续表五

遗址名		西范店	西范店	西范店	石道	石道	杜岗寺	杜岗寺
Site		XFD	XFD	XFD	SHD	SHD	DGS	DGS
单位(Sample)		P2H3(1)	P2H3(2)	P2H3(4)	P2(1)	P1H1	P2H2	
年代		龙山晚	龙山晚	龙山晚	二里头	二里头	殷墟	龙山晚
Period		L. Longst	L. Longs	L. Longs	Erlitou	Erlitou	Shang	L. Longsh
WEEDS	野草							
indet embryos	胚芽						3	
Agrostis/Calamagrostis group	剪股颖属/拂子茅属		6					
cf. Pennisetum alopecuroides	狼尾草	1					1	
grass rachis (Hordeae type, cf. Lolium?)	草的叶轴(大麦族或黑麦草属?)		1					
Alopecurus sp.	看麦娘属							
cf. Dactylis glomerata	鸭茅(鸡脚草)						9	
Digitaria sp.	马唐属	1		2	1		11	
Eleusine indica	牛筋草							
cf. Paspalum sp.	雀稗属				1			
grass infloresence type(dense)	草的花序(较密集)			1				
indet small grasses	小型草				1	1		
awn stipeae/aveneae	芒刺						5	
cf. Bromus	雀麦属							
cf. Lolium perenne	黑麦草属							
cf. Urochloa/Eriochloa	尾稃草/莩荠							
OTHER	其他							
culm, cf. Cyperaceae(?)	莎草科(?)秆							
Parenchyma	软组织		7		16	35	9	
vesiculate fragment	苞状残块		3	9			146	
indet. Fragment	残块	13	89	169	3		73	
epidermis	表皮			1				
pedicel indet delicate	小型的蒂							
pedicel large	大型的蒂							
large indet.	大型植物		1					
cf. dung fragment	粪的残块						5	
Setaria viridis intrusive	混入的现代莠		1		7		1	1
rice husk uncharred intrusive (?)	未炭化稻壳(可能为现代混入)							8
Amaranthus, uncharred, intrusive	混入的现代未炭化苋							
modern intrusive gen	现代昆虫					13		
Papavar unhcharrded, intrusive	混入的现代未炭化的罂粟							
Silene type uncharred	未炭化的蝇子草							

A preliminary report of the survey archaeobotany of the upper Ying Valley (Henan Province)

Introduction: survey archaeobotany

Archaeobotanical evidence offers insights into the nature of agricultural production and the means by which a region's population has an economy grounded into the biological productivity of its environment. While most archaeobotanical studies focus on individual sites, regional survey provides an opportunity establish recurrent patterns within a region during a period, and to assess the extent or uniformity or variation in agricultural production.

The potential to concentrate plant remains from archaeological layers through flotation was first employed in field archaeology in the 1960s. In the context of a the Deh Luran Plain survey of Iran archaeobotanoical samples collected from cleaned stratrigraphic layers from a few sites provided one of the first systematic overviews of the longer term development of plant economies in a region (Helbaek 1969). This approach was part of the inspiration of a South Indian project which sampled Twelve Neolithic sites stretching across a region by collecting a small number of samples from each site, providing a basis for characterising the main pattern in Neolithic agriculture in South India (Fuller et al 2004).

Despite the small number of samples form each site, recurrent patterns are to be expected. The nature of carbonized plant remains is that they have passed through ancient fires. And unless recovered from within preserved hearths or ovens they have then been redeposited, moved and mixed and various processes. At the point of coming near a fire too they been mixed as different waste disposal and accidents lead to plant parts entering a fire. As such it is those processes that occurred regularly which can be expected to numerically dominate most samples. As explored through ethnoarchaeological, research routines of crop – processing create structured assemblages of grains, chaff and weed seeds (Hillman 1984; G. Jones 1987; Reddy 1997). Archaeologically those crop – processing stages which are regularly exposed to fire may be preserved in charred archaeobotanical assemblages. The routine, or even daily, processing of the final stages of crops can be expected to occur in domestic contexts and enter fires as waste on a regular basis (Stevens 2003; Harvey and Fuller 2005). In addition cooking accidents may also contribute. Thus we can relate repeated patterns to repeated patterns of activity that have been averaged over time. Patterns discovered for sites, or groups of sites or periods can then be considered as evidence for differences in activity pattern. This may therefore indicate aspects of agricultural difference, or differences in how the crop – processing and food preparation activities were organized. As the organization of such activities is an aspect of the social mobilization of labour, archaeobotanical evidence may contribute to assessing some aspects of social change. It was with this in mind, as well as establishing the dominant crops, that archaeobotanical analysis was undertaken on this material.

Samples

Samples were collected in the field from freshly cleaned layers and contexts in stratrigraphic section. This preliminary dataset consists of 22 samples drawn from 13 different sites, ranging in age from the Yangshao to the Shang period. Flots were sorted under a low power binocular microscope and seeds, seeds fragments and other not - wood remains were separated from wood charcoal. In some cases uncahrred seeds were also encountered, but these are regarded as modern intrusions and are not considered in the seed counts. With a few taxa it can be difficult to tell because they have seeds that are naturally dark or black in color. This includes in particular *Amaranthus*, *Silene* and sometimes *Chenopodium* types. The initial sort of archaeological seeds may therefore include some amount of modern intrusice seeds in these categories. These categories, however, do not have a major effect on the overall patterns in this dataset.

More than 10000 seeds have been identified, but these are not evenly distributed chronologically (Figure 1). The large specimen counts from the Yangshao and the Longshan, we should at least be able to address large scale patterns of change across these periods. By combining Erlitou and Shang data we can also suggest further comparison with later Bronze Age agriculture. There is also substantial variation between periods and samples in terms of the density of seeds. The total density in all the material is about 36 seeds/L of sediment floated, although samples are often less than this. Individual samples range from 3. 5 seeds/L to 242seeds/L. For most aspects of this analysis we consider total statistics per period, but for considering crop - processing individual samples and sites are each considered separately. There is significant variation in sample size, in terms of the total number of seeds and fragments (Figure 2). Sample size is expected to have a

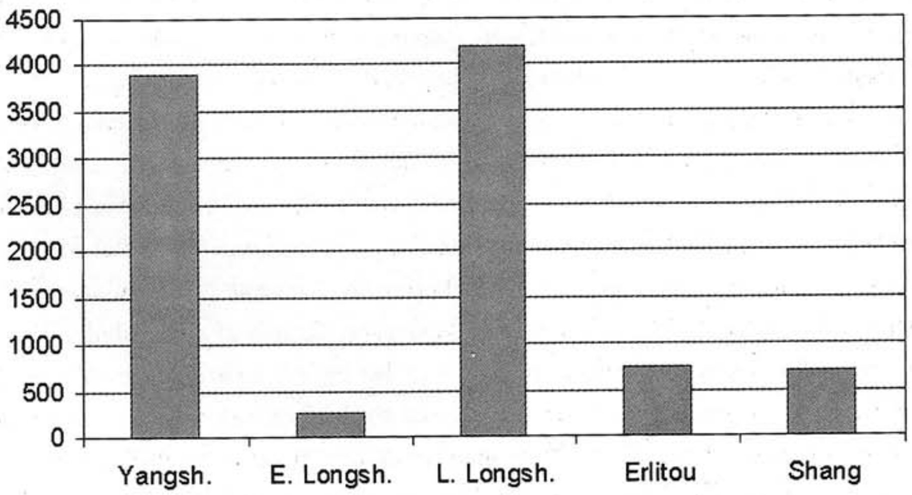


Figure 1. Total counts of identified seeds in preliminary dataset.

significant effect on taxa diversity, and such a pattern is reflected in the data here. Smaller and less diverse samples may be biased a less useful for quantitative comparisons of patterns such as crop - processing.

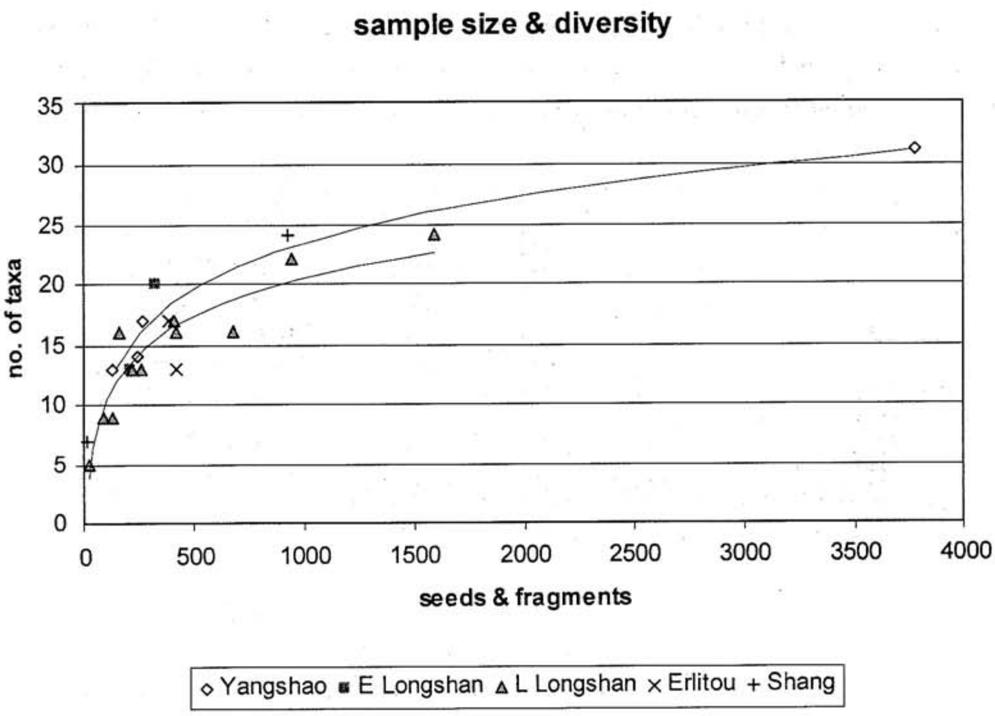


Figure 2. The relationship between sample size (total number of seeds and non - wood fragments) and sample diversity (number of identified taxa). Samples with less than 10 taxa all with less than 150 seeds are likely to be unrepresentative (WAD P2H4, WAD P6 (2), DGS P2H2, XFD P2H3 (1)), while another sample with less 200 seeds and 14 taxa may be biased due to sample size effect (YAC P1H1 (3)). The largest sample (YUQ P2H2), with high proportions of fruits and soybean, may also be rather atypical.

General patterns and comparisons.

The broad patterns in economic plants through time are shown in Figure 3. In general the dominance of millets is clear throughout all periods. Although in the Yangshao period soybeans appear much more frequent this is the effect of one particularly soybean rich sample (YUQ P2H2). There is a slight increase through time in the frequency of Panicum miliaceum, rice and panicoid weedy grasses. Rice is absent from the only shany period sample, Whereas rice was present during all earlier periods.

In addition to relative frequency the significane of taxa may be judged by a ubiquity score. This is calculated on the basis of the total percentage of samples in which a species is present regardless of whether it occurs as one seed or many. This can be expected to reflect in very general terms whether a species was used, and accidentally lost, often or rarely. Unlike relative frequency, ubiquity should be less influences by sample size effects.

The total ubiquity of all periods is shown in Figure 4 alongside relative frequency. Both measures can be seen to agree on the dominance of *Setaria italica*. The patterns in the Ying data can in turn be compared to relative frequencies calculated from some published datasets, including Longshan and post Longshan Zhouyuan, Liangchengzhen and the author's preliminary data from Baligang (Figure 5). This comparison suggests similarity with Zhouyuan in terms of the predominance of *Setaria italica* whereas at Liangchengzhen and Baligang rice is a much more prominent part of samples.

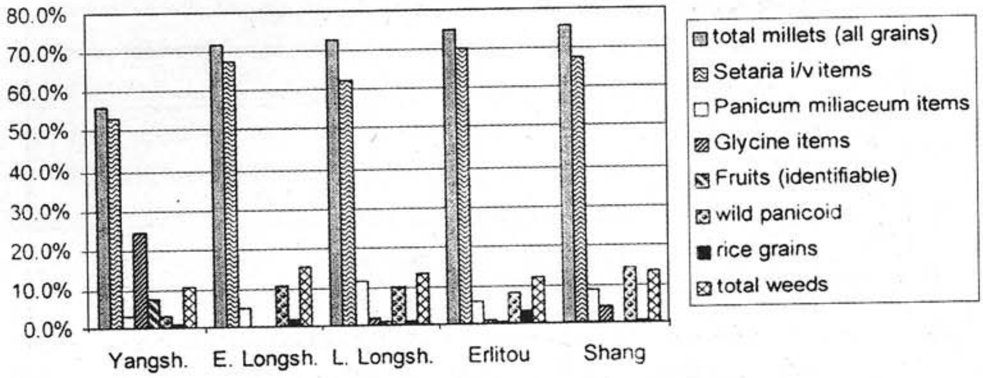


Figure 3. Relative frequency of crops or economic plant categories.

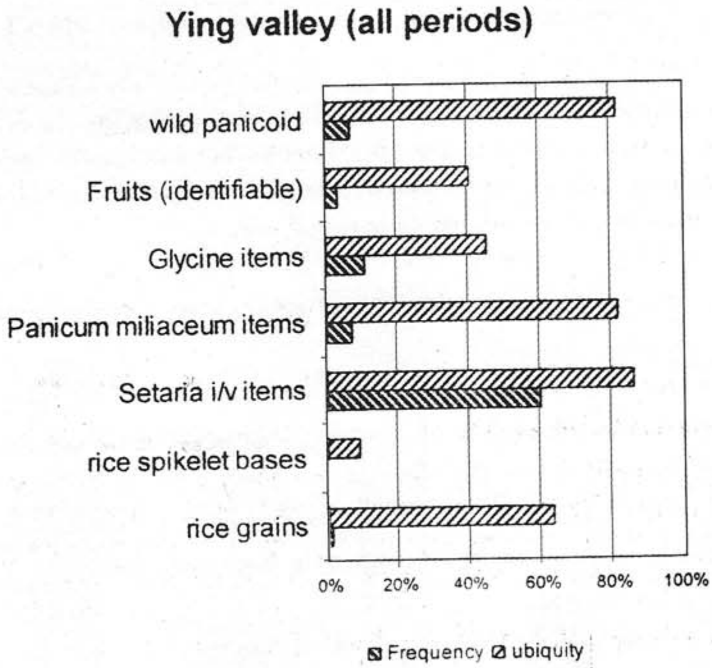


Figure 4. Relative frequency compared to ubiquity for all Ying samples (22 samples, 10072 seeds).

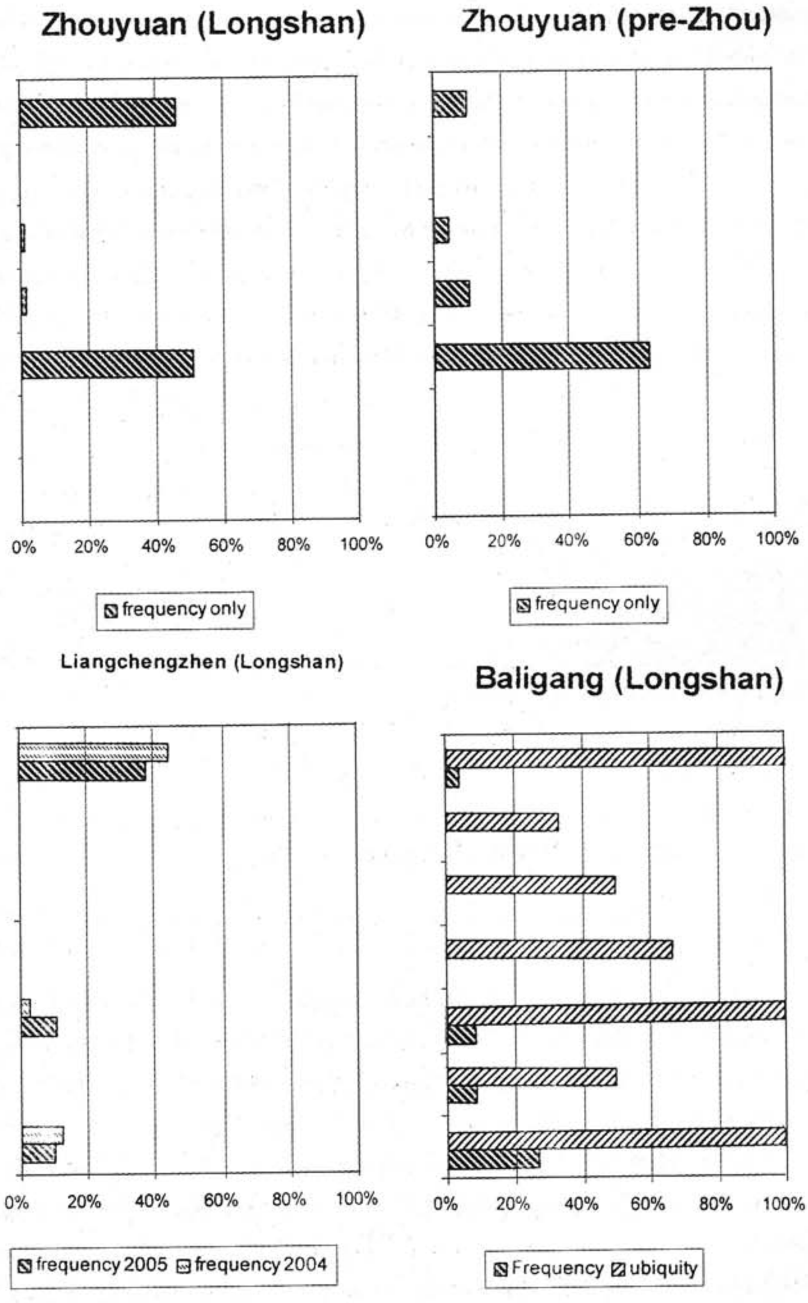


Figure 5. Comparative data, Charts arranged at in Figure 4: the relative frequency of the main categories at Zhouyuan, for Longshan period (11532 seeds) and pre - Zhou (926 seeds) (Zhouyuan archaeoloigical team 2004). Liangchengzhen, represented by two published reports on 3803 seeds and 5031 seeds (Crawford et al. 2004; 2005) and Baligang (author, preliminary data set of 2066 seeds from 6 samples).

The most widely recovered cereals were the millets, *Setaria italica and Panicum miliaceum.* In addition to the millet crops, related weeds and wild forms could also be distinguished, and at least three species each in the genera of Setaria and Panicum were recovered. This pattern has been widely reported from the central plains of China from the Yangshao through Shang periods, as at Liangchengzhen and Zhouyuan (Zhouyuan Archaeological Site Team 2004; Crawford et al. 2004; 2005). Of these it was foxtail millet (Setaria italica) which was most widespread and averaging about 30% of identified remains across all samples. This proportion is even higher, close to 60%, if immature *Setaria* grains and those which have been referred to weedy/wild type *Setaria* cf. *viridis* (but which may intergrade with S. *italica*) are included. These Setaria categories numerically dominate every sample, except a few with very low overall sample size which cannot be considered statistically representative. Through time there appears to be some increase in the proportion of *Panicum* (Figure 6).

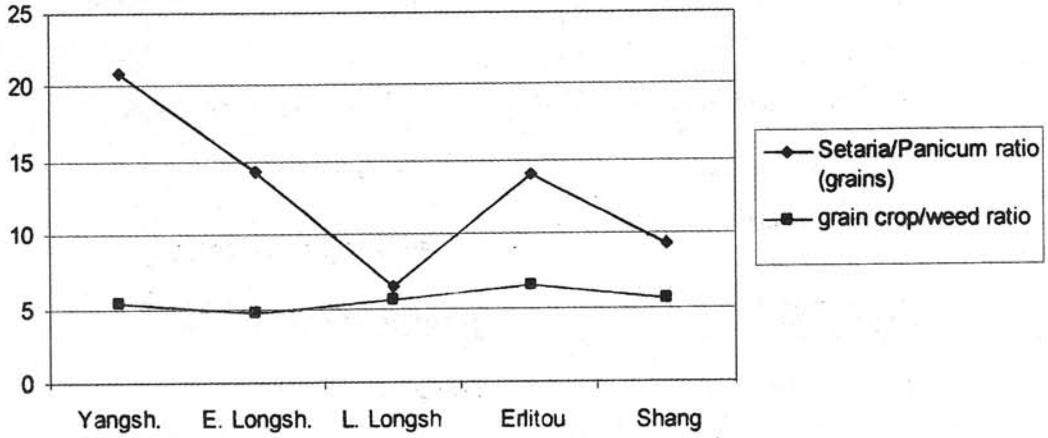


Figure 6. Chronological patterns in the proportions of the two millet types and grain crops to weeds.

Millets have been separated into species based largely on qualitative morphological criteria. The separation of *Setaria italica and Panicum miliaceum* is well – establihed both in Chinese and Western archaeobotany (e. g. Nesbitt and Summer 1998; Liu and Kong 2004). Clear distinctions of different species within these genera, especially domesticasted crops from their wild progenitors or weedy forms aree more problematic. Further research focusing on metrical traits is needed to confirm and enhance the separation of Panicum and Setaria spp. In the preliminary analysis separating, however, provisional separations have been made by eye. Elongate and rather skinner *Panicum* grains have been referred to cf. subsp. *Ruderale*, a weedy form (and possible wild progenitor) of broomcorn millet. Similarly smaller more distinctly narrowly ovate *Setaria* grains have been assigned to cf. *viridis*. In addition, much smaller, somewhat more angular *Setaria* grains with a pointed apex represent one (or more) additional species of wild *Setaria*. These show some similarity to *Setaria verticillata*, although a number of other wild *Setaria* spp. could be indicated (cf. Nasu et al. 2006). What is clear is that these represent a small – grained weedy *Setaria* that is not part of the S. *italica* – *viridis* crop/weed complex. Similarly there were some finds of small Panicum grains that represent another wild species. In addition immature grains of *Setaria* (probably S. *italica* and/or S. *viridis*) and *Panicum* (probably P. *miliaceum* and/or subsp. *Ruderale*).

Such immature grains are small and markedly flattened especially towards basal embryo end; the hilum tends to be proportionately larger relative to grain size than is the case in fully matured grains. It is indeed that case that millet plants are highly uneven in their ripening (see, e. g. Lu 2002) and therefore we expect that the harvests of even domesticated crops will include immature grains. In principle we would expect these lighter spikelet to be removed in early crop – processing stages such as winnowing. Therefore we expect higher proportions of immature millets grains in samples that included input from early processing stages.

Millet crops have been separated into different categories for counting on the grounds of traits that might be related to crop processing. Clean grains were counted separately from grains that has small adhering fragments of husk (lemma or palea) preserved. The presence of husk fragments implies that grains stil in the husk came into contact with fire, and this implies that grains were lost from the crop – processing seqeucne prior to the steps of dehusking (which would generally involve pounding and winnowing). While exposure to fire can be expected to destroy husk more readilyt than grains, the presence of at least some husk indicated that it was there. While some apparently clean grains could be those in whicc traces of the husk were envirely removed by charring, grains with husk fragments could not be the clean products of the dehusking stage. Therefore in some general way we can expect the proportion of dehusked grains to those with husk fragments to reflect the contribution to the assemablage of the products or loss of different processing stages.

Rice was much less common. Occurring on fewer sites, in fewer samples and when present in significantly lower proportions than Setaria italica millet grains. Rice then would appear to have been a relatively rare crop. The presence of charred rice spikelet bases in some samples attests to local dehusking of rice, i. e. the final processing steps. Rice has previously been reported from several Longshan sites and was the dominant crop at Baligang in Southern Henan (unpublished data) and at Liangchengzhen in Shandong (Crawford et al 2005) a few Yangshao period sites. It is absent from the only sample representing the shang period examined thus far.

Wheat and barley have only been recovered from Shang period samples and are represented by a just a few poorly preserved grains. Elsewhere in China wheat and barley have from the Longshan period, including the author's unpublished data from Baligang, as well as wheat from Liangchengzhen (Crawford et al. 2005), barley from late Longshan Taosi and a single wheat grain that may be Longhsan from Zhouyuan (Zhouyuan Team 2004). It is interesting to note the millet – dominated assemblages from the core regions of the Ying valley may have been delayed to taking up wheat or barley cultivation whereas more peripheral regions where rice was more important, such as Baligang and Shandong, adopted wheat earlier. It may be that the water demands for wheat were more easily met in areas that already had more widely developed rice agriculture systems. Wheat and barley are both native to Southwest Asia and are generally through to spread eastwards to be adopted in China as a result of the earliest period of trade along what would later become the silk road (Li 2002; 2004).

The wheat grains from DGS represent a small, compact grain form, which fits with other finds of early wheat in East Asia. While in the absence of chaff remains it is not possible to distinguish hexaploid (6 - genome) from tetraploid (4 - genome) free - threshing wheats, it is presumed that this represents a hexaploid wheat (i. e. bread wheat) as only hexaploid wheats have been known from East Asia in recent times. As discussed by Crawford (1992: 25 - 27), early wheats in Japan are recurrently compact grained, as are early wheat finds in South Korea (Crawford and Lee 2003). The wheat from DGS has grains little over 3mm in length and can be considered amongst such materials. One reason for the delay in the appearance of wheat in East Asia, by comparison to Central Asia and Pakistan, may have been the need for it to change in seasonal adaptation. Wild wheats and early cultivated wheats are normally planted and sprout in autumn, they grow through the winter and then are harvested in spring. This is presumably true of early wheat in Pakistan older than 6000 BC and Turkmenistan, ca. 6000 BC (Harris 1998; Fuller 2006). Wheat in East Asia, however, is normally spring sown and harvested at the end of summer. This requires a genetic change, which perhaps evolved in the mountainous regions of central Asia or northern central Asia. A delay in the evolution of this trait in Asia might be a factor that contributed to the delay in the spread of wheat (and barley) to China, although the periods of economic contact and trade must also be considered.

Pulse crops

The soybean is found wild through much of China as well as Korea and Japan. It is generally regarded as a domesticate of northern or central China, although clear archaeobotanical documentation of this is still needed. It has been suggested on the basis of apparently small seed size that this species may not have been domesticated until the Bronze Age (Crawford and Lee 2005; Crawford et al. 2005). But in other legume crops it now appears the seed size increase may not happen immediately with initially with domestication and may be delayed for some millennia (Fuller and Harvey 2006). Therefore seed size alone may not be a good indicator if whether or not pulses were cultivated. While the present material is yet to be measured, it is clear that the majority of seeds from YUQ P2H2 were small and included numerous immature seeds, as well as pod fragments. It could be that this represents the harvesting of soybean green for consumption of the green seeds as a vegetable. Further study of the soybeans are recommended, and presence of pod fragments in YUQ P2H2 could repay further study in terms of determining domestication status.

The presence of some cotyledons of *Vigna* sp. from the Shang period at DGS is intriguing and may represent a newly introduced crop. It could indicate the advent of a the cultivated adzuki bean *Vigna angularis* (*hongdou or xiao dou*). The seed fragments are perhaps large enough to represent the domesticated crop, although more specimens and more complete specimens are needed. This crop probably originated in Japan. Earlier small *Vigna* seeds were reported from Liangchengzhan, but these may be one of the local wild species, such as *Vigna* nakashimae or *Vigna* minima (Tomooka et al. 2003).

Fruits

A number of fruits have been identified in this material. All of these could have been gathered from wild populations although cultivation can not be ruled out. The most frequent and ubiquitous fruot remains are those of the Jujube (*Ziziphus jujube*), represented as charred fragments of the highly rugose stone. The tendency of these seed to be more round and less elongate may indicate that they are wild, as cultivated jujubes tend to be elongated. Rare grape seeds have also been found. The short stalk on these seeds suggests wild grapes. Other evidence for fruit comes from fragments the probable pits (endocarps) of peaces (*Amygdalus* (*Prunus*) persica and apricot (*Armeniaca vulgaris*, syn. *Prunus armeniaca*. Some hawthorn (*Crateagus*) identified from the largest and richest sample (YUQ P2H2). A single possible fragment of a melon seeds (cf. *Cucumis melo*) was noted at Late Longshan JIZ. Well – preserved compete seeds have been identified by the author at Longshan Baligang and All of these fruits are expected to have been natively wild in parts of northern or central China.

Weed species

Other seeds include some 36 categories of other wild plants. Most of these are likely to have been weeds, i. e. wild species that infested the fields of crops. These species would have set seed in the same season of the crops and would have been harvested along with the crop, ending up on the site as part of the stored crop and crop – processing waste. Those species which can be identified to family, genus and species all come from taxa that are well known arable weeds in modern China (Chinese Weed Flora). A selection of those taxa identified are illustrated, and in some cases it is clear that further comparative study is needed to confirm identifications. In the section that follows a few general notes on these taxa are provided together with any comments on chronological patterns in the presence and absence of taxa. Two samples, YUQ P2H2 and DGS P1H1, were particularly rich and weeds and have the greatest diversity of species. There are no particularly obvious trends in the weed flora through time, although the range of species from these site can be contrasted with that recovered at Baligang or report from Liangchengzhen in Shandong. In general most of the weeds represented are fairly tall erect species rather than ground creepers and as such would be expected to be harvested along with millets that were harvested high on the stalk. Most of the exceptions to this come from YUQ P2H2 where they are likely to be associated with the low – growing soybean crops that might have been harvested by pulling.

Amaranthus and *Chenopodium* spp. At least three distinct taxa in the Chenopodiaceae – Amaranthaceae group could be distinguished. This group was often represented by modern intrusive species, especially of *Amaranthus*. Nevertheless, some *Amaranthus* were plausibly charred and ancient. *Chenopodium* seeds were frequent and could be readily divided into two distinct size grades. The larger seeds are comparable to *C. album*, while the small seeds could be from several species. This distinction may be important in terms of crop – processing as *C. album* seeds are larger and heavier and closer in size to *Setaria* grains and might therefore be more prone to remaining until later crop – processing stages. Some 11 species of *Chenopodium* weeds are reported in as common weeds in China, especially of dryland crops, including wheat, pulses and vegetables, but probably also millets. There are six widespread species of Amaranthus weeds. All of these plants are erect annuals generally grow to heights of at least 30cm or more. Absence from Erlitou and Early longshan samples is likely due to small sample size.

Silene spp. , like many other Caryophyllaceae are erect herbs often growing to heights of 6cm or more. They can be prolific seed producers. As seeds are naturally black further care is needed to make sure the specimens are ancient. Absence from Erlitou and Early longshan samples is likely due to small sample size.

Polygonaceae nutlets could be from *Polygonum or Rumex*. Although it should be possible to tell through examination of internal anatomy (by breaking seeds), this was not done. This familiy is represented by 22 species *of Polygonum sensu lato* (including *Pericaria* spp.) and 5 species of *Rumex* spp. Rumex are normally erect perennials, while Polygonum is more often annuals, and often erect. These tend to be raltively large and heavy seeds. These were present in small quantities from all phases except Shang.

Sedges were represented by at least four types. This family as a whole was relatively rare, especially when compared to preliminary results from Baligang were sedges are the most common weed category and probably linked to wet rice production. *Cyperus* are represented by small elongate seeds with triangular sections. These are likely to be removed in early processing stages. The absence of this species in Erlitou and Shang samples might be significant. These may be annuals or perennials and can be somewhat short, e. g. 40 – 60cm, but produce nutlets near the edges of culms. Some species occur as weeds in dryland crops. Eleocharis type occurred only in the early Yangshao and Early Longshan period. Scirpus types occurs as individual seeds once each in the Yangshao and Late Longshan periods. S. triangulatus, with distinctive wavy ridges on its seeds, is commonly a weed of rice, and occurs at Baligang. Higher sedge counts are associated with rice – rich samples at Liangchengzhen as well (Crawford et al. 2005).

Euphorbia cf. helioscopia is an erect weed of dryland crops throughout China, but occurs only in the Yangshao period. Its seeds are large and would have been removed late in the processing sequence.

The Asteraceae family is represented by several specimens, often fragmented and probably several species. Further work s needed on the identification of this large and diverse family.

The mint family was represented by several different types. Particularly distinctive is Amethystea caerulea, a widespread weed in North and Northeast China. It is an erect annual, 30 – 100 cm high. Its seeds are relatively small but may be heavy and persist into later processing stages. *Salvia plebeia*, identified only from fragments in in one longshan sample is a common annual/biennial weed, somewhat gracile, but erect 15 – 90 cm. The seeds of *Salvia* like those of *Stachys* are large and heavy and likely to persist into dehusking waste.

Several leguminous weeds are present. Most are small or medium leguminous weeds, probably in the large Trifoliae subfamily which includes many weeds, such as *Medicago*, *Melilotus* and *Trifolium*. One large seeds example of probably Astragalus was identified from the Yangshao and three specimens of *Vicia/Lathyrus* type, also large - seeded legumes came from a Longshan sample. Leguminous weeds in general may thrive at the expense of other weeds on less fertile or more depleted soils. This are often low growing or twiners that entangle other plants. With the exception of particularly high counts in YUQ P2H2 there does not appear to be any clear chronological trend in wild legumes. The high quantity if YUQ P2H2 may be connected to the high count of soybean and represent weeds that were entwined on this low - growing legume crop.

The Solanaceae were represented by specimens in just two samples. Probable Solanum sp., comparable to S. *nigrum* in YUQ P2H2, perhaps to be associated with soybean crop. Probable *Hyoscyamus* is recorded from a Shang period sample. These are normally erect biennials.

Probable Oxalis seeds were found in the Yangshao period. These are generally low - growing species. *O. corniculata* is a widespread weed of soybeans, and it is perhaps no accident that Oxalis seeds are most frequent in the soybean rich YUQ P2H2.

The Malavaceae family is represented by small - seeded Malva types in a Longshan sample (WUW P5④) and a single large seed of *Hibiscus* type in a Shang sample (DGS P1H1). While *Hibiscus* are shrubs, *Malva* are are generally non - erect and grow along the ground.

Ranunculus weeds are also usually low - growing and may favour wetter fields. The presence in YUQ P2H2 reinforces other weed data that this sample included a large number of low - growing weeds due to input from uprooted or low harvested soybean.

Numerous weedy grasses could be identified. The guidance on West Asia grass identification by Nesbitt (2006) was found useful, although furthet checking against reference material in China is necessary. Amongst the most common weedy grasses were wild *Setaria*, including probabe S. *viridis* and a smaller - grained species that is broadly similar to S. *verticillata* (but could be another species). In addition two forms of weedy *Panicum* were also common. These have already been discussed together with the millet crops above. Also common were *Digitaria spp*. There are several weedy *Digitaria*, a further study may allow the separation of some of these although it seems unlikely that secure species level identifications will ever be possible from grain form alone. Major weeds include D. adscendens reaching heights of 30 - 50cm and the taller *D. sanguinalis* reaching upto one meter tall. Man other species are low - growing (Behrendt and Hanf 1979). These can be expected to infest millet crops. Tentatively a type referred to cf. Dactylis glomerata has been separated from *Digitaria* on the grounds of being longer with a more pointed (acuminate) apex, which tended to be slightly asymmetrical. Another common type has been referred to *Agrostis/Aira/Calamagrostis*. As noted by Nesbitt (2006) it is unlikely to be possible to distinguish this genera reliably, but all are reported to be crop weeds in China, including species preferring dry fields and some preferring irrigation.

A number of other grass species were identified only from the Longshan period, although this could be the effect of more samples from that period. Alopecurus could be *A. aequalis* a common weed reaching heights of 45 – 60 cm. *Eleusine indica* widespread as a weed of millets throughout the Old world, and may be represented by the of Pennisetam marphotype in the present material. , while it often lowgrowing it can reach heights of 90cm. *Pennisetum alopecuroides* si a tall perennial grass more common in field edges but might infest poorly tilled/ unploughed fields. Paspalum spp. are more often weeds of rice than of millets.

For the most part these grassy weeds have small, but heavy seeds. They can be expected to enter the dehsuking stage if they were still in their spikelets. Exceptions include E. indica which is particularly small and free – threshing and should be expected from earlier processing waste. It occurs only in the Longshan period.

Crop – Processing evidence and change

A preliminary attempt to consider patterns in crop – processing and how these might relate to

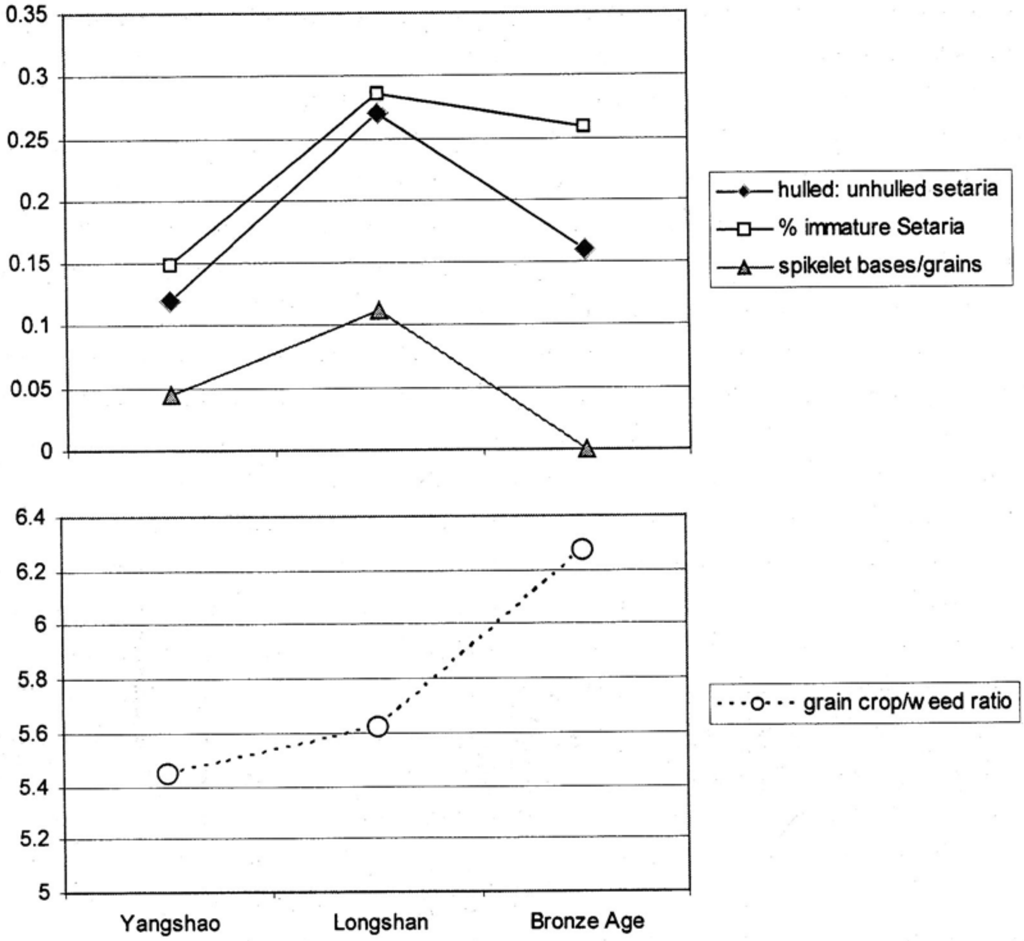


Figure 7. Overall changes in crop – processing ratios over the three main periods. The upper chart shows ratios for changes in Setaria as well as rice spikelet bases to grains. The lower graph shows the total ratio of cereal crop grains to weed seeds. Despite the apparent upward trend it should be noted that the scale is very fine and the overall change from 5. 4 to 6. 3 grains per weed maynot be significant.

social change is provided here. Inevitably the patterns in archaeobotanical may be messy. Any given sample is likely to represent mixed inputs from various activities over some period of time, which are waste that is disposed of in fire or used as fuel. After being charred such assemblages may continue to mixed both at the site of fire or after being swept away from the fire place and re-deposited. The presumption, however, is that recurrent patterns in the archaeobotanical data are likely to result from repetitive, routine activities.

In order to examine crop – processing variation has been considered on the basis of two ratios: the proportion of millet grains to weed seeds and the proportion of hulled and immature millets to clean millet grains. Higher proportions of hulled grains (i. e. with husk fragments) and immature grains are both expected in threshing by products than in dehusking by – products. While both dehuksing and winnowing by products should include weed seeds the input of both stages should result in higher proportions of weed seeds. It is not, however, possible to assume that weeds will be more common in either winnowing or dehusking waste on their own. The proportion of weed seeds, however, may be affected by other factors as well such as harvesting methods or even agricultural practices that might lead to increased or decreased weed quantities in the agricultural fields.

At the coarsest level of period totals it can be seen that changes occurred in the total clean grain to grains with husk and immature grains changed (Fig. 7). A clear trend from the Yangshao to later periods is an increase in proportion of husked and immature Setaria. This trend is clearest in the comparison between Yangshao and Longshan samples, suggesting increased input of winnowing waste in the Longshan samples. The grain crop to weed ratio, however, does not change very much, ranging between 5. 4 and 6. 3 grains per weed. While the trend does tend to be towards slightr more grains than weeds this change is not very significant. This tendency may

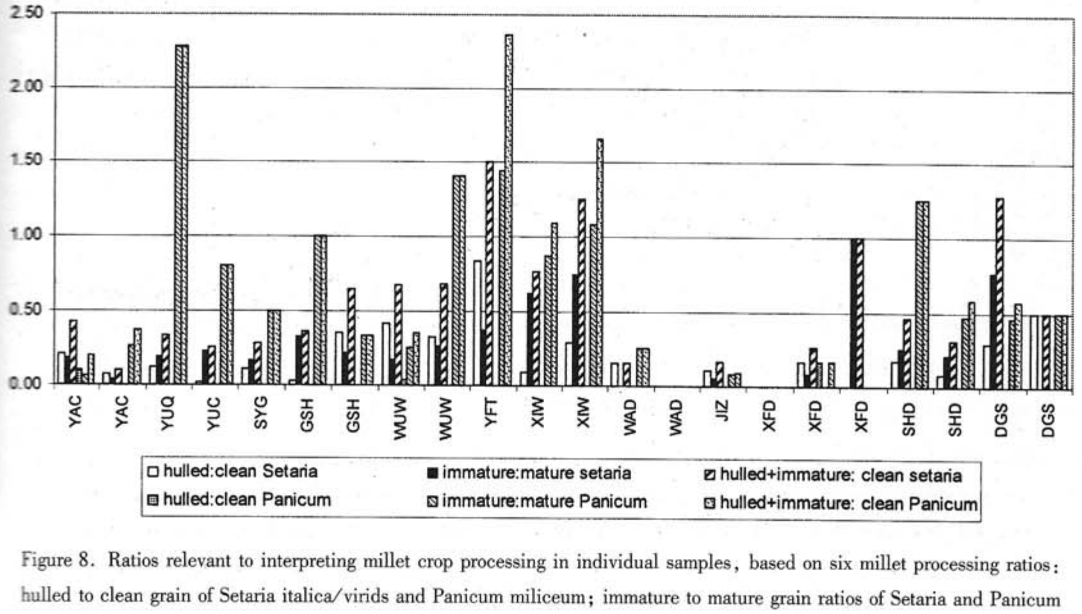


Figure 8. Ratios relevant to interpreting millet crop processing in individual samples, based on six millet processing ratios: hulled to clean grain of Setaria italica/virids and Panicum miliceum; immature to mature grain ratios of Setaria and Panicum and a ratio that combines hulled and immature grains as indicators of earlier processing stages.

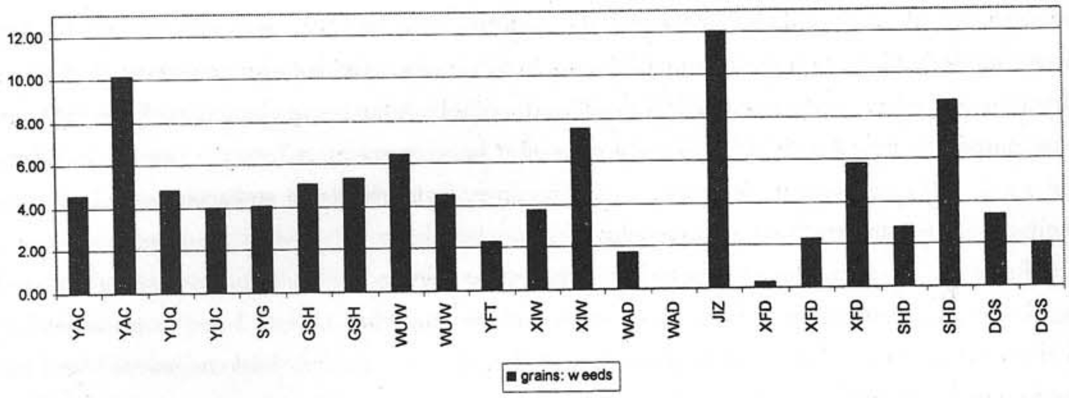


Figure 9. This chart gives the ratio of total crop grains (including rice, wheat, barley and millet) to weed seeds (including S. verticillata and small wild Panicum types)

indicate something about the increasing proportion of grains, including immature grains, resulting from winnowing by-products. There appears to be a slight trend in rice processing remains indicating an increase in rice spiklet bases, which results from dehusking, but the small quantity of rice remains overall does not make this trend reliable. The apparent increase in the Longshan period is due mainly to the presence of three spikelet bases in sample GSH P1H1③.

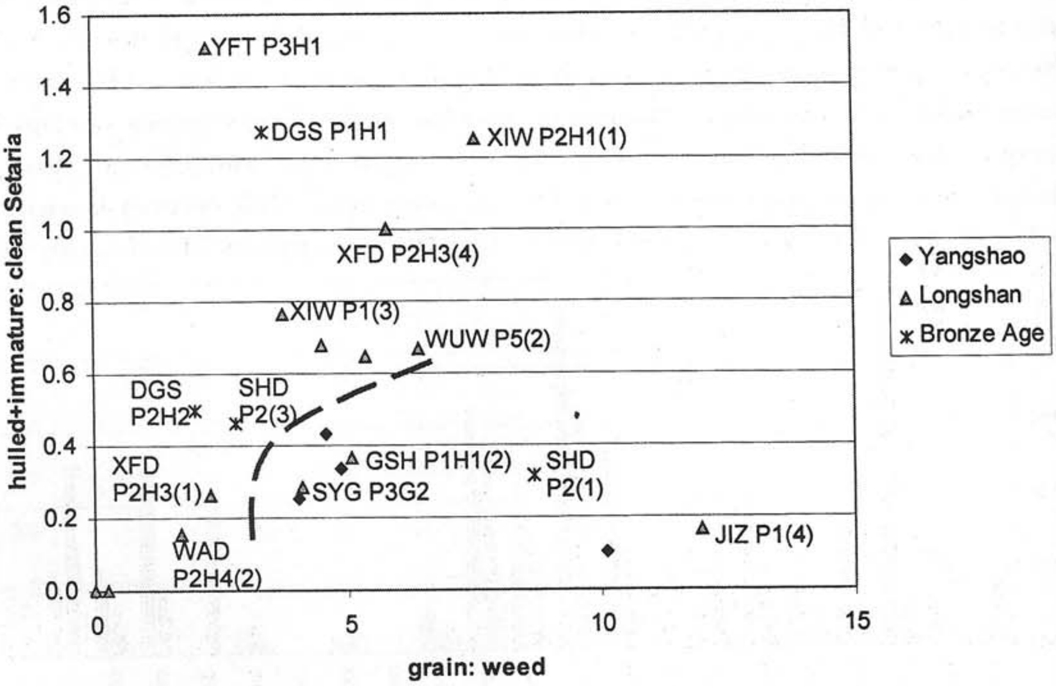


Figure 10. Scatter plot of individual samples on the basis of two ratios that may represent crop-processing differences between samples. The grain: weed ratio indicates increasing levels of grain and less crop-processing waste towards the right, while the ratio of clean Setaria grain to those that are immature and with husk fragments suggests increasing presence of earlier processing stages towards the top of the graph. Suggested division between samples indicated. Samples to right and lower are suggested to represent mainly dehusking waste. Samples to upper left are suggested to have a mixture of primary winnowing waste and dehusking waste. Longshan and Bronze Age samples labelled.

Considering crop – processing further, on an individual basis, a plot of various ratios can be seen in Figure 8, while Figure 9 shows the crop grain to weed seed ratio. In the top graph the relatively low proportions of immature and grains husk fragments can be seen for the most of the Yangshao samples. There is a discrepancy between Setaria and Panicum, with much higher proportions of immature Panicum at YUQ and YUC by comparison to *Setaria* in those samples or in the other two Yangshao samples. This suggests that the earlier stages of Panicum may be represented while those of *Setaria* are not. A similar pattern can be seen in a number of later sites, including GSH P1H1②, WUW P5④, and SHD P2③. For the Longshan samples several show ratios similar to those of the Yangshao period with low ratios of early processing indicators: SYG, WAD, JIZ, XFD P2H3① – ②. Other Longshan samples suggest significantly high proportions of early processing indicators: WUW, XIW, XFD P2H3④. There is clearly diversity amongst the Longshan samples, reflected also in the variable grain: weed ratios. The Shang and Erlitou samples show similar variation to the of the Longshan period.

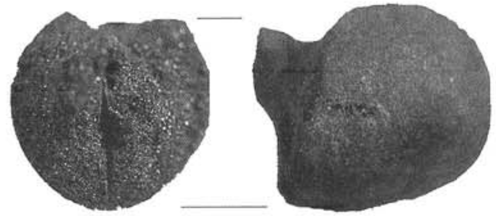
Since *Setaria* is the dominant crop in all samples, I focus further consideration on processing of this species alone. In Figure 10, the ratio of early to late *Setaria* indicators is plotted against the grain to weed ratio. Hulled *Setaria* (with husk fragments) and immature *Setaria* are summed and dividied by the total clean *Setaria* grain. Both S. *italica* and *S. viridis* types are considered. Figure 9 shows all the samples, while Figure 10 is an enlargement of the main grouping in the lower left hand corner. The division in Figure 10 is suggested to represent samples with regular input of both primary winnowing waste and dehusking waste (towards upper left) versus those with mainly dehusking waste (towards lower right). In this plot it can be seen that the Yangshao samples fall on one side of this divide. They show a general consistency in terms of the crop: weed ratio (between 5 and 10) and in the hulled/immature to unhulled millet grain ratio, below 4. 5. By contrast a much greater range of between sample variation is seen for all later samples. While some Longshan samples plot near those of the Yangshao period, thus suggesting general continuity in the organization of crop – processing, others are significantly dissimilar, mainly with higher proportions of hulled or immature grains and/or lower grain to crop ratios, suggesting in both cases increased input from earlier processing waste. A couple of later samples have significantly higher grain: weed levels, which together with the low chaff proportions suggest more input from dehusking only. Overall there appears to be a shift from Yangshao uniformity, with more significant input from dehusking waste, while during the Longshan period differences developed between sites with some, shown towards the left and up in Figure 10, having significant inputs of winnowing by – products while others did not. This Longshan differentiation may only occur in the late longshan, although the Early longshan is represented by only a small sample sizecz samples, This suggests variation between communities in the organization of agricultural labour. These winnowing products might be expected if crops were stored unprocessed (or threshed but not winnowed). The distant outlier samples towards the top left of the graph might represent just winnowing waste, without dehusking input (YFT P3H1, XIW P2H1①).

Based on the premise that samples are most likely to be statistically biased towards routine, post – storage processing, the shift from Yangshao to Longshan suggests an increased number of routine processing steps and consequently a smaller labour unit of initial harvest period processing prior to storage on many Longshan sites. This could have resulted from a shift from larger household groups towards smaller more nuclear households on many, but not all, Longshan sites. This might be hypothesized to relate to increased attention to small nucleated household units in the context of increasing status and wealth differentials. The quest for wealth and productivity might have decreased reliance on larger, extrafamilial labour groups, at least on those Longshan sites that show change (such as XFD, WUW, XIW, YFT, perhaps GSH), as opposed to those which continued to follow Yangshao pattern – charcacterized by higher input from dehusking waste – including the sites JIZ and SYG. One of the GSH samples also falls with the Yangshao cluster which could indicate diversity within or during the course of the GSH occupation. This hypothesis deserves further investigation, including more samples and more sampling loci on sites to insure that this pattern does not derive from spatial patterning in terms of where particular crop – processing stages were carried out on different parts of sites. Nevertheless it clearly suggests some changes on some Longshan sites in terms of agricultural organization, although the sample basic crop and weed repertoire persisted. The limited number of samples and sites examined can only be taken to point the way toward the kinds of patterns which may become more clearly discernable when more data is available.

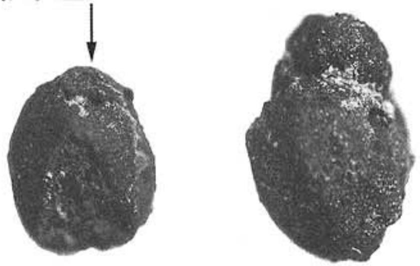
颍河中上游植物考古采集炭化农作物种子

1.Photograph of immature soybeans (*Glycine max/soja*) still attached to preserved pod fragment, from Yangshao YUQ P2H2
袁桥遗址P2H2仰韶文化未成熟并保留有豆荚的大豆

2.Photograph of charred soybean, from the side and showing the characteristic hilum, from Late Longshan XIW. These seeds were often poorly preserved and distorted by charring.
下毋遗址龙山文化晚期大豆的侧视图，可以观察到种脐。这些种子保存不好，在炭化的过程中常会变形。



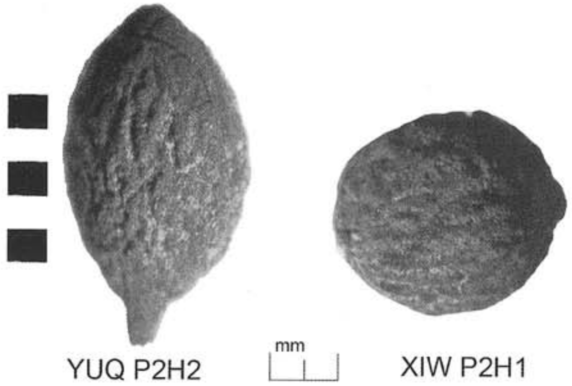
3.Vigna of. angularis seed fragment from Shang period DGS P1H1
杜岗寺遗址P1H1商代豇豆的残块



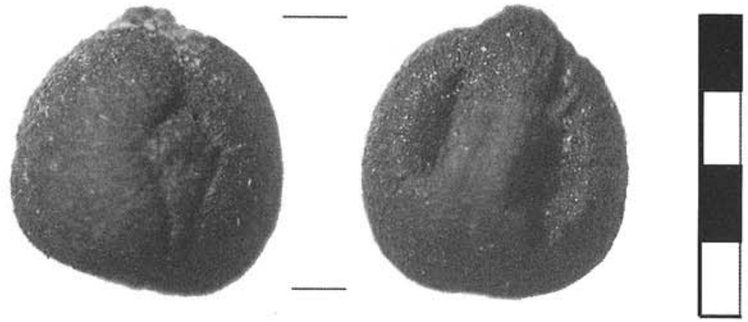
4.*Photographs* of *dorsal view* of *Setaria* of. *italica* grains with adhering husk fragments from Late Longshan WUW P5④. On the left the husk fragment is indicated by the arrow; on the right the adhering lemma husk obscures the grain's embryo.
吴湾遗址P5④龙山文化晚期带有附属物的粟的背视图：左侧箭头所示为粟残存的颖壳，右侧颖壳的外敷包着胚芽

5.Photographs of poorly preserved barley and wheat grains from DGS P1H1(Late Shang period). Barley shown in ventral and dorsal view, wheat only in dorsal view.
杜岗寺遗址P1H1保存状况差的商代晚期的大麦和小麦谷粒：大麦为正视和背视，小麦为背视

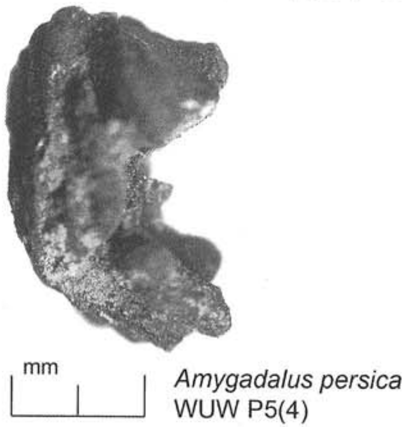
颍河中上游植物考古采集植物果实



1.*Ziziphus* sp. fruit stones. Example on left from Yangshao YUQ is elongate and pointed from and more suggestive of cultivated *jujuba* types. Example on right from Late Longshan XIW is rounder and more suggestive of the wild *rugosa* type.
野酸枣的果核。左侧为袁桥遗址仰韶文化遗存，形态长且尖，更接近于驯化的形态；右侧更圆，接近于野生形态。



2.An example of a wild grape seed, *Vitis* sp., from Yangshao YUQ P2H2
袁桥遗址P2H2仰韶文化的野生葡萄籽

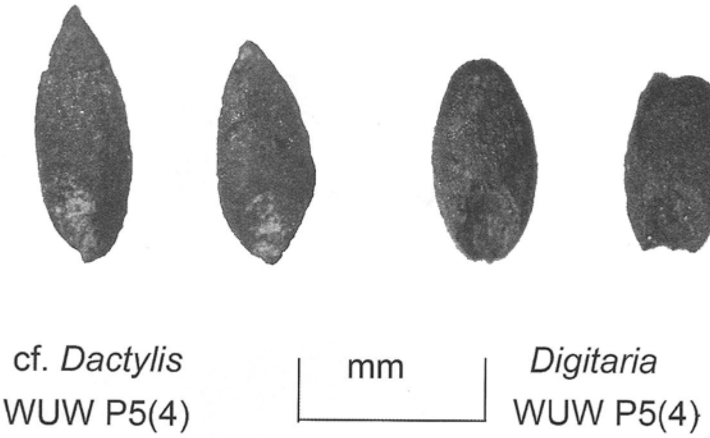


3.An fragment of a heavily and reticulately grooved peach endocarop from WUW P5④
吴湾遗址P5④带深槽的桃核残块

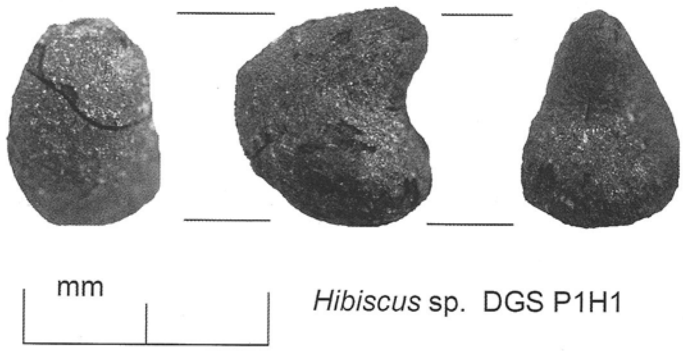
4.Pohograph of *Crataegus* (hawthorn) fruit seeds from YUQ P2H2
袁桥遗址P2H2的山楂种子

图版二四八

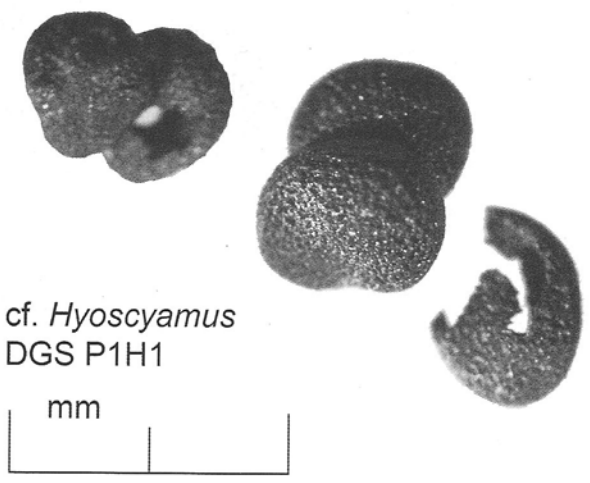
颍河中上游植物考古采集野草种子



1.Photographs comparing typical *Digitaria* sp.Type with cf. *Dactylis glomerata* type from Longshan WUW P5④
吴湾遗址P5④龙山文化晚期的马唐与鸭茅比较(左.鸭茅,右.马唐)



2.Apical,lateral and basal (hilum) view of *Hibiscus* seed from Late Shang DGS P1H1
杜岗寺遗址商代晚期的木槿侧视和底视



3.Solanceae,cf.*Hyoscyamus* seeds from DGS P1H1,Late Shang Period
杜岗寺遗址商代晚期P1H1天仙子