Walking with the Unicorn

Social Organization and Material Culture in Ancient South Asia

Jonathan Mark Kenoyer
Felicitation Volume

Edited by

Dennys Frenez, Gregg M. Jamison, Randall W. Law,
Massimo Vidale and Richard H. Meadow

Archaeopress Archaeology

Archaeopress Publishing Ltd
Summertown Pavilion
18-24 Middle Way
Summertown
Oxford OX2 7LG

www.archaeopress.com

ISBN 978 1 78491 917 7
ISBN 978 1 78491 918 4 (e-Pdf)

Front cover: SEM microphotograph of Indus unicorn seal H95-2491 from Harappa (photograph by J. Mark Kenoyer © Harappa Archaeological Research Project).
Back cover, background: Pot from the Cemetery H Culture levels of Harappa with a hoard of beads and decorative objects (photograph by Toshihiko Kakima © Prof. Hideo Kondo and NHK promotions).
Back cover, box: Jonathan Mark Kenoyer excavating a unicorn seal found at Harappa (© Harappa Archaeological Research Project).

ISMEO - Associazione Internazionale
di Studi sul Mediterraneo e l'Oriente
Corso Vittorio Emanuele II, 244
Palazzo Baleani
Roma, RM 00186

www.ismeo.eu

Serie Orientale Roma, 15

This volume was published with the financial assistance of a grant from the Progetto MIUR 'Studi e ricerche sulle culture dell'Asia e dell'Africa: tradizione e continuità, rivitalizzazione e divulgazione'

Printed in England by The Holywell Press, Oxford

This book is available direct from Archaeopress or from our website www.archaeopress.com

Contents

Looking beneath the Veneer. Thoughts about Environmental and Cultural Diversity in the Indus Civilization

Cameron A. Petrie, Danika Parikh, Adam S. Green and Jennifer Bates

There is clear evidence for degrees of uniformity in specific types of material culture that were used across the large area occupied by the populations that comprised the Indus Civilization. There is also evidence that there was considerable cultural diversity across its environmentally varied extent. J. Mark Kenoyer and others have described the cultural material that is widely attested across this area as a veneer that overlays a considerable degree of variation in material use and practices (e.g. Meadow and Kenoyer 1997). The tension between uniformity and diversity has significant ramifications for our understanding of a range of social, economic, and even political factors relating to Indus populations in the periods before, during and after South Asia's first period of urbanism. This contribution considers the range of variability inherent during these periods by assessing the diversity evident in four different categories of data, and the relationships between those datasets.

Keywords: Indus Civilization, Harappan Veneer, Environmental studies, Cultural Diversity.

Dedication

Jonathan Mark Kenoyer has been at the forefront of research on the Indus Civilization for 40 years, making major contributions in a diverse range of areas, perhaps most notably in material culture studies, where amongst other things, he has pioneered the integration of archaeological science and experimental archaeology. In this contribution, we explore aspects of diversity within the Indus environmental context, and the degree to which that diversity is (and is not) reflected in the socio-economic context of plant food exploitation, seals and sealings, and ceramic production and use. It includes aspects of the PhD research of several of the authors, and builds on some of the results of the *Land, Water and Settlement* project. We are conscious that Mark may not agree with all of our interpretations, but hope that he will appreciate our attempt to stimulate ongoing discussion.

Introduction

The Indus Civilization spanned large parts of modern Pakistan and India during its urban phase (*c*. 2600–1900 BC), and it is well recognised that Indus populations produced, used, and traded a range of distinctive types of material culture. This included painted pottery and figurines that were likely made using locally available raw materials, and a range of other items including material for personal adornment, standardized weights, and stamp seals that were made from raw materials typically obtained from medium and long-range sources (Law 2011; Kenoyer 1992, 1995, 1997, 1998a, 1998b; Vidale 2000). This material corpus is best known at the major Indus cities like Harappa and Mohenjo-daro, but similar material also occurs at settlements of various sizes throughout the extensive zone occupied by Indus populations, and Indus material is also known from sites in Central Asia, the Persian Gulf and Mesopotamia (e.g. Frenez *et al.* 2016; Kenoyer 2012; Kenoyer *et al*. 2013; Possehl 1996, 1997). This widespread use of similar material has led to the suggestion that there was uniformity in some aspects of Indus material culture, particularly beads, bangles, seals, weights, script and 'Classic' Harappan pottery (e.g. Agrawal 2007: 7; Chakrabarti 1999: 179ff.; Kenoyer 2008: 207; Miller 2013; Wright 2010: 23, 327, 334). However, diversity in material and practices over time and space has also been recognized for some time (e.g. Clark 2003, 2016; Joshi 1984; Kenoyer 1992, 2008: 195; Meadow and Kenoyer 1997: 139; Petrie 2013: 91, 95; Possehl 1982, 1992, 1999, 2002; Weber *et al.* 2010; Wright 2010: 180ff.). Further, with the progressive increase of research on the archaeology of the different regions occupied by Indus populations, the nature of this variation and diversity has come into increasingly sharper focus. Diversity is particularly evident in crop selection (e.g. Petrie and Bates 2017; Vishnu-Mittre and Savithri 1982: 215; Weber 1999; Weber *et al.* 2010; Weber and Kashyap 2016). It is also evident in settlement systems (Petrie 2013, 2017; Petrie *et al.* 2017), and the production and use of particular categories of material culture, most notably figurines (Clark 2003; Kenoyer 2008: 195), ceramic vessels (e.g. Parikh and Petrie 2017, in press; Petrie 2013; Uesugi 2011), and seals (Ameri 2013; Green 2015).

There is thus a tension between dynamics of uniformity and diversity within the Indus context, which is exemplified by overlapping spheres of production and distribution of different categories of material and different kinds of crops. The recognition of variation and diversity has encouraged a gradual, though not universally accepted, shift toward the interpretation that certain categories of Indus material acted as 'a veneer... overlying diverse local and regional cultural

expressions' (Chase *et al.* 2014: 77; Clark 2003: 323; Meadow and Kenoyer 1997: 139; Petrie 2013: 95). Crucially, it is likely that many components of this material and cultural veneer were predominately produced in urban centres or in smaller 'factory' sites near the sources of raw material, particularly objects like beads and shell bangles, but also seals and weights (e.g. Mohenjo-daro, Harappa, Chanhu-daro, Balakot, Ghola Dhoro/Bagasra; respectively, Mackay 1943; Dales and Kenoyer 1977; Kenoyer 1984, 2005; Bhan *et al.* 2005; Miller 2013; Chase *et al.* 2014). Although productive activities are common in a range of different types of settlements (Vidale 2000; Wright 2010), there is notably less evidence for highly specialised production at many smaller rural sites, though material such as beads are relatively abundant (e.g. Petrie *et al.* 2009).

The presence of a cultural veneer nonetheless suggests the existence of a rich socio-economic network in which settlements of all sizes were connected in multi-scale interactive relationships of differing intensity, with particular groups and populations potentially playing different roles as producers and consumers. However, our impression of the veneer is at least partly influenced by the way that excavated material has traditionally been published, and the tendency to focus on particular artefact types, particularly categories of objects that have been exchanged and/or traded from distant sources, such as carnelian and steatite beads, rather than on objects produced locally (Petrie *et al.* 2017: 16). Arguably, it is imperative to balance acknowledgement of large-scale dynamics of inclusion and interconnection with recognition of the importance of local- and/or small-scale production activities, which will enable a deeper understanding of regional and rural Indus groups and their products.

In addition to the acknowledgement of aspects of uniformity and diversity in behaviour and material culture, there is the growing consensus that there is considerable variation in climate, hydrology, and ecology across the extensive area in which Indus settlements are found (e.g. Agrawal and Sood 1982; Chakrabarti 1999: 153–160; Joshi 1984; Possehl 1982, 1992; Shinde *et al.* 2006; Singh and Petrie 2009; Weber *et al.* 2010; Wright 2010: 166–170). However, the specifics of this environmental diversity require further clarification, and the degree to which it relates to cultural variation has not been addressed in sufficient detail. Petrie *et al.* (2017) have argued that environmental factors are likely to have placed specific constraints on cultural behaviour and the range of choices that were open to the inhabitants of various regions occupied by Indus populations, but acknowledged that there is much to be learned in terms of our understanding of the nuances of human-environment interactions. What is clear is that the Indus Civilization spanned a large and environmentally diverse area, and it is unlikely that climate (and climate change) would have had identical or even comparable effects in all of those regions (Petrie 2017; Petrie *et al.* 2017; Wright 2010). Annual precipitation is extremely variable and is characterised by steep gradients for both summer and winter rainfall, and there is considerable diversity in the hydrology, which is comprised of a combination of perennial and ephemeral rivers and streams (Petrie 2017; Petrie *et al.* 2017). This variability and diversity are such that extreme climate events are likely to have had a variable impact - with strong or weak rainfall having direct impact and even causing devastation in some locations, but potentially having no direct impact in others. Petrie *et al.* (2017; Petrie 2017) have argued that human populations were most likely adapted to ecological regimes that were intrinsically variable between seasons and between years (see also Wright 2010: 25–44, 312–313, 315–319).

This contribution will briefly review the evidence for environmental diversity in northwest South Asia and compare it to new archaeological evidence relating to subsistence practices and the use of material culture in this region, and will consider the implications of this diversity for the Indus Civilization as a whole. In doing this, it presents aspects of the PhD research of several of the authors and also integrates research carried out as part of the *Land, Water and Settlement* project, which conducted collaborative work in northwest India between 2007 and 2014 (http://www.arch.cam.ac.uk/rivers; Petrie *et al.* 2017). The *Land, Water and Settlement* project excavations at Masudpur I (Sampolia Khera), Masudpur VII (Bhimwada Jodha), Burj, Dabli-vas Chugta and Bahola support a substantial amount of the discussion presented here, and provide an opportunity to understand ecological, material and behavioural variability within what has otherwise been regarded as one large and distinct culture-geographic region (e.g. Possehl 1999: 268–269, fig. 3.113; 2002: 6, fig. 1.3) (Figure 1a-b). Importantly, the chronological and spatial distribution of these sites is such that it is possible to explore variability in terms of differing local environmental conditions, but also in the nature of the relationships between small and ostensibly rural settlements and larger scale urban settlements. The following four sections discuss variability in environment, cropping strategies, ceramic material culture, and seals, integrating different categories of evidence both old and new in order to assess the nuances of diversity in the Indus.

Environmental diversity

It is not yet possible to reconstruct the distribution of rainfall in the Indus period, but Indus populations lived across multiple regions where today winter (December–February) and summer (June–September) rainfall systems overlap, and where each system has a steep

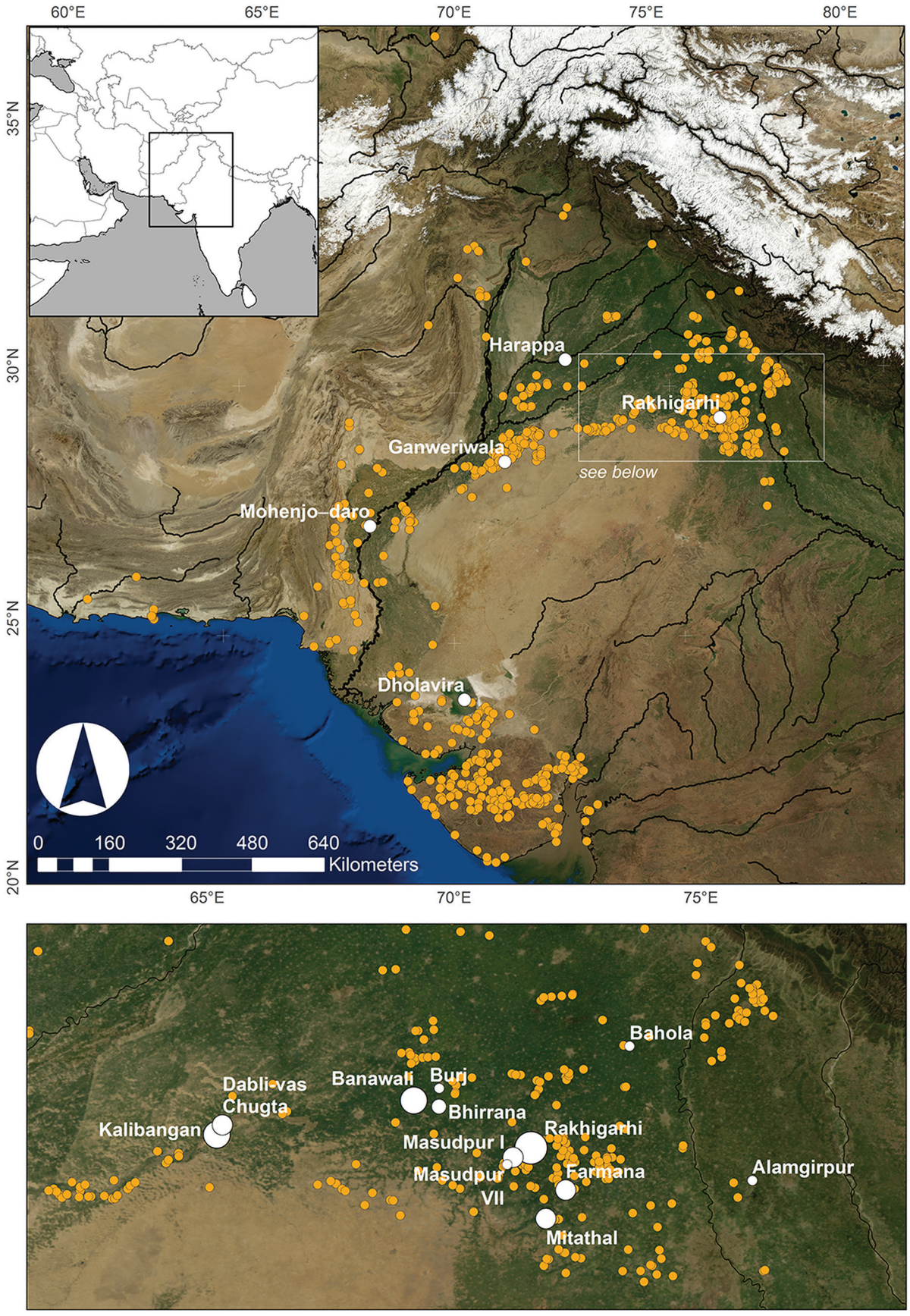

Figure 1. a) location of major Indus settlements, and b) sites excavated by the *Land, Water and Settlement* project (after Parikh and Petrie, in press: fig. 1).

rainfall gradient (Jones 2018; Petrie 2017; Petrie *et al.* 2017). This variability in rainfall distribution contributes to considerable environmental and ecological diversity on the ground. Indus populations thus occupied areas of arid hot desert, arid hot steppe and areas with warm and temperate with dry winters and hot summers. The regions occupied by Indus populations are flanked by the mountains of the Himalayas and the Suleiman Range, which receive winter snow (Petrie *et al.* 2017). The modern rainfall data suggests that the summer monsoon makes the dominant contribution to the average annual rainfall in the eastern and north-eastern areas of the Indus Civilization. The plains that comprise Pakistani and Indian Punjab are extensive and characterised by a steep rainfall gradient, such that areas close to the Himalayas receive relatively abundant rain, while areas of the plains, including the area around Harappa, receive very limited direct rainfall. Staubwasser and Weiss (2006) have suggested that the mid-Holocene was characterized by high intra-annual rainfall variability in an increasingly arid climate, and this has been supported by modelling by Wright *et al.* (2008). Nonetheless, we have little comprehension of the nature of variability of rainfall spatially in the past, as it has sensibly been argued that it is not feasible to extrapolate from individual records (e.g. Petrie 2017; Petrie *et al.* 2017; Wright 2010). The records that do come from within or immediately adjacent to the regions occupied by Indus populations suggest that there was increased rainfall in some areas during the Indus period (e.g. Dixit *et al.* 2018), but overall progressive aridification and a period of marked monsoon weakening *c.* 4.2 kya BP (Dixit *et al.* 2014a, 2014b, 2018). This pattern broadly corresponds to palaeoclimate records from elsewhere within the subcontinent, but it is clear that there is variability in both the spatial distribution and timing of climatic change across the greater region, and evidence for further perturbations after *c.* 4.2 kya BP (e.g. Berkelhammer *et al.* 2012; Joshi *et al.* 2017; Kotlia *et al.* 2017).

The historically recorded rainfall data from the twentieth century highlights the potential that spatial variability might also be accompanied by short-scale temporal variability. The second half of the twentieth century in particular provided evidence of dramatic inter-annual fluctuations in the intensity of monsoon rainfall, and years of particularly heavy rainfall that result in flooding and waterlogging were typically interspersed with years of monsoon failure (Adamson and Nash 2013; Petrie *et al.* 2017; Possehl 1999: 286–287; Sarma 1976).

Across the Indus Civilization, water was probably available from different sources at different times of the year, including winter rain, rain from the Indian summer monsoon, snowmelt from the Himalayas, and the surface and river runoff that results from all of the above. Although water is available from various sources, its supply can be extremely variable, and this context has been described as being predictably unpredictable (Petrie 2017; Petrie *et al.* 2017).

Although direct rainfall is (and no doubt was) important for populations living out on an extensive alluvial plain, water runoff was arguably more important. The lower parts of Punjab and Sindh both receive limited to no direct rain but benefit from runoff from both winter and summer rainfall. This water likely flowed through an abundance of perennial and ephemeral rivers and streams that redistribute water coming from the winter rains, snowmelt, and summer monsoon, which all influence the hydrological systems of the Indus zone (Flam 1993, 1999, 2013; Jorgensen *et al.* 1993; Miller 2006, 2015; Petrie 2017; Wright *et al.* 2008). The variation in water supply across the regions that were occupied by Indus populations combines with significant variation in local hydrology and soils to produce a range of distinct ecological niches. It is likely that these parameters both enabled and constrained the types and range of subsistence practices that were possible (see below; Petrie 2017; Petrie and Bates 2017; Petrie *et al.* 2017).

Since it was first described, the Indus Civilization has been regarded as riverine (e.g. Marshall 1931), like its contemporaries in Mesopotamia and Egypt. However, while several major Indus settlements were indeed located close to rivers (e.g. Harappa, Mohenjo-daro, Lothal), others were located in a range of other environments, including intermontane valleys (e.g. Dabar Kot, Periano Ghundai), alluvial fans (e.g. Nausharo and Ghandi Umar Khan), at the margins or inside of what are today arid zones (e.g. sites in Sindh, Cholistan, and Gujarat), in areas that lack perennial rivers but are watered by monsoon rainfall (e.g. sites in Haryana and east Punjab), and even on islands (e.g. Dholavira) (Petrie 2013, 2017; Petrie *et al.* 2017; Petrie and Thomas 2012; Wright 2010: 33–38).

Furthermore, the environmental context of each of the major Indus cities is distinctive, and Petrie *et al.* (2017; Petrie 2017; see also Weber *et al.* 2010; Wright 2010) have noted that each of the Indus cities was supported by a different hydrological regime. Harappa, Ganweriwala, and Mohenjo-daro lie in areas on the alluvial Indus plain that differ from each other in amounts of rainfall and proximity to major watercourses that supply both nonlocal rainfall and snowmelt from the Himalayas. Rakhigarhi lies at some distance from known major watercourses, and it is situated in the zone where both summer-monsoonal and, to a lesser extent, winter rainfall systems operate today. Several scholars have proposed that Rakhigarhi lay on the channel of a now extinct watercourse, (Garge 2006; Nath 1998; Nath *et al.* 2014; Valdiya 2002; Suraj Bhan 1975: 95–101), but no

evidence for this watercourse is visible today on the surface (Singh *et al.* 2010). Analysis of satellite imagery suggests that relatively small-scale watercourses are preserved in the subsurface (Mehdi *et al.* 2016, figs. 2, 10; Orengo and Petrie 2017, 2018), but their precise nature remains unclear. If the watercourse(s) in the vicinity of Rakhigarhi were indeed ephemeral, it is likely that the inhabitants of this urban centre made use of a combination of wells and ponds to collect monsoon runoff. Dholavira is also distinct, being located in an area of relatively limited rainfall, but lying close to two seasonal streams or runnels and it had a system of dams that help channel water into a series of large stone-lined reservoirs and tanks (Bisht 2005, n.d.:138–169; Wright 2010, 2017). Recognising this diversity in the relationship between settlement location and water availability is essential for understanding adaptations to different environments and responses to environmental challenges in the Indus context (Petrie *et al.* 2017).

Diversity in agricultural practices

The high level of environmental diversity across the subcontinent has both enabled and constrained the wide range of distinctive forms of early farming and cultivation that have developed there (Fuller 2011; Kingwell-Banham *et al.* 2015; also Chakrabarti 1988; Vishnu-Mittre and Savithri 1982; Weber *et al.* 2010). As Indus populations appear to have occupied an important environmental threshold where there is an overlap of summer and winter rainfall systems, they utilised and thrived on cropping systems of varying complexity, the unravelling of which has long been regarded as a fundamental challenge for South Asian archaeology and archaeobotany (e.g. Fairservis 1967; Fuller and Madella 2002; Madella and Fuller 2006; Vishnu-Mittre and Savithri 1982; Weber *et al.* 2010).

Issues of seasonality and environmental diversity have played a large role in understanding Indus agriculture, but have not always been extended into wider discourse. The evidence for wheat and barley (Mackay 1931a: 586–587; Luthra 1936), and field pea (Wheeler 1968: 84–85) from Mohenjo-daro suggested that agriculture in this area was carried out using late summer inundation from Himalayan snowmelt and monsoon rain to start the winter growing cycle, which was then sustained by winter rain and runoff (Miller 2006; Petrie 2017; Weber *et al.* 2010). This pattern observed in Sindh and Baluchistan was subsequently extrapolated as the norm for the other regions occupied by Indus populations (Fairservis 1967, 1971). More recent excavations in Gujarat at sites like Surkotada and Rojdi, however, emphasised the role of summer (*kharif*) crops (Vishnu-Mittre and Savithri 1982; Weber 1989, 1991, 1999). These discrete data sets contributed towards the formulation of models in which winter (*rabi*) crops were seen to dominate in the 'core' regions of Sindh and Punjab, and summer cropping predominated in the eastern 'periphery' or Gujarat, which was regarded as unusual and not representative of the situation across the Indus Civilization as a whole (e.g. Fuller and Madella 2002: 353–355). Fuller and Madella (2002: 355) also suggested that 'core' areas practised more intensive agriculture, whereas populations in the 'periphery' utilised more extensive systems.

Since the early 1980s, however, it has been argued that Indus populations also utilised multiple season cropping (Chakrabarti 1988: 96, 1995: 50; Fuller and Madella 2002: 354-355; Vishnu-Mittre and Savithri 1982; Weber 2003: 181), which suggests that a model of core/periphery *rabi*/*kharif* is overly simplistic. It is important to note, however, that the idea of multi-seasonal cropping has often been conflated with the notion of multi-cropping, which is defined by agronomists as 'the production of two or more crops per year on the same land' (Gallaher 2009: 255; see Andrews and Kassam 1976; Butler 1999: Table 24.1; Francis 1986). Multi-cropping actually consists of a wide variety of agricultural strategies, including both sequential multi-cropping and intercropping, and nuanced approaches are needed to differentiate specific approaches to cropping that were used by Indus farmers (Petrie and Bates 2017). The crop and weed ecology in combination with modern ethnographic and agricultural data from published sites and material from sites excavated by the *Land, Water and Settlement* project demonstrates that cropping strategies likely varied significantly from period to period and site to site (Bates 2016; Petrie and Bates 2017).

This variation in cropping strategies is best demonstrated by a brief review of the evidence from different regions. In Sindh there is at present only limited archaeobotanical data from excavations, but it is notable that the excavations from Mohenjo-daro only revealed evidence for winter crops. This could indicate that farmers were practicing single-season winter mono-cropping (Petrie 2017; Petrie and Bates 2017; Petrie *et al.* 2016, 2017; Weber *et al.* 2010: 72), or were only provisioning the city with these crops. In nearby Baluchistan, the 4th and 3rd millennium BC sites of Miri Qalat and Sohr Damb also showed a predominance of winter crops (Beneke and Neef 2005; Tengberg 1999), which could support the suggestion that mono-cropping of winter crops predominated in these southern and south-western regions.

This regional situation sharply contrasts that in Gujarat to the southeast, where the lack of winter rainfall is attested by the summer cropping strategies evidenced at sites like Rojdi and Babar Kot (Reddy 1994, 2003; Weber 1989, 1991). The populations living at these settlements appear to have exploited an almost entirely

single-season mono-cropping strategy focusing on millets (Reddy 1994, 2003; Weber 1989, 1991), with minimal input of winter crops.

Pakistani Punjab presents a very different picture to both southern regions. At Harappa, there is evidence that both winter and summer cropping was practiced (Weber 1999, 2003). However, although summer crops were present from the earliest phase of occupation, they formed only a minor component of the assemblage in terms of abundance, suggesting that winter cereal mono-cropping or cereal and pulse intercropping were the norm (Petrie and Bates 2017). The presence of some summer crops from the earliest phase does, however, counter arguments that summer cropping was not widespread beyond Gujarat until the Late Harappan period (post-1900 BC; e.g. Fuller and Madella 2002; Fuller 2011; Fuller and Murphy 2014; Meadow 1996; Pokharia *et al.* 2014). Nonetheless, data from Punjab remains limited to this single well-excavated site and is less well resolved across the rest of the region.

In the northeast Indus region of Indian Punjab and central Haryana, the analysis of archaeobotanical data from the *Land, Water and Settlement* project excavations have demonstrated the complexity of Indus agricultural strategies from at least the early 3rd millennium BC (Petrie and Bates 2017). At Masudpur I and VII direct radiocarbon dates have identified the earliest evidence for Indus populations' use of rice, native millets and tropical pulses alongside wheat, barley and other *rabi* crops (Petrie *et al.* 2016). These two sites in particular have explicit evidence for complex and variable intercropping and sequential multi-cropping strategies using both winter and summer crops, with Masudpur VII have evidence for these practices in all Indus periods (Bates 2016; Bates *et al.* 2017a, 2017b, 2017c; Petrie *et al.* 2016, 2017). The evidence from Burj, Dablivas Chugta, and Bahola extend the degree of variation chronologically, geographically and environmentally (Bates 2016; Petrie and Bates 2017).

There are several other regions where there were Indus settlements, but a lack of archaeobotanical data. For example, there is currently no direct evidence for Indus agriculture from Cholistan, which lies on the edge of alluvial plain on the Thar Desert margin, and has been proposed as a potentially important area of intensive and extensive cultivation (e.g. Madella 2014; Fuller and Madella 2002). Further investigation in this region is important given its location and its potential role in bridging the hypothesised intensive/extensive systems of agriculture (e.g. Madella 2014; Fuller and Madella 2002). However, Cholistan's distinctive environment is likely to have necessitated specific adaptations to enable successful farming that are distinct from those used at Harappa and on the plains of the northwest India (Petrie and Bates 2017).

Building from this evidence for regional diversity, Petrie and Bates (2017) have proposed a new zonation of Indus cropping (Figure 2). There was likely considerable variation across the Indus region, with dual season, variable multi-cropping in the northwest India, *rabi* dominated mono-cropping with some summer sequential cropping in Pakistani Punjab, *kharif* mono-cropping in Gujarat, and *rabi* mono-cropping in Sindh (see Petrie and Bates 2017; also Bates 2016; Petrie *et al.* 2017). This proposed model is similar to, yet fundamentally distinct from, the 'culture-geographic' or 'domains' regions of Possehl (1982, 1992, 1999, 2002) and Joshi (1984; also Weber *et al.* 2010), in that it argues that there is likely to have been more cultural and environmental variability within individual regions that have previously been identified. Perhaps unsurprisingly, it complements Petrie *et al.*'s (2017, Petrie 2017) suggestion that practices in northwest India were variable and allowed Indus populations to become resilient and adaptive to environment change (also Green and Bates *et al.*, in press; Petrie *et al.* 2016). It is possible that Indus populations made use of the different rainfall systems to innovate, and ultimately to mitigate risk in the face of variable climatic conditions (Green and Bates *et al.*, in press; Petrie *et al.* 2016, 2017, Petrie 2017).

While it is important to recognise the nature and significance of variability in crop choice and cropping practices, it is also important to acknowledge that there were also potentially integrative cultural forces in play. For example, given what we know about long-distance exchange within the Indus Civilization, it is likely that knowledge of crops and cultivation practices were shared between Indus populations in different regions (Fuller 2006). Furthermore, the use of bread wheat was widespread across the Indus zone, even in areas where the growing of winter crops is not an ideal choice, and it has been suggested that this might be related to dietary aspects of social and cultural interconnectivity and inclusion (Madella 2014).

Diversity in ceramic production and use

Ceramic vessels are the most abundant category of material recovered from Indus Civilization archaeological sites and have played a pivotal role in archaeologists' detection of regional diversity. Dales and Kenoyer's (1986) systematic analysis of the ceramics from the UC Berkeley excavation at Mohenjo-daro remains the canonical publication of Indus ceramics, but with continued work in different regions of the Indus Civilization the complexity and diversity of ceramic production and use across this area has become more apparent. With the recognition of regional styles like the so-called Sothi-Siswal ceramic assemblage from northwest India (IAR 1962-3; Dikshit 1984; Garge 2010; Mughal 1970; Suraj Bhan 1975), it became clear

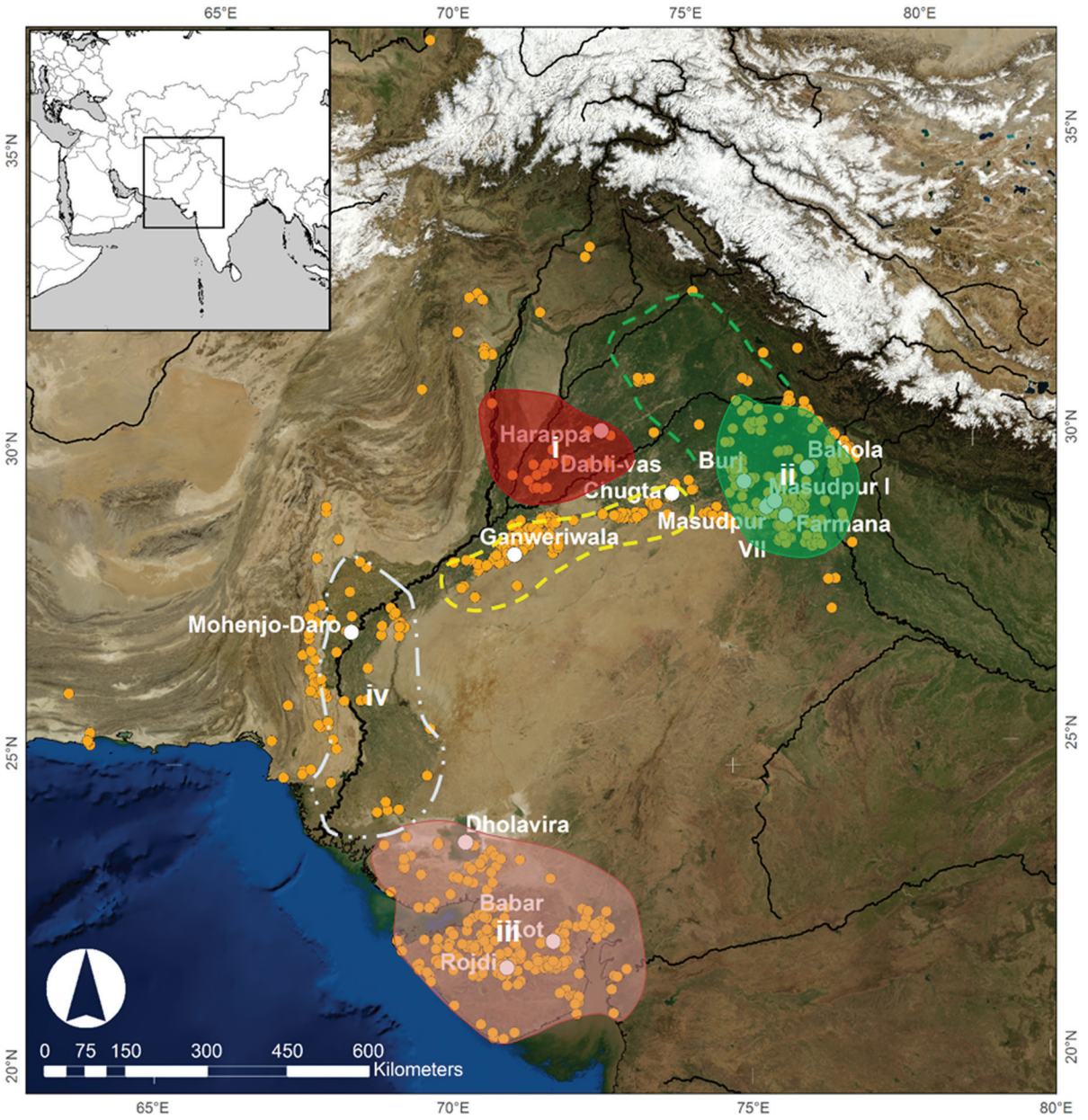

Figure 2. Suggested zonation of distinct approaches to cropping, with areas that are at least partially supported by archaeobotanical data being shown with solid outlines and shading, and areas that lack archaeobotanical data shown with dashed lines: i) area where sequential multi-cropping is possible but mono-cropped winter cereals predominated; ii) area where summer and winter crops grown flexibly; iii) area where summer crops predominated; and iv) area where winter crops predominated (after Petrie and Bates 2017: fig. 6).

that what had previously been considered as relatively static archetypes (e.g. the ubiquitous dish-on-stand) were likely being translated and interpreted differently in across the Indus zone. While still recognisably part of the Indus material canon and found in association with typical Indus material that conforms to our perception of a cultural veneer (particularly steatite, faience and carnelian beads), it is now clear that many Mature Harappan period ceramic types that were produced locally were distinct from the types seen at sites like Mohenjo-daro and Harappa. This variability emphasises the importance of flexibility when it comes to thinking about what it means for material culture to be thought of as being 'Harappan'.

The ceramic assemblages from the *Land, Water and Settlement* project excavations provide an ideal opportunity to investigate variability within the easternmost region occupied by Indus populations (see above). They also make it possible to compare material used as rural sites in the hinterland of more overtly urban sites, as Masudpur I is 6-8ha in size and is 12km

west of Rakhigarhi, Masudpur VII is 1ha and 16km west of Rakhigarhi, Burj is 2ha and 25km east-south-east of Banawali, and Dabli-vas Chugta is 5-6ha and 7km northeast of Kalibangan (Figure 1b).

The Indus-period ceramics of northwest India are dominated by a red fabric of medium fineness, and less frequent examples of a coarser red fabric and a grey fabric (Parikh, in prep; Parikh and Petrie 2017, in press; also Bala 2003: 103-105; Garge 2010). A buff fabric is also often associated with this regional ceramic tradition (Garge 2010), but it was absent at all four *Land, Water and Settlement* project sites. Within the three broad categories that we have recovered, there is substantial variation in colour, core, and quality, suggesting variation in firing and other stages of the vessel production sequence or *chaîne opératoire*. Red Ware dominates Indus assemblages in general, and typically has a medium texture and limited inclusions. The coarser red fabric has more inclusions and voids, many of which are channel-shaped, suggesting the addition of chaff as a temper, and it is rarely decorated in any way. The Harappan Grey Ware is typically finer in quality, distinguished by a grey-slipped and burnished exterior, and distinct from the later Painted Grey Ware. This presence of Grey Ware in this region emphasises that there are important regional variation in ceramic production.

Vessel forms from northwest India are broadly reflective of typical Indus ceramic assemblages, though there are some important variations, additions, and absences. For instance, the overall range of vessel forms is relatively limited. The storage vessels recovered from the *Land, Water and Settlement* project excavations were typically small in size, and there are a number of unusual or unique forms that are not common within northwest India, let alone across the broader Indus Civilization (Figures 3-5). From a post-firing graffito of a deer to unusual funnels that were elaborately incised on the interior, these rare finds add to the picture of a vibrant ceramic milieu, one in which ceramic styles reflect variation across time and space, and potters and villager consumers responded to a range of socio-economic developments.

The most variation in the *chaînes opératoire* can be observed by tracking surface traces on ceramic sherds, using techniques first tested on Indus ceramics by Courty and Roux (1995; Roux and Courty 1998). They observed that most Early Harappan fabrics from Kalibangan were made without use of the wheel, including 'the Harappan ceramics' and other fabrics (B, C, D) (Roux and Courty 1998). They also noted that 'a great diversity of surface features is present on the pre-Harappan assemblage compared to the Harappan one' (Roux and Courty 1998: 759). While their analysis of the Kalibangan material revealed abundant technological variation, perhaps their greatest contribution was the identification of a range of forming techniques that make use of the wheel to differing extents, and the recognition that vessels may be begun by coiling (or other techniques) and finished on the wheel (Courty and Roux 1995; Roux and Courty 1998). It is this clear variation in approaches to surface decoration that have led to the differentiation of Classic Harappan and Haryana Harappan or Sothi-Siswal in excavated assemblages, with the former being familiar at major centres (e.g. Harappa, Mohenjo-daro, Rakhigarhi, Banawali), and the latter either predominating (e.g. comprising 80% of the assemblage at Farmana; Uesugi 2011: 179ff.) or completely dominating the assemblage at rural sites (e.g. Masudpur I, Masudpur VII) (Parikh and Petrie 2017, in press).

These patterns raise important questions about how different communities throughout the Indus Civilization approached the appearance of new technologies, especially those that were strongly associated with larger centres. It is misleading to assume that once the fast wheel is incorporated into production sequences, it supersedes all other techniques due to its presumed efficiency. Broader ethnographic research of ceramic production across the globe suggests that the adoption of new ceramic technologies is complicated, and the wheel does not immediately win over potters used to other techniques and tools (e.g. Arnold *et al.* 2008). The initial expense of acquiring a wheel and completely retraining muscle memory results in a loss of productivity over a potentially lengthy period, potentially discouraging many potters, particularly if change was not mandated by socio-economic factors. Similarly, once use of the fast wheel began in ancient northwest India, the subsequent *chaînes opératoire* used to produce ceramic vessels were complex and variable. In Haryana Harappan ceramics, the extent to which the wheel is used varies and increases over time, but other techniques were never abandoned (Parikh and Petrie 2017, in press; Parikh, in prep). For example, rather than produce an entire vessel or most of the body on the wheel, it appears that the wheel was often used as a finishing tool towards the end of the production sequence. In particular, the fast wheel appears to have been used to finish rims and necks, while traces of other techniques such as coiling or hand-building are attested below the shoulder (Figure 6). These techniques and sequences are evident in on surface traces, making it necessary to record them separately as primary and secondary techniques as far as possible.

Along with the fabrics, techniques, and forms discussed above, decorative motifs also reveal important differences between Classic Harappan and Haryana Harappan/Sothi-Siswal ceramics. The regional ceramics are visually distinct as a result of distinct choices for surface treatments and painting styles.

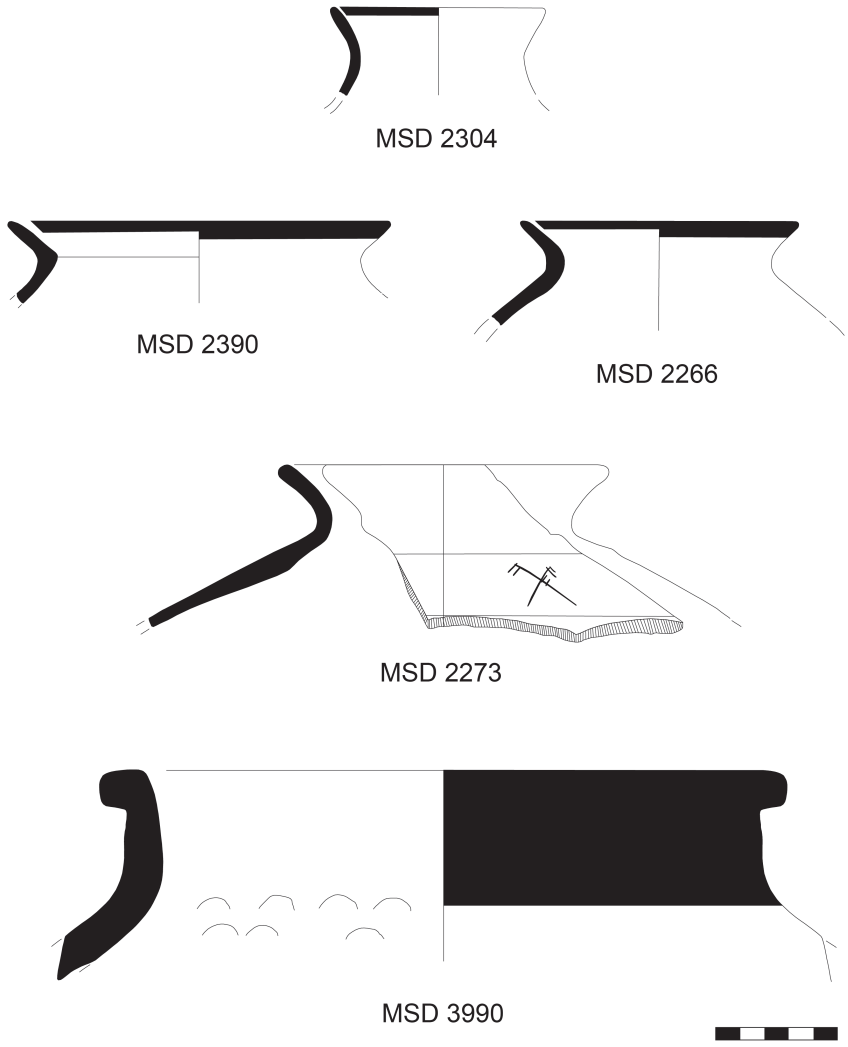

Figure 3. Examples of Early Haryana Harappan ceramics from Masudpur VII (after Parikh and Petrie 2017: fig. 2).

Classic Harappan ceramics are distinguished by a deep and glossy red slip and extensive and elaborate painted motifs (see Bala 2015: 319ff.; Uesugi 2011: 179-183, 184-203). Although there are examples of vessels with a red slip, the particular type of very glossy red slip seen on Classic Harappan vessels was not observed on any of the vessels excavated from the four village sites excavated by the *Land, Water and Settlement* project. Rather, a deep brown slip was the most common coating, particularly during the Early Harappan period. It was also frequently burnished to a low sheen, an effect that has led to its being referred to as 'chocolate slip' in the field. In addition to this, the painting styles show abundant variation, both in motif as well as in the use of white paint. Painted motifs are occasionally even combined with incised patterns, which is another regional development that shows variation from site to site. While the deep incised wavy motifs identified at Kalibangan and known as Kalibangan Fabric D (Bala 2003; Thapar 1975) is relatively common in the *Land, Water and Settlement* assemblages, other patterns of incision are also present and attest to the range of approaches that were used and the lack of standardisation.

Painting styles are more sharply delineated and show much less overlap than other stages in the production sequence. Naturalistic and geometric motifs predominate in rural assemblages, while ornate and tessellated motifs characterise the Classic Harappan assemblages. It should be noted, however, that simple motifs such as plain parallel black bands are very common in both assemblages. This encourages consideration of whether the same people made and painted these vessels. Perhaps different production stages involved different communities of potters, and vessel forms may have been made by potters who had

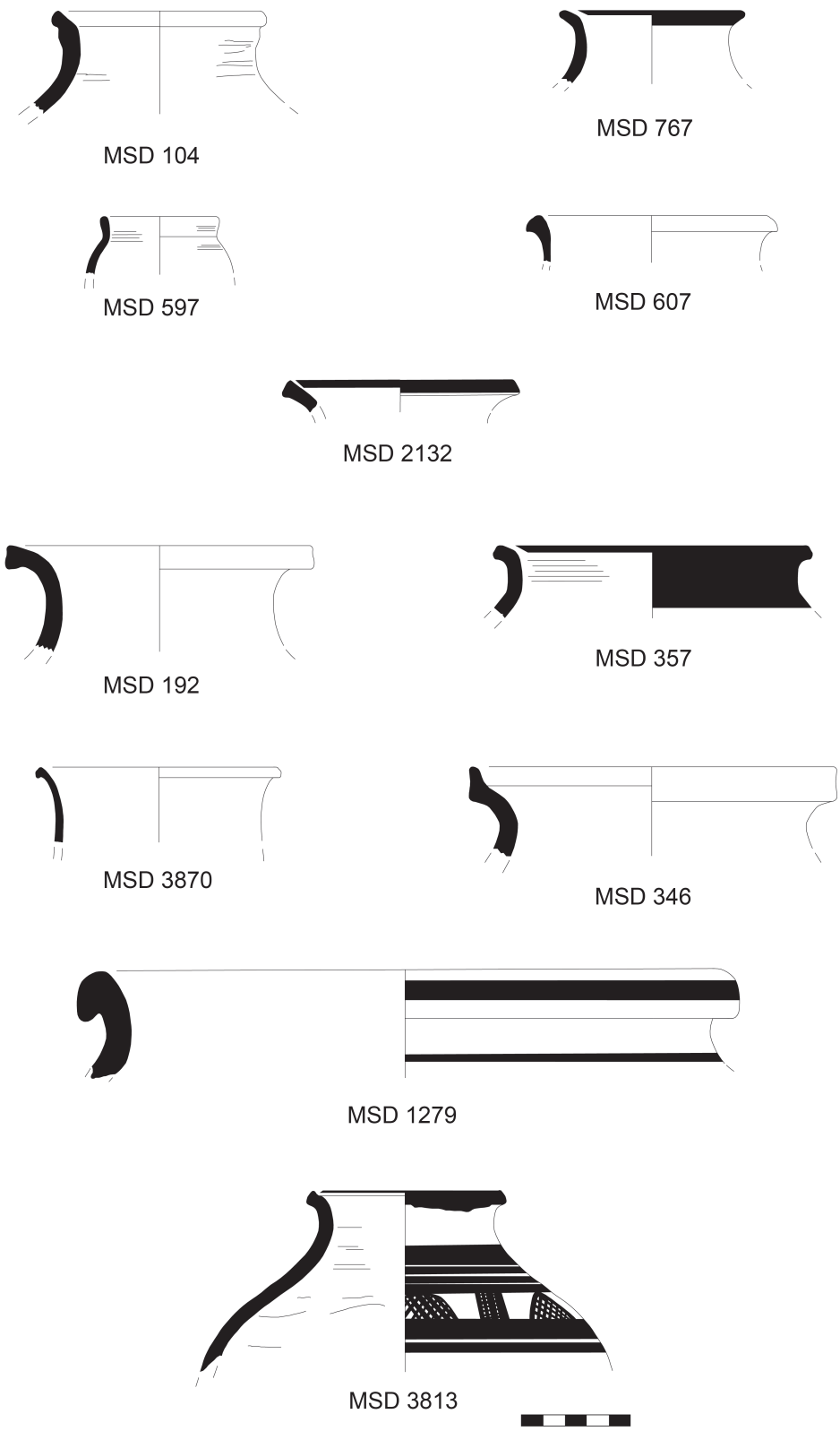

Figure 4. Examples of Mature Haryana Harappan ceramics from Masudpur I and VII (after Parikh and Petrie 2017: fig. 4).

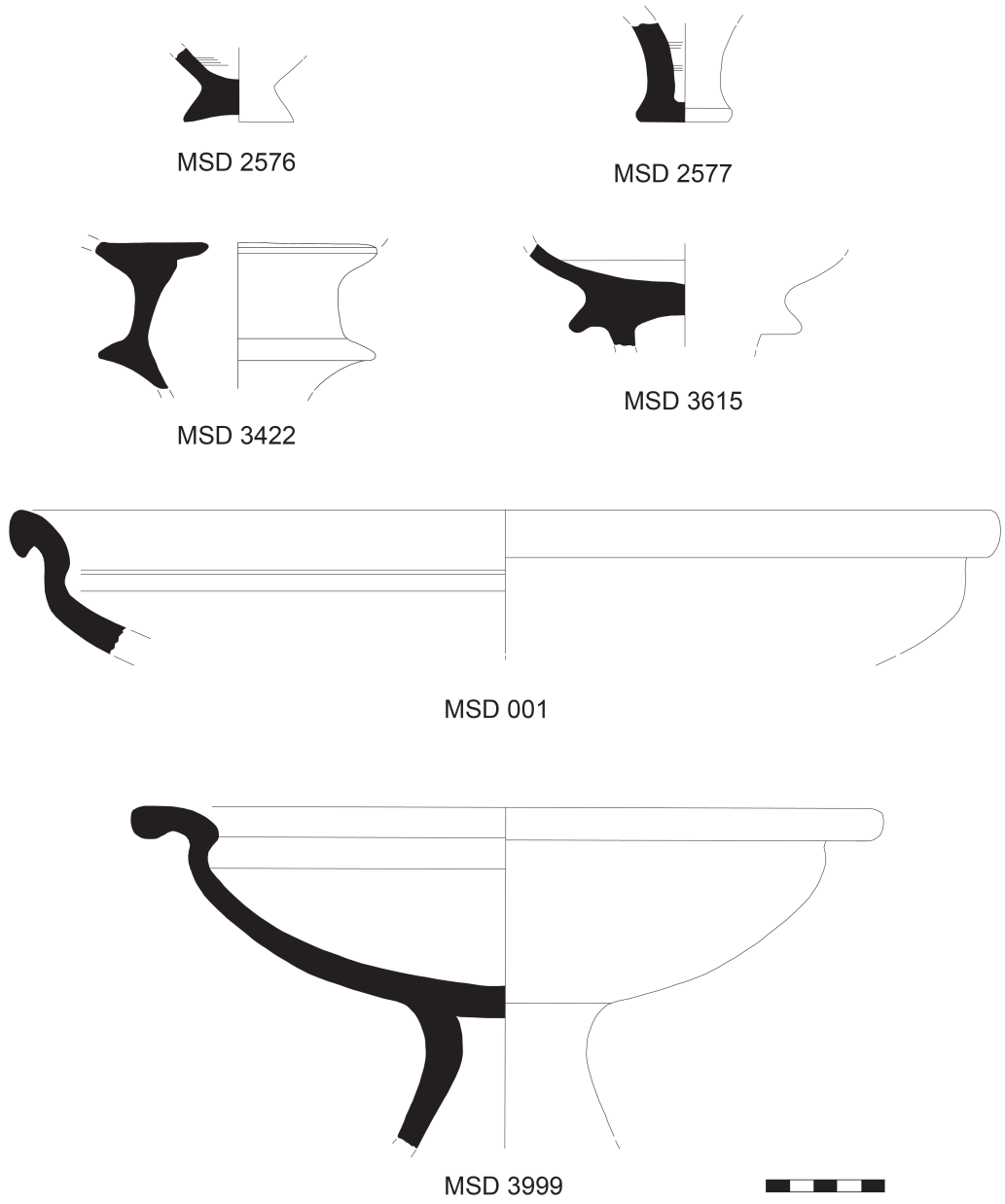

Figure 5. Examples of Mature and Late Haryana Harappan ceramics from Masudpur I and VII (after Parikh and Petrie 2017: fig. 7).

seen Classic Harappan vessels, but may have been decorated by people who had not been exposed to them. This is not entirely far-fetched when we consider that little-to-no attempt appears to have been made to imitate Classic Harappan painting styles, as the complex tessellated patterns are not translated at all by the painters of these pots. Ethnographic work in northwest India has demonstrated that other members of kinship-based pottery workshops may undertake the painting of vessels, and it is common for women to carry out this task (e.g. Kramer 1997). There may also have been distinctions between those who formed pots and those who painted pots in the Indus, although this would be difficult to reconstruct. Indus villagers in northwest India clearly had access to ostensibly urbane material from farther afield, such as beads and faience, which suggests an awareness of and desire to access such material. The care taken to incise and/or paint a vessel with bichrome motifs shows that aesthetics was certainly important, and it is possible that the variability in the pottery that they used reflects the differing needs of rural populations, where the demonstration of difference was important.

Important questions underlie what this variation in surface finish and decoration demonstrates about the

Figure 6. Examples of different approaches used in ceramic production sequences documented at sites excavated by the *Land, Water and Settlement* project (after Parikh and Petrie, in press: fig. 4).

potters, how they trained and worked, and how the vessels they made were used. The continued use of other technologies alongside the wheel suggests challenges in (re)training or in acquiring or accessing a wheel. It is possible that different potters completed different stages of production, and one potter in a workshop may have been responsible for wheel-finishing rims while others took care of building a vessel by coil, hand, or slab. The extensive use of turning or a slow wheel is also significant, as it suggests the use of some rotational kinetic energy or RKE (Roux and Courty 1998), but without achieving the same speed of a fast wheel, which involves a different skill set.

It is possible that the Indus potters who supplied small rural settlements in northwest India were exposed to Classic Harappan vessel forms, but were not trained specifically to produce identical reproductions on a fast wheel. It seems more likely that they were translating these forms when relevant, using techniques they already had in their repertoires. At present, we know little about the locus or organisation of these potters. Ethnographic examples suggest a range of possibilities, including producing vessels in specific locations and then distributing wares directly or through other agents, or being semi-mobile across a small area, servicing several villages, while also travelling to urban centres (e.g. Rye and Evans 1976; Kramer 1997). An assessment of the limited material that has been published suggests that at a city like Rakhigarhi, the assemblage includes a mixture of Classic and Haryana Harappan, which prompts a range of questions that need to be investigated further. For instance, does the appearance of different ceramic wares reflect the actions of different communities of potters? If the potters who made the Haryana Harappan vessels were based in the cities, then why did their work differ from the Classic material found at the same site? Do these differences reflect segregated potters' workshops, or a scenario with fixed groups of potters in cities, and mobile potters observing the vessels used in the cities and the tools used to make them, and then translating these forms and incorporating new tools in a practical way that makes sense for them? These dynamics remind us of Wright's (1991: 84) suggestion that despite an increase in standardisation and the scale of pottery production in the urban period at Harappa, it still appears to have been a household or kinship-based activity.

While there is some question as to how variation in the Early Harappan period was affected by increased interaction with other communities in the Indus Civilization during later phases, it is clear that there is an accelerated rate of change during the urban period. The shift in approaches to producing vessels from the early Mature to the later Mature phases is quite striking and reflects rapid cultural change. Elements of regional variation such as the use of white paint generally disappear during the urban phase, demonstrating that dynamics were anything but stagnant. Rather, the ceramic assemblages suggest an ebb and flow of urban influence that incurred changes at varying rates of intensity (Parikh, in prep). The pottery forms used in the later Mature phases become more similar to the Classic Harappan material, but remain visually distinct, and are clearly identifiable as being distinct, at least to the modern archaeologist. If these differences and variations were significant for Indus people, then this has implications for both our understanding of their relationship with populations in other parts of the Indus Civilization, as well as how they self-identified. Perhaps they saw themselves as similar but crucially, not the same as other Indus peoples. Ultimately, this could affect not just how we think of material culture as Harappan, but what it would have meant to be 'Harappan'.

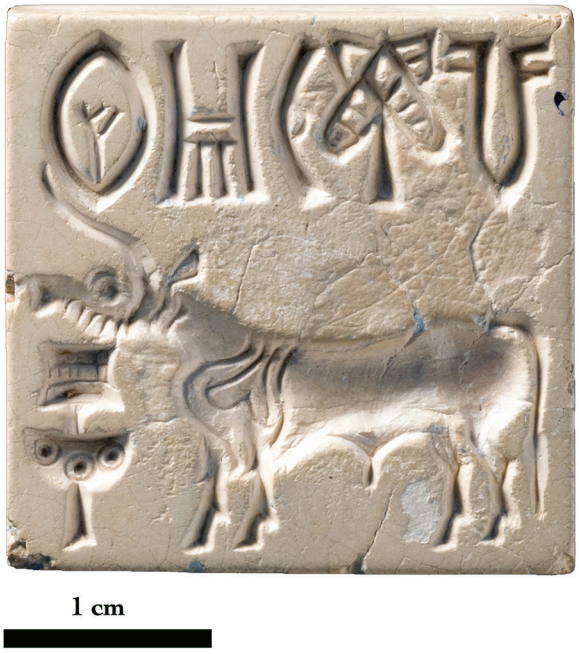

Figure 7. Unicorn seal from Mohenjo-daro. Accession No. 63.10/8 in the Archaeological Survey of India's Central Antiquities Collection. First reported as HR 5630 in Marshall 1931, recovered from a depth of 1.2192m below the surface in the HR Area. Assigned M-173 by the *CISI* (photograph by Adam S. Green).

Diversity in seal production and sealing practices

Indus stamp seals and the clay sealings that carry their impressions are typically used as examples of social and cultural uniformity, but they also exemplify patterns of variation. Portable stone seals that bear engraving are found in many early complex societies (e.g. Pittman 1995), and the typical Indus examples are small stone squares with an engraved image and on the obverse and a raised, perforated handle or 'boss' on the back (Shah and Parpola 1987: XXVIII) (Figure 7). Most, but not all, are made of steatite (Mackay 1931b: 372), which is a soft stone that is relatively easy to shape (e.g. Green 2016). Seals and sealings are one of the hallmark technologies of the Indus Civilization (Parpola *et al.* 2010), appearing in assemblages associated with its major urban centres. Furthermore, the appearance of seals and sealings in assemblages from smaller settlements is taken as strong evidence for local integration with the long-distance exchange and interaction networks that characterise Indus urbanism.

Indus seals and sealings constitute a technology that sharply contrasts with its counterparts in Mesopotamia or Egypt in that stamp seals far outnumber the clay sealings they were used to produce. This pattern is reflected in the three volumes of the *Corpus of Indus Seals and Inscriptions* (hereafter *CISI*) (Joshi and Parpola 1987;

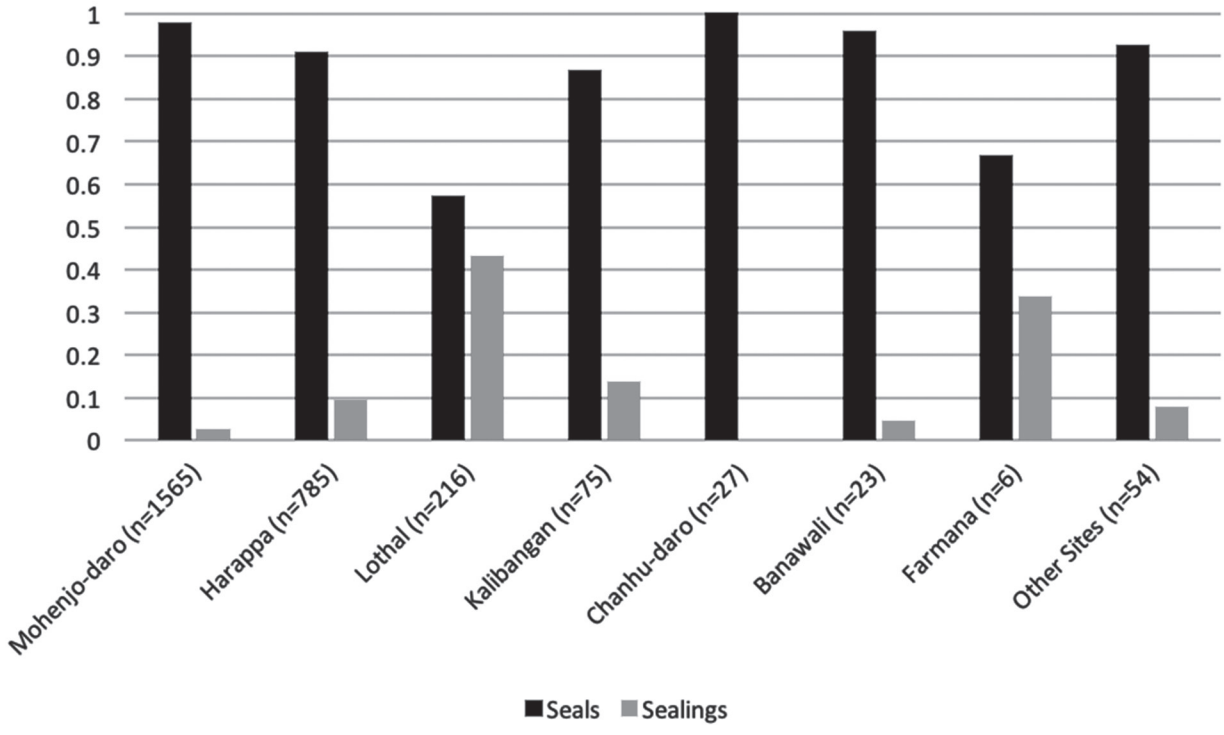

Figure 8. Proportions of seals to sealings at sites throughout the Indus Civilization as listed in the *Corpus of Indus Seals and Inscriptions* (data collated from Joshi and Parpola 1987; Shah and Parpola 1991; Parpola *et al.* 2010; Konasukawa *et al.* 2011).

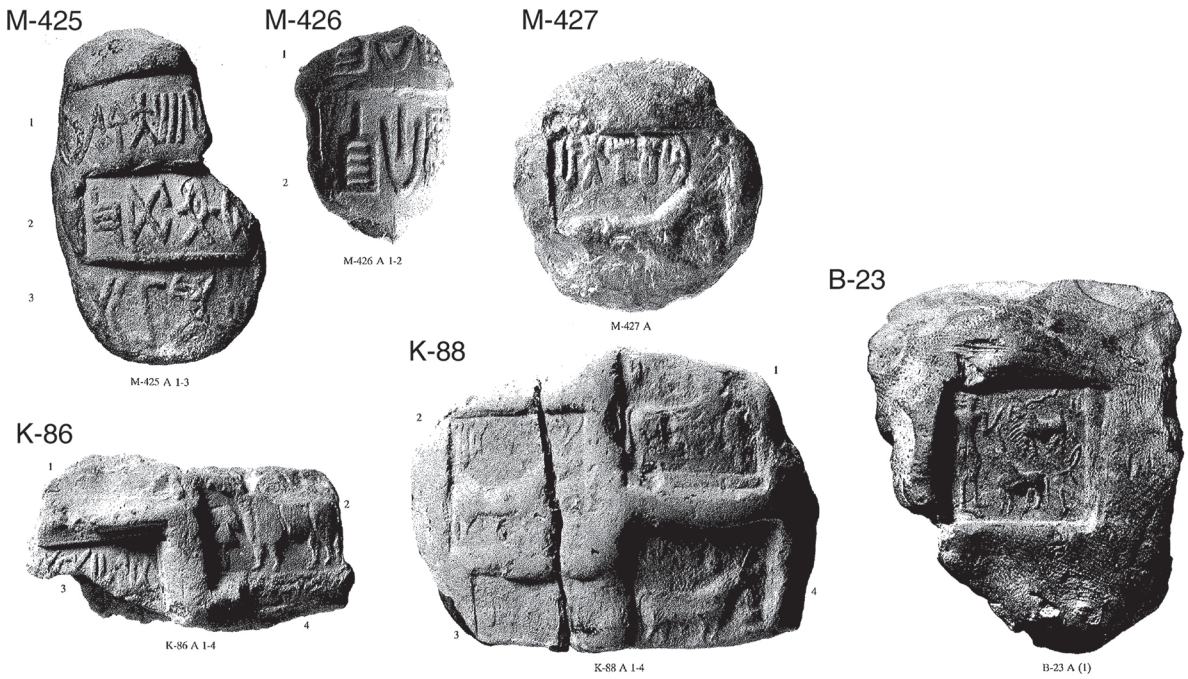

Figure 9. Sealings from different regions in the Indus Civilization (after Joshi and Parpola 1987; Parpola *et al.* 2010; Shah and Parpola 1991).

Parpola *et al.* 2010; Shah and Parpola 1991), where seals appear in much greater quantities than sealings (Figure 8). The low number of sealings recovered in early excavations prompted researchers to question whether Indus stamp seals were in fact seals, or simply amulets (e.g. Mackay 1931b: 379-380), but over time excavators have unearthed considerably more clay sealings, and the interpretation that seals were in fact used to make impressions is well established (e.g. Frenez and Tosi 2005; Kenoyer 1998b). The low proportion of sealings in Indus assemblages may result from contrasting recovery techniques employed by early excavation teams and distinct local site formation processes at particular sites (Kenoyer 1998), but it also potentially denotes differences in Indus sealing practices and those used in other early complex societies.

While seals are more abundant than sealings in excavated Indus assemblages, there are distinctions in assemblages from different sites and different regions. Sealings recovered from different sites vary in shape and in the number and arrangement of impressions, which again emphasises variability. Excavations at Lothal have produced the largest single cache of 93 sealings (Rao 1973, 1979, 1985) which included more than six distinct types that were used on a different kinds of structural features and containers, and could each carry as many as five different seal impressions (Frenez and Tosi 2005). This variety suggests that the sealings at Lothal were involved in a diverse range of practices, which Frenez and Tosi (2005: 82) have suggested relates to the work of a 'small commercial agency'. Other Indus regions have considerably fewer sealings, and the extensive early excavations at Mohenjo-daro recorded only 35 sealings (Mackay 1931b, 1938). While early excavation data at Harappa similarly produced a low number of sealings, recent excavations which employed more nuanced recovery techniques have increased the number of sealings recovered, such that the proportion of sealings to seals now stands at 9% (Figure 8).

The proportion of sealings to seals appears to be higher in the eastern regions of the Indus Civilization, as seen at Lothal, with relatively high percentages of sealings being reported from Kalibangan (Lal 1979, 1984, 2003; Thapar 1975); and Farmana, where four steatite seals and two impressed clay objects with seal impressions were recovered (33% sealings to seals) (Konasukawa *et al.* 2011: 371). While higher numbers of sealings are associated with the improved recovery methods employed by more recent excavations, the higher proportion of sealings to seals in the eastern regions of the Indus Civilization is a pattern that warrants further study.

The *CISI* shows that a range of sealing types have been found across the Indus Civilization, and in contrast to the variety of sealings recovered from Lothal, sealings

such as M-425 and M-426 from Mohenjo-daro, were impressed with three seals that carry only inscriptions (Joshi and Parpola 1987: 104) (Figure 9). More common are the larger, round clay lumps apparently unattached to a container, such as M-427, which was impressed with stamp seals carrying the more typical animal engraving and inscription (Joshi and Parpola 1987: 106). Sealings from Harappa present yet another contrast, with occasional examples of structural sealings (e.g. Kenoyer and Meadow 2008: 128), and impressed tablets made of faience or clay that appear to have been produced in substantial numbers (Kenoyer 2000b, 2006; Kenoyer and Meadow 2010). Diversity in sealing form is striking in the eastern areas. Kalibangan's sealings tend to be larger, incorporating multiple columns of seal impressions (K-86, K-88) (Joshi and Parpola 1987: 318-319). At Banawali, excavators unearthed a sealing with a single impression from a square seal on the obverse and a deep, smooth impression of a likely structural feature on the reverse (B-23) (Joshi and Parpola 1987: 347), which is the only reported Indus structural sealing with a narrative scene, rather than a seal with the more typical animal engraving and/or inscription.

Typical Indus stamp seals have been found in all of the regions occupied by Indus populations, but there are seal shapes and materials that set the assemblages of particular settlements apart. In the seal and sealing assemblage from Mohenjo-daro, for example, square stamp seals ('Type B') are but one type in a broader typology (Mackay 1938: 324). Significantly, Mohenjo-daro's assemblage includes numerous inscribed copper plaques whose imagery mirrors that found on typical Indus seals, but these are unlikely to have been used to make impressions (Joshi and Parpola 1987: 126-153). In contrast, and as noted above, Harappa's excavated assemblage includes a wide range of impressed tablets whose relationship to other Indus seal and sealing technologies is not precisely known (e.g. Kenoyer 2000b, 2006) Kalibangan's assemblage is even more unusual as it produced the only known cylinder seal from an Indus site (K-65) (Joshi and Parpola 1987: 311).

Seals and sealings provide one of the most abundant sources of Indus imagery and writing, which also exhibits considerable variation. Most Indus stamp seals depict an animal beneath an inscription that runs along the top of the seal, and Kenoyer (1992, 1995, 2000a, 2006) has argued that this juxtaposition of image and script appears to have conveyed messages to multiple audiences. The appearance of this form of seal is closely associated with the rise of Indus urbanism, suggesting that the emergence of stamp seals that combined image and script was analogous to transformations in seal complexity that are associated with the emergence of cities in other early complex societies (Green 2015). While narrative scenes, and depictions of zebu bulls, goats, elephants, tigers, bison, buffalo, and composite animals often appear, the majority of Indus stamp seals depict a 'unicorn' motif (Kenoyer 2013; Mahadevan 1977; Possehl 2002; Ameri 2013; Rissman 1989: 115). The unicorn motif consists of a bovid-like animal with a single horn in profile with its head turned to one of the carving field's upper corners and an abstract object often labelled a 'standard' in front of the animal. Kenoyer (2013: 121) has argued that the preponderance of unicorn motifs indicates that their use may not have been constrained to a small group of seal users. However, while unicorn seals are typical, their relative proportion in site assemblages is variable. For example, Frenez and Vidale (2012: 120) have argued that chimeras appear in relatively higher proportions in larger settlements. Scholars have noted that unicorn motifs are found on the majority of seals from Harappa, Mohenjo-daro and Lothal (Ameri 2013: 362; Franke-Vogt 1991: 62; Frenez and Vidale 2012: 120). At Banawali only 17% of the seals recovered carried the unicorn motif, marking a significant departure from assemblages where unicorn seals were in the majority (Ameri 2013: 367). Konasukawa (2014) has demonstrated that most of the animals depicted on seals from the eastern region of the Indus Civilization face the right side of the carving field, which is a pattern that diverges from other regions occupied by Indus populations.

Indus stamp seals provide evidence of broader technological styles that appear to have characterised the Indus Civilization. Most appear to have been made of dolomitic steatite obtained from sources in the mountains to the north of Pakistani Punjab, which whitens when heated to temperatures in excess of 1200°C (Law 2011: 249). The ability to transform steatite into whitened enstatite made it conducive to transformative technological styles that appear to have characterised many Indus crafts (Miller 2007; Wright 2010: 239). The complexity inherent in the creation of these artificial materials, along with the intricacy of Indus seal carving, also exhibit a technological virtuosity that spans various crafts, involving Indus artisans in the application of sophisticated knowledge to the production of ornaments (Vidale and Miller 2000). Their intricacy and artificiality thus make Indus stamp seals an essential component of a 'truncated pyramid of value' that appears to have supplied a large number of people with the tools and ornaments they needed to create and sustain complex urban social relations (Miller 2007: 225). While these styles and values appear to have been widespread, it is notable that while most stamp seals employed steatite from the same or similar sources, some also likely came from other steatite sources in the Siwalik foothills to the northeast and in the Aravalli foothills to the southeast of the Indus (Law 2011: fig. 7.49). This variability suggests that the use of specific materials was not mandated, and indicates diversity in certain types of cultural values even in the context of certain types of commonality.

Analyses of seal production processes reveals that even within the most standardised elements of Indus material assemblages, significant diversity underpins an overarching uniformity. Several studies have closely examined the production of Indus stamp seals with the unicorn motif. Rissman (1989: 166), for example, found significant stylistic variation among unicorn motifs, concluding that this type of seal must have been carved by multiple interconnected workshops or 'schools' potentially situated in different regions. Franke (Franke-Vogt 1991, 1992) revealed stylistic variability at a higher resolution within the seal assemblage from Mohenjo-daro, suggesting that even at a local scale, seal production was variable, and demonstrated that over time seal motifs became more standardised. Kenoyer and Meadow (2010) also drew upon stylistic attributes to identify changes in seal production through time, and Jamison (2016, in press) has demonstrated that micro-styles can be identified within the unicorn motif. Green (2010, 2015, 2016) reconstructed the sequences employed in the production of individual stamp seals from Mohenjo-daro and was able to identify the work of individual carvers. He has argued that this indicates that the technological styles manifest across Indus crafts were perhaps an emergent result of multiple communities of practice (Green 2016, in press). These observations suggest that even the hallmark example of Indus material uniformity may have been the product of interactions among multiple distinct communities.

Although there were overarching technological styles evident in Indus seals, the specific practices used to produce them, and the sealing they facilitated varied throughout the Indus Civilization's diverse regions. Variation in production was matched by variation in use, and as this diversity of practices comes into focus, it becomes clearer that multiple interacting communities contributed to one of the Indus Civilization's most distinctive urban technologies.

Conclusions

Although there is clear evidence for the widespread use of a range of distinctive material culture items and practices during the urban phase of the Indus Civilization, it is arguable that the degree of material uniformity has been overstated (Petrie 2013). As reiterated above, when excavations at Indus settlements are published, it is the typically Indus material (e.g. seals, beads, black-on-red decorated pottery) that is highlighted (Petrie *et al.* 2017: 16). We have attempted to emphasise here the importance of considering the range of other cultural material is also typically recovered, much of which - particularly ceramic vessels and figurines - were likely to have been produced and used locally.

The evidence for regional variation that we have reviewed here supports the suggestion that the widespread attestation of certain types of Indus material may be a veneer that overlaid a considerable degree of cultural diversity (Chase *et al.* 2014; Meadow and Kenoyer 1997: 139; Petrie 2013). However, it also highlights the fact that there is considerable variability in terms of how individual populations engaged with the styles, values and tenets that appear to have imbued the Indus Civilization. This veneer therefore appears to have been of variable thickness and is likely to have had nuanced and varied meanings to different populations.

Bibliography

Adamson, G. C. D. and Nash, D. J. 2013. Documentary reconstruction of monsoon rainfall variability over western India, 1781-1860. *Climate Dynamics* 42: 749–769.

Agrawal, D. P. 2007. *The Indus Civilization. An Interdisciplinary Perspective*. Delhi, Aryan Books.

Agrawal, D. P. and Sood, R. K. 1982. Ecological factors and the Harappan Civilisation. In G. L. Possehl (ed.), *Harappan Civilisation*: 222–229. Warminster, Aris and Phillips.

Ameri, M. 2013. Regional diversity in the Harappan World: the evidence of the seals. In S. A. Abraham, P. Gullapalli, T. P. Raczek and U. Z. Rizvi (eds), *Connections and Complexity: New Approaches to the Archaeology of South Asia*: 355–74. Walnut Creek, Left Coast Press.

Andrews, D. J. and Kassam, A. H. 1976. The importance of multiple cropping in increasing world food supplies. In M. Stelly (ed.), *Multiple cropping*: 1–10. Madison, American Society of Agronomy.

Arnold, D. E., Wilson, J. H. and Nieves, A. L. 2008. Why was the potter's wheel rejected? Social choice and technological change in Ticul, Yucatán, Mexico. In C. A. Pool and G. J. Bey III (eds), *Pottery Economics in Mesoamerica*: 59–85. Tucson: University of Arizona Press.

Bala, M. 2003. The pottery. In B. B. Lal, J. P. Joshi, B. K. Thapar and M. Bala (eds), *Excavations at Kalibangan: The Early Harappans 1960–1969* (Memoirs of the Archaeological Survey of India No. 98): 101–222. New Delhi, Archaeological Survey of India.

Bala, M. 2003. The pottery. In B. B. Lal, J. P. Joshi, A. K. Shama, M. Bala and K. S. Ramachandran (eds), *Excavations at Kalibangan: The Harappans 1960–1969* (Memoirs of the Archaeological Survey of India No. 110): 319–420. New Delhi, Archaeological Survey of India.

Bates, J. 2016. *Social Organisation and Change in Bronze Age South Asia: a Multi-Proxy Approach to Urbanisation, Deurbanisation and Village Life Through Phytolith and Macrobotanical Analysis*. Unpublished PhD thesis, University of Cambridge.

Bates, J., Petrie, C. A. and Singh, R. N. 2017. Approaching rice domestication in South Asia: new evidence from Indus settlements in northern India. *Journal of Archaeological Science* 78: 193–201 [http://dx.doi.org/10.1016/j.jas.2016.04.018]

Bates, J., Petrie, C. A. and Singh, R. N. 2017. Cereals, calories and change: exploring approaches to quantification in Indus archaeobotany. *Archaeological and Anthropological Sciences* [online first https://doi.org/10.1007/s12520-017-0489-2].

Bates, J., Singh, R. N. and Petrie, C. A. 2017. Exploring Indus crop processing: combining phytoliths and macrobotanical analysis to consider the organisation of agriculture in northwest India c.3200-1500BC. *Vegetation History and Archaeobotany* (special issue) 26: 25–41 [published online 21 May 2016; http://dx.doi.org/10.1007/s00334-016-0576-9].

Benecke, N. and Neef, R. 2005. Faunal and plant remains from Sohr Damb/Nal: A Prehistoric site (c.3500–200 BC) in Central Balochistan (Pakistan). In U. Franke-Vogt and J. Weisshaar (eds), *South Asian Archaeology 2003*: 81–91. Aachen, Linden Soft.

Berkelhammer, M., Sinha, A., Stott, L., Cheng, H., Pausata, F. S. R. and Yoshimura, K. 2012. An abrupt shift in the Indian monsoon 4000 years ago. In L. Giosan, D. Q. Fuller, K. Nicoll, R. K. Flad and P. D. Clift (eds.), *Climates, Landscapes and Civilizations*: 75–87. Geophysical Monograph Series 198. Washington D.C., AGU.

Bhan, K. K., Vidale, M. and Kenoyer, J. M. 2002. Some important aspects of the Harappan technological tradition. In S. Settar and R. Korisettar (eds), *Indian Archaeology in Retrospect Volume II: Protohistory, Archaeology of the Harappan Civilisation*: 223–271. New Delhi, Manohar.

Bhan, S. 1975. *Excavation at Mitathal (1968) and Other Explorations in the Sutlej-Yamuna divide*. Kurukshetra, Kurukshetra University.

Bisht, R. S. 2005. The water structures and engineering of the Harappans at Dholavira (India). In C. Jarrige and V. Lefévre (eds), *South Asian Archaeology 2001*, Volume I: 11–25. Paris, Éditions Recherche sur les Civilisations.

Bisht, R. S. n.d. *Excavations at Dholavira (1989-90 to 2004-2005)*. New Delhi, Archaeological Survey of India.

Butler, A. 1999. Traditional seed cropping systems in the temperate Old World: Models for antiquity. In C. Gosden and J. Hather (eds), *The Prehistory of Food: Appetites for Change*: 463–477. One World Archaeology 32. London, Routledge.

Chakrabarti, D. K. 1988. *Theoretical Issues in Indian Archaeology*. Delhi, Munshiram Manoharlal.

Chakrabarti, D. K. 1995. *The Archaeology of Ancient Indian Cities*. Delhi, OUP.

Chakrabarti, D. K. 1999. *India: An Archaeological History*. Delhi, OUP.

Chase, B., Ajithprasad, P., Rajesh, S. V., Patel, A. and Sharma, B. 2014. Materializing Harappan identities: Unity and diversity in the borderlands of the Indus Civilization. *Journal of Anthropological Archaeology* 35: 63–78 [http://dx.doi.org/10.1016/j.jaa.2014.04.005].

Clark, S. R. 2003. Representing the Indus body: sex, gender, sexuality and the anthropomorphic terracotta figurines from Harappa. *Asian Perpectives* 42.2: 304–328.

Clark, S. R. 2016. *The Social Lives of Figurines: Recontexualizing the Third-Millennium BC Terracotta Figurines from Harappa*. Papers of the Peabody Museum 86. Cambridge, Harvard University Press.

Courty, M.-A. and Roux, V. 1995. Identification of wheel throwing on the basis of ceramic surface features and microfabrics. *Journal of Archaeological Science* 22: 17–50.

Dales, G. F. and Kenoyer, J. M. 1977. Shell working at ancient Balakot, Pakistan. *Expedition* 19.2: 13–19.

Dales, G. F. and Kenoyer, J. M. 1986. *Excavations at Mohenjodaro, Pakistan. The Pottery*, Philadelphia, University Museum.

Dikshit, K. N. 1984. The Sothi Complex: Old Records and Fresh Observation. In B. B. Lal and S. P. Gupta (eds), *Frontiers of the Indus Civilization: Sir Mortimer Wheeler Commemoration Volume*: 531–537. New Delhi, Books and Books.

Dixit, Y., Hodell, D. A., Sinha, R. and Petrie, C. A. 2014. Abrupt weakening of the Indian summer monsoon at 8.2 kyr B.P. *EPSL* 391: 16–23 [https://doi.org/10.1016/j.epsl.2014.01.026].

Dixit, Y., Hodell, D. A. and Petrie, C. A. 2014. Abrupt weakening of the summer monsoon in northwest India ~4100 year ago. *Geology* 42: 339–342 [https://doi.org/10.1130/G35236.1].

Dixit, Y., Hodell, D. A., Giesche, A., Tandon, S.K., Gázquez, F., Saini, H. S., Skinner, L., Mujtaba, S. A. I., Pawar, V., Singh, R. N. and Petrie, C. A. 2018. Intensified Indian summer monsoon and the urbanization of the Indus Civilization in northwest India. *Scientific Reports* 8: 4225 [online first 09 March 2018; https://doi.org/10.1038/s41598-018-22504-5

Fairservis, W. A. 1967. The origin, character and decline of an early civilisation. *American Museum Novitates* 2302:1–48.

Fairservis, W. A. 1971. *The Roots of Ancient India*. New York, Macmillan.

Flam, L. 1993. Fluvial geomorphology of the lower Indus Basin (Sindh, Pakistan) and the Indus Civilization. In J. F. Shroder (ed.), *Himalaya to the Sea: Geology, Geomorphology and the Quaternary*: 2265–287. London, Routledge.

Flam, L. 1999. Ecology and population mobility in the prehistory settlement of the lower Indus Valley, Sindh, Pakistan. In A. Meadows and P. S. Meadows (eds), *The Indus River: Biodiversity, Resources, Humankind*: 313–323. Oxford, OUP.

Flam, L. 2013. The Sindh Archaeological Project: explorations in the lower Indus Basin and western Sindh. In S. A. Abraham, P. Gullapalli, T. P. Raczek and U. Z. Rizvi (eds), *Connections and Complexity: New Approaches to the Archaeology of South Asia*: 91–106. Walnut Creek, Left Coast Press.

Francis, C. A. 1986. *Multiple Cropping Systems*. New York, Macmillan.

Franke-Vogt, U. 1991. *Die Glyptik Aus Mohenjo-daro*. Mainz am Rhein, von Zabern.

Franke-Vogt, U. 1992. Inscribed objects from Mohenjodaro: some remarks on stylistic variability and distribution patterns. In C. Jarrige (ed.), *South Asian Archaeology 1989* Volume 1: 103–12. Monographs in World Archaeology, no. 14, Madison, Prehistory Press.

Frenez, D. and Vidale, M. 2012. Harappan Chimaeras as 'symbolic hypertexts': some thoughts on Plato, chimaera and the Indus Civilization. *South Asian Studies* 28 (2): 107–30 [doi:10.1080/02666030.2012.725578].

Frenez, D. and Tosi, M. 2005. The Lothal sealings: records from an Indus Civilization town at the eastern end of the maritime trade circuits across the Arabian Sea. In M. Perna (ed.), *Studi in Onore Di Enrica Fiandra. Contributi di Archaeologia Egea e Vicinorientale*: 65–103. Paris, De Boccard.

Frenez, D., Degli Esposti, M., Méry, S. and Kenoyer, J. M. 2016. Bronze Age Salūt (ST1) and the Indus Civilization. Recent discoveries and new insights on regional interaction. *Proceedings of the Seminar for Arabian Studies* 46: 107–124.

Fuller, D. Q. 2006. Agricultural origins and frontiers in South Asia: a working synthesis. *Journal of World Prehistory* 20: 1-86.

Fuller, D. Q. 2011. Finding plant domestication in the Indian subcontinent. *Current Anthropology* 52 (suppl.4): S347–S362.

Fuller, D. Q. and Madella, M. 2002. Issues in Harappan archaeobotany: Retrospect and prospect. In S. Settar and R. Korisettar (eds.), *Indian Archaeology in Retrospect Volume II: Protohistory, Archaeology of the Harappan Civilisation*: 317–390. New Delhi, Manohar.

Fuller, D. Q. and Murphy, C. 2014. Overlooked but not forgotten: India as a center for agricultural domestication. *General Anthropology* 21, 1–8.

Gallaher, R. N. 2009. Multiple cropping systems. In R. J. Hudson (ed.), *Management of Agricultural, Forestry, and Fisheries Enterprises*: 254–264. Oxford, Eolss Publishers.

Garge, T. 2006. Lohari Ragho – A Harappan satellite site revisited. *Man and Environment* 31.2: 43–49.

Garge, T. 2010. Sothi-Siswal ceramic assemblage: a reappraisal. *Ancient Asia* 2: 15–40.

Green, A. S.2010. Reconstructing operational sequences: a new methodology for the study of seal carving in the Indus Civilization. *Man and Environment* 35 (2): 15–34.

Green, A. S.2015. *Stamp Seals in the Political Economy of South Asia's Earliest Cities*. Unpublished PhD thesis, Department of Anthropology, New York University.

Green, A. S.2016. Finding Harappan seal carvers: an operational sequence approach to identifying people in the past. *Journal of Archaeological Science* 72: 128–41 [doi:10.1016/j.jas.2016.06.008].

Green, A. S. In press. Operational sequences, style and seals: approaching communities of practice in the Indus Civilization. In M. Ameri, S. Scott, S. Costello and G. Jamison (eds), *Small Windows New Approaches to the Study of Seals and Sealing as Tools of Identity, Political Organisation and Administration in the Ancient World*. Cambridge, Cambridge University Press.

Green, A. S., Bates, J., Acabado, S., Coutros, P., Miller, N., Rissolo, D., Sharratt, N. and Petrie, C. A. How to last a millennium: or a global perspective on the long-term dynamics of human sustainability. *Nature Sustainability* (to be submitted 2018).

Indian Archaeology: A Review 1962-63

Indian Archaeology: A Review 1980-81

Jamison, G. 2016. Seal production in the Indus Civilization: a comparative analysis of regional carving traditions. In V. Widorn, U. Franke and P. Latschenberger (eds), *South Asian Archaeology and Art: Contextualizing Material Culture in South and Central Asia in Pre-Modern Times*: 79–90. Brepols, Turnhout, Belgium.

Jamison, G. In press. Understanding Indus seal carving traditions: a stylistic and metric approach. In M. Ameri, S. Scott, S. Costello and G. Jamison (eds), *Small Windows New Approaches to the Study of Seals and Sealing as Tools of Identity, Political Organisation and Administration in the Ancient World*. Cambridge, Cambridge University Press.

Jones, P. J. 2018. *Climate change, water stress and agriculture in the Indus Civilization, 3000-1500 BC*. Unpublished PhD thesis, University of Cambridge.

Jorgensen, D. W., Harvey, M. D., Schumm, S. A. and Flam, L. 1993. Morphology and dynamics of the Indus River: implications for the Mohenjo Daro site. In J. F. Shroder (ed.), *Himalaya to the Sea: Geology, Geomorphology and the Quaternary*: 288–326. London, Routledge.

Joshi, J. P. 1984. Harappa culture: emergence of a new picture. *Puratattva* 13-14: 51–54.

Joshi, J. P. and Parpola, A. 1987. *Corpus of Indus Seals and Inscriptions: I. Collections in India*. (Memoirs of the Archaeological Survey of India, No. 86). Helsinki, Suomalainen Tiedeakatemia.

Joshi, L. M., Kotlia, B. S., Ahmad, S. M., Wu, C.-C., Sanwal, J., Raza, W., Singh, A. K., Shen, C.-C., Long, T. and Sharma, A. K. 2017. Reconstruction of Indian monsoon precipitation variability between 4.0 and 1.6 ka BP using speleothem δ18O records from the Central Lesser Himalaya, India. *Arabian Journal of Geosciences* 10: 356 [DOI 10.1007/s12517-017-3141-7].

Kenoyer, J. M. 1984. Shell working industries of the Indus Civilization: A summary. *Paléorient* 10.1: 49–63.

Kenoyer, J. M. 1992. Harappan craft specialization and the question of urban segregation and stratification. *The Eastern Anthropologist* 45 (May): 39–54.

Kenoyer, J. M. 1995. Interaction systems, specialised crafts and culture change: the Indus Valley Tradition and the Indo-Gangetic Tradition in South Asia. In A. Wexler and M. Witzel (eds), *Indian Philology and South Asian Studies* Volume 1: 213–57. Berlin, de Gruyter.

Kenoyer, J. M. 1997. Early city-states in South Asia: comparing the Harappan Phase and the Early Historic Period. In D. L. Nichols (ed.), *The Archaeology of City States: Cross-Cultural Approaches*: 51–70. Washington D.C., Smithsonian Institution.

Kenoyer, J. M. 1998a. Craft traditions of the Indus Civilization and their legacy in modern Pakistan. *Lahore Museum Bulletin* 9 (2): 1–8

Kenoyer, J. M. 1998b. Seals and sculpture of the Indus cities. *Minerva* 9 (2): 19–24.

Kenoyer, J. M. 2000a. Wealth and socioeconomic hierarchies of the Indus Valley Civilization. In J. Richards and M. van Buren (eds), *Order, Legitimacy and Wealth in Ancient States*: 88–109. Cambridge, Cambridge University Press.

Kenoyer, J. M. 2000b. The tiny steatite seals of Harappa. In M. Taddei and G. De Marco (eds), *South Asian Archaeology 1997, Volume 1*: 1–20. Rome, IsIAO.

Kenoyer, J. M. 2005. Steatite and faience manufacturing at Harappa: New evidence from Mound E excavations 2000-2001. *Museum Journal* III-IV (Jan - Dec 2002): 43–56.

Kenoyer, J. M. 2006. The origin, context and function of the Indus script: recent insights from Harappa. In T. Osada and N. Hase (eds), *Proceedings of the Pre-Symposium of RIHN and 7th ESCA Harvard-Kyoto Roundtable*: 9–27. Kyoto, Research Institute for Humanity and Nature.

Kenoyer, J. M. 2008. Indus Urbanism: new perspectives in its origin and character. In J. Marcus and J. A. Sablof (eds), *The Ancient City: New Perspectives in the Old and New World*: 85–109. Santa Fe, SAR.

Kenoyer, J. M. 2012. Marine and riverine trade of the Indus Cities: strategies for research and interpretation. In A. Tripathi (ed.), *Proceedings of the International Seminar on Marine Archaeology*: 43–57. New Delhi, Indian Society for Marine Archaeology.

Kenoyer, J. M. 2013. Iconography of the Indus unicorn: origins and legacy. In S. A. Abraham, P. Gullapalli, T. P. Raczek and U. Z. Rizvi (eds), *Connections and Complexity: New Approaches to the Archaeology of South Asia*: 107–125. Walnut Creek, Left Coast Press.

Kenoyer, J. M. and Meadow, R. H. 2008. The early Indus script at Harappa: origins and development. In E. Olijdam and R. H. Spoor (eds), *Intercultural Relations between South and Southwest Asia: Studies in Commemoration of E.C.L. During Caspers*: 124–31. Oxford, BAR International Series.

Kenoyer, J. M. and Meadow, R. H. 2010. Inscribed objects from Harappa: excavations 1986-2007. In A. Parpola, B. M. Pande and P. Koskikallio (eds), *Corpus of Indus Seals and Inscriptions: 3.1. New Material, Untraced Objects, and Collections outside India and Pakistan*: xliv–lviii. Helsinki, Soumalainen Tiedeakatemia.

Kenoyer, J. M., Price, T. D. and Burton, J. 2013. Connections between the Indus Valley and Mesopotamia: preliminary results of strontium isotope analyses from Harappa and Ur. *Journal of Archaeological Science* 40: 2286–2297.

Konasukawa, A. Endo, H. and Uesugi, A. 2011. Minor objects from the settlement area, In V. Shinde, T. Osada and M. Kumar (eds), *Excavations at Farmana: District Rohtak, Haryana, India 2006-2008*: 369–529. Indus Project. Kyoto, RIHN.

Konasukawa, A. 2014. *Diversity of Harappan Civilization: a Case Study of the Ghaggar Basin (with Special Reference to Seals)*. Unpublished PhD thesis, Deccan College Post-Graduate Research Institute.

Kingwell-Banham, E., Petrie, C. A. and Fuller, D. Q. 2015. Early Agriculture in South Asia. In G. Barker and C. Goucher (eds), *Cambridge World History, Volume 2: A World with Agriculture, 12,000 BCE-500 CE*: 261–288. Cambridge, CUP.

Kotlia, B. S., Singh, A. K., Joshi and Bisht, K. 2017. Precipitation variability over Northwest Himalaya from ~4.0 to 1.9 ka BP with likely impact on civilization in the foreland areas. *Journal of Asian Earth Sciences* [online first: https://doi.org/10.1016/j.jseaes.2017.11.025].

Kramer, C. 1997. *Pottery in Rajasthan: Ethnoarchaeology in Two Indian Cities*. Washington, Smithsonian Institute Press.

Lal, B. B. 1979. Kalibangan and the Indus Civilization. In D. P. Agrawal and D. K. Chakrabarti (eds), *Essays in Indian Protohistory*: 65–97. Delhi, B.R. Pub. Corporation/ISPQS.

Lal, B. B. 1984. Some reflections on the structural remains at Kalibangan. In B. B. Lal and S. P. Gupta (eds), *Frontiers of the Indus Civilization*: 55–62. New Delhi, Books and Books.

Lal, B. B. 2003. *Excavations at Kalibangan, the Early Harappans, 1960-1969*. Memoirs of the Archaeological Survey of India, No. 98. New Delhi, Archaeological Survey of India.

Law, R. W. 2011. Inter-Regional Interaction and Urbanism in the Ancient Indus Valley: A Geological Provenience Study of Harappa's Rock and Mineral Assemblage. *Linguistics, Archaeology and the Human Past, Occasional Paper* 11: 1–800.

Luthra, J. C. 1936. Ancient wheat and its viability. *Current Science* 4: 489–490.

Mackay, E. J. H. 1931a. Ivory, shell, faience, and other objects of technical interest. In J. H. Marshall (ed.), *Mohenjo-Daro and the Indus Civilization*: 586–87. London: Arthur Probsthain.

Mackay, E. J. H. 1931b. Seals and seal impressions, copper tablets, and tabulation. In J.H. Marshall (ed.), *Mohenjo-Daro and the Indus Civilization*: 370–405. London: Arthur Probsthain.

Mackay, E. J. H. 1938. *Further Excavations at Mohenjo-Daro, Being an Official Account of Archaeological Excavations at Mohenjo-Daro Carried Out by the Government of India Between the Years 1927 and 1931*. Delhi, Manager of Publications.

Mackay, E. J. H. 1943. *Chanhu-Daro Excavations 1935-36*. New Haven, American Oriental Society.

Madella, M. 2014. Of crops and food: a social perspective on rice in the Indus Civilization. In M. Madella, C. Lancelotti and M. Savard (eds), *Ancient Plants and People: Contemporary Trends in Archaeology*: 218–236. Tuscon, University of Arizona Press.

Madella, M. and Fuller, D. Q. 2006. Palaeoecology and the Harappan Civilisation of South Asia: a reconsideration. *Quaternary Science Review* 25: 1283–1301.

Mahadevan, I. 1977. *The Indus Script: Texts, Concordance and Tables*. Memoirs of the Archaeological Survey of India 48. New Delhi, Archaeological Survey of India.

Marshall, J. H. 1931. *Mohenjo-Daro and the Indus Civilization* (3 volumes). London, Arthur Probsthain.

Meadow, R. H. 1996. The origins and spread of agriculture and pastoralism in northwest South Asia. In D.R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia*: 390–412. London, UCL Press.

Meadow, R. H. and Kenoyer, J. M. 1997. Excavations at Harappa 1994-1995: new perspectives on the Indus script, craft activities, and city organization. In F. R. Allchin and B. Allchin (eds), *South Asian Archaeology 1995*: 139–172. New Delhi, Oxford and IBH.

Mehdi, S. M., Pant, N.C., Saini, H. S., Mujtaba, S. A. I., Pande, P. 2016. Identification of palaeochannel configuration in the Saraswati River basin in parts of Haryana and Rajasthan, India, through digital remote sensing and GIS. *Episodes* 39: 29–38

Miller, H. M-L. 2006. Water supply, labour requirements, and land ownership in Indus floodplain agricultural systems. In J. Marcus and C. Stannish (eds), *Agricultural Strategies*: 92–128. Los Angeles, Cotsen Institute.

Miller, H. M.-L. 2007. Archaeological Approaches to Technology. New York, Academic Press.

Miller, H. M.-L. 2013. Weighty matters: evidence for unity and regional diversity from the Indus Civilization weights. In S. A. Abraham, P. Gullapalli, T. P. Raczek and U. Z. Rizvi (eds), *Connections and Complexity: New Approaches to the Archaeology of South Asia*: 161–76. Walnut Creek, Left Coast Press.

Miller, H. M.-L. 2015. Surplus in the Indus Civilization, agricultural choices, social relations, political effects. In C. T. Morehart and K. De Lucia (eds), *Surplus: The Politics of Production and the Strategies of Everyday Life*: 97–119. Boulder, University Press of Colorado.

Mughal, M. R. 1970. *The Early Harappan Period in the Greater Indus Valley and Northern Baluchistan (c. 3000–2400 BC)*. Unpublished PhD thesis, University of Pennsylvania

Nath, A. 1998. Rakhigarhi: a Harappan metropolis in the Saraswati-Drishadwati divide. *Puratattva* 28: 39–45.

Nath, A., Garge, T. and Law, R. W. 2014. Defining the economical space of Harappan Rakhigarhi: an interface of local subsistence mechanism and geological provenience studies. *Puratattva* 44: 83–100.

Orengo, H. A. and Petrie, C. A. 2017. Large-scale, multi-temporal remote sensing of palaeo-river networks: a case study from northwest India and its implications for the Indus Civilization. *Remote Sensing* 9.735 [doi: https://doi.org/10.3390/rs9070735

Orengo, H. A. and Petrie, C. A. 2018. Multi-Scale Relief Model (MSRM): a new algorithm for the analysis of subtle topographic change in digital elevation models. *Earth Surface Processes and Landforms* [online first 14 December 2017; doi: https://doi.org/10.1002/esp.4317].

Parikh, D. In preparation. *Influence, Interactions and Identity in the Indus Hinterland: Understanding Village Life and the Urban-Rural Relationship in northwest India through Ceramic Production and Iconography c.3200 – 1600 BC*. Unpublished PhD thesis, University of Cambridge.

Parikh, D. and Petrie, C. A. 2017. Urban-rural dynamics and Indus ceramic production in northwest India: a preliminary analysis of the pottery from Masudpur I and Masudpur VII. In V. Lefèvre, A. Didier and B. Mutin (eds), *South Asian Archaeology 2012. Man and Environment in Prehistoric and Protohistoric South Asia: New Perspectives*: 221–241. Turnhout, Indicopleustoi, Brepols.

Parikh, D. and Petrie, C. A. in press (submitted 2018). 'We are inheritors of a rural civilisation': rural complexity and the ceramic economy in the Indus Civilization in northwest India, *World Archaeology* (special issue).

Parpola, A., Pande, B. M. and Koskikallio, P. 2010. *Corpus of Indus Seals and Inscriptions. 3.1 New Material, Untraced Objects, and Collections Outside India and Pakistan*. Helsinki, Suomalainen Tiedeakatemia.

Petrie, C. A. 2013. South Asia. In P. Clark (ed.), *Oxford Handbook of Cities in History*: 139–173. Oxford, OUP.

Petrie, C. A. 2017. Crisis, what crisis? Adaptation, resilience and transformation in the Indus Civilization. In T. Cunningham and J. Driessen (eds), *Crisis to Collapse: The Archaeology of Social Breakdown*: 43–64. UC Louvain, Aegis Publications.

Petrie, C. A. and Bates, J. 2017. 'Multi-cropping', intercropping and adaptation to variable environments in the Indus Civilization. *Journal of World Prehistory* 30: 81–130 [doi: https://doi.org/10.1007/s10963-017-9101-z].

Petrie, C. A., Bates, J., Higham, T. and Singh, R. N. 2016. Feeding ancient cities in South Asia: dating the adoption of rice, millet and tropical pulses in the Indus Civilization. *Antiquity* 90.354: 1489–1504 [doi: https://doi.org/10.15184/aqy.2016.210

Petrie, C. A., Singh, R. N. and Singh, A. K. 2009. Investigating changing settlement dynamics on the plains: the 2009 survey and excavations at Masudpur (Hissar District, Haryana). *Puratattva* 39: 38–49.

Petrie, C. A., Singh, R. N., Bates, J., Dixit, Y., French, C. A. I., Hodell, D., Jones, P. J., Lancelotti, C., Lynam, F., Neogi, S., Pandey, A. K., Parikh, D., Pawar, V., Redhouse, D. I. and Singh, D. P. 2017. Adaptation to variable environments, resilience to climate change: investigating Land, Water and Settlement in northwest India. *Current Anthropology* 58.1: 1–30 [http://www.journals.uchicago.edu/doi/full/10.1086/690112].

Petrie, C. A. and Thomas, K. D. 2012. The topographic and environmental context of the earliest village sites in western South Asia. *Antiquity* 86.334: 1055–1067 [http://antiquity.ac.uk/ant/086/ant0861055.htm].

Pittman, H. 1995. Cylinder seals and scarabs in the Ancient Near East. In J. Baines, G. Beckman and K. S. Rubinson (eds), *Civilizations of the Ancient Near East* Volume 3: 1589–1604. Peabody, Hendrickson Publishers Inc.

Pokharia, A. K., Kharakwal, J. S. and Srivastava, A. 2014. Archaeobotanical evidence of millets in the Indian subcontinent with some observations on their role in the Indus civilization. *Journal of Archaeological Science* 42: 442–455.

Possehl, G. L. 1982. The Harappan Civilisation: a contemporary perspective. In G. L. Possehl (ed.), *Harappan Civilisation: A Contemporary Perspective*: 15–28. Delhi, Oxford and IBH and the American Institute of Indian Studies.

Possehl, G. L. 1992. The Harappan cultural mosaic: ecology revisited. In C. Jarrige (ed.), *South Asian Archaeology 1989* (Monographs in World Prehistory 14): 237–244. Madison: Prehistory Press.

Possehl, G. L. 1996. Meluhha. In J. E. Reade (ed.), *The Indian Ocean in Antiquity*: 133–208. London, Kegan Paul International in association with the British Museum.

Possehl, G. L. 1997. Seafaring merchants of Meluhha. In B. Allchin (ed.), *South Asian Archaeology 1995*: 87–100. Cambridge, Ancient India and Iran Trust; New Delhi: Oxford and IBH Publishing.

Possehl, G. L. 1999. *Indus Age: The Beginnings*. Philadelphia, University of Pennsylvania Museum.

Possehl, G. L. 2002. *The Indus Civilization: A Contemporary Perspective*. Walnut Creek, Altamira Press.

Rao, S. R. 1973. *Lothal and the Indus Civilization*. Bombay, G. G. Pathare at Popular Press.

Rao, S. R. 1979. *Lothal: a Harappan Port Town (1955-62)*. Vol. 1. New Delhi, Memoirs of the Archaeological Survey of India.

Rao, S. R. 1985. *Lothal: a Harappan Port Town (1955-62)*. Vol. 2. New Delhi, Memoirs of the Archaeological Survey of India.

Reddy, S. N. 1994. Plant usage and subsistence modelling: An ethnoarchaeological approach to the Late Harappan of northwest India. Unpublished PhD thesis, University of Wisconsin–Madison.

Reddy, S. N. 2003. *Discerning Palates of the Past: An Ethnoarchaeological Study of Crop Cultivation and Plant Usage in India*. Ann Arbor, International Monographs in Prehistory.

Rissman, P. C. 1989. The organisation of seal production in the Harappan Civilisation. In J. M. Kenoyer (ed.), *Old Problems and New Perspectives in the Archaeology of South Asia*: 159–170. Madison, Wisconsin Archaeological Reports 2.

Roux, V. and Courty, M. A. 1998. Identification of wheel-fashioning methods: technological analysis of 4th–3rd millennium BC Oriental ceramics. *Journal of Archaeological Science* 25: 747–763.

Rye, O. S. and Evans, C. 1976. *Traditional Pottery Techniques of Pakistan: Field and Laboratory Studies*. Smithsonian Contributions to Anthropology 21, Washington DC, Smithsonian Institution.

Sarma, V. V. 1976. A hydrometeorological study of the rainfall trend in the Ghaggar catchment area. *Indian National Science Academy* 42 (2):102–108.

Shah, S. G. M. and Parpola, A. 1991. *Corpus of Indus Seals and Inscriptions. 2. Collections in Pakistan*. Helsinki, Suomlainen Tiedeakatemia.

Shinde, V., Deshpande, S., Osada, T. and Uno, T. 2006. Basic issues in Harappan archaeology: some thoughts. *Ancient Asia* 1: 63–72.

Singh, R. N. and Petrie, C. A. 2009. Lost rivers and life on the plains – approaches to understanding human/environment interaction between the collapse of Indus urbanism and the rise of the Early Historic cities (the Land, Water and Settlement Project). In *Sarasvati River – A Perspective*: 102–111. Kurukshetra, Kurukshetra University.

Singh, R. N., Petrie, C. A., Pawar, V., Pandey, A. K., Neogi, S., Singh, M., Singh, A. K. Parikh, D. and Lancelotti, C. 2010. Changing patterns of settlement in the rise and fall of Harappan urbanism: preliminary report on the Rakhigarhi Hinterland Survey 2009. *Man and Environment* 35.1: 37–53.

Staubwasser, M. and Weiss, H. 2006. Holocene climate and cultural evolution in late prehistoric-early historic West Asia-introduction. *Quaternary Research* 66:372–387.

Tengberg, M. 1999. Crop husbandry at Miri Qalat Makran, SW Pakistan (4000–2000 BC). *Vegetation History and Archaeobotany* 8.1–2: 3–12.

Thapar, B. K. 1975. Kalibangan: a Harappan metropolis beyond the Indus Valley. *Expedition* 17 (2): 19–32.

Uesugi, A. 2011. Pottery from the settlement area. In V. Shinde, T. Osada and M. Kumar (eds), *Excavations at Farmana: District Rohtak, Haryana, India 2006-2008*: 168–328. Indus Project. Kyoto, RIHN.

Valdiya, K. S. 2002. *Saraswati: The River that Disappeared*. Hyderabad, Universities Press.

Vidale, M. 2000. *The Archaeology of Indus Crafts: Indus Craftspeople and why we study them*. Rome, IsIAO.

Vidale, M. and Miller, H. M.-L. 2000. On the development of Indus technical virtuosity and its relation to social structure. In *The Archaeology of Indus Crafts: Indus Craftspeople and why we study them*: 115–32. Rome, IsIAO.

Vishnu-Mittre and R. Savithri. 1982. Food economy of the Harappans. In G. L. Possehl (ed.), *Harappan Civilisation*: 205–221. Warminster: Aris and Philips.

Weber, S. A. 1989. *Plant and Harappan subsistence: An example of stability and change from Rojdi*. Unpublished PhD dissertation, University of Pennsylvania.

Weber, S. A. 1991. *Plants and Harappan Subsistence: An Example of Stability and Change from Rojdi*. New Delhi, Oxford and IBH.

Weber, S. A. 1999. Seeds of urbanism: Paleoethnobotany and the Indus civilization. *Antiquity* 73: 813–826.

Weber, S. A. 2003. Archaeobotany at Harappa: indications of change. In S. A. Weber and W. R. Belcher (eds), *Indus Ethnobiology: New Perspectives from the Field*: 175–198. Lanham, Lexington Books.

Weber, S. A. and Kashyap, A. 2016. The vanishing millets of the Indus Civilization. *Archaeological and Anthropological Sciences* 8: 9–15.

Weber, S. A., Barela, T.A. and Lehman, H. 2010. Ecological continuity: an explanation for agricultural diversity in the Indus Civilization and beyond. *Man and Environment* 35 (1): 62–75.

Wheeler, R. E. M. 1968. *The Indus Civilization (3rd edition)*. Cambridge, Cambridge University Press

Wright, R. P. 2010. *The Ancient Indus: Urbanism, Economy and Society*. Case Studies in Early Societies. Cambridge, CUP.

Wright, R. P. 2017. Comments on Petrie *et al.* 'Adaptation to Variable Environments, Resilience to Climate Change: Investigating Land, Water and Settlement in Indus Northwest India'. *Current Anthropology* 58.1: 22–23.

Wright, R. P., Bryson, R. A. and Schuldenrein, J. 2008. Water supply and history: Harappa and the Beas regional survey. *Antiquity* 82: 37–48.