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Agriculture and the Development of Complex Societies: An Archaeobotanical Agenda

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Throughout his career, Gordon Hillman pursued important research on early agriculturalists, hunter-gatherer plant subsistence and the transition from gathering to farming. In the course of this research he has made fundamental contributions to the methodology and theoretical basis of archaeobotany. It was Hillman who pioneered an approach to analysing archaeobotanical evidence in terms of patterns of human action. An approach that tied charred archaeological assemblages of grains, chaff and weed seeds, to the stages of crop-processing, that are necessary to take a growing cereal from the field and turn it into food (Hillman 1973a&b; 1981; 1984a; 1984b; 1985). As he recalled recently, he began his research career embarrassed that he 'had no specific knowledge of traditional systems of agriculture and horticulture in arid-zone Southwestern Asia' (Hillman 2003: 77). He subsequently pursued ethnoarchaeological research in the modern non-mechanized agricultural village of Asvan to unearth for himself 'the pattern of correlation between the composition of products and the operation that had generated them' (Hillman 2003: 78).

As a result of this work, Hillman not only supplied an analytical framework through which to understand early agriculture but indeed any agricultural production. This change in archaeobotanical thinking, towards a crop-processing perspective, was fundamental, in that not only did it create a more methodologically mature field through an awareness of taphonomic problems and formation processes (see, e.g. M. Jones 1985; Murray 2000; Fuller 2002: 261-264; Weber 2001), but provided a basis for exploring aspects of social organisation through archaeobotanical evidence. It is this potential of Hillman's work, that though archaeobotanical data we can explore the very socio-economic structure of past societies, that we believe to still be vastly under exploited. It is our aim in this paper to call attention to this still dormant aspect of archaeobotanical studies. To explore how archaeobotanical approaches to agricultural production and social organisation can be used in the study of more ‘complex’ societies. We will examine this relationship by reference to a range of case studies from England, Morocco, and South Asia (Figure 1).

Beyond surplus: agriculture in the political economy

All human societies have economies founded on the extraction, modification, exchange and consumption of natural resources. But as societies become more complex and hierarchical, these processes become increasing differentiated and restricted. Within this transformation we see elements of the society who become specialists within procuring or transforming these resources into materials and objects. These in turn may acquire special ideological value, potentially becoming recognized as wealth, that leads to increasing control over their production and consumption. The anthropology and archaeology of the emergence of social complexity and its relationship to how materials are valued and imbued with ideology is well developed (e.g. Renfrew and Cherry 1986; Richards and Van Buren 2000; Earle 2002; Chapman 2003), but the contribution of archaeobotanical approaches to such studies has been all but absent (but see, e.g. Hastorf 1993).

A key element in understanding any complex society is a study of the means by which surplus staple resources are sequestered by non-food producing elites and specialists. Status items and ritual displays are important for legitimising elites, and one use of that legitimacy is to sequester agricultural surplus from those who farm. One particular aspect of the emergence of complex societies that needs to be empirically explored is how the demands of increasing social complexity impact on the organisation of food-producing households, indeed whether they alter the very structure of these households at all. Ethnographic studies suggest that the impact of major socio-economic change filters down to the very household and families lying at the vary base of these societies (e.g. Meillasoux 1981; Netting, Wilk and Arnold 1984; Wilk and Netting 1984; Wilk 1984). While archaeologists also have long been aware that changes within settlement patterns are indicative of significant socio-economic change (e.g. Willey 1953; Trigger 1968; Adams and Nissen 1972; Sanders *et al.* 1979).

What has been neglected are the intricacies of the relationships between the structure of broadest part of the picture, the general economy of any given society and the organisation of the individual components that contribute to it, the households. For example, can we detect whether centralized political power was directly brought to bear on the organisation of production? Alternatively can we also trace whether household structure and kin-groups reorganize production activities in response to social changes and economic demands, becoming either more restricted or communal?

Production and consumption can be organised through kinship and non-kin social institutions, and the articulation of these two labour sources may be fundamental to understanding social complexity (Arnold 2000). Various perspectives on social evolution suggest fundamental shifts that relate ultimately to this balance between kin-based and non-kin based production. For example, Eric Wolf (1982) sees an important universal transition between the "kin-ordered mode of production" and the "tributary" mode. In archaeological terms we might equate this with the distinction between "Stone Age" economies (*sensu* Sahlins 1972), which are organised at a small, mainly familial scale, and "Bronze Age" economies (*sensu* Earle 2003) in which a more corporate scale of economic organisation comes to the fore, through the exchange of staples for "luxuries" and specialised labour. What all these different scales of societies have in common are the flows of materials through the society and the organisation of labour that procures, creates or transforms those materials, thereby creating value until such materials are consumed or discarded. One set of materials that all societies share is food. Thus agricultural organisation becomes the common angle from which to regard similarities and differences between societies and communities that are spatially and temporally distanced. In turn such studies can then afford a means by which we may compare and contrast continuities and changes within them.

There are three key elements of agricultural production that are frequently associated with the development of social complexity: surplus production, labour mobilisation, and "cash crops".

To begin we may examine the issue of how adequate surpluses are produced, what role, if any, intensification played within this production, and how such intensification was achieved. Much has already been written on this aspect (e.g. Adams 1966: 45-78; Butzer 1976; Earle 1997: 67-104), and we therefore do not intend to explore this line in detail. However to begin with we can outline a few scenarios that link intensification to the development of complex societies. We may cite firstly the intensification of production through increased (and recurrent) labour input, as through tillage, which was highlighted in Sherrat's formulation of the secondary products revolution (Sherrat 1980; 1981; 1996; 1999). Then there is intensification through the investment of what we may term long-term capital input or "landesque" (*sensu* Brookfield 1972; also Kirch 1995: 15-20). This forms the basis of theories, resulting from Wittofogel's (1957) theory of 'Oriental despotism', in which the construction and control of irrigation was fundamental to state formation (also Steward 1949; however this theory has attracted many critics e.g. Adams 1966: 68; Steward 1977; Kirch 1995: 159; Earle 1997: 75-76).

A second aspect of surplus agricultural production, less considered, is the social scale of organisation. By this we are referring to the relatively simple concept of the availability and size of a labour-force within any "unit of production", and the means by which these people are mobilised to carry out the harvesting and processing prior to storage for the remainder of the year. The variables of labour organization can be simplified in a triangular diagram in which two main components of variations of related: the scale of labour and for larger scales of labour, the organizing ethos or the form of solidarity (Figure 2).

The organisation and scale of this labour to meet the seasonal demands of the agricultural cycle can be considered as falling along a spectrum. At one end we find organisation is small-scale, *focused* on a few individuals perhaps drawing on no more than the single nuclear family. At the other end organisation is on a grand-scale, with many people simultaneously mobilised to conduct processing as a single unit. Intermediate, semi-large scale organization is also possible, for example when extended family units are large. These larger scale units can be divided in terms of the underlying ethos that lies behind their solidarity. In these cases the formulation of concepts surrounding ownership of land and labour and its implications for the ownership of the resultant produce (for example, Marx's *means of production*) become critical to any subsequent investigation (cf. Marx 1964). An elemental part of Marx's *means of production* that is central to this discussion was the mechanisms by which that labour was both motivated and organised (encompassed within Marx's *relationships of production*), whether communally or centralized.

Within more traditional societies, perhaps akin to what Durkheim (1893) termed *mechanical solidarity*, such organisation may be largely communal, in which the driving force is a sense of a shared values, with relatively little social differentiation between groups of people (a communal ethos). It might be summarised that within such egalitarian systems the ownership of the other elements contained within the *means of production*, the land, tools and animals is also largely communal. Alternatively such systems may have a greater degree of social differentiation with the existence of institutions, and the organisation of labour being centralised within these, with a top-down operation of social power (a centralized ethos).

While much of this paper focuses on the labour scale, another element of agriculture, which we will also consider, is the production of "cash crops". Although the term "cash crop," may seem anachronistic, we use this term (following Sherratt 1999) as a convenient way of refering to cultivars that do not directly contribute towards subsistence, either because they are used for another purpose like craft production or which when produced in quantity they are traded, such as dried or pickled fruits. Cash crops are important elements of historical agriculture in complex societies, from wine and olive oil production to cotton textile industries. Their importance for providing a basis for wealth accumulation and a labour sink, in which subjugated segments of the population may be used, make them a clear area for archaeobotanical consideration. In the case studies presented below, cash crops are significant in Medieval Morocco and the Bronze Age Indus Valley and very possibly also within later Roman Britain.

Within each of the following case studies it is this issue of the mobilisation of agricultural labour that is pursued, providing a universal basis for inter-societal comparison. While labour organisation is inferred specifically for the processing of crops at the harvest period prior to storage, the social scale of this labour output is likely to be related to other activities, including land-holding and cultivation activities, although these can only be addressed indirectly through the evidence for processing taken in the wider archaeological context. We may highlight several potential ways by which labour mobilisation may vary within and between societies. Such differentiation may occur between sites, between areas of sites, and between different occupational phases.

The Hillman perspective: content before context

The starting point for an archaeobotanical approach to labour mobilisation is the crop-chaff-weed associations derived from crop-processing studies, and first outlined by Hillman (1973a&b; 1981; 1984a; 1984b). What Hillman realised as a result of his ethnographic observations what that the *relative proportions* of the cereal grains, types of seeds and chaff within charred assemblages contain vital information about the activities that played a role in their formation. In other words the *content* of the charred assemblages themselves contain information about activities that formed them. This is why Hillman (1984a) was keen to draw attention to the different role context played within his own and Dennell's (1972; 1974; 1976) approach to crop-processing.

While Dennell interpreted the composition of archaeobotanical remains by reference to the past function of the context in which they were found, Hillman (1981, 1984a) advocated that the interpretation of an assemblage's composition could only be understood by reference to ethnographic models. These models could in turn only be built up through observation of the methods employed by traditional societies to processes crops and the examination of the resultant waste and produce generated at each stage. These inferences made through comparison of a sample's composition with known ethnographic models *might* be used to identify activities with particular contexts, but only if we suppose that the charred material has been unmoved and unmixed since the original activities. It is however likely, as Hillman (1981) acknowledges, that waste and resultant products from different stages are subject to a degree of mixing . It is further inevitable that such mixing will involve the movement of assemblages; first from the location of the activity in which the uncharred assemblage was formed to the place in which it is burnt, then perhaps from the place of burning to a midden, and quite feasibly again to the fields.

Although it may appear to be stating the obvious, that charred remains only become charred and hence preserved through virtue of coming into contact with fire, it is a factor all too often brushed aside within archaeobotanical reports. It is essential that archaeobotanists are clear on the mode of preservation by which the assemblage under study is preserved. By far the most common mode by which plant material is preserved on archaeological sites is through charring. The assumptions or inferences about how the assemblage came to be charred and deposited archaeologically then become of paramount importance in understanding the archaeological information they may yield.

The presence of fires on human occupation sites is a universal (explaining the prevalence of charred remains) and the ash and charcoal that is produced by such fires, must be disposed of. Such disposal often sees it becoming concentrated within middens, parts of which may become dispersed across the site, or mixed with organic animal waste and taken as manure to the fields. While disposal practices may be structured (e.g. Moore 1986, 109-110), we can assume that at least some fire waste will be deposited on or near settlements. Redeposition may also occur through various processes, such as wind, rain-wash, animal trampling and human activity, such as sweeping. Given all these process we should expect a degree of charred remains to linger as part of the general “background noise” of human occupation. How these elements become incorporated into archaeological features will also effect their density, be it through virtue of having been burnt within the feature (cf. Hubbard and Clapham 1992: *class A*), through deliberate dumping (*class B*), or perhaps just as background scatters becoming incorporated into it (*class C*) .

What archaeobotanical experience has shown, especially in Europe where systematic flotation and the study of large assemblages has taken place for over 30 years, is that the majority of samples are highly similar in their composition. Similar in that they are composed of an extremely limited subset the floristic diversity of the European flora. Prior to Hillman's crop-processing studies Körber-Gröhne (1967; 1981) and Knörzer (1971), had commented on the recurrent nature of archaeobotanical assemblages, that time and again they comprised three basic elements; grains of crops, especially cereals, chaff and seeds of probable weed species. Occasionally species would be represented that were not known from modern associations as weeds. In some cases these were wild edible fruits (e.g. grape, bramble and plum) and nuts (e.g. hazelnut). In other cases they were of species which could potentially have been weeds, such as spikerush that might have infested wetter, more poorly drained fields in the past (M. Jones 1988). Thus most of this material can be seen as derived from arable plant communities rather than the environment at large, and thus bringing up back to the need for a crop-processing perspective.

That this similarity between assemblages, coming from many different and diverse types and periods of sites, exists argues for the case that the majority are attributable to a closely related set of activities. That most would appear to represent the waste from such processing would argue that they can be related directly to the burning of waste from crop-processing (Hillman 1981; 1984; Jones 1984; 1987a; van der Veen 1992; Stevens 2003a; Wilkinson and Stevens 2003; Fuller 2002: 266-267; Fuller and Madella 2001: 346-348; Fuller *et al*. 2005; Harvey and Fuller 2005).

Further to this we can add a further observation. That charred plant material is 365 times more likely to relate to routine processing activities that are conducted day-in, day-out than to the once-in-a-year or occasional event (Stevens 2003a; Fuller 2002, 264). So while some deposits may be related to, for example the burning of old thatch, the cereal processing accident, the burnt store, or ritual these are relatively rare by comparison. It is often the case that wood charcoal makes up the bulk of archaeobotanical assemblages. Wood as fuel is intentionally burnt, in quantity, and thus wood charcoal is produced routinely in quantity. Seeds are generally a smaller proportion of the assemblage, but one of the remarkable things that every archaeobotanist will have experienced is the general uniformity of assemblages across contexts, sites and periods.

In the routine, perhaps ‘daily’ activities of crop-processing for food preparation, crops, and their contaminants, are taken <u>from</u> storage and processed towards consumption. The waste and incidental loss of grain, that results from these activities is then disposed of, some of it directly into fires or secondarily swept into fires and thus to potential preservation. Those by-products not disposed into fires will disintegrate in most environments, although they may also leave a signature in phytoliths (Harvey and Fuller 2005, Robinson and Straker

1991). These by-products of routine activities often become combined, firstly in places of charring and then again in places where hearth cleaning is disposed, and in quantitative terms averaged. Material is first amassed in the fire and then mixed in subsequent disposal and reworking of rubbish and sediment.

As Hillman's crop-processing studies, and those that followed (e.g. G. Jones 1984; 1987a; Thompson 1996; Reddy 1997; 2003) indicate, the by-products that remain with the crop vary through the crop-processing sequence. Crop-processing serves to filter plant components on the basis of physical attributes, e.g. size or weight and the way and degree to which they break apart from other components. For example, elements of chaff that adhere strongly to edible grains, or seeds that are readily retained in the seed head. Thus depending on what steps have been conducted prior to storage different components will have been filtered out and therefore should be absent from routine assemblages (Steven 2003a; Fuller *et al.* in press).

From the composition of an assemblage we can then infer the stages of processing carried out before storage by their absence, and therefore infer something about relative quantities of labour that would have been needed to process and store the crop in that state. As the harvest period is normally one of labour bottlenecks (see, e.g. Stone *et al.* 1990), larger groups of people mobilized together can get more of the crop processed and stored, whereas the seasonal demands on smaller groups, will make it more efficient to store the crop less processed and carry out the full processing sequence on a day-to-day basis. Indeed, in 16th century Britain, storage as unprocessed sheaths is advised by Tusser (1580), when weather and time conspire against the farmer to assure that the crop is stored before the rains.

The object of processing is to remove all the contaminants, weed seeds and chaff to leave clean grain. Consequently the proportion of weed seeds to grain is diminished as we progress through the processing sequence (Figure 3.**)**. Assemblages, from the final stages will be dominated by grain with relatively few weed seeds. Those from the earliest stages will still contain high numbers of weed seeds. As grain is also lost within the waste through processing we may expect this pattern to be reflected both in the crop-product and the waste from each stage. Processing also removes weed seeds in a very selective manner according to various physical qualities and these can be used to interpret the stages represented within charred assemblages (G. Jones 1984; 1987a). The model we are using here is based on a highly simplified observation, that smaller weed seeds are removed primarily while grain-sized (large) weed seeds stay until the final processing stage, hand-sorting. As such the ratio of large to small weed seeds is indicative of how far along the processing sequence any given assemblages has gone (Figure 3.). If we then combine these two observations then those assemblages coming from processing sequences that include the earliest stages will be comparably rich in small weed seeds. Those containing processing waste that only includes the later stages will then be richer in grain, with a predominance of larger rather than smaller weed seeds.

Taking the model one stage further we can see that those assemblages coming from the processing of semi-clan spikelets will produce a more limited array of material (Process2). Vice-versa those where resulting from crops that are stored relatively unprocessed will have a greater array of material, being dominated by small weed seeds. In terms of labour, the storage of semi-clean spikelets will create a great demand on labour after harvest and prior to storage, but less demand through the year. Those storing as relatively unclean crops e.g. partially threshed ears, will have less intensive demand on labour in summer but routine 'daily processing' will consume more time (Figure 4).

Crop-processing in different communities: The case of Iron Age Britian

It was through the application of various parts of Hillman's original model (1981, 1984), using methods adapted from G.E.M. Jones (1987) and van der Veen (1992) to Iron Age sites in Southern England that the relationship between charred assemblages, storage and the scheduling of processing was first investigated (Stevens 2003a, Fuller *et al.* in press). This work built upon that of Martin Jones (1985) who had noticed patterns of variation, in the proportions of grain to weed seeds, for charred assemblages from Iron Age settlement sites in the Thames Valley. Jones had reasoned, based upon the location of past settlements and the apparent suitability for agriculture, that those with the grain rich pattern corresponded to "producer-sites", arable farming settlements, situated on the more cultivatable, drier gravels. Those that contained higher proportions of weed seeds were located upon the less cultivatable, wetter margins of river floodplains, and so this pattern corresponded to those consuming or receiving grain from the arable farming settlements. The reasoning behind the pattern was that grain would have been highly prevalent on arable farming sites so readily swept into fires and charred. Upon the smaller consumer sites it was speculated that because grain was scarcer it would be more fervently protected and so less would be wasted.

These observations stood in direct contrast to those of Hillman (1981, 1984a), who had devised a model that speculated the exact opposite. Namely that small weed seeds would predominate on sites that were producing grain, as such remains were most common in the earlier stages. Conversely, as sites consuming grain through exchange would receive that grain at a stage after which most weed seeds had been removed they would always be richer in grain. While the models by Jones and Hillman contained flaws, there were aspects of each that were highly insightful and provided the basis of the development of a new model that paid greater attention to the taphonomic processes involved in the creation of charred assemblages (Stevens 2003a, Fuller *et al*. forthcoming).

While Hillmans model relied on the presence of earlier processing stages in a charred form, Jones' speculated that these would be absent, with processing often being conducted in the field and hence away from settlements and fires. Jones' model then relied on the assumption that most charred assemblages were related to waste, but that the earlier stages would be absent. While Jones did not explicably state that charred assemblages related to the routine processing of crops taken from storage and subsequent charring of the waste, it was an implicit part of his model. It is curious that the models agreed on many aspects, however, the main flaw in both was in assuming that crops would always be stored or indeed exchanged in the same manner between sites. Van der Veen (1992) demonstrated the weakness and inapplicability of both models when applying them to archaeological sites in Northeast England. What van der Veen also highlighted is that most assemblages, as predicted by both workers, were indeed related to waste from the final stages of processing, in that glume chaff vastly outnumbered hulled wheat grains despite many factors biasing assemblages towards preservation of the latter (cf. Boardman and Jones 1990).

Hillman (1981) had long speculated that within the wetter English climate hulled wheats were more probably stored in spikelet form. That sites both from van der Veen's study region and also from the Thames Valley (Stevens 1996) could all be shown to contain at least waste from the final stage of dehusking, suggested that all as M. Jones implied, were derived from the taking and processing of crops from storage. The model developed (Stevens 2003a) and further explored within this paper (Figure 5), explained variation in assemblages not by the role of the sites' inhabitants as consumers or producers but rather by how the inhabitants stored the grain. Following the reasoning already outlined above that most archaeobotanical assemblages represent waste from routine, daily activities we can then interpret variation between assemblages on sites as differences in storage practices. In turn, as discussed in the introduction, these differences in storage practice may reveal evidence for social organisation and labour mobilisation. Storing crops as clean grain will require a larger number of people and a higher degree of ability to mobilise this labour. Those storing crops with little to no processing will be able to perform harvesting and perhaps preliminary threshing and raking within just the nuclear household.

The Routine Processing Model on British Iron Age sites

In order to relate crop-processing patterns to possible aspects of social complexity, it is important to consider correlations with settlement patterns. It is reasonable to assume that patterns within charred assemblages correspond either to the size of the site (cf. Cordell and Plog 1979) or to social interrelation between sites. Put simply we might expect to see grain rich assemblages predominating on larger sites where more labour might reasonably be seen to be available. *Vice-versa* we might expect smaller sites to be dominated by small weed seeds. The alternative explanation is that such patterns are regional, and demonstrate social organisation between settlements. So that sites with assemblages containing high amounts of grain are situated within the same broad region, as are sites with assemblages containing high amounts of small weed seeds. For the purpose of this paper we have chosen some thirty-five sites and divided them broadly into 4 regions (Table 1).

In terms of size, the sites can be broadly divided into four basic groups. Large enclosed nucleated sites, which are characterised by hillforts, for example Danebury (Cunliffe 1984; 1985), Balksbury (Wainwright and Davies 1995), Asheldham (Bedwin 1991) and Maiden Castle (Sharples 1991), but also includes the Late Iron Age defended *oppida*, for example, Abingdon (Allen 1990), Stanwich Tofts (Haselgrove 1990) and open nucleated sites, such as Ashville (Parrington 1978, Muir and Roberts 1999). That such settlements clearly demonstrate the ability to mobilise large groups of people in the construction of the defences (Hill 1996; Startin 1982), may also hint that they may also be capable of mobilising larger numbers of people to harvest and process cereal crops in late summer.

Smaller settlements, as might be expected, are more numerous. Examples of small enclosed settlements include the smaller northern “hillforts” e.g. Dod Law (Smith 1990) ,the southern “banjo” and small enclosed settlements of southern England e.g. Whitehouse Road (Mudd 1992), Wardy Hill (Evans 2003), Blackhorse Road (Fitzpatrick *et al.* 1999) and Mingies Ditch (Allen and Robertson 1993). More dispersed, unenclosed small settlements include sites such as Yarnton (Hey *et al.* forthcoming) and Sherborne House (Bateman, Enright and Oakley 2003). Finally there are settlements that are less easily categorised. Gravelly Guy is unenclosed and thought to have been larger in size than Yarnton, consisting perhaps of four to six contemporary houses (Lambrick 1992). Similarly while some hillforts, such as Uffington today display many aspects in common with the other ridgeway hillforts, excavation and survey has revealed relatively little evidence for intensive occupation (Miles *et al. 2003*).

When we examine the assemblages according to their composition it is difficult to see that either site size or regional spacing can be solely responsible for the patterns seen. In this respect both hypotheses fail to explain entirely the patterns seen. With regard to hillforts the assemblages from Asheldham, Danebury, Balksbury and Battlesbury all display the pattern associated with storage of semi-clean spikelets (and therefore semi-centralized labour mobilization, cf. Figure 5 upper left), while other hillforts, such as Uffington, Berkshire (Robinson 2003), Ham Hill Somerset (Ede 1999) and Wandlebury, Cambridgeshire (Ballentyne 2004) also hint at such patterns, although the data from these sites is far from clear. However, at Maiden Castle, despite the vast defences, the charred assemblages display a mixed pattern implying some small scale (focused) processing on some parts of the site, or during some sub-phases of occupation.

Neither can the absence of vast defences be used as an indication of the inability to organise large amounts of labour for cereal processing. Ashville, while providing evidence for a denser and more nucleated occupation than many sites, does not have considerable defences, but still displays the storage of relatively clean grain/spikelets, suggesting that more centralized mobilization for processing need not correlate with fortification. Nevertheless most fortified sites in Southern England do show semi-clean storage (or a mixed pattern), indicating some semi-centralized mobilization. Of interest is the fact that within small regions, there are apparent contrasts between sites, suggesting differentiation in the organization of processing. For example, Ashville is scarcely 2 kilometres from Abingdon yet while the assemblage of the former is dominated by grain, weed seeds dominate the assemblage of the latter.

Some regional differences can also be suggested, with fortified sites of North East England consistently have a smaller-scale focused pattern, in contrast to most larger or fortified sites in the Southern regions. Many of the sites displaying patterns associated with a higher degree of mobilisation are often southern hillforts, e.g. Danebury, Balksbury, Battlesbury, Uffington, Wandlebury and Asheldham. Regarding sites within the vicinity of the hillforts, Rollright Stones site 6 (Moffett 1988), lies within the Hillfort region, while Lains Farm (Monk and Fasham 1980) is also similarly situated and both show similar storage patterns to the hillforts. We might also add to these sites, Fifield Bavant examined by Biffin (1924), as well as those of Gussage All Saints, Dorset (Evans and Jones 1979) and Micheldever Wood (Monk and Fasham 1980), of which the former was seen by one of the authors to correspond to the pattern of storage of semi-clean spikelets, while the summary of the latter also indicates such a pattern.

While it is clear more data is needed to fully appreciate the emergent patterns, it is worth considering what other factors might be responsible for the patterns seen. Jones original model was largely based on the current then view that hillforts represented central places in the landscape though which goods were brought in and redistributed (Jones 1985, Cunliffe 1983, Grant 1986). This model was challenged and dismissed by a large number of authors (e.g. Hill 1995; 1996; Collis 1986) who have suggested Iron Age society may have been more egalitarian in nature and less based on chiefdoms). Indeed Cunliffe (1992) speculated that the large numbers of pits were suitable for sowing an adequate supply to feed the population in Danebury, as were the large numbers of four-posters. The examination of the role of hillforts within such patterns then rests more or the detection of large storage facilities far beyond the needs of the immediate population. What becomes clear is that several hillforts do display such evidence suggestive of the collection and redistribution of crops, although the association is far from universal (Hill 1996). Examining the patterns produced within the assemblages of the souther hillforts by contrasts to smaller sites in the region. we can suggest the mobilisation of larger numbers of people for processing in the harvest period. This implies a social system spreading beyond the nuclear household, and thus plausibly somewhat centralized. Contrary to the suggestion of Hill (1995, 1996) the unit of production for some sites is beyond that of the nuclear family and can be contrasts with contemporary sites nearby or in northern England (Figure 6).

Romanization, complexity and agricultural labour

The potential of archaeobotany in combination with crop-processing models to study the impact of Romanisation on the native Iron Age communities was something that had appealed to Hillman. Alas at the time of his original insights into the use of ethnographical models in interpreting such a change, flotation was but rarely carried out upon British sites (Hillman 1981). However, since this time the impetus to process samples for the recovery of charred remains has become commonplace upon British sites, and often obligatory upon developer-funded projects. To this extent we are now at least in a position to begin to address what effect the Romans had upon the agricultural practices of Britain.

Taking the scenario for labour organisation within Iron Age we can begin to address the issue posed by Hillman, namely the contrasting nature of the impact of Romanization on native as opposed to more Roman types of farming settlements, for example, the manorial farmstead and villa. In turn we can also compare these patterns with those seen in the Roman town and forts. Of the native settlements that continue into the Roman period very few show any change within the way crops are processed at all, and so we may assume for many of these settlements the structure, organisation and mobilisation of labour remained largely unchanged. This would appear to be the same for both small sites, such as Yarnton, and larger sites, such as Abingdon (Stevens 1996, 2003a).

Where the impact of Romanisation is noticeable is upon settlements, often founded during the Roman period, or demonstrating considerable evidence for Romanisation. Many of these display a pattern consistent with the storage of semi-clean spikelets, and so to a greater degree of processing and labour mobilisation. Hillman (1984:9) speculated that the "agrarian technology of native farmsteads and Roman manors may have differed dramatically, especially in the processing of glume wheats". By and large he attributed this to the appearance of larger barns on the latter that would facilitate carrying out a greater number of processing stages in the wet British climate. While the possible appearance of barns on more Romanised sites may have facilitated such processing there is reason to believe that economic change was perhaps behind the changes seen in storage practices and the scheduling of processing, since the same scale of mobilization was already present on some of the larger Iron Age sites (without the technology of barns).

Upon several Roman sites, situated on the edge of larger Roman towns, and in association with villas or larger manorial farms we see the appearance of a distinctive pattern within charred assemblages, especially in the later Roman period. While Iron Age assemblages as seen often contain more glumes than grain, upon many of these types of sites large deposits of charred material consisting sometimes of many thousands of glumes are commonplace. Examples outside Roman towns include Dorchester (Letts 1993), Poxwell (Jones 1987b) and Ilchester (Stevens 1999), Turning to manorial farms and villas, we see such patterns emerging at Thenford Villa, Northants, Welton Wold, East Yorkshire (Robinson and Straker 1991), Droitwich (Greig 1997), Catsgore, Somerset (Hillman 1982) and the site that inspired Hillman to postulate on the existence of barns to pursue such processing, Wilderspool in Cheshire (Hillman 1992). Many other examples exist too numerous to mention, however, contrasting this evidence to many Iron Age sites we might propose that dehusking in bulk became more routinely practised upon more Romanised settlements. At a more generalized level we can see that the Roman period presented a greater diversity of processing regimes than the iron age, with some small-scale focused, some semi-centralized and some fully centralized (Figure 7). The increasing degrees of social and economic differentiation brought by Romanization can be contrasts with the more incipient level of social differentiation in the Iron Age.

We can speculate about the purpose increasing centralized dehusking. Given that normally grain would be dehusked in relatively small quantities, to feed perhaps nuclear or even extended families, the dehusking of cereals on such a scale implies that they were destined to supply a larger number of people. It is possible that they were also to be further processed *en mass* for immediate preparation into flour, food or beer. An alternative is that they were to be transported and exchanged. The removal of chaff would facilitate its transport in a similar manner to the advantages suggested for the adoption of bread wheat over hulled wheats (Green 1979, Jones 1981, van der Veen and O'Connor 1998). Curiously despite the argument that bread-wheat was favoured in the Roman period it would appear that this crop was relatively rare, with most assemblages dominated by spelt (cf. van der Veen and O'Connor 1998).

Roman Consumers?

While models developed by Hillman and Jones to distinguish between arable producers and consumers was largely dismissed by van der Veen (1991, 1992) and Stevens (2003a), elements of Hillmans model in some cases still ring true. If the evidence for mass processing in the form of high quantities of glumes is indeed for exchange, be it as tribute, taxation, barter or even monetary exchange then those sites receiving such grain should, as Hillman forecast, be grain rich. Clean grain has the advantage not just of transport, but also it saves on the need for further processing, especially large scale *en-mass* processing, if it is destined for mass production into beer or flour, or for use by specialised bakers etc. In addition it is easier to assess its value, while spikelets may conceal aborted or under-developed grains, clean grain can be more thoroughly visually inspected.

Evidence for Roman "consumer" sites is naturally curtailed for the very reasons already outlined above. Namely that if grains are stored in an almost clean condition, then the limited number of processing stages will limit the wastage. As such grain is less likely to make it into the fire. Further following a point made by Jones (1985) consumers are less likely to waste grain where it is valued. Despite this list of possible reasons why such evidence may not be forthcoming, a number of examples of such cases do exist from Roman Britain. Ede (1993) comments that the grain at the Roman town of *Durnovaria*, modern Dorchester, grain seemed to have arrived at least in the late Roman period in a relatively clean state with only perhaps hand-sorting to be conducted. Similarly at Roman Colchester Murphy comments that the samples appeared to consist of "fully-processed prime grain" (Murphy 1984a: 108). Roman London also potentially reveals such patterns (cf. Grey 2002), while certainly the warehouses in the Forum contains seemingly clean grain (Straker 1984). To add to this list of urban sites one of the authors has also noted such patterns emerging at Roman Winchester. The other type of site that potentially demonstrates such patterns are Roman Forts. South Shields certainly appeared to contain clean grain (van der Veen 1992), as potentially also did the fort at *Bremetenacum*, Roman Ribchester (Huntley 2000). As van der Veen (1989) predicts it might be expected that such military sites and urban settlements received clean grain, for the reasons outlined above.

Technological change and cash-crops in the Romanisation of Britain

It is worth considering how little attention is often paid to tying archaeological evidence that relates directly or indirectly to agricultural practices to archaeobotanical evidence. The potential of such combined studies was envisaged in the early 1980s by Hillman (1981) but relatively few studies have been conducted, notable exceptions being those by van der Veen (1989) and M. Jones (1981, 1991, 1996). That such evidence is often divided within archaeological reports and examined by different specialists is a curious artefact traceable to the growth of environmental studies within archaeology (Wilkinson and Stevens 2003a: 244). Of those artefacts that can be seen as also indicative of agricultural change, the most obvious are corn-driers and millstones. Both of these artefacts imply the processing of grain on a much grander scale than that required by the nuclear family. While such structures may have been used for a number of purposes, their role in dehusking would seem quite probable (van der Veen 1989). Van der Veen has commented that the presence of grain dryers would imply that processing conducted on a larger scale than the nuclear family, and that indeed that such processing was either collective and probably for the exchange of surplus production (van der Veen 1989, Ede 1993).

While evidence in the way of large quantities of chaff and corn-driers may indicate the dehusking of grain in bulk, the existence of large animal driven millstones, indicates the grinding of grain in bulk. For while many rotary quern stones recovered from sites are still not much larger in size than many known from Iron Age sites, e.g. 40-50 cm, occasionally larger stones of around 80 cm are recovered from Roman Towns such as at Dorchester (Seager-Smith 1997)

The findings of large quantities of chaff often precede chronologically the evidence for corn-driers, suggesting the latter was a technological demand to perhaps facilitate existing practises. These changes can be seen in terms of the development of towns through the 2nd century AD and the changes in the agricultural economy that such development would bring about (Fulford 1989, 189). It has been suggested that the ability of individuals to produce a surplus over and above the level of taxes, and its subsequent purchase by the government would provide an important criteria for increased agricultural production (Middleton 1979). That corn-driers often appear in the 3rd and 4th centuries, and are often present even on relatively small settlements, such as Yarnton (Hey *et al* in prep.), may provide some evidence for the use of surplus grain as a “cash-crop”. Corn-driers have also been associated with brewing (Hillman 1982, Reynolds 1981, van der Veen 1991) and it is possible that surplus grain was further utilised as a “cash-crop” by brewing it into beer and which could be sold year round (Jones 1981). It is also probable that other “cash crops”, such as dill, celery, beet, cherry, and plum were grown for the urban market (van der Veen and O’Connor 1998).

Variation in the urban world: crop-processing and cash crops at Medieval Volubilis

In Medieval Morocco, Volubilis was chosen to be the first capital of Idriss, newly arrived from the Middle East, and royalty by virtue of being a descendant of Mohoammed the prophet of Islam. Through an intermarriage with the local chief’s daughter, he established his dynasty and chose the ruined Roman city of Volubilis as his first capital, in which to build a palace, mosque and *hamam* bath. While Volubilis is well-known as Roman provincial capital, its medieval archaeology is less well-studied (see http://www.sitedevolubilis.org/). A recent research excavation program of the Institute of Archaeology (University College London) and INSAP, has focused in particular on the medieval portion of the site with a certain amount of emphasis on the Idrissid period. Excavations (2001-2005) have explored two different areas, one (Sector D) an area of domestic occupation that shows use from the Roman through to the Idrissid period (with a possible hiatus in the 6th century), and the other (Sector B) the central quarter with the prominent *haman* and buildings that have been identified as part of the palace complex. Thus within the same urban site we have the potential to explore contrasts between an elite and a normal area of occupation. Archaeobotanical evidence relating to these two areas will be discussed here (under analysis by Fuller).

As above, of interest is how the crops were stored, or after what stage of processing. Cereals were the staple foodstuffs in medieval, as in modern, Morocco. These occur in nearly all samples and generally represent the most common component of the seed assemblage in samples in which they occur. These include six-row hulled barley, emmer and einkorn wheat and free-threshing wheats (both bread wheat and durum), and in general the free-threshing wheats appear to be more frequent than the glume wheats. These cereals, together with pulses (grasspea, lentils and broad-bean) represent traditional Mediterranean winter agriculture, based on sowing in autumn and harvest in Spring, followed by storage. Although only selected contexts have preserved chaff remains, these suggest potential patterns. Glume wheat chaff is less common than free-threshing wheat chaff, which follows the patterns for the presence of these species as grains. The presence of barley and free-threshing wheat rachis remains, removed early in the processing sequence, implies at least some routine processing of the early stages on-site, which would suggest that these cereals were stored at least sometimes in the ear. The advantages of this might have included lower labour demands during the busy period of harvests, especially if agricultural production was organized on a small household level (see Stevens 2003a; Harvey and Fuller 2005; Fuller, Stevens and McClatchie, in press). In addition, the chaff of the free-threshing cereals may have helped to resist fungal infection of grains stored in underground silos

In terms of weed: cereal ratios and large: small weed seed ratios, daily processing appears to have included the final sieving and cleaning stages of free-threshing-cereals as well as dehusking of glume wheats (Figure 8). This implies that cereals were stored semi-clean, with earlier processing stages being carried out at the time of harvest. For most domestic farming families this is likely to have taken place off-site near the fields. It may be that relatively little care was taken to ensure clean winnowing, thus allowing some quantities of early stage chaff remains, such as wheat and barley rachis to enter the stores and be removed in the routine fine-sieving operations. By contrast only a few contexts contain weed ratios that point to early processing stages and these same contexts often also have higher cereal chaff levels. These include the unique context 311 in Sector D, which is silo fill from the earliest phase of Building L, and thus probably very late Roman. This may imply very small-scale labour units in this period, with crops being stored unprocessed and full-processing being carried out piecemeal on a routine basis, thus producing waste rich in the evidence for early stages. By the later periods, including probable pre-Idrissid early medieval contexts, large labour units (perhaps reflecting larger extended family units) were mobilized at harvest allowing storage in a semi-clean state, reflected in the evidence for only/mainly late processing stages in Sector D samples, a pattern which remained in place through the Idrissid, post-Idirssid and more recent (sub-modern) periods. The almost complete predominance of large-seeded weeds amongst identified remains at Al-Basra (see Figure 8, cf. Mahoney 2004), despite recovery down to 0.2mm size, suggests a similar domestic pattern at that site as well. The evidence from Setif in Algeria also points to a similar pattern in labour organisation (cf. Palmer 1991: 262).

One area of medieval Volubilis that stands out on account of evidence for early processing waste are some silo fills in the large courtyard of Sector B (the palace/bath quarter). These contain more evidence for early processing waste than the norm across the site. These samples are Idirssid (780-800 BC) but relate the secondary infilling of slightly earlier Idrissid silos, as confirmed by radiocarbon dates from two samples. This implies input from the early stages of processing that we would expect to have been carried *en masse* at the time of harvest. Therefore it seems plausible that associated with the large courtyard of the

Idrissid buildings was the centralized mobilization of labour to carry out the early processing stages of harvested crops in the courtyard space prior to their storage (Figure 9). The final processing stages would then have been carried out on a daily basis as was the norm across the site and probably most medieval Moroccan communities.

In terms of the history of the site, this evidence is congruent with an interpretation of a period of centralization by Idriss focused on this area. We can imagine Idriss establishing a large central building, at which communal labour was mobilized to process cereals immediately after harvest for his central stores. This occurred in the same general area as the processing of flax and cotton for fibres, perhaps at other seasons (see below). The waste of some of these activities was then burnt and either remained in burnt patches in the courtyard, or secondarily was deposited in abandoned storage silos in the courtyard. As the Idrssids (Idriss and his son Idriss II) may have only inhabited this site for a fairly short period (less than 20 years), the waste that in-filled the silos may be quite close in date the actual use of the silos. Later re-uses of the silos, which included structured depositions of human skulls and tortoise shell, are associated with typically domestic cereal processing refuse, from a period after the central authority had left the quarter.

The courtyard of the Idrissid palace complex also stands out in terms of evidence for cash crops and craft production. Several samples from this area included evidence for cotton in the form of charred seeds and fragments. Cotton is otherwise absent from the site of Volubilis. In addition flax seeds (*Linum ussitatissimum*) occurred in these samples but were nearly absent from samples on other parts of the site. The presence of both of these suggests that some charred waste from the processing of fibre crops for craft production was also associated with this building. While flax is traditionally grown in this part of Morocco, cotton is not and is only produced much further South. This suggests that the cotton seeds may have come into the site as inclusion in bolls. This cotton then would have been deseeded (ginned), carded, spun and woven. All of these, and equivalent processes for flax, are labour intensive activities which we might also see as organized through a centralized power as was the seasonal bulk processing of cereals. By contrast olives are almost entirely absent from this courtyard, although they occur in small quantities elsewhere on the site. In the case of this cash crop, we can suggest domestic processing and consumption, and that which made it to the palace area is likely to have been processed already (e.g. as olive oil).

The case of Volubilis demonstrates variation of labour organization across a single, urban site. The patterns for contexts in a special, elite building indicates access to labour on a larger scale as well as activities related to cash crops, including imported cotton. The silos in the building indicate storage on a larger scale than that found associated with domestic houses elsewhere on the site, and we appear to actually be dealing with a few rare contexts of seasonal processing. Thus in a complex society variation in labour access, and to cash crops and their products may vary across a site.

Complex transformations: climate, processing and decentralization of the Bronze Age Indus

The Third Millennium BC in northwestern South Asia (modern Pakistan and adjacent parts of India) was a period in which a large urban civilization arose in the greater Indus Valley region, the Harappan civilization, with its main 'mature' phase from ca. 2600/2500 BC to 2000/1900 BC (Allchin and Allchin 1982; Kenoyer 1998; 2000; Possehl 1998; 2002). The core region of the civilization was based along the Indus river valley, which has shifted its course since that time, and another river course, the paleo-Ghaggar-Hakra, the valley of which ran parallel to the Indus at least during the Early to Mid-Holocene (Figure 10). During the period of the urban civilization it may have been more of a seasonal watercourse in places, but was nevertheless an important focus of settlement and agricultural production (Possehl 2002: 8-9). This civilization emerged during a period of slightly declining rainfall which reached a height of aridity by ca. 2200 BC, with conditions similar to those of present but possibly more variable (see Fuller and Madella 2001; Enzel *et al.* 1999; Staubwasser et a 2003). The basic agriculture of the Indus and Ghaggar-Hakra (and their tributaries) was winter cultivation of the Near Eastern cereals and pulses (wheat, barley, lentils, peas, chickpeas, grasspea) (Fuller and Madella 2001; Weber 1999; 2003). These cereals could be grown on the receding flood silts, as the Indus river swells during late spring and summer on the basis of snowmelt in the Himalayas, with a lesser contribution of late summer monsoon rains near headwater areas (Leshnik 1973; Fuller and Madella 2001: 349). Summer cultivation would have been more limited to areas not under flood and where water and flood could be sufficiently controlled to prevent floods from damaging crops. This probably restricted much summer cultivation to lands that are not normally flooded and have required use of small-scale irrigation (such as pot lifting devices like the long lever of the shaduf). Such summer crops that are documented included sesame, as well as woody perennials like the native tree cotton (*Gossypium arboreum*), grapes and dates.

On this agricultural basis most of the vast Harappan civilization depended, although different regimes were practiced in its southeastern and northeastern territories (Fuller and Madella 2001). In the northeastern zone, such as Haryana and towards the upper Yamuna river sites have produced evidence for summer (monsoon) grown pulses, and some rice and millets in addition to the typical winter Harappan crops (e.g. Willcox 1992; Saraswat 1997; Saraswat and Pokharia 2002; 2003). On the Saurashtra peninsula, winter cereals were insignificant, while the staple cereals were summer grown millets together with a mixture of summer and winter pulses. Harappan civilization also had significant 'cash crop' production, including tree cottons and fruits like dates, bananas and grapes. The production of these cash crops, along with the well-documented craft production, including the transformation of a fibre crops like cotton into commodities for trade, presupposes some centralized control of surpluses that could support specialists and expenditure of labour for non-subsistence production (see Kenoyer 2000).

It has long been recognized that agricultural changes occurred through much of the core Indus region between the urban heyday of the civilization and its less urban late period (e.g. Jarrige 1985; Meadow 1989; Weber 1999; Fuller and Madella 2001: 368-371). In general there was a temporal diversification through the addition of cropping seasons, as summer cereals came to be grown further west, such as rice at Harappa from ca. 2200 BC (Weber 1997; new evidence indicates some summer millets were already present at Harappa in proto-Urban times and its earliest phase, Weber 2003, and personal communication), and at Pirak in western Sindh after 1900 BC. Additional millets also came to be grown in Saurashtra after 2000 BC, including new millets like sorghum and pearl millet (and probably finger millet) which had arrived from Africa certainly by 1700 BC. Such seasonal diversification may be important in overcoming labour 'bottlenecks' (see Stone *et al.* 1990) and hints at decreasing potential for large labour mobilisation at any one harvest time. It may also help in risk buffering.

The Harappan civilization as a whole underwent a major transformation around 2000-1900 BC, the period at which the 'collapse,' or deurbanization is usually placed (Possehl 1997; 2002: 237-245; Kenoyer 1998). This change did not lead to the disappearance of sites of the Harappan tradition, although many sites were abandoned, but it did lead to significant changes in settlement pattern: community size and distribution. As estimates of site size compiled by Possehl (1997) indicate, there is actually an increase in the total number of sites, and total area of habitation estimated from those sites in the Late Harappan period, but there is marked decline in the average area of individual sites and in the maximum size range. In other words there were more smaller communities, and no urban centres. These communities were highly biased towards the eastern parts of the Harappan distribution whereas areas of the old Harappan core, especially along the Lower Indus most sites were abandoned (see Figure 10). This downsizing of communities seems to parallel a downsizing of agricultural labour units as well.

At one of the key urban sites, Harappa, significant changes can be understood in terms of a decrease in agricultural labour units. Although the available data (Weber 1999; 2003) does not allow us to plot individual samples as in previous case studies, the large combined data by phases suggests a change from storage of clean crops to less-fully processed, or in others in decline in the scale of agricultural labour mobilization. As noted by Weber, there is an increase in the ubiquity (percentages of samples) and relative frequency (percentage within samples) of weeds and chaff in the Late Harappan. There is also an increase in the diversity of non-crop species, suggesting that more early processing stage weeds are being found (see Figure 11). All of this suggests a move from larger labour mobilization, which should probably be inferred to be centralized given the urban nature of the site, towards a smaller scale in which crops are stored part processed.

A parallel trend can be identified at the site of Rojdi in Gujarat (Fuller 2001; Fuller and Madella 2001: 346-347; based on Weber 1991; 1999). This site is in a monsoon zone, and its cultivation was based almost entirely on monsoon crops, especially small millets. As at Harappa there is an increase in weed seed taxa diversity, and in overall weed quantity (see Figs.; also, Weber 1999; 2003).. There is also a change in the composition of the of the millet assemblage. Unfortunately there remain unresolved controversies over the millet identification at this site (Fuller 2001; 2002: 277-281; 2003a; although the latest reassessment suggests the presence of some finger millet, *Eleusine coracana,* as well as native wild *Eleusine indica*; Weber, personal communication). In much of the older Indian archaeobotanical reports with photographs, the cleaned grain of hulled millets (including *Setaria* spp, *Echinochloa colona, Brachiaria ramosa*) have been mis-attributed to the free-threshing finger millet (*Eleusine coracana*) (for morphological details see Fuller 2003a). Because *Eleusine* is free-threshing it is always encountered in reference material as grains, whereas many discussions of *Setaria* identification deal only with hulled grains, i.e. lemma and palea characters, despite that such chaff is expected to be often destroyed by charring. Thus the dehusked round grains of various millets have been attributed to free-threshing *Eleusine.* The evidence from Rojdi site shows a change from '*Eleusine*' to '*Setaria*' dominance. This might be re-stated as simply a shift from de-hulled grains (which may include some native dehusked *Setaria,* as well as free-threshing *Eleusine* spp.) to hulled grains/spikelets (Figure 12). The significance of this change can then be considered in terms of a change in crop-processing, alongside that of the range and quantity of weed taxa.

This suggested a shift from larger-scale labour mobilization towards more small-scale focused production. The fully-cleaned millet grains of the earlier periods would be expected to be accompanied by a minimal number and range of weed seeds as these would have been removed during processing (Reddy 1997; 2003). This is most-likely dehusking waste (assuming the identification as *Setaria*), indicating storage partly processed (Fuller 2001), i.e. semi-centralized (centralized since we presume some hierarchical complexity as part of the Harappan civilization). By contrast hulled *Setaria* represents loss from an earlier processing stage, i.e. before final pounding, final winnowing and hand-picking, and we would expect a greater range of weeds to be present. In the later phase in which crops were stored in less-processed form, they were more routinely taken through a larger number of processing steps presumably on a focused scale such as at the small household level. By comparison to Harappa, Rojdi starts out less centralized and shifts towards focused, while Harappa shows a change from more fully centralized to less so.

The direction of change, despite the vast differences in site size and agricultural regime is parallel (Figure 13), suggesting parallel change across the Harappan civilization as part of a wider social process (Weber 1999; 2003). While there are as yet few other archaeobotanical datasets from the Harappan era with enough detail to support this kind of assessment, there are indeed additional sites that suggest the same direction: decentralization. In Haryana, a few sites provided flotation samples studied by Willcox (1992; full data set unpublished). Among these is the Mature Harappan Burthana Tigrana and the Late Harappan Mitathal. At both sites wheat and barley are the predominant crops, but at Tigrana chaff (barley and free-threshing wheat rachises) are completely absent, suggesting storage after threshing and winnowing (although this could be a sample size effect). By contrast Mitathal has chaff, with wheat chaff to grain ratios of ca. 0.29 and barley at 0.05, on par with the ratios from late period Harappa. Some basal cereal culm nodes are also present at Mitathal. Mitathal also marks an increase in weed taxa diversity from 16 species at Tigrana to 26 at Mitathal, including new small-seeded weeds like sedges (although these might also relate to the addition of rice to the economy at Mitathal). Thus the contrasts between Tigrana and Mitathal are the same as those between Mature and Late Harappa. Mature Harappa samples are also available from Miri Qalat in the Makran (Tengberg 1999) and from Shortughai in Afghanistan (Willcox 1991), which is generally regarded as a distant Harappan colony. At these sites, bread wheat rachises and barley rachis are fairly common suggesting less centralized storage. This indicates that there is not one pattern for all mature Harappan sites but rather that different communities were more or less centralized in this regard, as we might expect for a complex society (compare Roman Britain, discussed above). What does seem to be clear, however, is that those sites which were more centralized, such as Harappa or Burthana Tigrana and semi-centralized (Rojdi) showed marked shifts away from this as part of the process of de-urbanization that marked the transformation of the Harappan civilization. Although explaining the causation behind this pattern lies beyond the scope of the current pattern, it is worth noting that there are climatic changes in the late third millennium BC (ca. 2200 BC) after which variability between dry and wet episodes on a sub-century scale were quire marked (see Staubwasser *et al.* 2003). Ultimately smaller settlements, especially in the monsoon zone (to the east), and more focused scales of production may have proved a more effective way to deal with some of the economic uncertainties of the changes in environment (Fuller and Madella 2001: 354-355).

Discussion

What the examples explored in this paper demonstrate is that archaeobotanical assemblages can be found to vary in systematic ways. These differences can be related to recurrent waste from crop-processing stages and provide a basis for inferring scales of labour organization. Archaeobotany has the potential therefore to contribute to some of the major issues in social archaeology. It has been suggested that there are two critical axes of variation against which social organization can be judged (Feinman 2000): one is the corporate/network dimension by which power is distributed within a society, and the other is the egalitarian/hierarchical continuum by which people and their access to power is ranked. We have proposed an alternative way of phrasing these dimensions and in diagramming them, with one key dimension being the mobilization of labour, which can vary from large integrated work groups to very small numbers of in-groups that might consist of just a nuclear family, which we term *focused* to avoid confusing use of terms like domestic, household or family any of which can vary considerably between societies. Superimposed on this is another dimension of variation between hierarchical societies and egalitarian societies. While for small, focused workgoups there is no practical difference between egalitarian or hierarchical ethos, for larger groups there is a significant difference. This larger work groups (or intermediate states) need to be assessed as either more communal or centralized—an assessment which requires moving beyond the archaeobotanical evidence to the wider archaeological or historical context.

This diagram provides one way for charting an important aspect of social change and socio-cultural evolution. The fundamental contrast between communally organized egalitarian societies, which is often assumed to be the original state of humanity, and centralized, complex societies is common. Durkheim made his distinction between his 'mechanical' societies and his 'organic' societies. It is unlikely, and to our knowledge undocumented that a truly communal society has transformed into a fully centralized society, and thus we can suggest the general directionality of social evolution has been along the vertical sides of the labour triangle, either towards or away from focused forms of organization. On the left-hand side of the triangle with more egalitarian ethos we can place those societies that anthropologists have traditionally called ‘tribes’ (e.g. Sahlins 1968) and those with a hierarchical ethos include agriculturalists traditionally defined as ‘peasants’ (Redfield 1953: 31-32; Wolf 1966). This distinction was clearly drawn by Redfield (1953: 31) who defines the peasant in relation to the city, as a “rural native whose long-established order of life takes important account of the city,” or at least of the social hierarchy. Redfield implies that once complex societies are established and the farming population have become peasants there is no returning to the status of ‘primitive’ tribesmen. While this seems likely, it requires empirical assessment to which archaebotany can make an important contribution.

Drawing on the few cases outlined in this paper a few general observations about directionality in social cultural evolution can be made. Amongst more hierarchical societies it seems to be a recurrent feature that different groups within societies, represented by different archaeological sites or areas within sites, often had different degrees of labour mobilization. This is as we might predict for increasingly complex societies, whereas for more ‘tribal’ societies there may be more unitary organization. The trend amongst egalitarian societies seems to be towards a focused level of organization, although we suspect that various hunter-gatherer and agricultural societies could be placed along the labour spectrum on the egalitarian side. Once past the tipping point of the focused organization and with a hierarchical ethos directionality may shift towards larger group mobilization, but also towards divergence between sites and groups, and with important reversals, such as those suggested by Harappan collapse. In terms of contemporary archaeology these are issues raised by studies of social complexity and political economy (e.g. Earle 2002; Chapman 2003), to which archaeobotany has important contributions to make, as more sites are systematically sampled and quantitatively analyzed. The roots of this archaeobotanical approach lie in the fertile ground prepared by Gordon Hillman through his ethnoarchaeological transformation of the labour that is archaeobotany.

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Figure 2. The labour mobilization diagram. At the larger scale end (top) a distinction must be sought between more egalitarian societies with a communal ethos and centralized societies with a hierarchical ethos. On purely archaeobotanical grounds these may resemble each other, and thus evidence from the broader social context is needed.

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Table 1. Thirty-five British Iron Age sites divided by region, indicating the state in which crop were stored based on the recurrent signature of the archaeobotanical sample ratios summarized in Figures 3-5. Large (nucleated) sites are indicated by *L*, and fortified sites are indicated by *F*. Large fortified sites (*LF*) include hillforts and oppida.

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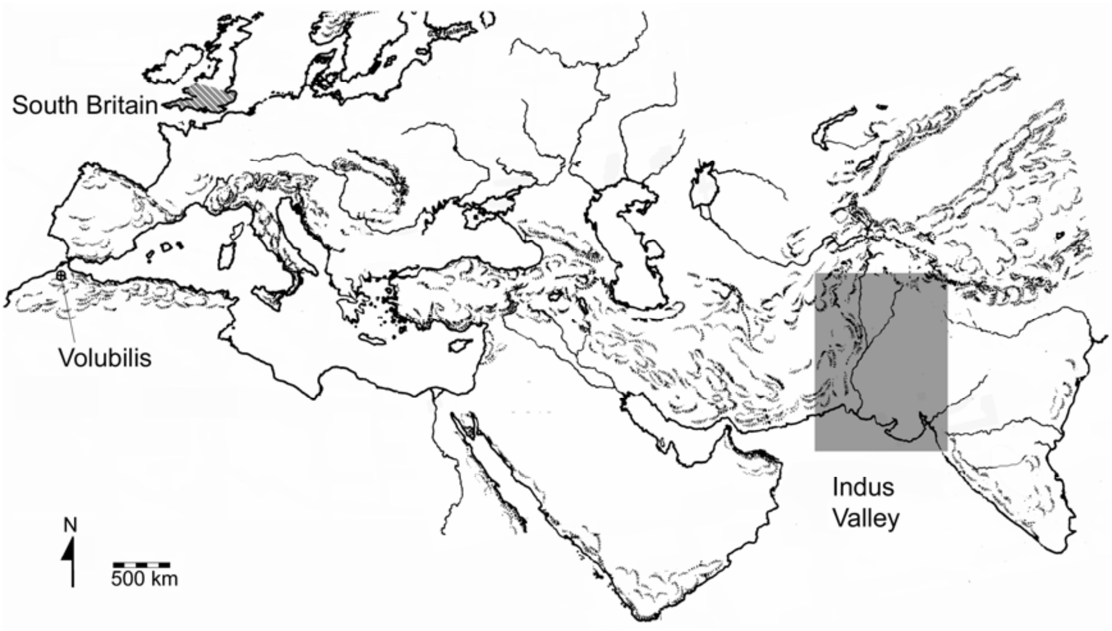
Figure 13. Mature and Late Harappan sites plotted in the labour mobilization triangle indicating the directionality of Late Harappan shift towards less-centralized production.

Illustrations for **Fuller and Stevens**. 'Agriculture and Complex Societies: An Archaeobotanical Agenda'



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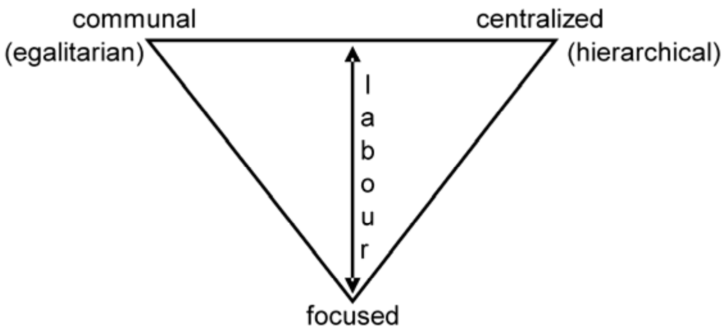

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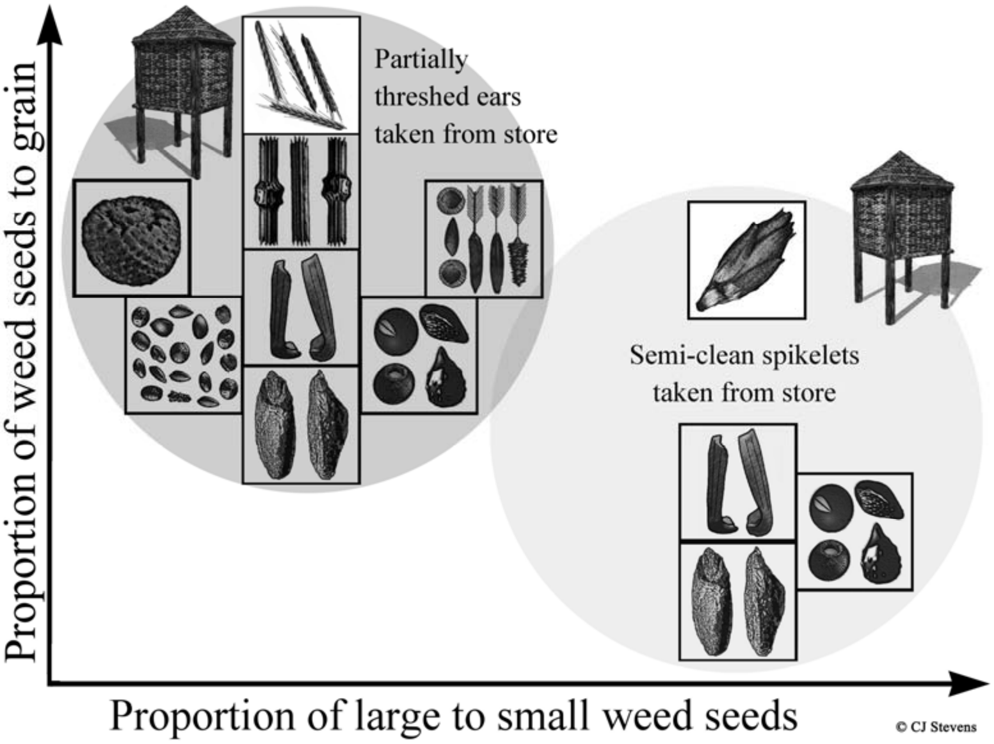

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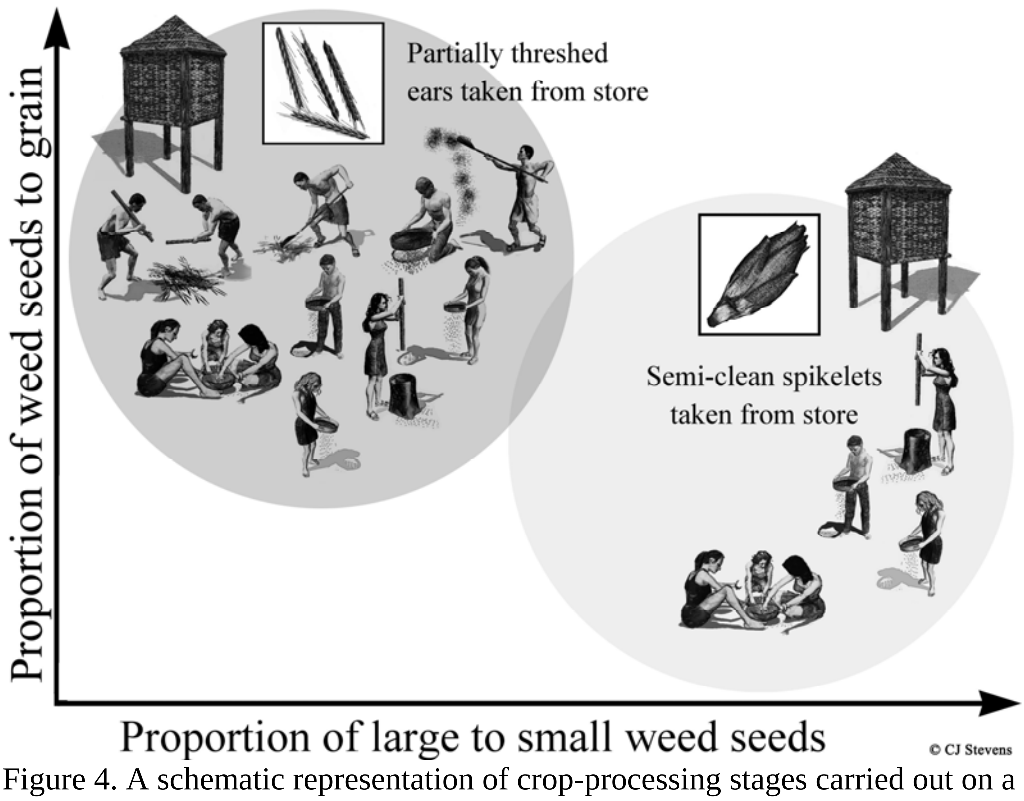

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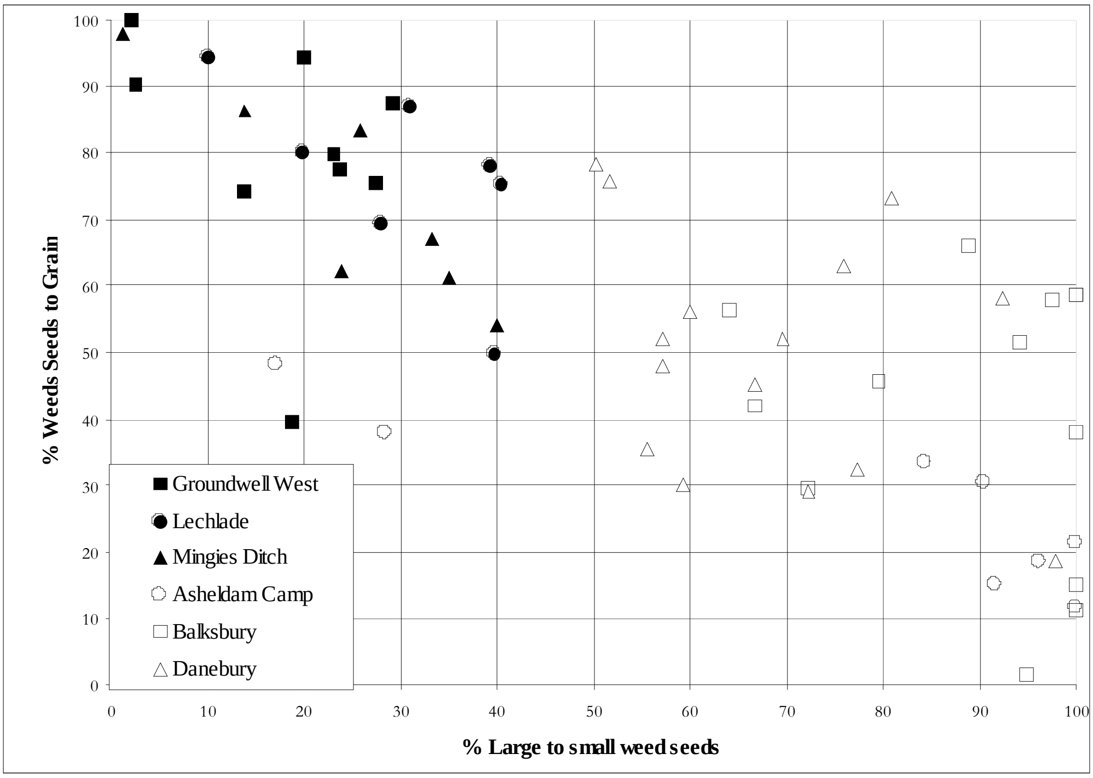

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Site	**References**	**Storage as**
Thames Valley		
Abingdon *LF*	Stevens 1996	Partially threshed ears
Ashville *L*	Jones 1978; 1984a	Semi-clean spikelets
Claydon Pike	Jones 1984a	Partially threshed ears
Gravelly Guy	Moffett 1989	Partially threshed ears
Blunsden (Groundwell West)	Stevens 2001	Partially threshed ears
Lechlade	Stevens 2003b	Partially threshed ears
Mingies Ditch	Jones 1993	Partially threshed ears
Mount Farm	Jones 1984a	Semi-clean spikelets
Rollright Stones	Moffett 1988	Semi-clean spikelets
Whitehorse Rd.	Letts 1994	Semi-clean spikelets
Yarnton	Stevens 1996	Partially threshed ears
Wessex (Hampshire, Dorset, Wiltshire, Devon)		
Balksbury *LF*	de Moulins 1995	Semi-clean spikelets
Battlesbury *LF*	Clapham & Stevens *forthcoming*	Semi-clean spikelets
Blackhorse	Clapham 1999, Clapham & Stevens 1999	Partially threshed ears
Danebury *LF*	Jones and Nye 1991	Semi-clean spikelets
Easton Lane	Carruthers 1989	Semi-clean spikelets
Lains Farm	Monk and Fasham 1989	Mixed pattern
Maiden *LF* Castle	Palmer and Jones 1991	Mixed pattern
North-East England		
Chester House	van der Veen 1992	Semi-clean spikelets
Dod Law *F*	van der Veen 1992	Partially threshed ears
Hallshill *F?*	van der Veen 1992	Partially threshed ears
Murton *F*	van der Veen 1992	Partially threshed ears
Rocks Castle	van der Veen 1992	Partially threshed ears
Scotch Corner	Huntley 1995	Partially threshed ears
Stanwick the tofts *LF*	van der Veen 1992	Partially threshed ears
Sutton Common *F*	Boardman and Charles 1997	Semi-clean spikelets
Thorpes Thewles	van der Veen 1992	Partially threshed ears
East-South-east England		
Asheldon *LF*	Murphy 1991	Semi-clean spikelets
Bierton	Jones 1988	Semi-clean spikelets
Earith	Stevens 1998	Partially threshed ears
Greenhouse Fm.	Stevens 1997	Partially threshed ears
Hurst Lane	Stevens 2003d	Partially threshed ears
Marion Close	Stevens unpublished	Partially threshed ears
Wardy Hill	Murphy 2003; Stevens 2003e	Partially threshed ears
Wilby Way	Stevens 2003b	Semi-clean spikelets

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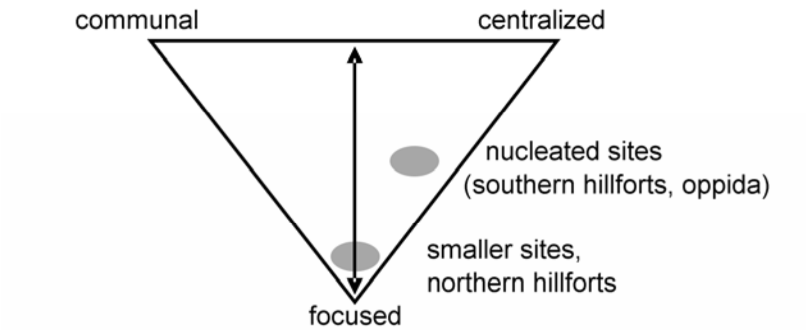

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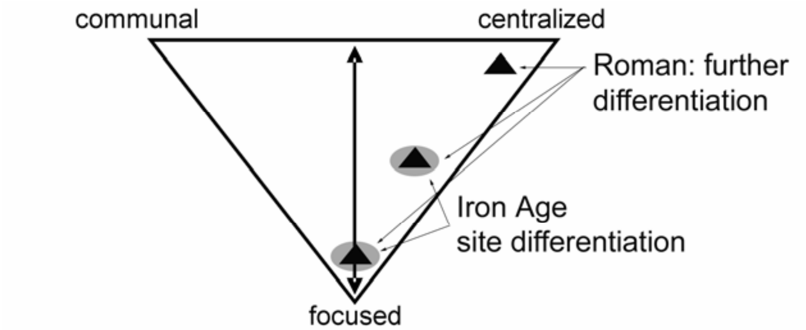

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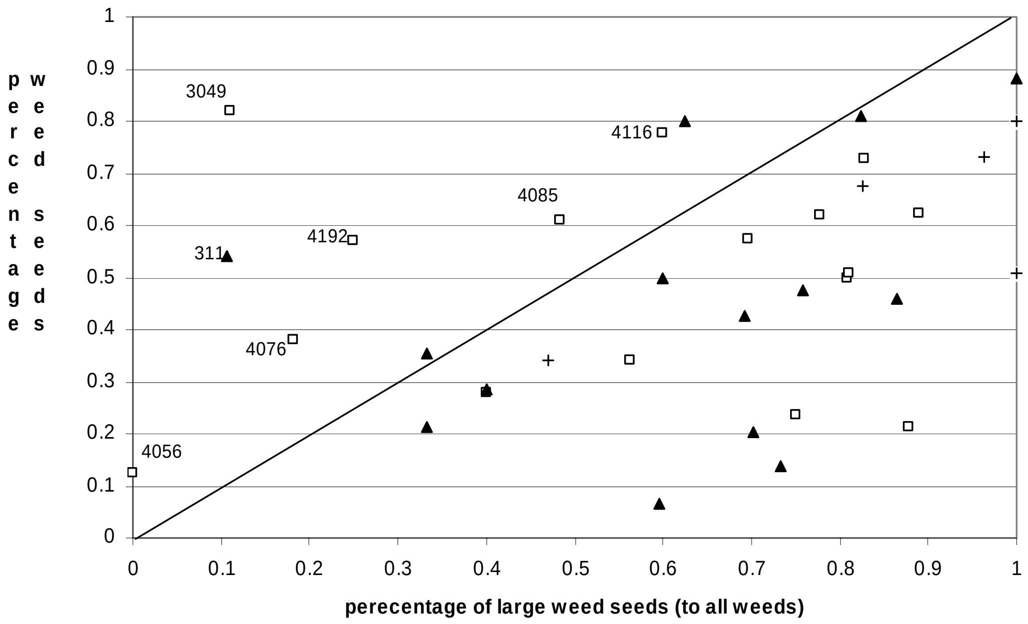

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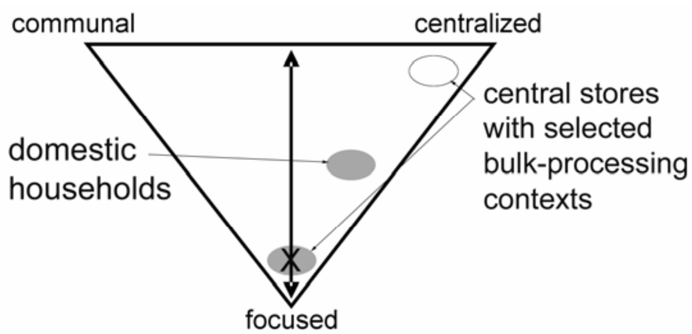

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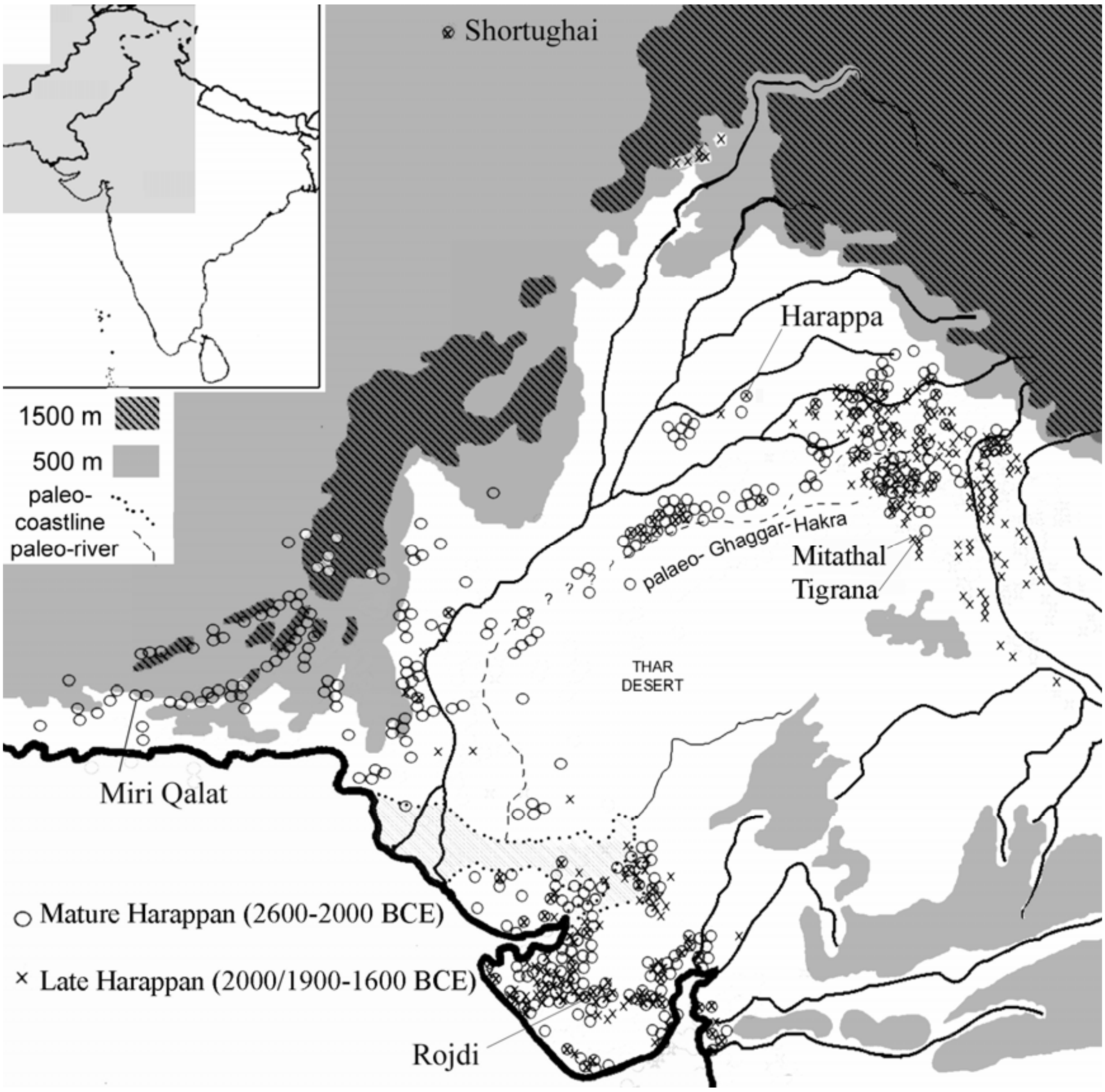

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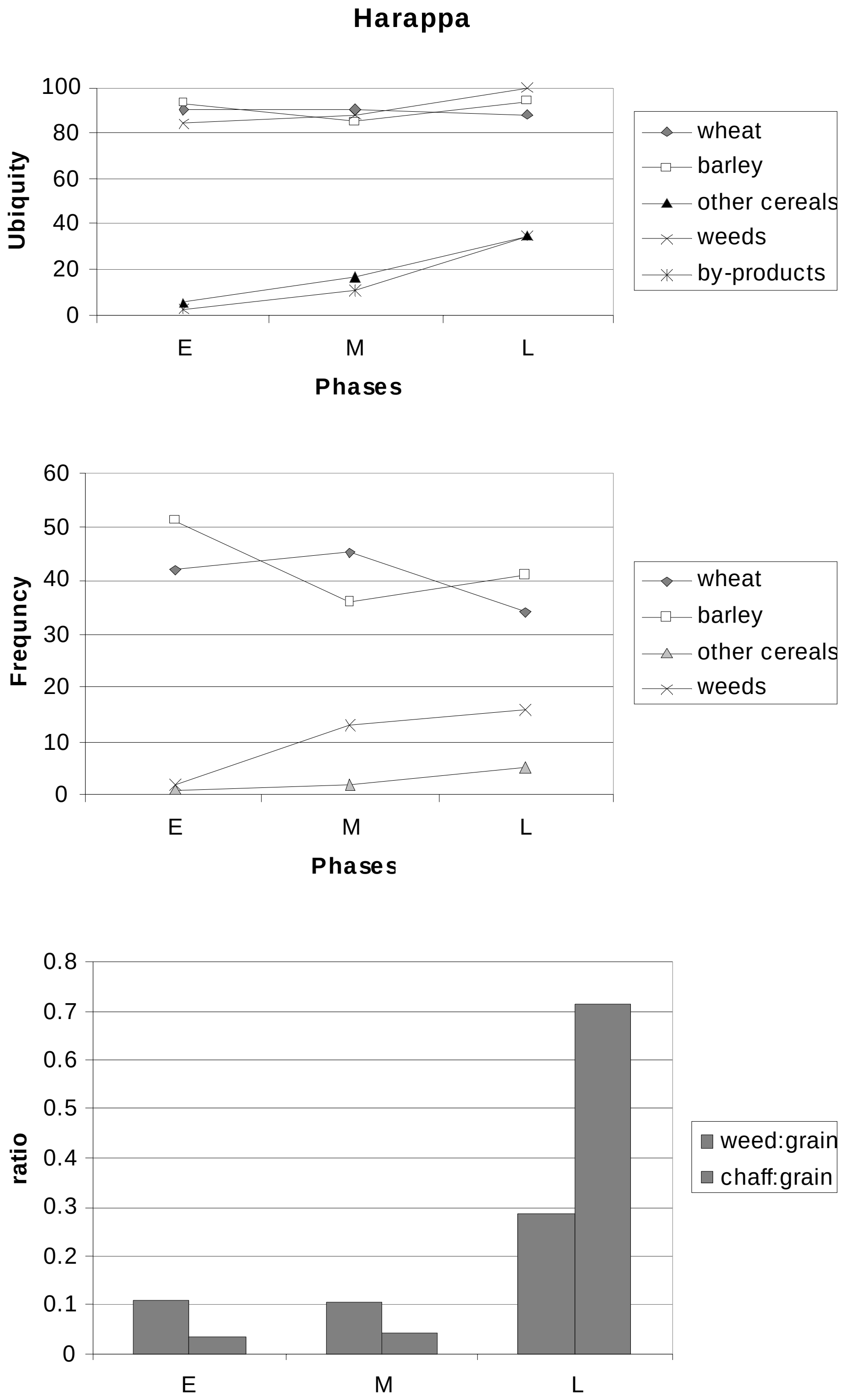

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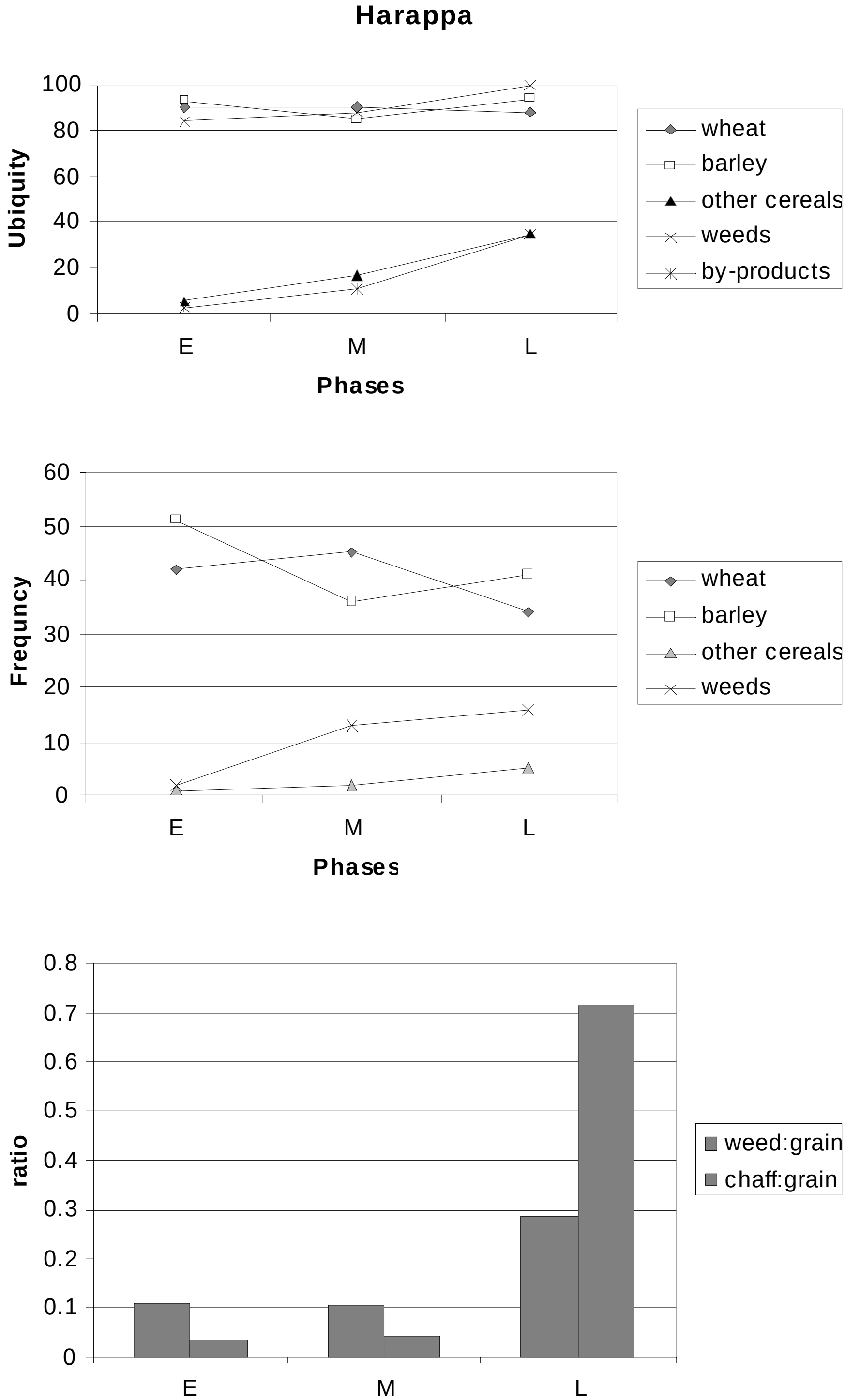

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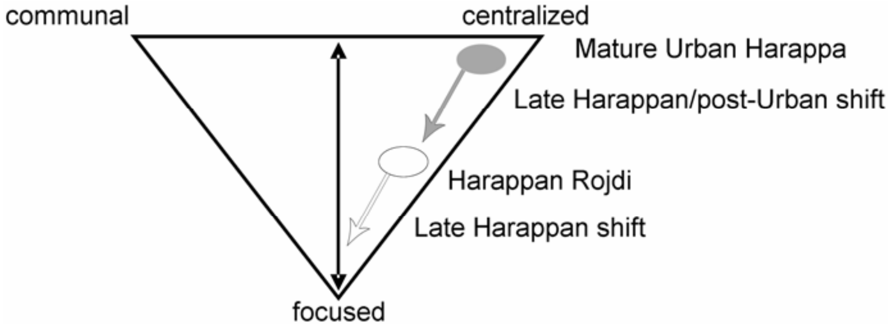

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