jar	**Rim diameter**	**Widest diameter**	**Bottom diameter**	**Height**	**Wall thickness**	**Rim/height**	**Average diameter**	**Volume (average diameter * height)**
Average	21.58	27.25	13.83	30.81	0.51	1.12	20.38	655.91
Standard error	1.10	1.51	0.54	2.76	0.04	0.39	1.01	79.04
Median	21.45	28.00	14.25	33.30	0.50	0.66	21.42	674.58
Mode	26.20	35.00			0.30			
Standard deviation	4.65	6.23	2.28	11.73	0.18	1.66	4.27	335.34
Sample variance	21.60	38.81	5.22	137.58	0.03	2.74	18.26	112,453.26
Kurtosis	−0.51	−1.10	−0.19	0.92	−0.21	16.12	−1.07	−0.77
Skewness	−0.04	−0.15	−0.62	−1.01	0.60	3.96	−0.34	−0.07
Range	17.00	19.30	8.50	45.00	0.60	7.10	13.47	1193.43
Minimum	12.50	16.50	8.70	2.30	0.30	0.51	12.57	37.95
Maximum	29.50	35.80	17.20	47.30	0.90	7.61	26.03	1231.38
Quantity	18.00	17.00	18.00	18.00	17.00	18.00	18.00	18.00
Coefficient of variation (95.0%)	2.31	3.20	1.14	5.83	0.09	0.82	2.12	166.76

Small jar	**Rim diameter**	**Widest diameter**	**Bottom diameter**	**Height**	**Wall thickness**	**Rim/height**	**Average diameter**	**Volume (average diameter * height)**
Average	10.75	12.85	7.33	12.98	0.53	0.84	8.17	108.87
Standard error	0.76	1.15	0.64	1.16	0.03	0.06	1.65	28.51
Median	10.40	12.85	7.20	12.85	0.50	0.85	7.82	97.63
Mode					0.50			
Standard deviation	1.53	1.63	1.28	2.32	0.05	0.11	3.29	57.03
Sample variance	2.33	2.65	1.65	5.40		0.01	10.84	3252.18
Kurtosis	−0.11		1.21	−3.65	4.00	0.28	−4.03	0.77
Skewness	1.00		0.56	0.18	2.00	−0.69	0.29	0.99
Range	3.40	2.30	3.10	5.00	0.10	0.27	6.83	132.10
Minimum	9.40	11.70	5.90	10.60	0.50	0.69	5.10	54.06
Maximum	12.80	14.00	9.00	15.60	0.60	0.96	11.93	186.16
Quantity	4.00	2.00	4.00	4.00	4.00	4.00	4.00	4.00
Coefficient of variation (95.0%)	2.43	14.61	2.04	3.70	0.08	0.18	5.24	90.74

Appendix 1. (Cont.)

Urn	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)
Average	54.26	49.74	15.71	43.46	0.58	1.27	36.22	1587.37
Standard error	2.40	6.47	0.69	2.30	0.08	0.07	3.18	174.75
Median	54.70	58.00	15.10	41.70	0.50	1.29	40.67	1708.47
Mode			15.20		0.50			
Standard deviation	7.21	17.13	2.07	6.91	0.24	0.22	9.54	524.25
Sample variance	51.94	293.34	4.29	47.70	0.06	0.05	90.93	274,842.57
Kurtosis	2.05	−0.35	3.50	2.69	−1.52	0.80	−0.38	−0.11
Skewness	0.84	−1.24	1.92	1.49	0.34	−0.57	−0.99	−0.19
Range	26.00	41.30	6.50	23.60	0.60	0.77	25.50	1693.60
Minimum	43.30	20.80	14.00	35.20	0.30	0.84	19.20	760.32
Maximum	69.30	62.10	20.50	58.80	0.90	1.62	44.70	2453.92
Quantity	9.00	7.00	9.00	9.00	9.00	9.00	9.00	9.00
Coefficient of variation (95.0%)	5.54	15.84	1.59	5.31	0.18	0.17	7.33	402.98

Appendix 1. (Cont.)

Vessel type	Find number	Period	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)	Cearmic quality	Decoration
closed bowl	H769:1	Miaodigou	21	22.6	9.7	11	0.3	1.9	17.8	195.4	red fine ware	undecorated
closed bowl	H640:2	Miaodigou	21	23.2	9.6	9.7	0.2	2.2	17.9	174.0	red fine ware	undecorated
closed bowl	H540:1	Miaodigou	28	29.6	10.4	10.2	0.4	2.7	22.7	231.2	red fine ware	burnished
closed bowl	H627:1	Miaodigou	19.2	19.4	7.2	8.4	0.3	2.3	15.3	128.2	red fine ware	burnished
closed bowl	W13:3	Miaodigou	29.5	32	11.5	11.5	0.3	2.6	24.3	279.8	orange fine ware	undecorated
closed bowl	H776③:103	Miaodigou	29.4	31.6	12.3	13.1	0.3	2.2	24.4	320.1	red fine ware	undecorated
closed bowl	H228:14	Miaodigou	38	40.2	19.8	19.6	0.8	1.9	32.7	640.3	red fine ware	undecorated
closed bowl	G8–2②:60	Miaodigou	27.287	28.635	9.77	12	0.582	0.7	21.9	262.8	red fine ware	undecorated
closed bowl	G8–2②:8	Miaodigou	26.5	27.181	10.021	11.4	0.418	0.8	21.2	242.1	orange fine ware	slipped
closed bowl	G8–2②:53	Miaodigou	30	31.156	11.78	13.4	0.7	1.1	24.3	325.8	red fine ware	painted
closed bowl	G8–2③:59	Miaodigou	29.9		10.4	12.2	0.3	2.5	13.4	163.9	red fine ware	undecorated
closed bowl	G8–2③:54	Miaodigou	30	31.279	10.7	12.4	0.614	1.1	24.0	297.5	red fine ware	painted
closed bowl	G8–2③:80	Miaodigou	30.4		10.1	12.7	0.5	2.4	13.5	171.5	red fine ware	undecorated
closed bowl	G8–2①:29	Miaodigou	19.7		3.9	5.6	0.4	3.5	7.9	44.1	red fine ware	undecorated
closed bowl	G8–2③:64	Miaodigou	28.3		8.6	11.2	0.6	2.5	12.3	137.8	brown fine ware	painted and burnished
closed bowl	H766③:83	Miaodigou	23.3		8.1	10.2	0.5	2.3	10.5	106.8	red fine ware	painted and burnished
closed bowl	H776⑤:41	Miaodigou	28		8	10.6	0.5	2.6	12.0	127.2	red fine ware	painted and burnished
closed bowl	H776②:4	Miaodigou	11.8		6.4	8	0.8	1.5	6.1	48.5	red fine ware	undecorated
closed bowl	H776:67	Miaodigou	12.6		12	8.2	0.8	1.5	8.2	67.2	red fine ware	undecorated
open bowl	H573:10	Miaodigou	22	20.6	6.5	7.7	0.3	2.9	16.4	126.0	orange fine ware	slipped
open bowl	H776:25	Miaodigou	18.3	17.6	6.2	7.3	0.4	2.5	14.0	102.4	orange fine ware	undecorated
open bowl	H776③:74	Miaodigou	21.5	19.6	7.2	5.9	0.4	3.6	16.1	95.0	orange fine ware	undecorated
open bowl	H776:15	Miaodigou	18.8	19.4	6.4	6.5	0.3	2.9	14.9	96.6	grey fine ware	undecorated
open bowl	H776④:13	Miaodigou	17.4	17.4	7.2	5.3	0.15	3.3	14.0	74.2	red fine ware	undecorated
open bowl	H776④:52	Miaodigou	24.4	24.4	9	8.2	0.3	3.0	19.3	158.0	orange fine ware	undecorated
open bowl	H776⑤:45	Miaodigou	17.2	17.2	8	4.9	0.3	3.5	14.1	69.3	grey fine ware	undecorated
open bowl	H776:51	Miaodigou	16.8	16.8	7	5.3	0.2	3.2	13.5	71.7	orange fine ware	incisions
open bowl	H384:1	Miaodigou	20.9	20.9	6.9	5.9	0.3	3.5	16.2	95.8	orange fine ware	slipped
open bowl	G8–1③:28	Miaodigou	22.1		7.8	6.4	0.477	3.5	10.0	63.8	red fine ware	undecorated
open bowl	H785:6	Miaodigou	18	19	6.6	5	0.577	3.6	14.5	72.7	red fine ware	undecorated
open bowl	G8–4:1	Miaodigou	19.9	19.9	5.6	5	0.47	4.0	15.1	75.7	red fine ware	undecorated
open bowl	G8–1①a:1	Miaodigou	14.8		5.5	4.3	0.533	3.4	6.8	29.1	red fine ware	undecorated
open bowl	H95:2	Miaodigou	16.2		4.5	5.6	0.469	2.9	6.9	38.6	brown fine ware	undecorated
open bowl	H785:37	Miaodigou	19.5		14.2	7.5	0.493	2.6	11.2	84.3	red fine ware	undecorated
basin	H886②:7	Miaodigou	35.3		11.5	21.2	0.4	1.7	15.6	330.7	red fine ware	painted and burnished
basin	G8–2②:40	Miaodigou	34.7		10.8	18.6	0.8	1.9	15.2	282.1	red fine ware	painted and burnished
basin	G8–2③:12	Miaodigou	26.6		10.5	16.8	0.6	1.6	12.4	207.8	red fine ware	painted and burnished
basin	H776:26	Miaodigou	25.6	24	9.2	9.3	0.3	2.8	19.6	182.3	red fine ware	undecorated
basin	H776⑤:27	Miaodigou	32	35	11.3	12.6	0.3	2.5	26.1	328.9	red fine ware	painted
basin	W1:2	Miaodigou	30.2	31	10.3	14.3	0.6	2.1	23.8	340.8	red fine ware	painted
basin	H577:7	Miaodigou	27.3	15.5	12	20	0.3	1.4	18.3	365.3	red fine ware	painted
basin	H776③:39	Miaodigou	33.3	31	10.4	17.3	0.3	1.9	24.9	430.8	brown fine ware	painted
basin	G8–2②:40	Miaodigou	29.4		10.2	37.9	0.3	0.8	13.2	500.3	red fine ware	painted
basin	H320:1	Miaodigou	26.6	27.8	11.6	26.7	0.5	1.0	22.0	587.4	red fine ware	painted
basin	H370:7	Miaodigou	26.8	31.6	11.4	19	0.3	1.4	23.3	442.1	red fine ware	painted
basin	G8–2④:147	Miaodigou	25.9	28.1	9.8	18.6	0.3	1.4	21.3	395.6	red fine ware	painted
basin	G8–2④:7	Miaodigou	29.9	32.8	11.7	17.4	0.3	1.7	24.8	431.5	red fine ware	painted
basin	G8–2②:21	Miaodigou	19.6		12.8	20.4		1.0	10.8	220.3	grey fine ware	burnished
basin	H776:28	Miaodigou	23.5		15.3	21.9	0.8	1.1	12.9	283.2	grey fine ware	burnished
straight-sided dish	G8–2⑤:26	Miaodigou	18.8		18.2	6.8	1.1	2.8	12.3	83.9	red fine ware	undecorated

Appendix 1. (Cont.)

Vessel type	Find number	Period	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)	Cearmic quality	Decoration
straight-sided dish	G8–2①:6	Miaodigou	22.6		16.3	9	1.1	2.5	13.0	116.7	red fine ware	undecorated
straight-sided dish	G8–2③:51	Miaodigou	22.8		16.1	11.8	0.7	1.9	13.0	153.0	red fine ware	undecorated
flat-bottom flask	H776:92	Miaodigou	4.6	16.8	11.2	50	0.4	0.1	10.9	543.3	red fine ware	fine corded ware
flat-bottom flask	G8–2②:32	Miaodigou	4.7	17.8	12.1	55	0.8	0.1	11.5	634.3	grey fine ware	fine corded ware
flat-bottom flask	G8–2④:59	Miaodigou	3	11.6	8.2	28		0.1	7.6	212.8	red fine ware	fine corded ware
flat-bottom flask	H547:6	Miaodigou	4.7		9.5	14.9		0.3	4.7	70.5	red fine ware	undecorated
pointed-bottom amphora	W18:1	Miaodigou	4.5			80		0.1	1.5	120.0	red fine ware	fine corded ware
pointed-bottom amphora	W13:1	Miaodigou	4.8			83.6		0.1	1.6	133.8	red fine ware	fine corded ware
pointed-bottom amphora	G8–2④:43	Miaodigou	4.5	20.4		70	0.4	0.1	8.3	581.0	red fine ware	incisions
pointed-bottom amphora	W13:1	Miaodigou	4.7	25.8		84	0.3	0.1	10.2	854.0	grey fine ware	incisions
pointed-bottom amphora	G8–2④:139	Miaodigou	4.5	21.5			0.5				orange fine ware	slipped, incisions
pointed-bottom amphora	H274:5	Miaodigou	4.5	23.7			0.5				orange fine ware	slipped, incisions
pointed-bottom amphora	T0211④	Miaodigou	4.8	25.7			0.5				red fine ware	incisions
pointed-bottom amphora	W12:2	Miaodigou	4.9	23.5			0.5				grey fine ware	incisions
pointed-bottom amphora	T2008④	Miaodigou	4.6	26.5			0.5				grey fine ware	incisions
pointed-bottom amphora	W28:1	Miaodigou	4.2	25.8			0.4				grey fine ware	incisions
goblet	H776④:6	Miaodigou	20				1.0		6.7		grey fine ware	burnished
goblet	H776③:21	Miaodigou	20		8.5	24	0.7	0.8	9.5	228.0	grey fine ware	burnished
goblet	H773.6:44	Miaodigou	17		5.8	24.1	0.7	0.7	7.6	183.2	grey fine ware	burnished
straight-sided jar	H785:31	Miaodigou	14	11.2	7	17	0.5	0.8	10.7	182.5	brown coarse ware	appliqué, corded ware
straight-sided jar	H776:86	Miaodigou	13	11.5	8.5	15.8	0.6	0.8	11.0	173.8	red coarse ware	corded ware
round-bodied jar	G8—2③:91	Miaodigou	17.2	18	10.8	21.4	0.4	0.8	15.3	328.1	grey coarse ware	coarse corded ware
round-bodied jar	H784:13	Miaodigou	29.5	30.4	15.3	38	0.4	0.8	25.1	952.5	brown medium coarse ware	corded ware, flangen
round-bodied jar	H776④:33	Miaodigou	18.5	24	13.5	32.4	0.7	0.6	18.7	604.8	brown coarse ware	coarse corded ware
round-bodied jar	H841:3	Miaodigou	19.8	22.7	14.5	33.1	0.6	0.6	19.0	628.9	red coarse ware	corded ware, crossed corded ware, appliqué band
round-bodied jar	H621:1	Miaodigou	12.5	16.5	8.7	19.5	0.5	0.6	12.6	245.1	red coarse ware	crossed corded ware
round-bodied jar	H621:9	Miaodigou	15.2	21.5	11	22.1	0.3	0.7	15.9	351.4	brown coarse ware	coarse corded ware
round-bodied jar	H764:1	Miaodigou	17.5	20.2	11.8	2.3	0.5	7.6	16.5	38.0	red coarse ware	coarse corded ware
round-bodied jar	H776:23	Miaodigou	23.5	29	12	33.5	0.3	0.7	21.5	720.3	grey coarse ware	corded ware
round-bodied jar	H784:40	Miaodigou	18.5	24	13.3	32	0.3	0.6	18.6	595.2	brown coarse ware	corded ware
round-bodied jar	W16:2	Miaodigou	23.7	35.3	15.7	46.4	0.9	0.5	24.9	1155.4	red coarse ware	corded ware
round-bodied jar	G8–2③:152	Miaodigou	26.2	35.8	15.9	38.4	0.6	0.7	26.0	997.1	black coarse ware	coarse corded ware
round-bodied jar	W4:2	Miaodigou	21.8	28.2	14	34.6	0.8	0.6	21.3	738.1	red coarse ware	corded ware
round-bodied jar	W10:1	Miaodigou	21.1	35	14.7	10.1	0.6	2.1	23.6	238.4	red coarse ware	corded ware
small jar	H776.6:15	Miaodigou	9.8		7.4	14.2	0.5	0.7	5.7	81.4	red coarse ware	coarse corded ware
small jar	H776③:96	Miaodigou	12.8	14	9	15.6	0.5	0.8	11.9	186.2	grey coarse ware	coarse corded ware
straight-necked jar	G8–2③:156	Miaodigou	28.6	35.4	16.2	38		0.8	26.7	1015.9	brown coarse ware	coarse corded ware
straight-necked jar	G8–2③:152	Miaodigou	25.5	34.3	15.2	46		0.6	25.0	1150.0	brown coarse ware	coarse corded ware
urn	H776③:49	Miaodigou	50	58	14	44	0.5	1.1	40.7	1789.3	grey fine ware	burnished
urn	H816:2	Miaodigou	69.3	20.8	14.5	49	0.3	1.4	34.9	1708.5	grey fine ware	undecorated
urn	G8–2③:33	Miaodigou	55.3	62	15	43.5	0.4	1.3	44.1	1918.4	grey coarse ware	burnished
urn	G8–2④:48	Miaodigou	54.7	29.6	15.2	39.5	0.3	1.4	33.2	1310.1	grey medium coarse ware	burnished
urn	H836:10	Miaodigou	56.9	62.1	15.1	35.2	0.9	1.6	44.7	1573.4	grey fine ware	undecorated
urn	H310:10	Miaodigou	49.5	55.2	20.5	58.8	0.9	0.8	41.7	2453.9	grey fine ware	undecorated
urn	G8–2③:39	Miaodigou	57.8	60.5	15.2	41.7	0.8	1.4	44.5	1855.7	grey fine ware	burnished
urn	G8–2④:34	Miaodigou	51.5		17.6	39.8	0.6	1.3	23.0	916.7	grey medium coarse ware	burnished
urn	H766:142	Miaodigou	43.3		14.3	39.6	0.5	1.1	19.2	760.3	grey fine ware	burnished

Appendix 1. (Cont.)

Closed bowl	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)
Average	25.47	28.80	10.01	11.13	0.49	2.02	17.39	208.63
Standard error	1.50	1.71	0.72	0.66	0.04	0.17	1.65	31.34
Median	28.00	29.60	10.02	11.20	0.50	2.24	17.77	173.95
Modus	21.00		10.40	10.20	0.30			
Standard deviation	6.53	5.67	3.16	2.86	0.19	0.73	7.18	136.61
Standard variance	42.70	32.12	9.97	8.19	0.04	0.53	51.54	18,663.63
Kurtosis	0.38	0.70	4.93	3.79	−1.00	−0.24	−0.62	4.71
Skewness	−0.61	0.21	1.28	1.02	0.37	−0.22	0.22	1.72
Range	26.20	20.80	15.90	14.00	0.60	2.80	26.60	596.21
Minimum	11.80	19.40	3.90	5.60	0.20	0.72	6.07	44.05
Maximum	38.00	40.20	19.80	19.60	0.80	3.52	32.67	640.27
Quantity	19.00	11.00	19.00	19.00	19.00	19.00	19.00	19.00
Coefficient of variation (95.0%)	3.15	3.81	1.52	1.38	0.09	0.35	3.46	65.85

Urn	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)
Average	54.26	49.74	15.71	43.46	0.58	1.27	36.22	1587.37
Standard error	2.40	6.47	0.69	2.30	0.08	0.07	3.18	174.75
Median	54.70	58.00	15.10	41.70	0.50	1.29	40.67	1708.47
Modus			15.20		0.50			
Standard deviation	7.21	17.13	2.07	6.91	0.24	0.22	9.54	524.25
Standard variance	51.94	293.34	4.29	47.70	0.06	0.05	90.93	274,842.57
Kurtosis	2.05	−0.35	3.50	2.69	−1.52	0.80	−0.38	−0.11
Skewness	0.84	−1.24	1.92	1.49	0.34	−0.57	−0.99	−0.19
Range	26.00	41.30	6.50	23.60	0.60	0.77	25.50	1693.60
Minimum	43.30	20.80	14.00	35.20	0.30	0.84	19.20	760.32
Maximum	69.30	62.10	20.50	58.80	0.90	1.62	44.70	2453.92
Quantity	9.00	7.00	9.00	9.00	9.00	9.00	9.00	9.00
Coefficient of variation (95.0%)	5.54	15.84	1.59	5.31	0.18	0.17	7.33	402.98

Appendix 1. (Cont.)

Vessel type	Find number	Period	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)	Cearmic quality	Decoration
closed bowl	H534:1	Banpo IV	23.8	25.4	8.2	12.7	0.3	1.9	19.1	243.0	red fine ware	burnished
closed bowl	H181:1	Banpo IV	26	29	13.2	12.7	0.4	2.0	22.7	288.7	orange fine ware	undecorated
closed bowl	H492:1	Banpo IV	14.4		10.6	10.7	0.5	1.3	8.3	89.2	red coarse ware	flangen
closed bowl	H402:7	Banpo IV	20.4		8.8	9	0.3	2.3	9.7	87.6	red fine ware	undecorated
closed bowl	H402:14	Banpo IV	23.8		10.8	10	0.3	2.4	11.5	115.3	red fine ware	undecorated
closed bowl	H85.8.5	Banpo IV	30	33	12	9	0.3	3.3	25.0	225.0	red fine ware	undecorated
open bowl	H402:12	Banpo IV	35.2	35.2	14.2	13.4		2.6	28.2	377.9	grey fine ware	undecorated
open bowl	H402:22	Banpo IV	35.6	35.6	15	12.8		2.8	28.7	367.8	grey fine ware	undecorated
open bowl	H1.3.1	Banpo IV	18	18					12.0		red fine ware	undecorated
open bowl	H85.13.27	Banpo IV	15	15	5	4.3		3.5	11.7	50.2	red fine ware	burnished
open bowl	H85.13.30	Banpo IV	34	34	11	8		4.3	26.3	210.7	brown fine ware	undecorated
open bowl	H85.8.25	Banpo IV	18	18	9	8		2.3	15.0	120.0	red fine ware	burnished
straight-sided bowl	H144:5	Banpo IV	29.4	29.4	13	16.5	0.4	1.8	23.9	394.9	brown fine ware	undecorated
straight-sided bowl	H85.13.28	Banpo IV	23	23	6	8		2.9	17.3	138.7	red fine ware	undecorated
straight-sided bowl	H85.8.7	Banpo IV	13	13	6	4		3.3	10.7	42.7	red medium-coarse ware	undecorated
straight-sided bowl	H85.8.8	Banpo IV	27	28	9	9		3.0	21.3	192.0	red fine ware	undecorated
straight-sided bowl	H85.8.16	Banpo IV	22	25	7	5		4.4	18.0	90.0	brown fine ware	burnished
straight-sided bowl	H85.8.10	Banpo IV	28	25	8	8		3.5	20.3	162.7	brown fine ware	burnished
straight-sided bowl	H85.8.11	Banpo IV	30	32	11	10		3.0	24.3	243.3	brown fine ware	burnished
straight-sided dish	H402:16	Banpo IV	11	11.7	7	11.5	0.6	1.0	9.9	113.9	brown coarse ware	undecorated
pointed-bottom amphora	H402:32	Banpo IV	12.4			65.2		0.2	4.1	269.5	grey fine ware	corded ware
pointed-bottom amphora	H402:28	Banpo IV	6.4			48.8		0.1	2.1	104.1	red fine ware	fine corded ware
pointed-bottom amphora	H580:10	Banpo IV	11	26		62.5	0.2	0.2	12.3	770.8	red fine ware	slipped, incisions, appliqué band
pointed-bottom amphora	H402:21	Banpo IV	12.6	30.2		64.5	0.3	0.2	14.3	920.2	grey fine ware	incisions, flangen
pointed-bottom amphora	H402:25	Banpo IV	13.6	32.8		68	0.3	0.2	15.5	1051.7	orange fine ware	incisions
pointed-bottom amphora	H402:19	Banpo IV	7.6	30.4		63.6	0.5	0.1	12.7	805.6	grey fine ware	incisions
pointed-bottom amphora	H402:20	Banpo IV	8.1	30.7		64.7	0.5	0.1	12.9	836.8	grey fine ware	incisions, flangen
pointed-bottom amphora	H402:31	Banpo IV	7.8	31.4		67.5	0.5	0.1	13.1	882.0	grey fine ware	incisions, flangen
pointed-bottom amphora	H402:26	Banpo IV	7.4	30.9		66.5	0.4	0.1	12.8	849.0	grey fine ware	incisions, flangen
pointed-bottom amphora	H402:27	Banpo IV	7.6	31.8		66		0.1	13.1	866.8	grey fine ware	incisions, flangen
pointed-bottom amphora	H402:33	Banpo IV	7.6	28.7		63.8	0.6	0.1	12.1	772.0	grey fine ware	appliqué, incisions
straight-sided jar	H25:24	Banpo IV	25.7		17	35.8	0.7	0.7	14.2	509.6	brown fine ware	undecorated
straight-sided jar	H85.13.29	Banpo IV	28	23	12	32		0.9	21.0	672.0	brown fine ware	undecorated
straight-sided jar	H85.8.22	Banpo IV	20	24	18	33		0.6	20.7	682.0	grey coarse ware	corded ware
straight-sided jar	H589:3	Banpo IV	25.2		16.4	43.2	0.7	0.6	13.9	599.0	red coarse ware	impressions, flangen
straight-sided jar	H776:84	Banpo IV	17.5	16.5	11	24.5	0.6	0.7	15.0	367.5	brown coarse ware	crossed corded ware, flangen
round-bodied jar	H247:13	Banpo IV	22	32	12.8	40.1	0.5	0.5	22.3	892.9	brown medium coarse ware	coarse corded ware
round-bodied jar	H402:35	Banpo IV	26.2		15.2	30.8		0.9	13.8	425.0	red coarse ware	appliqué band, flangen
round-bodied jar	H580:2	Banpo IV	28.8	27.6	16	37.7	0.4	0.8	24.1	909.8	grey coarse ware	incisions, flangen
round-bodied jar	H800:5	Banpo IV	20.5	28	16.5	34.8	0.3	0.6	21.7	754.0	red coarse ware	appliqué, corded ware, basket ware
round-bodied jar	W17:1	Banpo IV	25.9	35	17.2	47.3	0.6	0.5	26.0	1231.4	red coarse ware	crossed corded ware, flangen
small jar	H79:2	Banpo IV	11	11.7	7	11.5	0.6	1.0	9.9	113.9	brown coarse ware	corded ware
small jar	H234:1	Banpo IV	9.4		5.9	10.6	0.5	0.9	5.1	54.1	grey fine ware	coarse corded ware

Appendix 1. (Cont.)

Closed bowl	**Rim diameter**	**Widest diameter**	**Bottom diameter**	**Height**	**Wall thickness**	**Rim/height**	**Average diameter**	**Volume (average diameter * height)**
Average	23.07	29.13	10.60	10.68	0.35	2.21	16.08	174.80
Standard error	2.16	2.19	0.77	0.69	0.03	0.27	2.91	35.88
Median	23.80	29.00	10.70	10.35	0.30	2.16	15.33	170.17
Modus	23.80			12.70	0.30			
Standard deviation	5.29	3.80	1.88	1.69	0.08	0.66	7.13	87.89
Standard variance	27.99	14.45	3.55	2.85	0.01	0.44	50.82	7723.96
Kurtosis	0.96		−1.08	−2.01	1.43	1.74	−2.45	−2.49
Skewness	−0.63	0.16	0.03	0.41	1.54	0.78	0.18	0.19
Range	15.60	7.60	5.00	3.70	0.20	1.99	16.67	201.11
Minimum	14.40	25.40	8.20	9.00	0.30	1.35	8.33	87.60
Maximum	30.00	33.00	13.20	12.70	0.50	3.33	25.00	288.71
Quantity	6.00	3.00	6.00	6.00	6.00	6.00	6.00	6.00
Coefficient of variation (95.0%)	5.55	9.44	1.98	1.77	0.09	0.69	7.48	92.23

Appendix 1. (Cont.)

Open bowl	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)
Average	25.97	25.97	10.84	9.30			20.32	225.30
Standard error	4.04	4.04	1.82	1.69		0.35	3.37	65.41
Median	26.00	26.00	11.00	8.00		2.78	20.67	210.67
Modus	18.00	18.00		8.00				
Standard deviation	9.90	9.90	4.07	3.79		0.79	8.26	146.25
Standard variance	97.96	97.96	16.53	14.36		0.63	68.29	21,389.25
Kurtosis	−3.14	−3.14	−0.67	−1.55		−0.34	−3.04	−2.49
Skewness	−0.04	−0.04	−0.59	−0.13		0.82	−0.04	−0.01
Range	20.60	20.60	10.00	9.10		2.00	17.07	327.71
Minimum	15.00	15.00	5.00	4.30		2.25	11.67	50.17
Maximum	35.60	35.60	15.00	13.40		4.25	28.73	377.88
Quantity	6.00	6.00	5.00	5.00		5.00	6.00	5.00
Coefficient of variation (95.0%)	10.39	10.39	5.05	4.71		0.99	8.67	181.59

Pointed-bottom amphora	Rim diameter	Widest diameter	Bottom diameter	Height	Wall thickness	Rim/height	Average diameter	Volume (average diameter * height)
Average	9.28	30.32			0.41	0.15	11.36	738.96
Standard error	0.78	0.66		1.58	0.05	0.01	1.27	86.29
Median	7.80	30.70		64.70	0.45	0.13	12.77	836.79
Modus	7.60				0.50			
Standard deviation	2.57	1.98		5.23	0.14	0.04	4.20	286.21
Standard variance	6.63	3.91		27.34	0.02	0.00	17.64	81,913.86
Kurtosis	−1.31	2.43		8.19	−1.08	−1.68	1.95	1.92
Skewness	0.74	−1.35		−2.71	−0.29	0.67	−1.73	−1.64
Range	7.20	6.80		19.20	0.40	0.09	13.33	947.63
Minimum	6.40	26.00		48.80	0.20	0.11	2.13	104.11
Maximum	13.60	32.80		68.00	0.60	0.20	15.47	1051.73
Quantity	11.00	9.00		11.00	8.00	11.00	11.00	11.00
Coefficient of variation (95.0%)	1.73	1.52		3.51	0.11	0.02	2.82	192.28

Appendix 1. (Cont.)

Straight-sided jar	**Rim diameter**	**Widest diameter**	**Bottom diameter**	**Height**	**Wall thickness**	**Rim/height**	**Average diameter**	**Volume (average diameter * height)**
Average	23.28	21.17	14.88	33.70	0.67	0.70	16.95	566.02
Standard error	1.95	2.35	1.41	3.02	0.03	0.05	1.60	58.47
Median	25.20	23.00	16.40	33.00	0.70	0.71	15.00	599.04
Modus					0.70			
Standard deviation	4.36	4.07	3.16	6.76	0.06	0.12	3.57	130.74
Standard variance	19.00	16.58	9.97	45.67	0.00	0.01	12.73	17,093.03
Kurtosis	−1.85		−2.77	1.19		0.43	−3.23	0.01
Skewness	−0.51	−1.62	−0.51	0.11	−1.73	0.82	0.56	−0.97
Range	10.50	7.50	7.00	18.70	0.10	0.29	7.13	314.50
Minimum	17.50	16.50	11.00	24.50	0.60	0.58	13.87	367.50
Maximum	28.00	24.00	18.00	43.20	0.70	0.88	21.00	682.00
Quantity	5.00	3.00	5.00	5.00	3.00	5.00	5.00	5.00
Coefficient of variation (95.0%)	5.41	10.12	3.92	8.39	0.14	0.14	4.43	162.34

Round-bodied jar	**Rim diameter**	**Widest diameter**	**Bottom diameter**	**Height**	**Wall thickness**	**Rim/height**	**Average diameter**	**Volume (average diameter * height)**
Mittelwert	24.68	30.65	15.54	38.14	0.45	0.66	21.58	842.63
Standardfehler	1.51	1.76	0.76	2.77	0.06	0.06	2.09	130.46
Median	25.90	30.00	16.00	37.70	0.45	0.59	22.27	892.89
Modus								
Standardabweichung	3.37	3.52	1.70	6.18	0.13	0.14	4.67	291.72
Stichprobenvarianz	11.36	12.36	2.88	38.24	0.02	0.02	21.84	85,100.61
Kurtosis	−1.68	−2.64	1.79	0.62	−1.20	−2.04	2.74	1.21
Schiefe	−0.19	0.58	−1.28	0.60	0.00	0.76	−1.49	−0.24
Wertebereich	8.30	7.40	4.40	16.50	0.30	0.30	12.23	806.34
Minimum	20.50	27.60	12.80	30.80	0.30	0.55	13.80	425.04
Maximum	28.80	35.00	17.20	47.30	0.60	0.85	26.03	1231.38
Anzahl	5.00	4.00	5.00	5.00	4.00	5.00	5.00	5.00
Konfidenzniveau(95.0%)	4.18	5.59	2.11	7.68	0.21	0.17	5.80	362.22

Appendix 2. Measurements of Vessels Produced by Hao and Zhao and Their Statistical Evaluation

Potter	Type/Potter	Vessel Type	Sample Number	Vessel Size	Weight (kg)	Height	Rim Diameter (Outer)	Rim Diameter (Inner)	Bottom Diameter	Widest Diameter	Knob Diameter	Rim/Height	Average Diameter	Volume (Average Diameter * Height)
Hao	large jar (Hao)	guan jar	1	large	2.04	20.1	14.1	12.3	13.3	22.4		0.7	15.5	312.1
Hao	large jar (Hao)	guan jar	2	large	2.23	20.1	14.6	12.6	14	22.3		0.7	15.9	319.1
Hao	large jar (Hao)	guan jar	3	large	2.23	19.8	14.8	12.6	13.9	22.2		0.7	15.9	314.3
Hao	large jar (Hao)	guan jar	4	large	2.16	20.1	14.1	12.1	13.2	22.3		0.7	15.4	310.0
Hao	large jar (Hao)	guan jar	5	large	2.18	19.6	14.9	12.6	13.9	21.8		0.8	15.8	309.7
Hao	small jar (Hao)	guan jar	1	small	1.05	14.5	12	10.3	11.3	17.5		0.8	12.8	185.2
Hao	small jar (Hao)	guan jar	2	small	1.05	14.9	12.2	10.3	11.4	17.3		0.8	12.8	190.7
Hao	small jar (Hao)	guan jar	3	small	1	15.8	12.2	10.8	11	18.1		0.8	13.0	205.8
Hao	small jar (Hao)	guan jar	4	small	0.94	15	12	10.5	10.8	17.4		0.8	12.7	190.1
Hao	small jar (Hao)	guan jar	5	small	1.15	14.5	11.8	10.4	11.2	17.1		0.8	12.6	183.1
Hao	large lid (Hao)	lid	1	large	0.39	1.1	15				3.5	13.6	3.8	4.1
Hao	large lid (Hao)	lid	2	large	0.36	1.1	15.2				3.1	13.8	3.8	4.2
Hao	large lid (Hao)	lid	3	large	0.37	1.2	15.2				3.2	12.7	3.8	4.6
Hao	large lid (Hao)	lid	4	large	0.49	1.5	15.15				3.5	10.1	3.8	5.7
Hao	large lid (Hao)	lid	5	large	0.37	0.95	14.9				3	15.7	3.7	3.5
Hao	small lid (Hao)	lid	1	small	0.23	1.1	12.2				2.5	11.1	3.1	3.4
Hao	small lid (Hao)	lid	2	small	0.23	1	12.35				2.2	12.4	3.1	3.1
Hao	small lid (Hao)	lid	3	small	0.23	1	12.1				2.5	12.1	3.0	3.0
Hao	small lid (Hao)	lid	4	small	0.23	1.15	12.2				2.3	10.6	3.1	3.5
Hao	double-handled jar (Hao)	double-handled jar	1		0.69	11.6	11.7	10.4	11.9	15.6		1.0	12.4	143.8
Hao	double-handled jar (Hao)	double-handled jar	2		0.67	11.6	11.6	10.5	11.8	15.6		1.0	12.4	143.6
Hao	double-handled jar (Hao)	double-handled jar	3		0.65	12.6	11.9	10.5	12	16.1		0.9	12.6	159.1
Hao	double-handled jar (Hao)	double-handled jar	4		0.6	11.2	10.9	9.8	11.7	15		1.0	11.9	132.7
Hao	double-handled jar (Hao)	double-handled jar	5		0.66	11.8	11.7	10.1	11.5	15.3		1.0	12.2	143.4
Hao	large basin (Hao)	pen basin	1	large	5.61	17.5	44.5	40	32.5			2.5	29.3	511.9
Hao	large basin (Hao)	pen basin	2	large	5.77	17	43.5	40	32.6			2.6	29.0	493.4
Hao	large basin (Hao)	pen basin	3	large	3.99	15.4	43.5	40.3	31.5			2.8	28.8	443.9
Hao	large basin (Hao)	pen basin	4	large	4.34	16.7	43.6	39.7	32			2.6	28.8	481.4
Hao	large basin (Hao)	pen basin	5	large	3.99	16.5	43.1	39.5	31.4			2.6	28.5	470.3

Appendix 2. (Cont.)

Potter	Type/Potter	Vessel Type	Sample Number	Vessel Size	Weight (kg)	Height	Rim Diameter (Outer)	Rim Diameter (Inner)	Bottom Diameter	Widest Diameter	Knob Diameter	Rim/Height	Average Diameter	Volume (Average Diameter * Height)
Hao	medium basin (Hao)	pen basin	1	middle	2.25	13	35.8	33.1	26			2.8	23.7	308.4
Hao	medium basin (Hao)	pen basin	2	middle	2.22	12	35.5	32.7	24.9			3.0	23.3	279.3
Hao	medium basin (Hao)	pen basin	3	middle	2.18	12.4	35.7	23.2	26.1			2.9	21.3	263.5
Hao	medium basin (Hao)	pen basin	4	middle	2.16	12.5	35.7	32.9	25.3			2.9	23.5	293.4
Hao	medium basin (Hao)	pen basin	5	middle	2.22	12.5	36.2	33.2	26.2			2.9	23.9	298.8
Hao	small basin (Hao)	pen basin	1	small	1.39	10.8	29.3	27	20.2			2.7	19.1	206.6
Hao	small basin (Hao)	pen basin	2	small	1.41	10.7	29.4	26.3	20.1			2.7	19.0	202.8
Hao	small basin (Hao)	pen basin	3	small	1.32	10.7	29.2	27	19.9			2.7	19.0	203.6
Hao	small basin (Hao)	pen basin	4	small	1.35	10.4	29.3	26.3	20			2.8	18.9	196.6
Hao	small basin (Hao)	pen basin	5	small	1.38	10.6	29	26.8	19.8			2.7	18.9	200.3
Zhang	large jar (Zhang)	guan jar	1	large	2.57	20	15	13.3	14.5	22.8		0.8	16.4	328.0
Zhang	large jar (Zhang)	guan jar	2	large	2.37	20	15.2	13	15.5	22.8		0.8	16.6	332.5
Zhang	large jar (Zhang)	guan jar	3	large	2.22	19.1	15	13.1	15.6	23		0.8	16.7	318.5
Zhang	large jar (Zhang)	guan jar	4	large	2.23	19.2	15.1	13.5	15	22.4		0.8	16.5	316.8
Zhang	large jar (Zhang)	guan jar	5	large	2.42	19	14.9	12.8	15.1	23		0.8	16.5	312.6
Zhang	small jar (Zhang)	guan jar	1	small	1.49	17.9	12.3	10.4	11.3	19.3		0.7	13.3	238.5
Zhang	small jar (Zhang)	guan jar	2	small	1.41	17.8	12	10.3	11.5	19.8		0.7	13.4	238.5
Zhang	small jar (Zhang)	guan jar	3	small	1.47	17.8	12.1	10.3	11.5	19.8		0.7	13.4	239.0
Zhang	small jar (Zhang)	guan jar	4	small	1.37	17	12	10.4	10.9	18.4		0.7	12.9	219.7
Zhang	small jar (Zhang)	guan jar	5	small	1.46	16.3	11.6	12.2	10.3	19.3		0.7	13.4	217.6
Zhang	small lid (Zhang)	lid	1	small	0.27	1.7	11.9	8.3			2.5	7.0	5.1	8.6
Zhang	small lid (Zhang)	lid	2	small	0.27	1.8	12.2	8.3			2.2	6.8	5.1	9.2
Zhang	small lid (Zhang)	lid	3	small	0.28	2	12	7.9			2.4	6.0	5.0	10.0
Zhang	small lid (Zhang)	lid	4	small	0.27	1.6	12.1	8.5			2.5	7.6	5.2	8.2
Zhang	small lid (Zhang)	lid	5	small	0.27	1.8	12.3	8.8			2.4	6.8	5.3	9.5
Zhang	large lid (Zhang)	lid	1	large	0.38	0.9	14.5				3.3	16.1	3.6	3.3
Zhang	large lid (Zhang)	lid	2	large	0.39	0.9	14.5				3.2	16.1	3.6	3.3
Zhang	large lid (Zhang)	lid	3	large	0.37	0.8	14.5				3.8	18.1	3.6	2.9
Zhang	large lid (Zhang)	lid	4	large	0.38	0.9	14.6				3.4	16.2	3.7	3.3
Zhang	large lid (Zhang)	lid	5	large	0.34	0.85	14.6				3.3	17.2	3.7	3.1
Zhang	medium basin (Zhang)	pen basin	1	middle	2.54	13.5	36.1	32.5	24.1			2.7	23.2	312.9
Zhang	medium basin (Zhang)	pen basin	2	middle	2.39	12.6	36.1	32.6	25.1			2.9	23.5	295.5
Zhang	medium basin (Zhang)	pen basin	3	middle	2.61	13.3	36.4	33	25.1			2.7	23.6	314.2
Zhang	medium basin (Zhang)	pen basin	4	middle	2.45	12.9	35.5	32.2	24.8			2.8	23.1	298.3
Zhang	medium basin (Zhang)	pen basin	5	middle	2.48	13	36.5	33.1	25.4			2.8	23.8	308.8

Appendix 2. (Cont.)

Large jar (Hao)	Weight (kg)	Height	Rim diameter (outer)	Rim diameter (inner)	Bottom diameter	Widest diameter	Knob diameter	Rim/Height	Volume
Average	2.17	19.94	14.50	12.44	13.66	22.20			313.04
Standard error	0.03	0.10	0.17	0.10	0.17	0.10		0.01	1.72
Median	2.18	20.10	14.60	12.60	13.90	22.30		0.73	312.05
Mode	2.23	20.10	14.10	12.60	13.90	22.30		0.70	#N/A
Standard deviation	0.08	0.23	0.38	0.23	0.38	0.23		0.03	3.86
Sample variance	0.01	0.05	0.15	0.05	0.14	0.05		0.00	14.87
Kurtosis	2.11	−1.01	−2.95	−1.01	−3.01	3.32		−2.42	0.77
Skewness	−1.43	−1.02	−0.27	−1.02	−0.59	−1.74		0.19	1.15
Range	0.19	0.50	0.80	0.50	0.80	0.60		0.06	9.41
Minimum	2.04	19.60	14.10	12.10	13.20	21.80		0.70	309.68
Maximum	2.23	20.10	14.90	12.60	14.00	22.40		0.76	319.09
Coefficient of variation	0.04	0.01	0.03	0.02	0.03	0.01			0.01
Quantity	5.00	5.00	5.00	5.00	5.00	5.00		5.00	5.00

Small jar (Hao)	Weight (kg)	Height	Rim diameter (outer)	Rim diameter (inner)	Bottom diameter	Widest diameter	Knob diameter	Rim/Height	Volume
Average	1.04	14.94	12.04	10.46	11.14	17.48			190.99
Standard error	0.03	0.24	0.07	0.09	0.11	0.17		0.01	3.97
Median	1.05	14.90	12.00	10.40	11.20	17.40		0.81	190.13
Mode	1.05	14.50	12.00	10.30	#N/A	#N/A		#N/A	#N/A
Standard deviation	0.08	0.53	0.17	0.21	0.24	0.38		0.02	8.89
Sample variance	0.01	0.28	0.03	0.04	0.06	0.14		0.00	78.99
Kurtosis	0.83	1.71	−0.61	1.93	−0.95	2.52		1.22	2.64
Skewness	0.37	1.29	−0.51	1.45	−0.60	1.38		−1.19	1.52
Range	0.21	1.30	0.40	0.50	0.60	1.00		0.06	22.73
Minimum	0.94	14.50	11.80	10.30	10.80	17.10		0.77	183.06
Maximum	1.15	15.80	12.20	10.80	11.40	18.10		0.83	205.80
Coefficient of variation	0.07	0.04	0.01	0.02	0.02	0.02			0.05
Quantity	5.00	5.00	5.00	5.00	5.00	5.00		5.00	5.00

Appendix 2. (Cont.)

Double-handled jar (Hao)	**Weight (kg)**	**Height**	**Rim diameter (outer)**	**Rim diameter (inner)**	**Bottom diameter**	**Widest diameter**	**Knob diameter**	**Rim/Height**	**Volume**
Average	0.65	11.76	11.56	10.26	11.78	15.52			144.51
Standard error	0.02	0.23	0.17	0.14	0.09	0.18		0.01	4.21
Median	0.66	11.60	11.70	10.40	11.80	15.60		0.99	143.55
Mode	#N/A	11.60	11.70	10.50	#N/A	15.60		#N/A	#N/A
Standard deviation	0.03	0.52	0.38	0.30	0.19	0.41		0.03	9.40
Sample variance	0.00	0.27	0.15	0.09	0.04	0.17		0.00	88.45
Kurtosis	2.03	2.40	3.63	−0.42	−0.02	0.46		0.36	2.28
Skewness	−1.17	1.23	−1.78	−1.04	−0.59	0.27		−1.01	0.72
Range	0.09	1.40	1.00	0.70	0.50	1.10		0.06	26.36
Minimum	0.60	11.20	10.90	9.80	11.50	15.00		0.94	132.72
Maximum	0.69	12.60	11.90	10.50	12.00	16.10		1.01	159.08
Coefficient of variation	0.05	0.04	0.03	0.03	0.02	0.03			0.07
Quantity	5.00	5.00	5.00	5.00	5.00	5.00		5.00	5.00
Large basin (Hao)	**Weight (kg)**	**Height**	**Rim diameter (outer)**	**Rim diameter (inner)**	**Bottom diameter**	**Widest diameter**	**Knob diameter**	**Rim/Height**	**Volume**
Average	4.74	16.62	43.64	39.90	32.00				480.17
Standard error	0.39	0.35	0.23	0.14	0.25			0.05	11.39
Median	4.34	16.70	43.50	40.00	32.00			2.61	481.38
Mode	3.99	#N/A	43.50	40.00	#N/A			#N/A	#N/A
Standard deviation	0.88	0.78	0.52	0.31	0.55			0.11	25.48
Sample variance	0.78	0.61	0.27	0.09	0.31			0.01	648.98
Kurtosis	−3.10	1.62	3.01	−0.66	−2.84			3.60	0.25
Skewness	0.51	−0.95	1.42	−0.09	0.00			1.83	−0.36
Range	1.78	2.10	1.40	0.80	1.20			0.28	67.97
Minimum	3.99	15.40	43.10	39.50	31.40			2.54	443.91
Maximum	5.77	17.50	44.50	40.30	32.60			2.82	511.88
Coefficient of variation	0.19	0.05	0.01	0.01	0.02				0.05
Quantity	5.00	5.00	5.00	5.00	5.00			5.00	5.00

Appendix 2. (Cont.)

Medium basin (Hao)	**Weight (kg)**	**Height**	**Rim diameter (outer)**	**Rim diameter (inner)**	**Bottom diameter**	**Widest diameter**	**Knob diameter**	**Rim/Height**	**Volume**
Average	2.21	12.48	35.78	31.02	25.70				288.68
Standard error	0.02	0.16	0.12	1.96	0.25			0.03	7.86
Median	2.22	12.50	35.70	32.90	26.00			2.88	293.44
Mode	2.22	12.50	35.70	#N/A	#N/A			#N/A	#N/A
Standard deviation	0.04	0.36	0.26	0.26	0.57			0.07	17.58
Sample variance	0.00	0.13	0.07	19.15	0.33			0.01	308.98
Kurtosis	−1.32	1.78	2.40	4.96	−1.71			1.66	−0.50
Skewness	−0.22	0.27	1.23	−2.23	−0.81			−0.78	−0.61
Range	0.09	1.00	0.70	10.00	1.30			0.20	44.93
Minimum	2.16	12.00	35.50	23.20	24.90			2.75	263.50
Maximum	2.25	13.00	36.20	33.20	26.20			2.96	308.43
Coefficient of variation	0.02	0.03	0.01	0.01	0.02				0.06
Quantity	5.00	5.00	5.00	5.00	5.00			5.00	5.00

Small basin (Hao)	**Weight (kg)**	**Height**	**Rim diameter (outer)**	**Rim diameter (inner)**	**Bottom diameter**	**Widest diameter**	**Knob diameter**	**Rim/Height**	**Volume**
Average	1.37	10.64	29.24	26.68	20.00				18.98
Standard error	0.02	0.07	0.07	0.16	0.07			0.02	0.04
Median	1.38	10.70	29.30	26.80	20.00			2.74	18.95
Mode	#N/A	10.70	29.30	27.00	#N/A			#N/A	18.90
Standard deviation	0.04	0.15	0.15	0.36	0.16			0.04	0.10
Sample variance	0.00	0.02	0.02	0.13	0.03			0.00	0.01
Kurtosis	−0.69	1.46	1.46	−3.13	−1.20			3.28	−0.17
Skewness	−0.57	−1.12	−1.12	−0.39	0.00			1.70	0.99
Range	0.09	0.40	0.40	0.70	0.40			0.10	0.23
Minimum	1.32	10.40	29.00	26.30	19.80			2.71	18.90
Maximum	1.41	10.80	29.40	27.00	20.20			2.82	19.13
Coefficient of variation	0.03	0.01	0.01	0.01	0.01				0.01
Quantity	5.00	5.00	5.00	5.00	5.00			5.00	5.00

Appendix 2. (Cont.)

Large lid (Hao)	**Weight (kg)**	**Height**	**Rim diameter (outer)**	**Rim diameter (inner)**	**Bottom diameter**	**Widest diameter**	**Knob diameter**	**Rim/Height**	**Volume**
Average	0.40	1.17	15.09					13.18	4.42
Standard error	0.02	0.09	0.06				0.10	0.91	0.36
Median	0.37	1.10	15.15				3.20	13.64	4.18
Mode	0.37	1.10	15.20				3.50	#N/A	#N/A
Standard deviation	0.05	0.20	0.13				0.23	2.04	0.80
Sample variance	0.00	0.04	0.02				0.05	4.16	0.63
Kurtosis	4.16	2.10	−1.54				−2.72	1.37	1.86
Skewness	2.02	1.19	−0.81				0.20	−0.66	1.08
Range	0.13	0.55	0.30				0.50	5.58	2.14
Minimum	0.36	0.95	14.90				3.00	10.10	3.54
Maximum	0.49	1.50	15.20				3.50	15.68	5.68
Coefficient of variation	0.14	0.18	0.01						0.18
Quantity	5.00	5.00	5.00				5.00	5.00	5.00

Small lid (Hao)	**Weight (kg)**	**Height**	**Rim diameter (outer)**	**Rim diameter (inner)**	**Bottom diameter**	**Widest diameter**	**Knob diameter**	**Rim/Height**	**Volume**
Average	0.23	1.06	12.21					11.54	31.36
Standard error	0.00	0.04	0.05				0.08	0.41	28.12
Median	0.23	1.05	12.20				2.40	11.60	3.36
Mode	0.23	1.00	12.20				2.50	#N/A	#N/A
Standard deviation	0.00	0.08	0.10				0.15	0.82	62.88
Sample variance	0.00	0.01	0.01				0.02	0.68	3953.50
Kurtosis		−3.90	1.79				−3.90	−3.97	5.00
Skewness		0.37	0.71				−0.37	−0.21	2.24
Range	0.00	0.15	0.25				0.30	1.74	140.82
Minimum	0.23	1.00	12.10				2.20	10.61	3.03
Maximum	0.23	1.15	12.35				2.50	12.35	143.84
Coefficient of variation	0.00	0.07	0.01						2.00
Quantity	4.00	4.00	4.00				4.00	4.00	5.00

Appendix 2. (Cont.)

Large jar (Zhang)	Weight (kg)	Height	Rim diameter (outer)	Rim diameter (inner)	Bottom diameter	Widest diameter	Knob diameter	Rim/Height	Volume
Average	2.36	19.46	15.04	13.14	15.14	22.80			321.67
Standard error	0.06	0.22	0.05	0.12	0.20	0.11		0.01	3.70
Median	2.37	19.20	15.00	13.10	15.10	22.80		0.78	318.49
Mode	#N/A	20.00	15.00	#N/A	#N/A	22.80		#N/A	#N/A
Standard deviation	0.15	0.50	0.11	0.27	0.44	0.24		0.02	8.28
Sample variance	0.02	0.25	0.01	0.07	0.19	0.06		0.00	68.59
Kurtosis	−0.70	−3.20	−0.18	−0.68	−0.29	2.00		−2.21	−1.90
Skewness	0.55	0.52	0.40	0.18	−0.59	−1.36		−0.79	0.45
Range	0.35	1.00	0.30	0.70	1.10	0.60		0.04	19.95
Minimum	2.22	19.00	14.90	12.80	14.50	22.40		0.75	312.55
Maximum	2.57	20.00	15.20	13.50	15.60	23.00		0.79	332.50
Coefficient of variation	0.06	0.03	0.01	0.02	0.03	0.01			0.03
Quantity	5.00	5.00	5.00	5.00	5.00	5.00		5.00	5.00

Small jar (Zhang)	Weight (kg)	Height	Rim diameter (outer)	Rim diameter (inner)	Bottom diameter	Widest diameter	Knob diameter	Rim/Height	Volume
Average	1.44	17.36	12.00	10.72	11.10	19.32			230.67
Standard error	0.02	0.31	0.11	0.37	0.23	0.26		0.01	4.91
Median	1.46	17.80	12.00	10.40	11.30	19.30		0.69	238.52
Mode	#N/A	17.80	12.00	10.40	11.50	19.30		#N/A	#N/A
Standard deviation	0.05	0.69	0.25	0.83	0.51	0.57		0.02	10.98
Sample variance	0.00	0.48	0.07	0.69	0.26	0.33		0.00	120.62
Kurtosis	−1.05	−0.29	2.00	4.93	0.58	1.62		−2.51	−3.21
Skewness	−0.74	−1.13	−0.91	2.22	−1.21	−1.24		0.34	−0.63
Range	0.12	1.60	0.70	1.90	1.20	1.40		0.04	21.36
Minimum	1.37	16.30	11.60	10.30	10.30	18.40		0.67	217.61
Maximum	1.49	17.90	12.30	12.20	11.50	19.80		0.71	238.97
Coefficient of variation	0.03	0.04	0.02	0.08	0.05	0.03			0.05
Quantity	5.00	5.00	5.00	5.00	5.00	5.00		5.00	5.00

Appendix 2. (Cont.)

Large lid (Zhang)	Weight (kg)	Height	Rim diameter (outer)	Rim diameter (inner)	Bottom diameter	Widest diameter	Knob diameter	Rim/Height	Volume
Average	0.37	0.87	14.54					16.75	3.16
Standard error	0.01	0.02	0.02				0.10	0.40	0.07
Median	0.38	0.90	14.50				3.30	16.22	3.26
Mode	0.38	0.90	14.50				3.30	16.11	3.26
Standard deviation	0.02	0.04	0.05				0.23	0.89	0.16
Sample variance							0.06	0.79	0.03
Kurtosis	2.61	0.31	−3.33				3.32	0.02	0.97
Skewness	−1.52	−1.26	0.61				1.74	1.19	−1.37
Range	0.05	0.10	0.10				0.60	2.01	0.39
Minimum	0.34	0.80	14.50				3.20	16.11	2.90
Maximum	0.39	0.90	14.60				3.80	18.13	3.29
Coefficient of variation	0.05	0.05	0.00						0.05
Quantity	5.00	5.00	5.00				5.00	5.00	5.00

Small lid (Zhang)	Weight (kg)	Height	Rim diameter (outer)	Rim diameter (inner)	Bottom diameter	Widest diameter	Knob diameter	Rim/Height	Volume
Average	0.27	1.78	12.10	8.36				6.83	9.10
Standard error	0.00	0.07	0.07	0.15			0.05	0.25	0.31
Median	0.27	1.80	12.10	8.30			2.40	6.83	9.23
Mode	0.27	1.80	#N/A	8.30			2.50	#N/A	#N/A
Standard deviation	0.00	0.15	0.16	0.33			0.12	0.56	0.69
Sample variance	0.00	0.02	0.03	0.11			0.02	0.31	0.47
Kurtosis	5.00	0.87	−1.20	0.86			2.00	1.71	−1.55
Skewness	2.24	0.55	0.00	−0.12			−1.36	−0.45	−0.11
Range	0.01	0.40	0.40	0.90			0.30	1.56	1.71
Minimum	0.27	1.60	11.90	7.90			2.20	6.00	8.24
Maximum	0.28	2.00	12.30	8.80			2.50	7.56	9.95
Coefficient of variation	0.02	0.08	0.01	0.04					0.08
Quantity	5.00	5.00	5.00	5.00			5.00	5.00	5.00

Appendix 2. (Cont.)

Medium basin (Zhang)	**Weight (kg)**	**Height**	**Rim diameter (outer)**	**Rim diameter (inner)**	**Bottom diameter**	**Widest diameter**	**Knob diameter**	**Rim/Height**	**Volume**
Average	2.49	13.06	36.12	32.68	24.90				305.92
Standard error	0.04	0.16	0.17	0.17	0.22			0.03	3.82
Median	2.48	13.00	36.10	32.60	25.10			2.75	308.75
Mode	#N/A	#N/A	36.10	#N/A	25.10			#N/A	#N/A
Standard deviation	0.08	0.35	0.39	0.37	0.49			0.07	8.54
Sample variance	0.01	0.12	0.15	0.14	0.24			0.01	73.01
Kurtosis	−0.47	−0.87	1.46	−1.62	1.90			−0.30	−2.75
Skewness	0.31	−0.03	−1.14	−0.08	−1.28			0.19	−0.44
Range	0.22	0.90	1.00	0.90	1.30			0.19	18.74
Minimum	2.39	12.60	35.50	32.20	24.10			2.67	295.47
Maximum	2.61	13.50	36.50	33.10	25.40			2.87	314.21
Coefficient of variation	0.03	0.03	0.01	0.01	0.02				0.03
Quantity	5.00	5.00	5.00	5.00	5.00			5.00	5.00

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