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Fingerprints, sex, state, and the organization of the Tell Leilan ceramic industry

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A R T I C L E I N F O

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A B S T R A C T

The goal of this research is to elucidate the organization of ceramic production at Tell Leilan, Northeast Syria with respect to gender roles from 3400 to 1700 BCE through a study of fingerprint impressions on pottery. Using the distribution of epidermal ridge densities, a technique has been developed and tested to determine the proportion of men and women who formed and finished vessels in a ceramic assemblage. Analysis of 106 fingerprints preserved on sherds indicates that there is a discrete change in the sex ratio of potters at Leilan coincident with the rise of urbanism and state formation in northern Mesopotamia. No change in this pattern, however, are yet correlated with other political shifts, such as changes in the various regimes that had hegemony over the site during the Early and Middle Bronze Age. These results provide new information about the effect of state authority on the public and private organization of crafts as well as the division of society along gender lines. Surprisingly, this transformation in gender roles, which coincides with the rise of the state at Tell Leilan, is not visible at village sites in the Tell Leilan Regional Survey. This indicates that the changes in social fabric that occurred at urban sites with the establishment of state institutions did not occur to the same extent in smaller settlements even though the state did control some of the ceramic production at these sites, at least during the Akkadian period. This methodology and research has implications beyond northern Mesopotamia and provides an innovative technique to empirically test the highly theoretical literature on the relationship of gender to craft production in the archaeological record.

1. Introduction

Tell Leilan, known as Šehna in the Early Bronze Age (ca. 3200–1900 BCE) and Šubat-Enlil during the Middle Bronze Age (ca. 1900–1500 BCE), was one of the major cities during this two-thousand-year span in the Khabur basin of northeastern Syria, in northern Mesopotamia (Fig. 1). This paper seeks to elucidate the organization of ceramic production at Tell Leilan, particularly with respect to political authority and gender roles from 3400 to 1700 BCE through a study of fingerprint impressions on pottery. As an innovative application of fingerprint analysis in Near Eastern archaeology, it may serve as a model for future studies of gender roles in the ancient world, and provide new information on the wider political and societal implications of these changes. This endeavor, therefore, stands in contrast to almost half a century of archaeological discussion of gender roles in prehistory and early polities that rely heavily on essentialist theoretical suppositions and tangentially related ethnography.

1.1. Gender and pottery production across time in Mesopotamia

Previous studies addressing the role of gender in craft production have been highly abstract and theoretical and their methods have been based either on ethnographic parallels or on methods that are imprecise and widely criticized.

Until the last two decades, most prehistoric archaeologists maintained that with the advent of agriculture, urbanism, and finally state formation, women's roles in society became increasingly restricted (Campbell, 2008). This alleged change has been attributed to the development of craft specialization and the rise of private property (Leacock et al., 1978), a change from a kin-based social structure in which women had a comparatively equal status as “sisters” to a class-based social structure in which women held dependent status as “wives” (Sacks, 1979), and/or the transfer

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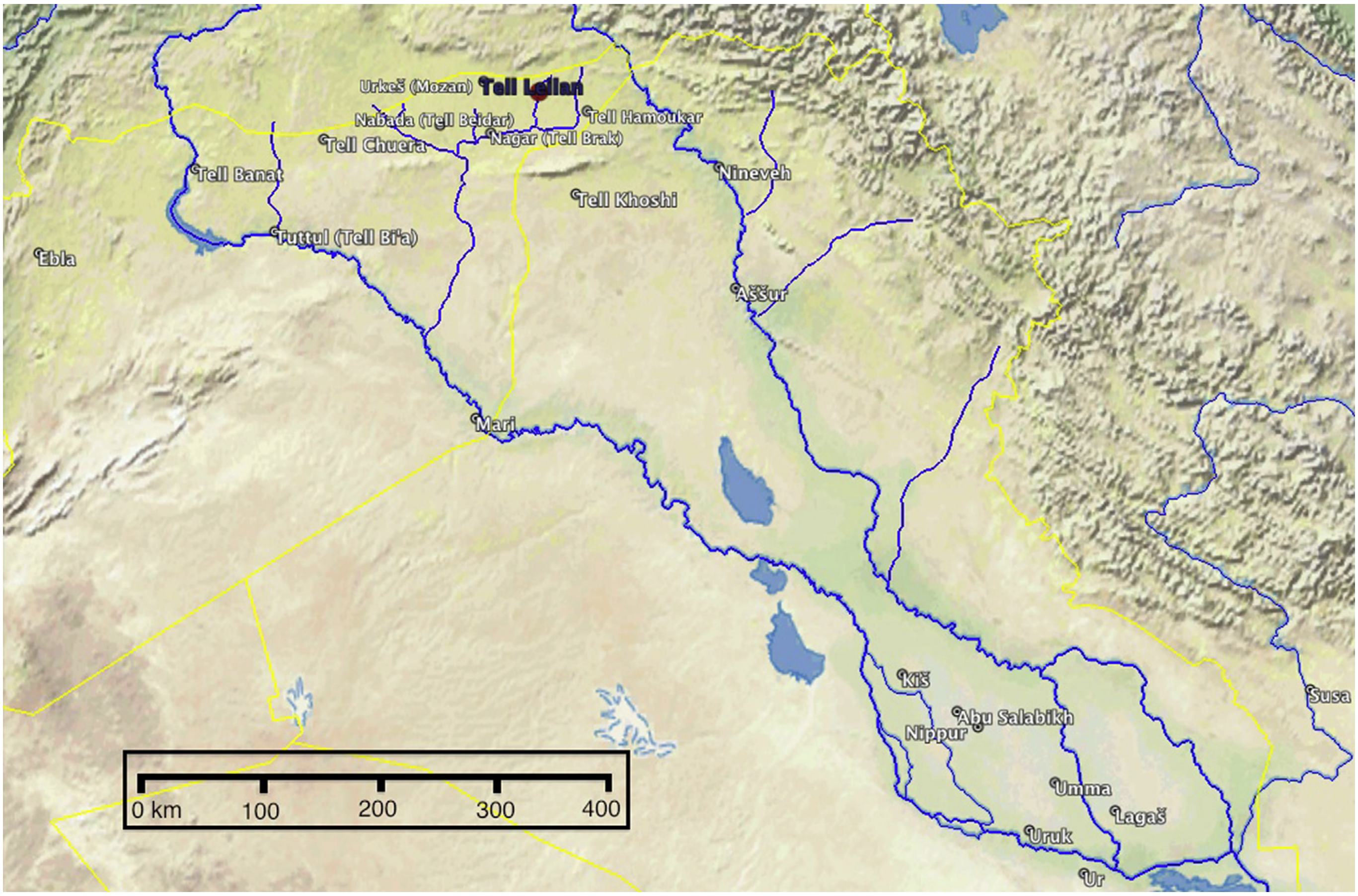

Fig. 1. Important sites of Early Bronze Age Mesopotamia.

of activities traditionally associated with the household to civic institutions, including cultic ritual and craft production (Wright, 2007). More generally, an increase in social complexity was associated with stricter and more hierarchical gender roles. In this context, Joy McCorriston studied the shift in textile production from flax-based to wool-based during the Mesopotamian Chalcolithic (1997). This change, she argues, prevented women who manufactured textiles from accessing materials needed to produce goods and thus alienated their labor from its products, preventing them from attaining higher economic status.[1]

Textual evidence for pottery production in Mesopotamia supports these suppositions. All of the names in lists of potters from the Akkadian, Ur III, and Old Babylonian states in the late third and early second millennia are invariably male gendered (Senior and Weiss, 1992: 19). These lists refer only to institutionally attached potters, leaving the question of the gender of potters producing ceramics for domestic use unanswered. Steinkeller suggests that the "only feasible explanation" of how private individuals acquired craft products in southern Mesopotamia is that the same workshops produced pottery for state and private consumption (Steinkeller, 1996: 253). This suggestion is commensurate with the hypothesis that the role of women became more constrained with the rise of state-organized craft production, establishing them as the sole producers of textiles, but not of pottery.

However, others have argued that both men and women may have produced pottery, with gendered participation depending on the scale and degree of specialization necessary. Some ethnographic data suggest that wheel-made pottery is produced exclusively by males in preindustrial societies (Kramer, 1985: 79, Senior, 1998: 184) and/or that household-based domestic pottery production is dominated by females in societies where pottery production is not the major source of subsistence for the households of those engaged in the craft (Byrne, 1994: 238). As a result, many archaeologists of ancient Near Eastern complex societies hypothesize that wheel-made pottery was made by male specialists on a large scale, while handmade pottery was made in small-scale domestic contexts in villages by women (Potts, 1997:161, Renger, 1984: 66). Ethnographic observations have confirmed that both men and women act as potters in the Near East (Kramer, 1985: 83, Matson, 1974: 345). However, the line between "wheel-made" and "hand-made" pottery cannot be drawn with any level of precision. Pottery was frequently made using a variety of hand and wheel techniques, particularly during the second and third millennia BCE (Courty and Roux, 1995; Roux and Courty, 1998).

1.2. Questioning assumptions of Women's roles and the definition of potters

Recently, Diane Bolger and Rita Wright have argued that the role of women was in flux throughout prehistoric and historical periods

[1] This study, however, has faced criticism due to our inability to precisely track the use of various fibers in textiles over prehistoric periods, as well as the roles of women in the various tasks associated with craft production during this period (Zettler in McCorriston, 1997).

alongside changes in culturally specific phenomena, refuting the hypothesis that women's roles are uniformly constrained with rising complexity. Their survey of women's roles in northern and southern Mesopotamia during the Ubaid, Uruk, and Early Dynastic Periods highlights the degree to which these roles can vary across time and space, even within a limited geographical area (Bolger and Wright, 2013: 382–4, Wright, 2008). Wright and Bolger's hypothesis is supported by Wright's analysis of Harappan craft production, in which she argues that after the rise of urbanism ca. 2500 BCE, two parallel systems of ceramic production involved in regional trade co-existed in the Indus Valley. The first system was limited to small-scale production in towns and villages, continuing the traditions of pottery production from the pre-state period, presumably including female labor if not exclusively relying on it. The second system centered on segregated craft quarters and was likely centrally administered (Wright, 1991). Furthermore, Bolger suggests that these segregated workshops included cooperative male and female labor throughout the various steps of the ceramic production process (Bolger, 2013: 172–3). This model of urban cooperative labor is found ethnographically in Rajasthan, where women are not permitted to touch the potter's wheel but spend much time in close proximity to it (Kramer, 1997: 49). In this case it is important to note that, comparable to the attached potters in ancient Mesopotamia, only men are accorded the official status of "potters," symbolized by their monopoly over the actual forming stage of pottery production. This indicates a cultural constraint on female ceramic production in the cities, despite their actual participation in many of the production processes. Bolger and Wright, then, suggest that growing social complexity did not have a uniform effect on how men and women produced pottery over time or space. However, neither author employs direct, empirical evidence to confirm their suggestion.

1.3. Past empirical studies

The few empirical studies of gender roles in archaeological contexts have concerned themselves with pre-state societies and build on differences in bone-wear patterns among male and female remains. Theya Molleson found that stress associated with completing repetitive tasks in the squatting position is documented primarily among females at Neolithic Abu Hureyra, suggesting that sitting tasks such as weaving, grinding, basketry were undertaken mainly by women (Molleson, 2007: 191–2). Jane Peterson confirmed this result with Levantine bone samples from during the Natufian period. During the late Neolithic period, however, she found that these stress patterns become more similar, indicating that with the spread of agriculture, new tasks were likely shared across gender lines (Peterson, 2002: 143–5). Pottery production only occurs in one of the periods she studied, the Early Bronze I, just before the rise of urbanism in the Levant. In this period, the stress value for the pronator quadratus, associated with several ceramic production activities (Perry, 2008: 106) was approximately equal for males and females (Peterson, 2002: 116). However, many different tasks make use of the same

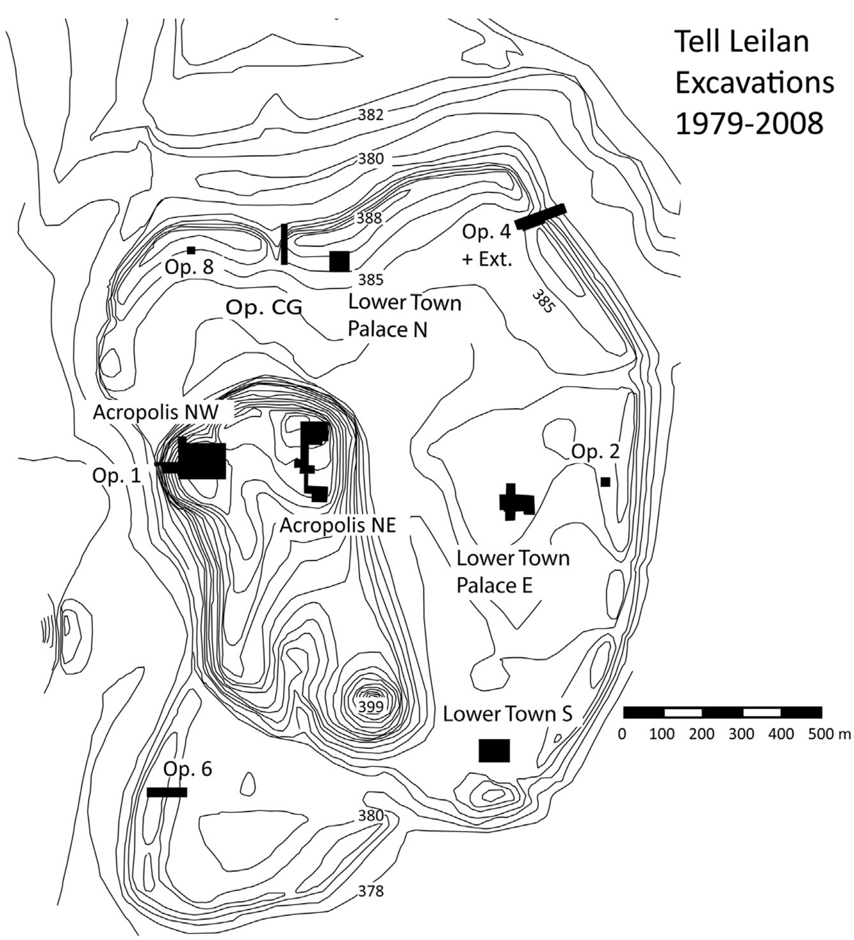

Fig. 2. Site plan of Tell Leilan.
Source: Weiss et al., 2012.

general motions and positions, making it difficult to identify which precise tasks are represented by a certain set of stress patterns.

Over the past half-century scholars have offered a plethora of theories about the relationship of gender to craft production. These theories have been constructed primarily based on broader theories of gender relations within human societies and ethnographic data, with few attempts to use controlled archaeological evidence to construct arguments. The current study presents a unique opportunity to distinguish among these theories through the consideration of actual material culture. By tracking the sex ratio of potters diachronically over periods of change in technology, scale and complexity and synchronically across different settlement types, we can evaluate which factors affected the sex ratio of potters in ancient northern Mesopotamia.

2. Ceramic assemblage

This project focused on ceramics from Operation 8, a 5 × 5 m sounding at Tell Leilan (Fig. 2, NW corner). Material from Op. 8 spans from the period of initial state formation in the region until the final destruction of the site: In period IIId and IIa (ca. 2600–2300 BCE), Tell Leilan witnessed the rise of urbanization and state formation, followed shortly by a period when the site likely fell under the hegemony of a regional state centered at nearby Tell Brak (Archi, 1998: 3). In period IIb (ca. 2300–2150 BCE), Tell Leilan was administered by the Akkadian Empire, which united a variety of disparate cultural and spatial areas under a single dynastic regime, centered in southern Mesopotamia (Weiss and Courty, 1993). This period was followed by an interval of over 300 years during which the site and its

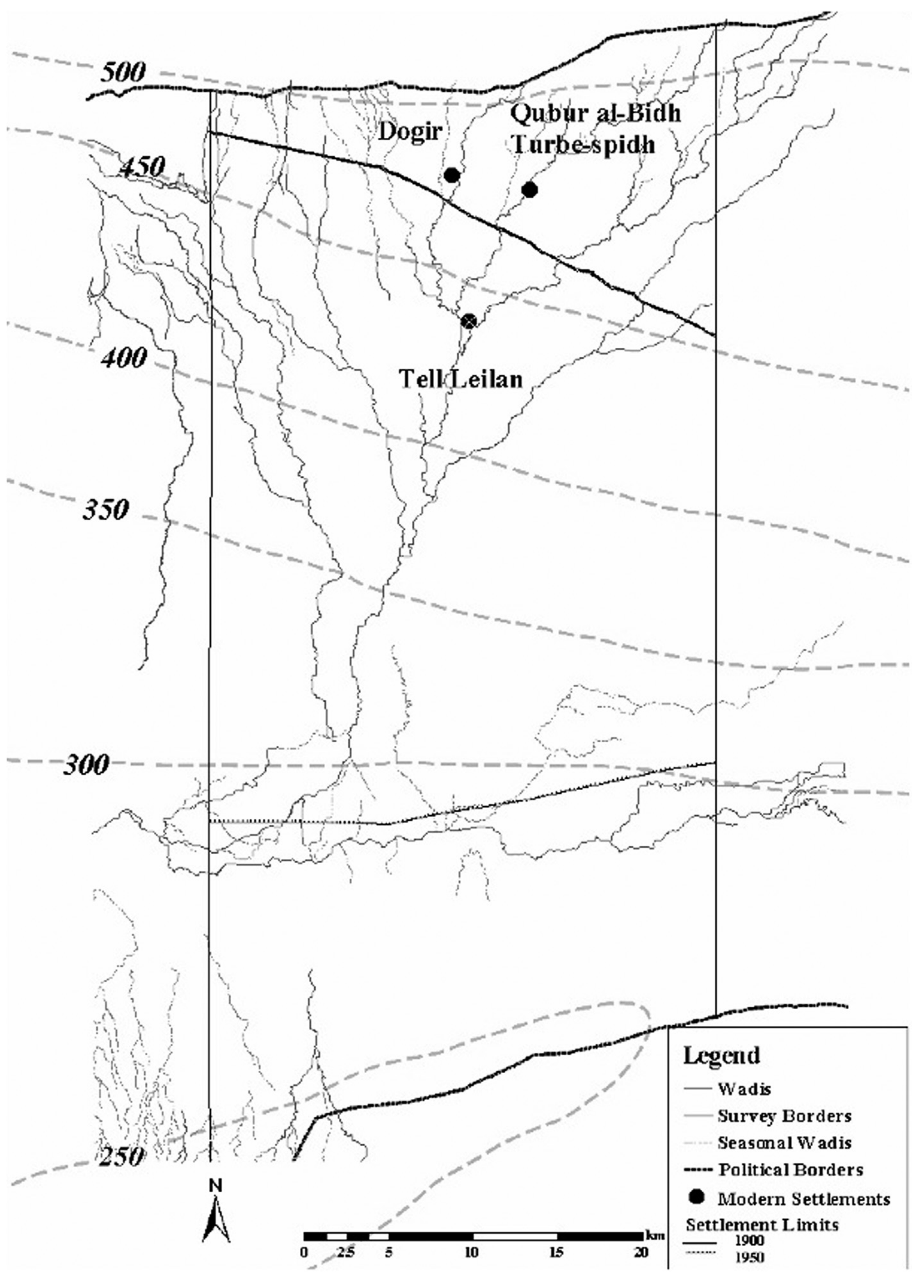

Fig. 3. Detail of the Tell Leilan Survey with modern settlements.
Source: Weiss et al., 2002.

Table 1
Tell Leilan Periodization.

Leilan Period	Regional Period	Dates (BCE)	Leilan excavation areas analyzed	# of sherds
I	Old Assyrian	1806–1726	Op. 8, LRS	19, 3
II	Multiple	2500–2150	Op. 8, LRS	1, 3
IIb	Akkadian	2300–2150	Op. 5	7
IIId–IIa	2nd Urban Revolution	2600–2400	Op. 8, LRS	8, 4
IIIc–IIIa	Ninevite V	3200–2600	Op. I	37
V–IV	Uruk	4100–3200	Op. I	23

surroundings, as well as much of the Khabur plains were unoccupied by permanent settlement (Weiss, 2012). Finally, in period I (1806–1726 BCE, Middle Chronology), it came under the hegemony of the Kingdom of Northern Mesopotamia, which was administered from Tell Leilan itself by an Amorite warlord named Šamši-Adad (r. 1809–1776). During this period, the site was the center of a massive program to resettle the Khabur plains and create a state resembling those in southern Mesopotamia (see Ristvet, 2005: 116 and 127). Tell Leilan subsequently served as the capital of several successor states to Šamši-Adad's kingdom until its destruction by Samsu-Iluna (r. 1750–1712 BCE), a king of the First Dynasty of Babylon, in 1726 BCE. The broad chronological range of the Op. 8 sounding allows me to investigate how economic and administrative schemes with very different goals may have affected ceramic production. In order to have a more representative sample from each period, the ceramics from Op. 8 were supplemented with pottery taken from Op. 5, a domestic quarter occupied during period IIb. Ceramics from Leilan's Op. 1 dating to the earlier pre-state Uruk (Periods V–IV) and Ninevite 5

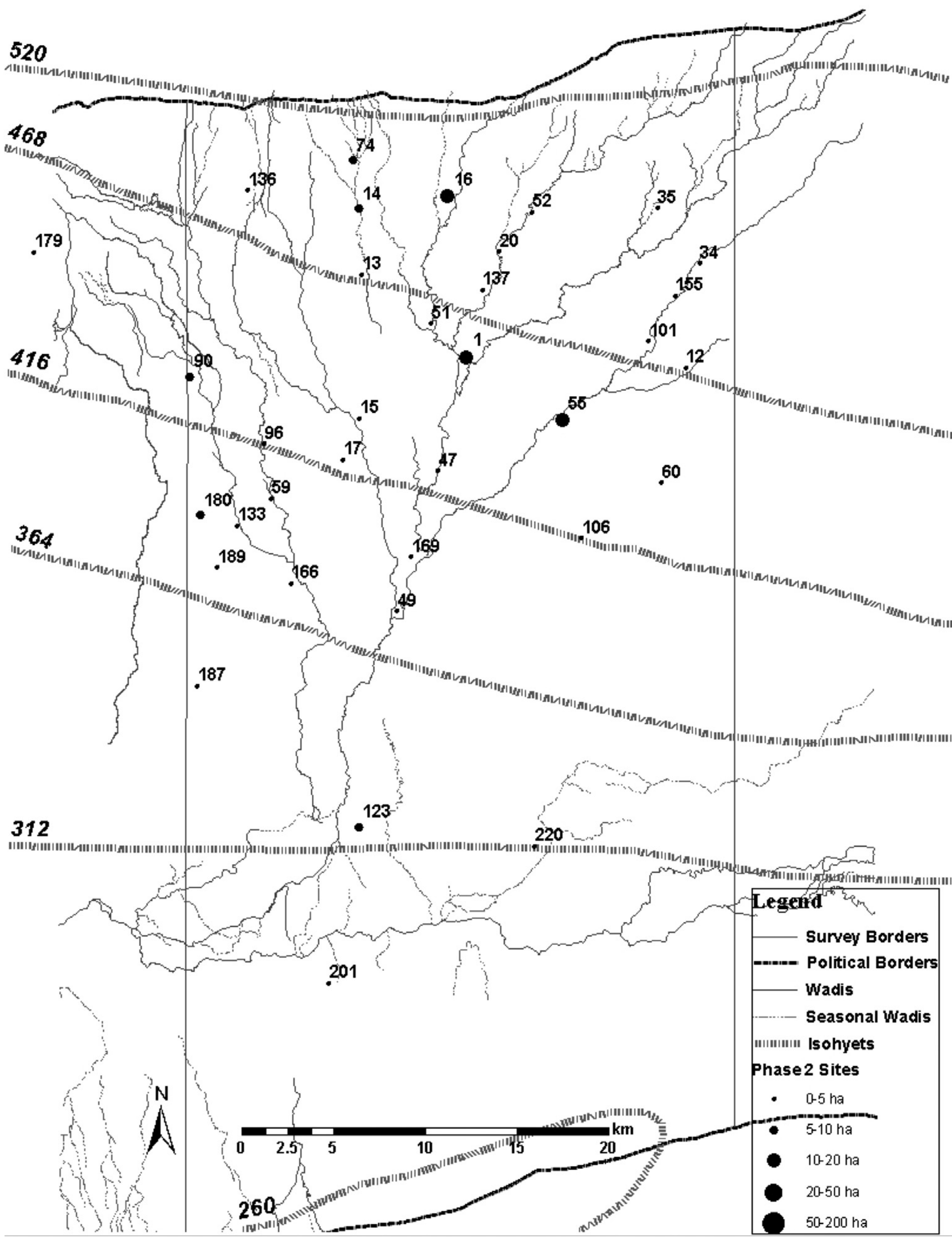

Fig. 4. Leilan Regional Survey site sizes in Periods IIIb–IIIc.
Source: Weiss et al., 2002.

(Periods IIIa–c) periods were also analyzed in order to compare practices during Leilan's prehistory to those which occurred under the complex polities in the Op. 8 sequence. Finally, ceramics from parallel occupations at village sites in the 1987 Tell Leilan Regional Survey (LRS) area (Fig. 3) were analyzed in order to study the social effects of different intensities of occupation over periods IIId–I in non-urban settlements (Table 1).

2.1. Pottery production and State Formation at Tell Leilan (Period IIId)

The "Second Urban Revolution" in northern Mesopotamia and Western Syria was a period of cultural change during the mid-third millennium characterized by the appearance of cities and secondary state formation (Akkermans and Schwartz, 2003; Weiss et al., 1993; Porter, 2002; Stein and Blackman, 1993). Harvey Weiss identified urbanization and indigenous state formation within Period IIId at Tell Leilan, radiocarbon dated to around 2600 BCE, along with the earliest evidence for state formation in the area of the Khabur triangle during the Second Urban Revolution (Weiss et al., 1993). At the beginning of this period, the site grew from a town of approximately 15 ha to a city of around 90 ha with a planned street grid, demonstrating guidance by a central authority at the site. Tell Leilan's expansion was also correlated with a large-scale migration to the city from the countryside (Ristvet, 2005: 59, Figs. 4 and 5). In addition, an administrative and storeroom complex, with evidence of large quantities of sealings from a limited number of public officials, was constructed on the site's acropolis,

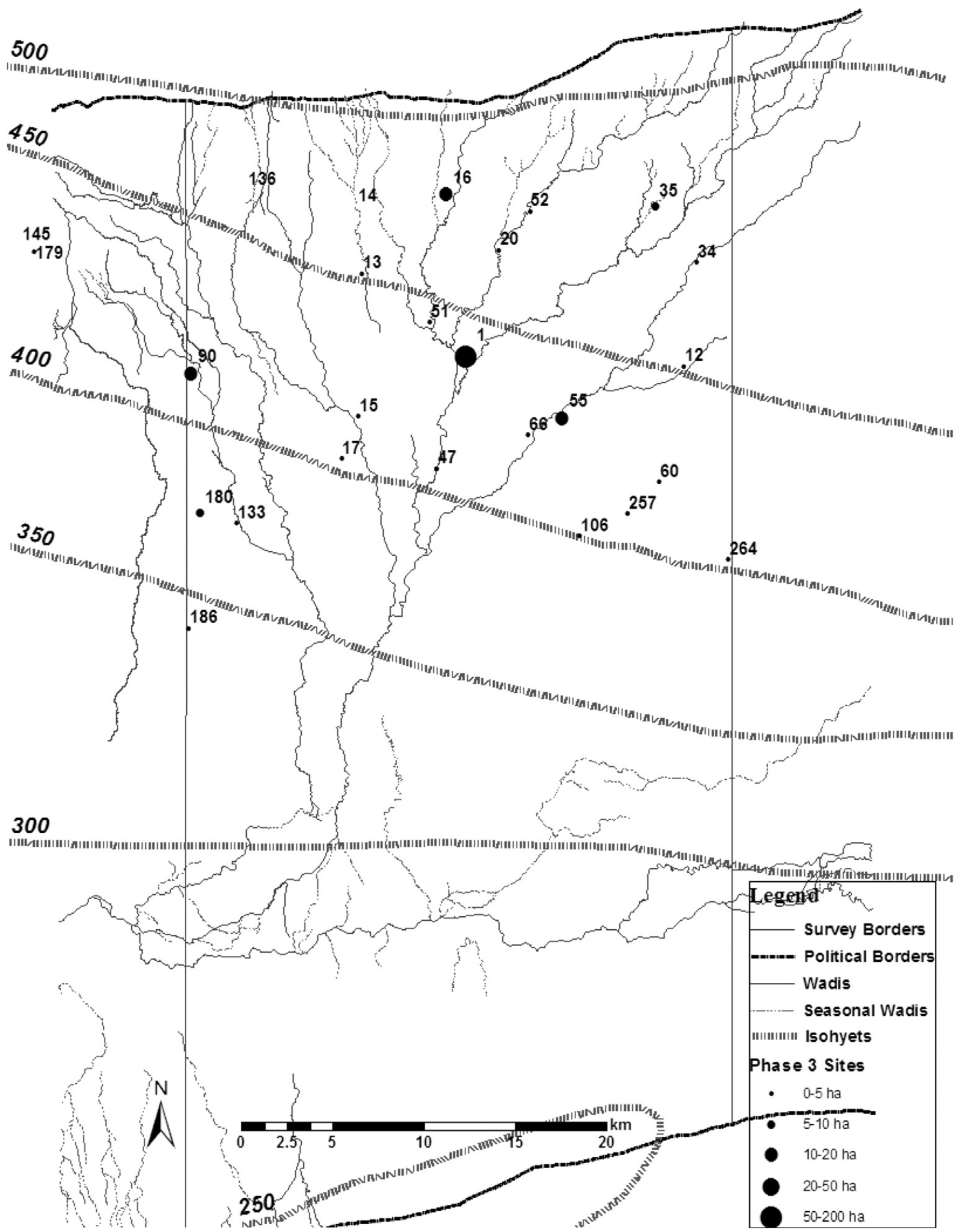

Fig. 5. Leilan Regional Survey site sizes in Period IIId.
Source: Weiss et al., 2002.

demonstrating the intensely hierarchical structure of this early state (Weiss, 1990: 209, Parayre, 2003). This evidence indicates a rapid change from the village-based economy of the previous period with a low level of craft specialization to an urban economy based on large scale storage and centralized redistribution of resources (Weiss et al., 1993: 996).

Because no ceramic workshops have been excavated at Tell Leilan and we have no administrative documents from the site dating to the first phase of urbanization, it has been necessary to consider contemporary evidence for other areas to reconstruct the relationship of state administration to craft production at Tell Leilan. At Tell Banat on the Upper Euphrates, several kilns were found on the western edge of the tell. All but one date to Tell Banat period IV, 2600–2450 BCE, contemporary with Leilan IIId and early IIa. These kilns are tentatively associated with building 12, which the excavators identified as an administrative building (Fig. 6). This identification suggests that this large-scale ceramic production was organized around a public institution (Porter and McClellan, 1998: 20), an observation supported by the construction of a large public building in a different area of the site at the same time as the first use of these kilns (Porter, 2002: 27). The vessels fired in these kilns included large numbers of standardized vessels that were found in tombs belonging to members of all socioeconomic strata (Cooper, 2006: 198). This pattern of recovery suggests that pottery workshops were centrally controlled by an administrative apparatus that redistributed its products to the general populace as containers for staple allotments, as has been argued for later states in northern and southern Mesopotamia. Likewise, the best-documented pottery workshop in Early Dynastic Sumer was excavated at Abu Salabikh near Nippur. This workshop dates from the ED II–III period and is contemporaneous with the first phase of urbanism at Leilan. This workshop was littered with about 20 sealings, mostly door sealings, indicating that the state had a direct role in administering the workshop and likely the craft quarter in general (Postgate, 1990: 104). It seems likely that a similar pattern may have occurred at Leilan, given that the process of state formation at Tell Leilan was accompanied by emulation of southern Mesopotamian administrative seal iconography (Parayre, 2003: 277).

From the following period, personnel lists detailing craftsmen who received rations have been uncovered at nearby Tell Beydar. These lists included potters, indicating that this was an attached industry (Van Lerberghe, 1996: 121). Indeed, a comparison of rationed personnel working at Beydar and the total likely population of Beydar and its hinterland, determined from an intensive archaeological survey, indicates that almost all the adults residing in the area were employed by the palace (Sallaberger and Ur, 2004), which must have included a large proportion, if not all of the potters at the site. The all-encompassing level of central control over labor during this period confirms the rapid pace of centralization of labor associated with the development of states in the Khabur, in order to mirror the type of centralization seen in southern Mesopotamia, from which state institutions were adapted. Given that this rapid change in the organization of the ceramic industry that coincided with the rise of urbanism and the state at Tell Leilan, we might hypothesize corresponding changes in the organization of social roles during this period including the demographic makeup of potters.

3. Methods

Ancient fingerprints have been explored minimally, mostly with unsatisfying results. In general, pilot studies have looked at small assemblages of fingerprints and have attempted to find exact

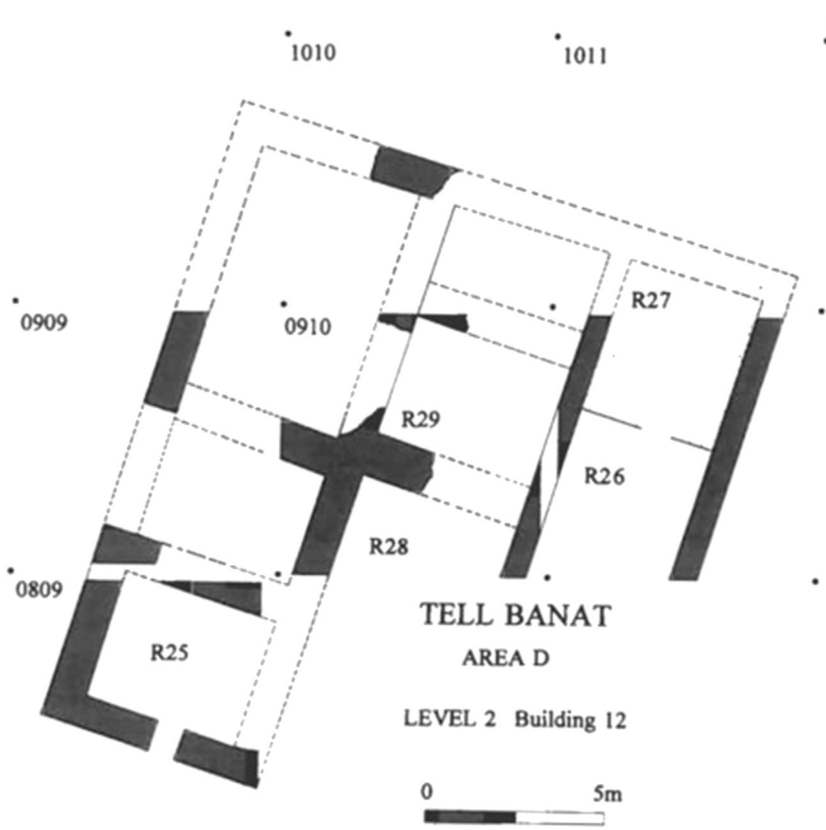

Fig. 6. Tell Banat building 12.
Source: Porter and McClellamn, 1998.

Table 2
Mean fingerprint ridge densities of males and females in various populations.

	Male	Female	M:F ratio	Population
Acree 1999	11.14	13.32	0.836	Caucasian American
Acree 1999	10.9	12.61	0.864	African American
Nayak et al., 2010	11.73	14.15	0.829	Chinese
Nayak et al., 2010	11.44	13.63	0.839	Malaysian
Gungadin 2007	12.77	14.6	0.875	South Indian
Kaur and Garg 2011	12.99	15.61	0.832	North Indian
Average	11.83	13.99	0.846	
Observed Leilan	12.94			
Theoretical Leilan	12.2–12.68	14.43–15.01		

matches, a process that requires a vast collection of impressions of a completeness that is very rarely present on ancient artifacts. These pilot studies have ended with frustration regarding the future of archaeological fingerprint studies (eg. Branigan et al., 2002). With this investigation, both of these obstacles have been overcome through the application of a method that has only recently been developed in criminology. Since 1999, several studies have confirmed a uniform difference between average male and female fingerprint ridge density in populations from around the world (Table 2, Acree, 1999; Gungadin, 2007; Nayak et al., 2010; Kaur and Garg, 2011).

Through an evaluation of the concentration of epidermal ridges, it should be possible, given an adequate sample size, to determine the sex ratio of the craftspeople who finished vessels or formed them in the case of unfinished ceramics using much more fragmentary prints than those necessary for studies of exact matches. This analysis is possible only if we assume that these fingerprints are in fact left by the craftsmen themselves and not, for example, by their supervisors. This assumption is supported by the mostly fragmentary status of the fingerprints, their inconsistent location on the vessel, their existence on all types of wares, and by the fact that for the most part the fingerprints are difficult to find.

This is the first time that such a protocol has been applied to archaeological ceramics with a large enough sample size to trace changes in the sex ratio of ceramic producers diachronically and synchronically across settlement type and ware type, and the author hopes that it will become a protocol that is applied widely to excavated assemblages. There is one recent example in a Chinese journal of the sexing of fingerprints left on clay bricks (Yinghong et al., 2007) and V. Gordon Childe reported that gender was determined “by an expert in daktylography” in a Russian excavation as early as the 1930s (Childe, 1943: 5). Julie Hruby also recently published brief discussions of the use of fingerprints for sexing potters (using a different methodology) in the appendices to a final report of the Midea excavations with a sample size too small to produce robust results (Hruby, 2007) and in an article on the gender and ages of Mycenean ceramic producers that found no significant difference in sex ratio between those who formed vessels and those who affixed handles (Hruby, 2011).

The effectiveness of using ridge densities to determine sex of pottery producers was dismissed in a 1999 study that used a comparison of ridge densities to distinguish between pots made by adults and figurines made by children (Kamp et al., 1999). This study was published before the rigorous cross-cultural findings cited above, but it raises two vital points: First, the ridge density of a single print is not sufficient to determine if the sex of the person who made it, as the distributions for male and female ridge densities are overlapping. However, with a large enough sample size one may find two assemblages whose distributions are statistically significantly different, indicating a measurably different sex ratio in the producers of those assemblages. Furthermore, a clearly bimodal distribution of ridge densities would point to the fact that both males and females were necessarily active in producing a certain assemblage. Second, the possibility of sub-adult potters (apprentices) must also be addressed. This pattern can be distinguished from that left by both male and female potters, as the cooperation between adult and child potters should produce a broad unimodal distribution with a positive skew, as opposed the bimodal distribution produced by adult male and female production. This result would be expected for adult-child cooperation as decrease in fingerprint ridge density is partially due to increase in body size and there would be no discrete break in the production of pottery as the child grew.

The total number of fingerprints from which ridge density could be measured was 106 (Table 4). Ridges were counted within a square of 5 mm × 5 mm following the methodology of Gungadin 2007 using ImageJ software (Fig. 7), starting with a

Table 3
Drying and firing shrinkage for experimental impressions.

Sample	1	2	3	4	5	6	9	7a	8a
Treatment	Wet, shallow	Wet, normal	Wet, deep	Plastic, normal	Plastic, shallow	Plastic, deep	Bone dry + wet	Leather hard	Leather hard + wet
Thickness before	0.5 cm	0.5 cm	0.5 cm	0.5 cm	0.5 cm	0.5 cm	0.5 cm	0.5 cm	0.5 cm
Weight before (g)	14.93	13.33	16.22	15.61	18.96	15.59	15.32	16.74	14.61
Weight at impress.	14.93	13.33	16.22	15.61	18.96	15.59	12.68	16.02	14.16
Weight dry	12.28	10.95	13.31	12.94	15.67	12.82	12.57	13.7	12
% Drying weight los	21.58	21.74	21.86	20.63	21.00	21.61	0.88	16.93	18.00
Weight after	11.36	10.1	12.3	11.95	14.46	11.81	11.61	12.64	11.11
% Firing weight los	8.10	8.42	8.21	8.28	8.37	8.55	8.27	8.39	8.01
%Total weight loss	31.43	31.98	31.87	30.63	31.12	32.01	9.22	26.74	27.45
L. of print before (cm)	1.954	2.071	2.463	2.336	2.16	2.447	2.381	2.412	2.454
W. of print before (cm)	1.24	1.246	1.509	1.462	1.392	1.639	1.557	1.447	1.541
2 cm at impression	2	2	2	2	2	2	1.895	1.914	1.881
Length of print dry	1.899	1.942	2.26	2.198	2.129	2.431	2.376	2.325	2.36
Width of print dry	1.115	1.173	1.445	1.387	1.274	1.516	1.554	1.395	1.482
2 cm line dry	1.881	1.87	1.862	1.926	1.913	1.911	1.891	1.845	1.809
% Drying linear shrink	6.811	6.606	6.941	5.176	5.089	4.476	0.205	3.736	3.981
Length of print after	1.866	1.913	2.219	2.133	2.099	2.352	2.334	2.241	2.268
Width of print after	1.09	1.132	1.423	1.355	1.249	1.477	1.519	1.388	1.466
2 cm line after	1.866	1.851	1.855	1.92	1.904	1.905	1.87	1.84	1.796
% Firing linear shrink	1.622	2.055	1.257	1.907	1.301	2.105	1.742	1.508	1.957
% Total linear shrink	8.553	8.793	8.285	7.193	6.466	6.665	1.951	5.301	6.017

Table 4
Ridge density measurements.

Site	Field	Lot#	Obj.#	Location	Leilan Period	Ware	Ridge density
Gir Souar	A3	Pd. 2		Outside	II	Medium	15[a]
Gir Souar	H2	Pd. 2		Outside	II	Fine	16
Bayandur	D1	Pd. 2		Outside	II	Fine	12
Bayandur	A2	Pd. 3		Inside	IIId	Fine	13[a]
Bayandur	B3	Pd. 3		Outside	IIId	Medium	15[a]
Bayandur	D1	IIId–IIa		Outside	IIId–IIa	Fine	16[a]
Blaij	E2	Khabur and Late		Inside And Outside	I	Fine	16[a]
Farsouk Kebir	O2	Pd. 3		Outside	IIId	Fine	14[a]
Girde Halime	A5	Pd. 1		Outside	I	Medium	13
Girde Halime	F1	Pd. 1		Outside	I	Medium	13[a]
Girde Halime	A2	Pd. 2		Outside	II	Fine	15[a]
Tell Leilan	Op1	98	2	Inside	IIIa	Medium	12
Tell Leilan	Op1	97	2	Inside Near Rim	IIIa	Medium	14[a]
Tell Leilan	Op1a	4	2	Inside	IIIa	Coarse	12
Tell Leilan	Op1	96	1	Inside Under Neck	IIIa	Medium	13
Tell Leilan	Op1	97	3	Inside	IIIa	Coarse	13[a]
Tell Leilan	Op1a	3	1	Outside	IIIa	Coarse	13[a]
Tell Leilan	Op1a	3	2	Outside	IIIa	Coarse	15[a]
Tell Leilan	Op1	98	1	Inside Under Neck	IIIa	Medium	15[a]
Tell Leilan	Op1a	4	1	Outside	IIIa	Coarse	15[a]
Tell Leilan	Op1	97	1	Outside Near Base	IIIa	Fine	16[a]
Tell Leilan	Op1	43	4	Outside	IIIb	Fine	12
Tell Leilan	Op1	43	1	Outside	IIIb	Fine	13
Tell Leilan	Op1	43	2	Outside	IIIb	Fine	13[a]
Tell Leilan	Op1	43	3	Outside	IIIb	Fine	13[a]
Tell Leilan	Op1	74	1	Outside	IIIb	Fine	13
Tell Leilan	Op1	74	5	Outside	IIIb	Fine	13
Tell Leilan	Op1	74	4	Outside	IIIb	Fine	14[a]
Tell Leilan	Op1	27	1	Outside	IIIb	Fine	15[a]
Tell Leilan	Op1	36	1	Outside Shoulder	IIIb	Fine	15
Tell Leilan	Op1	28	1	Outside	IIIb	Fine	15[a]
Tell Leilan	Op1	32	1	Inside Multiple	IIIb	Fine	15[a]
Tell Leilan	Op1	37	1	In Incisions	IIIb	Coarse	16[a]
Tell Leilan	Op1	74	2	Outside	IIIb	Fine	16
Tell Leilan	Op1	74	3	Outside	IIIb	Fine	16
Tell Leilan	Op1	14	2	Outside on Base	IIIc	Coarse	12
Tell Leilan	Op1	6	3	Outside	IIIc	Fine	12[a]
Tell Leilan	Op1	6	4	Outside	IIIc	Medium	13[a]
Tell Leilan	Op1	6	6	Outside	IIIc	Fine	13[a]
Tell Leilan	Op1	14	1	Inside	IIIc	Coarse	13
Tell Leilan	Op1	6	5	Outside	IIIc	Fine	14[a]
Tell Leilan	Op1	6	7	Outside	IIIc	Coarse	14[a]
Tell Leilan	Op1	6	1	Inside	IIIc	Medium	15
Tell Leilan	Op1	6	2	Outside	IIIc	Fine	15[a]
Tell Leilan	Op1	12	2	Inside	IIIc	Medium	15
Tell Leilan	Op1	12	3	Outside Near Base	IIIc	Medium	15
Tell Leilan	Op1	12	1	Inside	IIIc	Medium	16
Tell Leilan	Op1	12	4	Outside	IIIc	Medium	16[a]
Tell Leilan	Op1b	19	1	Inside Near Rim	IV	Medium	12[a]
Tell Leilan	Op1a	24	2	Outside	IV	Coarse	13[a]
Tell Leilan	Op1b	7	1	On Top of Rim	IV	Medium	13[a]
Tell Leilan	Op1a	26	1	Outside	IV	Coarse	14[a]
Tell Leilan	Op1b	12	1	Outside Near Rim	IV	Medium	14[a]
Tell Leilan	Op1a	23	2	Outside Rim	IV	Medium	15[a]
Tell Leilan	Op1a	19	1	Inside Rim	IV	Medium	15
Tell Leilan	Op1a	37	1	Outside Near Base	IV	Fine	15[a]
Tell Leilan	Op1a	35	1	Outside Under Rim	IV	Medium	15
Tell Leilan	Op1a	24	1	On Top of Rim	IV	Fine	15[a]
Tell Leilan	Op1b	2	1	Outside	IV	Fine	15[a]
Tell Leilan	Op1a	23	1	Outside	IV	Fine	16[a]
Tell Leilan	Op1a	19	2	Outside	IV	Coarse	16[a]
Tell Leilan	Op1b	28	1	Outside Near Rim	V	Medium	12
Tell Leilan	Op1b	32	2	Outside Under Rim	V	Medium	12
Tell Leilan	Op1b	33	1	Outside	V	Fine	13[a]
Tell Leilan	Op1b	30	1	Outside	V	Medium	14[a]
Tell Leilan	Op1b	25	1	Outside Under Rim	V	Medium	14[a]
Tell Leilan	Op1b	30	2	Outside Rim	V	Medium	15
Tell Leilan	Op1b	32	1	Inside Rim	V	Medium	15[a]
Tell Leilan	Op1b	17	1	Outside	V	Coarse	15
Tell Leilan	Op1b	39	1	Outside Under Rim	V	Medium	15
Tell Leilan	Op1b	35	1	Outside	V	Medium	16[a]
Tell Leilan	Op8	21	282	Outside	I	Medium	11
Tell Leilan	Op8	7	1	Outside	I	Coarse	12

(continued on next page)

Table 4 (*continued*)

Site	Field	Lot#	Obj.#	Location	Leilan Period	Ware	Ridge density
Tell Leilan	Op8	12	1239	Outside	I	Coarse	12
Tell Leilan	Op8	7	1249	Outside	I	Medium	12
Tell Leilan	Op8	19	421	Outside	I	Medium	13
Tell Leilan	Op8	8	139	Outside	I	Medium	13[a]
Tell Leilan	Op8	26	405	Outside	I	Coarse	13
Tell Leilan	Op8	6	161	Inside of Base	I	Fine	13[a]
Tell Leilan	Op8	13	240	Outside Near Base	I	Fine	13[a]
Tell Leilan	Op8	24	835	Outside	I	Coarse	14
Tell Leilan	Op8	18	7	Outside	I	Medium	14
Tell Leilan	Op8	5	879	Outside Base	I	Fine	14
Tell Leilan	Op8	6	43	Outside	I	Fine	14[a]
Tell Leilan	Op8	7	3	Outside	I	Coarse	14[a]
Tell Leilan	Op8	18	21	Outside	I	Medium	15
Tell Leilan	Op8	5	891	Inside	I	Medium	15
Tell Leilan	Op8	34	1417	Inside Near Rim	I	Medium	12
Tell Leilan	Op8	34	1410	Outside on Base	I	Fine	13
Tell Leilan	Op8	34	1467	Outside	I	Medium	13
Tell Leilan	Op8	29	1067	Outside Multiple	II	Fine	13
Tell Leilan	Op5	61	1	Outside	IIb	Fine	12[a]
Tell Leilan	Op5	44	2	Outside	IIb	Medium	12
Tell Leilan	Op5	44	4	Outside	IIb	Medium	12[a]
Tell Leilan	Op5	61	2	Outside	IIb	Medium	13[a]
Tell Leilan	Op5	61	3	Outside Rim	IIb	Fine	13
Tell Leilan	Op5	44	1	Outside	IIb	Medium	13
Tell Leilan	Op5	44	3	Outside	IIb	Fine	14[a]
Tell Leilan	Op8	35	5	Outside Under Base	IIId	Fine	12
Tell Leilan	Op8	31	40	Outside and Inside	IIId	Medium	12
Tell Leilan	Op8	31	1127	Outside Base	IIId	Fine	12
Tell Leilan	Op8	39	1485	Top of Rim	IIId	Fine	12
Tell Leilan	Op8	31	1145	Inside Multiple	IIId	Medium	13
Tell Leilan	Op8	31	33	Outside Near Rim	IIId	Medium	13
Tell Leilan	Op8	31	1107	Outside Under Rim	IIId	Fine	13[a]
Tell Leilan	Op8	48	1051	Inside Under Rim	IIId	Fine	13[a]

[a] Area of analysis was 2.5 × 2.5 mm.

ridge in one corner of the square and proceeding diagonally to the opposite corner. For those impressions that were too small for a 5 × 5 mm square to be analyzed, a 2.5 × 2.5 mm square was analyzed and the result was doubled. These results are marked with an asterisk. Beginning with a raised ridge, each raised and lower band was counted as a half ridge (Fig. 8). The results of this procedure were found to be consistent with those of the previous method.

Because ridge density may have been increased through the process of drying and firing the ceramics, an experimental protocol was developed to explore these effects among prints impressed at various stages during this process. My protocol involved a mixture of red and white cone 6 firing clays from the University of Pennsylvania Fine Arts Department. that were used to make 13 briquettes of 0.5 cm thickness each. A 2 cm incision was made in each briquette, and they were labeled according to their respective treatment and weighed. The treatments of the briquettes were devised to explore the varying effects of drying and firing shrinkage on ridge density given impressions made in various stages of the firing and finishing process. Briquettes 1–3 were impressed in the plastic state with added water to various depths to emulate fingerprints deposited during the forming process itself, during which extra liquid would have been added to enhance and preserve the clay's plasticity. Briquettes 4–6 were impressed in the plastic state

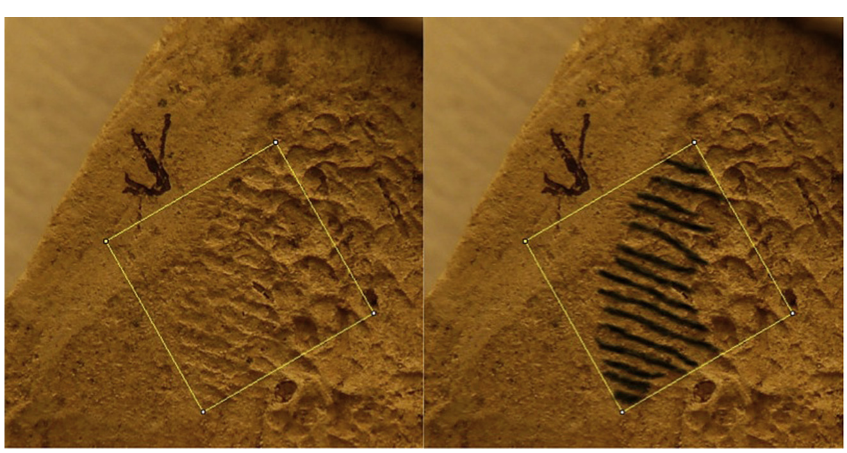

Fig. 7. Illustration of the counting of 12 epidermal ridges in a 5 × 5 mm square on Op. 1 6/1.

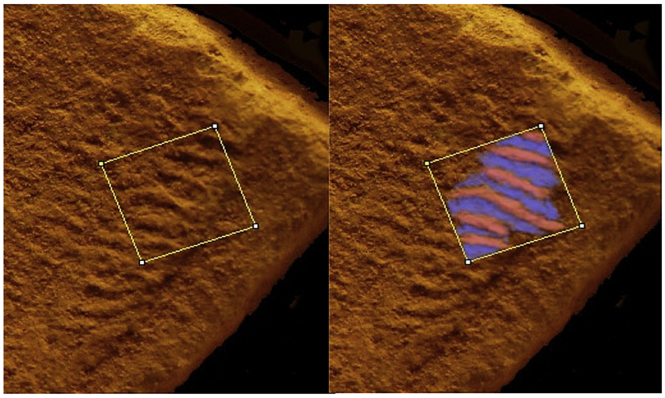

Fig. 8. Illustration of the counting of 6 ridges and 6 indents in a 2.5 × 2.5 mm square, recorded as 12*, on Op. 1 6/3.

without added moisture to various depths to emulate fingerprints deposited during transportation at the end of the forming process. Briquette 7a was impressed in the leather-hard state without added moisture to emulate fingerprints deposited during transportation after the finishing process, while Briquette 8a was impressed in the leather-hard state with added water to emulate fingerprints deposited during the finishing process. Briquette 9 was impressed in the bone-dry state with added water to emulate fingerprints deposited during last-minute finishing touches before firing.

Dried briquettes (Fig. 9) were weighed, and their 2 cm incisions and the dimensions of their impressions were measured. They were fired in a small Paragon Industries kiln with an initial temperature 22.8 °C, a maximum temperature of 750 °C, a ramp speed of spd 3 = 555 c/h, and a soaking time of one hour (Fig. 10). On the final day of this experiment, all of the fired briquettes were weighed, and their 2 cm incisions and the dimensions of their impressions were measured.

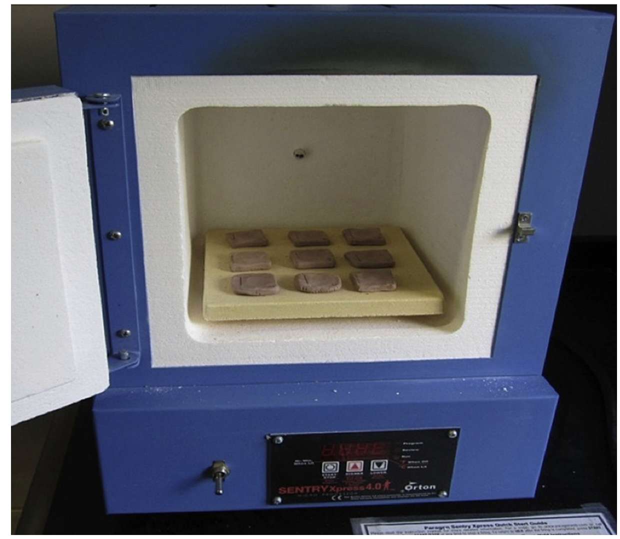

Fig. 10. Placing dry briquettes in the kiln.

4. Results and discussion

The weights of the briquettes, dimensions of the impressions, the length of the 2 cm line, and the ridge densities of the experimental impressions at various points in the drying and firing

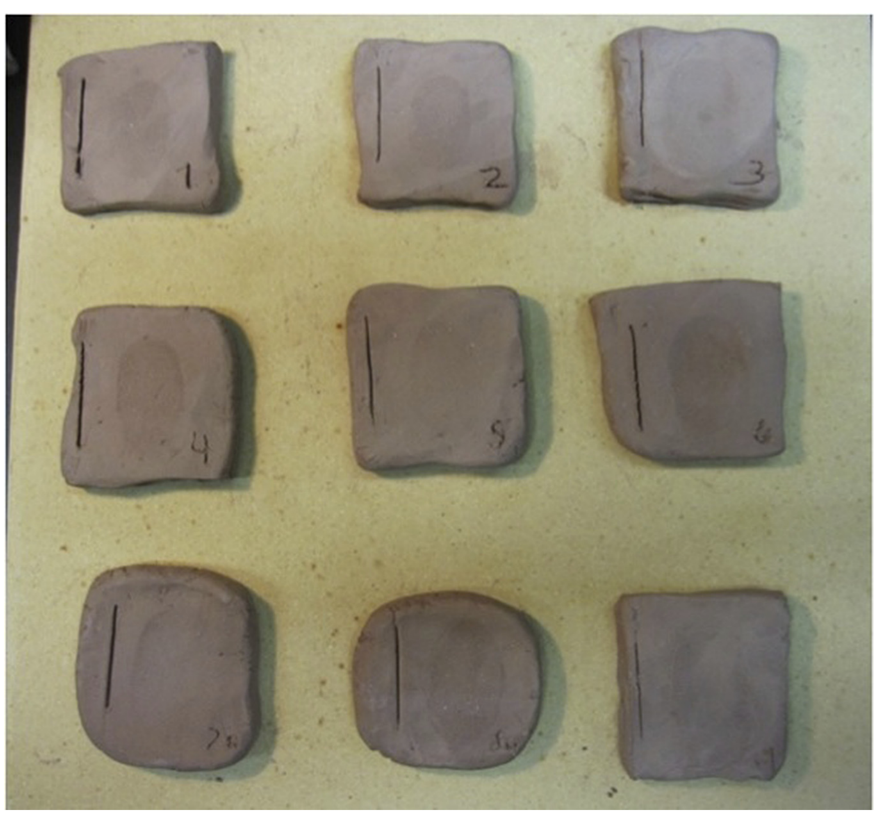

Fig. 9. Bone-dry briquettes with impressions.

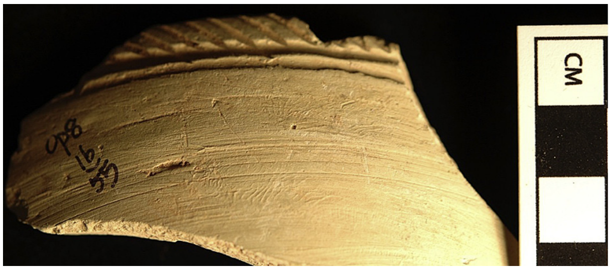

Fig. 11. Fingerprints observed on top of finishing marks on Op. 8 16/5.

process are shown in Table 3, along with the reduction percentages of each of these features.

As expected, those briquettes that were impressed later in the drying process displayed less linear shrinkage and weight loss from the time they were impressed until they completed drying. Although the state of plasticity at the time of impression cannot be determined with certainty using surface features alone, it is likely that the fingerprints in the assemblage were applied during the leather-hard stage of drying or later, since most of the ceramics were finished in the leather-hard state, a process that would have erased any previous fingerprints (Fig. 11).

To use these results to estimate the expected shrinkage in our ceramic assemblage, it was necessary to take into account differences in composition and firing temperature. The Khabur Basin is dominated by illite and montmorillonite clays that have high levels of calcite and some quartz (Mulders, 1969: 26). These major features were observed in clay samples from Tell Beydar, as well as cooking pots from the site (Broekmans et al., 2004: 96). The weight loss due to firing of this type of clay at 750 °C is equal to approximately 8.43% (Freeman, 1964: 481: Fig. 3), very close to the average of 8.29% weight loss from firing at 750 °C observed in our experimental clay. The firing temperature of third-millennium Beydar coarse ware was between 600 °C and less than 850 °C (Broekmans et al., 2004) and Leilan fine wares from periods IIId–IIb were fired on average between 800 °C and 900 °C. However, these differences in temperature would not have caused a significant difference in overall shrinkage as the vast majority of shrinkage took place during the drying and not the firing phase (Table 3). However, some of the coarse ware Leilan ceramics have significant grit inclusions, which would limit those ceramics' shrinkage during both drying and firing. Taking these considerations into account, the fingerprint shrinkage that occurred in the drying and firing stages of the ceramics studied was likely between 2 and 6% (Table 3).

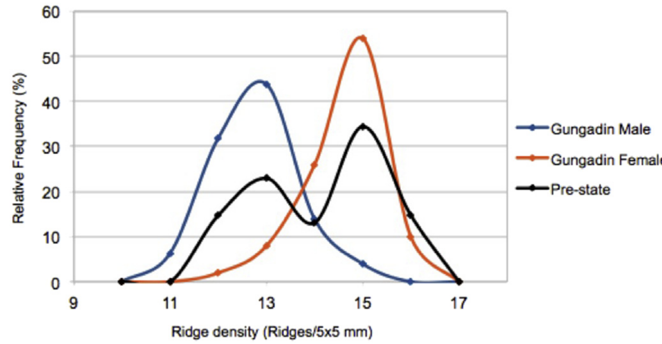

Fig. 13. Relative frequency of ridge densities on Leilan ceramics before the rise of the state.

The ridge densities for all of the sherds studied by period and lot are given in Table 4. Fig. 12 compares the distributions of ridge densities observed for males and females in Gungadin 2007 to the distributions observed on the post-state formation Leilan assemblage (Periods IIId–I, n = 35). From a comparison of these three distributions, it is clear that the theoretical distribution of epidermal ridge densities of the individuals that impressed the ceramics studied is unimodal, and this distribution matches well with the observed ridge density distribution for modern males. The mean ridge density for the post-state Leilan assemblage is 12.94, meaning that the pre-shrinkage density would have likely been between 12.2 and 12.68. This figure falls well within the range of average male ridge densities observed in contemporary populations and implies an average pre-shrinkage female ridge density of around 14.4–15 (Table 2). Since the observed post-shrinkage ridge density on the Tell Leilan ceramics seems to correspond relatively well to Gungadin's observations of modern South Indians, the observed distribution of ridge density will be used as a proxy for the initial distribution at impression and Gungadin's male and female ridge densities as a proxy for the ridge densities of males and females at Tell Leilan.

The observed distribution among sherds from pre-state Leilan (n = 60) and the post-state-formation Leilan survey materials (n = 11) are given in Figs. 13 and 14. They each clearly show a bimodal distribution in which the more prominent mode corresponds with the female distribution of ridge densities and the less prominent mode corresponds to the male distribution. A plot of the relative frequencies of ridge densities in the respective periods studied before the rise of the state at Tell Leilan show

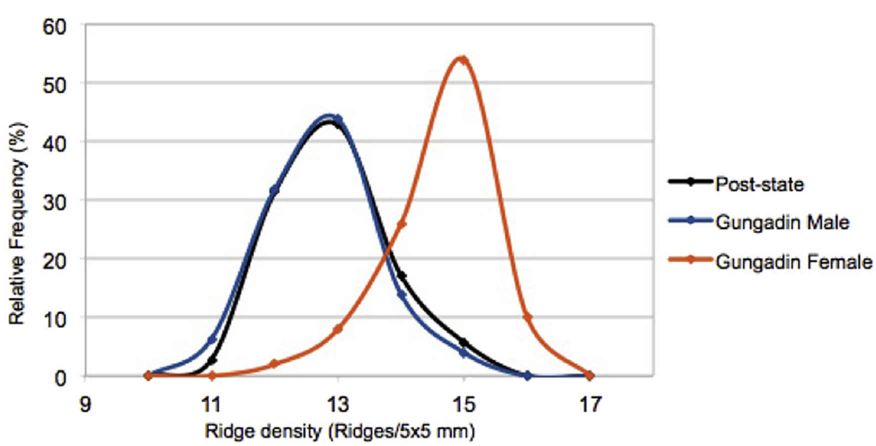

Fig. 12. Relative frequency of ridge densities on Leilan ceramics after the rise of the state.

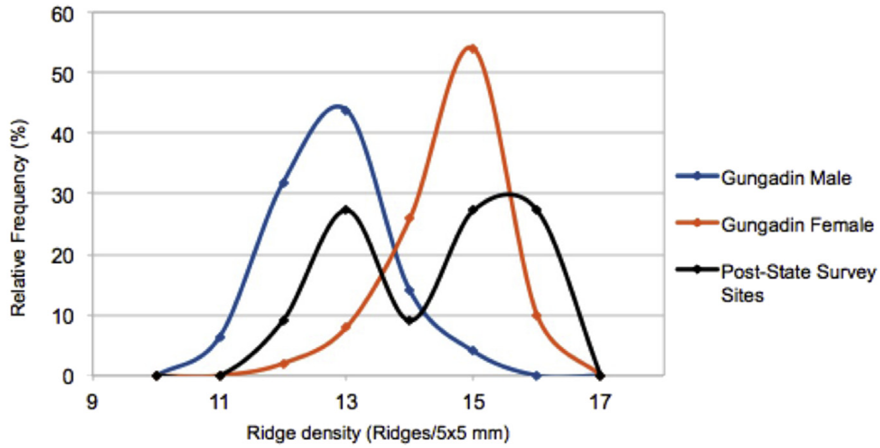

Fig. 14. Relative frequency of ridge densities on ceramics from the Leilan Regional Survey after the rise of the state at Tell Leilan.

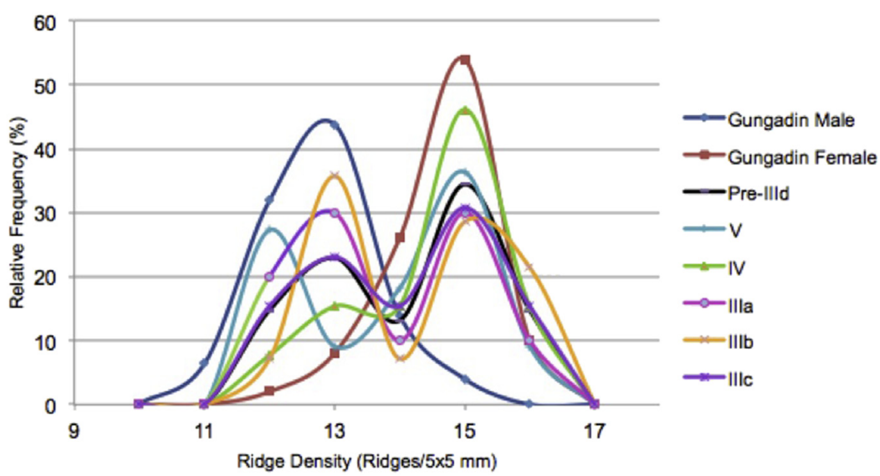

Fig. 15. Relative frequency of ridge densities for individual pre-state periods at Tell Leilan.

that there were comparable levels of both male and female potters in each of these periods indicating that this was stable up to the rise of the state (Fig. 15). The similarity of these distributions is confirmed by the non-significance of one-tailed t-tests comparing the corresponding distributions of ridge densities (Table 5). Likewise, the evidence from the fingerprints demonstrates that men and women each formed ceramics made of the whole range of fabrics before the rise of the state with similar frequencies (Fig. 16), indicating that certain types were not relegated to gender specific production by exclusively male or female potters. The similarity of these distributions is also confirmed by one tailed t-tests (Table 6). Since the survey material includes only eleven prints, the sample size is too small to indicate the relative frequencies of male and female-produced ceramics in the assemblage with a high level of confidence, though it is clear that both exist during state hegemony over Tell Leilan. However, despite the small sample size, the distribution of ridge densities from the survey site sherds does approximate the distribution found in the pre-state Leilan prints (Fig. 13). These similarities are also confirmed statistically, and contrast with the highly significant difference between these distributions and the distribution corresponding to post-state Tell Leilan (Table 7). The broader distribution for females in this assemblage may suggest cooperative labor with adolescents, but this may simply be an artifact of the small sample size.

Table 5
One-tailed t-tests comparing various distributions of fingerprint ridge densities.

	IIIc	IIIb	IIIa	IV	V
IIIc		0.399	0.448	0.228	0.484
IIIb	0.399		0.356	0.311	0.421
IIIa	0.448	0.356		0.208	0.437
IV	0.228	0.311	0.208		0.258
V	0.484	0.421	0.437	0.258	

5. Conclusion

The analysis of the ridge density distribution among fingerprint impressions on the Leilan ceramics from the beginning of the Uruk expansion to the establishment of state control at the site show that ceramics of all types were formed and finished by both male and female potters. This result suggests that before the rise of urbanism and the state at Tell Leilan, pottery production was not a gendered task. With the rise of urbanism and the state at Tell Leilan, however the social context of pottery production was transformed, such that those who handled plastic and leather-hard ceramics became exclusively male. These results suggest that the production of domestic ceramics in any of the following periods in Leilan was no

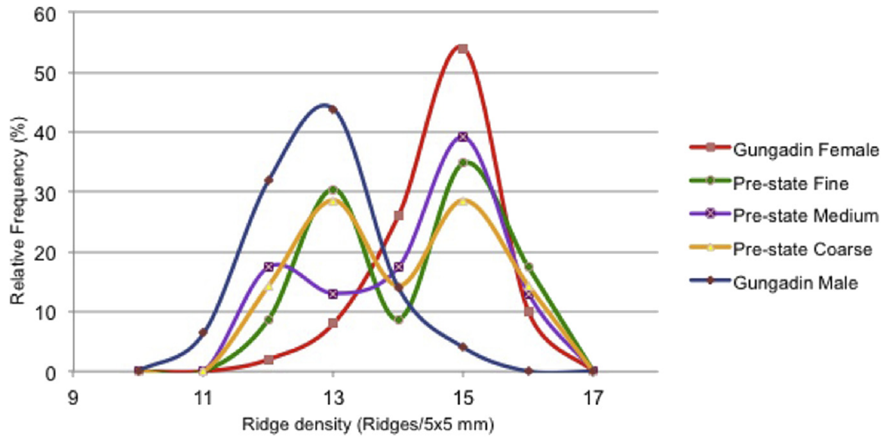

Fig. 16. Relative frequencies of ridge densities for various fabrics among pre-state ceramics at Tell Leilan.

longer performed on a household level, given the correlation of such tasks with female labor in the ethnographic record (Byrne, 1994). It is possible that these ceramics were produced in the same workshops as the pottery produced on behalf of the state or that they were produced in parallel large-scale private workshops. However, the preponderance of ethnographic parallels does not conclusively demonstrate the relationship of gender to household production in the past.

The restriction of the performance of this stage of pottery production to males alone occurred in parallel to the establishment of state administrative control over some part of the total pottery production. This social change indicates that while crafts probably continued to be passed down from parent to child as the textual record shows (see Steinkeller, 1996), with the larger scales of production associated with urbanization, the relationship within and among kinship groups in cities had changed to one where the division along gendered lines became more important. The stricter division of productive tasks by gender with the rise of urbanism, like the stricter division of tasks by class and by family, may have contributed to the specialization of production by allowing future workers to begin training in crafts at a very young age. These divisions probably also had major benefits for the ideological foundation of the northern Mesopotamian state, reinforcing the importance of social differentiation in every sphere of human interaction. Alternatively, the stricter division of labor between men and women may have required a stronger ideology of innate social distinction that was only present after state emergence to function and be reproduced over generations.

This analysis also indicates that the change in the relationship between gender and ceramic manufacture that coincided with the establishment of state control only occurred in the regional urban center at Tell Leilan and not in its hinterland. Pottery production at village-level sites continued to be carried out by both males and females, despite the presence of state institutions at Tell Leilan. This may indicate that although domestic gender-neutral production of ceramics was no longer practiced at urban sites, it still existed at village settlements in parallel to state-controlled production. This suggests more broadly that the deep changes in social organization that accompanied state formation in cities were less pronounced and perhaps more superficial in the hinterland, despite the fact that state-sponsored production of ceramics did occur at village sites, at least during the period of Akkadian imperialization (see Blackman et al. 1993). This observation undermines the hypothesis that the gender division of labor is determined by the (wheel vs. hand) production technology, as precisely the same ceramic types were being made by men at Tell Leilan and by women in the hinterland. Furthermore, there was no major change in ceramic types from period IIIc to period IIId with the emergence of state-level administration; rather the major change (the end of the long-lived Ninevite V tradition) occurred during the transition to period IIa around a century later (Rova, 2011: 57, Weiss, 1990). The change in ceramic producers, therefore, coincided with the rise of urbanism itself and not with a shift in the type of ceramics being produced.

These results further support the application of Wright's (1991) model of two parallel systems of production at different scales, contexts, and settlement types to the Khabur Plains in the mid-to-late third and early second millennia. This study confirms that women were directly involved in the small-scale system of production in villages, but shows that they were not necessary involved in the more centralized larger scale production in cities. However, it is important to note that my results do not imply that women could not have participated in centralized production at all. Those who formed, finished, and moved formed and finished but not yet totally dry vessels in urban Leilan were invariably male, but females may have participated in collecting and preparing clays, firing dried ceramics, and decorating completed vessels. Nevertheless, there was clearly a restriction of women's roles in the production of pottery that accompanied mid-third millennium BCE urbanization and state formation at Tell Leilan.

In each of the periods of occupation after the initial establishment of state control over Tell Leilan, the gendered pattern of pottery production is uniform, despite control by a diverse set of regimes. In addition, the continuation of this pattern even after the site was reoccupied during Leilan Period I makes clear that the

Table 6
One-tailed t-tests comparing various distributions of fingerprint ridge densities.

	Fine	Medium	Coarse
Fine		0.456	0.318
Medium	0.456		0.353
Coarse	0.318	0.353	

Table 7
One-tailed t-tests comparing various distributions of fingerprint ridge densities.

	Survey	Pre-state	Post-state
Survey		0.326	3.89×10^{-3}
Pre-State	0.326		1.97×10^{-7}
Post-State	3.89×10^{-3}	1.97×10^{-7}	

tradition of this type of organization was an intentional part of the state culture that was created when Šamši-Adad chose the Khabur Plains as the center of his new regime. Ultimately, this analysis must be situated within a broader understanding of gender, production, and politics across time, space, and regime type, potentially accomplished through a wider application of this protocol, in order to track how gender roles in craft production are determined by and themselves influence the enactment of political authority in the ancient Near East.

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