# Reports

## Late Neolithic Plant Remains from Northern China: Preliminary Results from Liangchengzhen, Shandong[1]

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31 VIII 04

[Supplementary material appears in the electronic edition of this issue on the journal's web site (http://www.journals.uchicago/ edu/CA/home.html).]

Understanding of Late Neolithic food production in China has been hampered by a lack of palaeoethnobotanical research. Studies of economic systems in China have tended to emphasize chronology, technology, individual settlements, and chance finds of plant and animal remains (that is, remains not recovered by flotation) (Chang 1986, Crawford and Shen 1998, Underhill 1997). Setting such studies in an interdisciplinary framework is essential if we are to understand not only Late Neolithic agriculture but the origins of food production in China as well. The systematic collection of plant remains has been as integral part of a multifaceted, international archaeological investigation of the Longshan culture (ca. 2600–1900 BC) Liangchengzhen site in southeastern Shandong Province (fig. 1). The findings reported here are the first to come from a large-scale program of systematic flotation carried out at a Chinese Late Neolithic site. The samples reported here are from the first two field seasons, 1999 and 2000. For this initial report, we document and contextualize the Longshan crops and other plant remains, explore intrasite spatial patterning, and review implications of the new data for the understanding of Late Neolithic subsistence ecology.

### LONGSHAN AGRICULTURE

Most Longshan sites, distinguished mainly on the basis of shared pottery styles, are found in both warm and cool temperate zones in north-central China. This broad distribution suggests that Longshan was ethnically diverse and would have employed locally appropriate subsistence strategies. Longshan agriculture is thought to have been millet-based, with rice having little importance although it is reported from a number of Longshan and preceding Late Dawenkou sites (Underhill 1997) (table 1). Agriculture supported a Longshan society that was ranked. Debate focuses on whether the society consisted of chiefdoms or states (Liu 1996, Underhill 2002). Settlements were hierarchically organized, and Liangchengzhen was a significant regional center within an eastern Shandong settlement hierarchy (Underhill et al. 2002). Earthen walls surround several large sites, suggesting concern with defending economic resources. Chang 1986:250) and Luan (1997) have proposed that Longshan social differentiation was facilitated by intensive resource acquisition and production; however, until the palaeoethnobotanical details of Longshan and its predecessors have been assessed and appropriate specimens AMS-dated, this hypothesis cannot be adequately tested.

### ARCHAEOBOTANICAL DATA COLLECTION AND ANALYSIS

The 1999–2000 Longshan samples reported here (table 2) are mainly from the largest excavation area (704 m$^2$), situated on a hill about 12 m above and about 600 m



1. We are grateful to the Henry Luce Foundation (1999; award to Underhill, Feinman, von Falkenhausen) and the National Science Foundation (2000–2001; award BCS-99-11128 to Underhill and Feinman) for making our excavations at Liangchengzhen possible. The plant-remains analysis is supported by these grants as well as an operating grant from the Social Sciences and Humanities Research Council of Canada, award 72022345. Jacqueline Brenne, Michelle King, Kathryn Morrisey, and Emily Holland did an exceptional job assisting with the sample analysis. Excavations at Liangchengzhen took place under the auspices of Shandong University and the Field Museum. We thank the National Bureau of Cultural Relics in Beijing for granting the excavation permit. Many local people at Liangchengzhen, especially Zhang Zibo, worked very hard to process our samples. Gary Crawford prepared all the figures with two exceptions; Jeff Cunnar and Russ Quick prepared figure 2 and Jill Seagard of the Department of Anthropology, the Field Museum, figure 3, both of which were modified by Crawford for this paper. Any opinions, findings, and conclusions expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

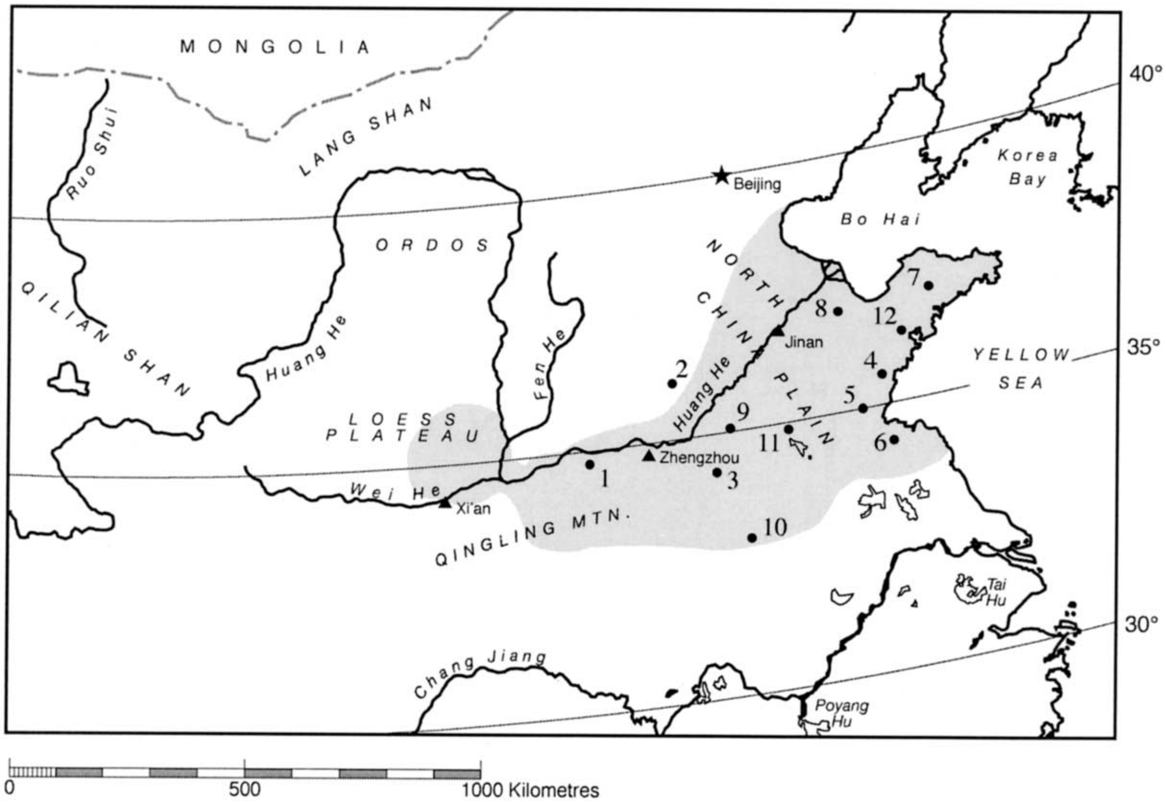


FIG. 1. *Site locations and northern Longshan distribution (*shaded area*).* 1, *Zaojiaoshu*; 2, *Anyang*; 3, *Shantaisi*; 4, *Liangchengzhen*; 5, *Yaowangcheng*; 6, *Tenghualuo*; 7, *Yuangjiaquan*; 8, *Tianwang*; 9, *Zhanglixi*; 10, *Yuchisi*; 11, *Jianxin*; 12, *Sanlihe.*

west of the Bei Xiao He (fig. 2). Seven cultural layers, 241 pits, 19 structures (probably houses), 27 burials, and numerous activity surfaces were exposed (fig. 3). We took at least one 5- or 10-liter sample whenever possible from each context. About two-thirds of the flotation samples are from the pits. Three samples are from trench T022, 460 m to the northeast. Two are from the bottom of a ditch and the third from a house foundation. The sampling strategy was designed to document variation in density, so future intersite comparisons will need to take into account potential functional relationships among contexts (see Hillman 1984). The features are mainly Middle Longshan, distinguished mainly on the basis of ceramic styles. Some contexts younger than Longshan were sampled but are not reported here. A flotation apparatus similar to the SMAP device (Watson 1976) was used to process the soil samples. Only the light fractions have been analyzed so far. Analysis followed a standard procedure outlined elsewhere (Crawford 1983).

## RESULTS

The 1999–2000 flotation light fractions contain charred seeds[2] representing cultigens, weedy annuals, wild grasses, fleshy-fruit producers, and other plants. A number of samples contain grass internode (stem) fragments. Wood charcoal occurs in negligible quantities (3.8 g). Some seeds are either "unknown" or "unidentifiable" because diagnostic traits are missing. Many unknowns are represented, but one type is particularly common.

Rice (fig. 4) is the most common cultigen by density, number, and weight. A rice grain from H93 is AMS-dated to 3,610 ± 60 cal BP or 2135 (1950) 1860 cal BC (1-sigma, TO-10206), confirming its Longshan association. Rice can be grown in a variety of ways including dry cropping, sowing in seasonal ponds, terracing, paddy fields, and combinations of these methods. We hypothesize that some form of rice production took place at Liangchengzhen. Seasonally wet habitats are common in the area today and could have been utilized during the Longshan occupation. (Local farmers have tried to grow rice near the site but failed for lack of sufficient water.) Sedges, common in wet habitats, occur in five contexts but mainly in the G022 ditch sample. Phytoliths of the common reed that grows in disturbed, damp, or wetland habitats (*Phragmites* sp.) have also been identified in the samples (Jin et al. n.d.). The rice grains are, on average, significantly smaller (4.0 mm by 2.0 mm) than either wild rice or modern rice cultigens. The rice may have

2. "Seeds" refers colloquially to all types of plant propagules.

TABLE 1
*Chronology of Late Neolithic Sites with Crop Remains*

| Culture/Period and Site | Rice | Millet | Wheat | Source |
|---|---|---|---|---|
| Longshan (2600–1900 BC) | | | | |
| Zhuanglixi | g | x | – | Kong, Liu, and He (1999) |
| Zhaojiaoshu | g | f, b | g | Ye (2000) |
| Tianwang | g | – | – | Jin et al. (n.d.) |
| Tenghualuo | g, p | – | – | National Bureau of Cultural Relics (2000:3) |
| Yuangjiaquan | g, i | x, i | – | Luan (1997) |
| Yaowangcheng | g | – | – | *Zhongguo Wenwu Bao* (1994) |
| Shantaisi | g | f, b | – | Crawford, Leng, and Lee (2001), Murowchick and Cohen (2001) |
| Late Dawenkou (3000–2600 BC) | | | | |
| Jianxin | – | f, b | – | Shandong Province Institute of Archaeology and Zaozhuang City Bureau of Cultural Relics (1996) |
| Sanlihe | – | f, b | – | Kong, Liu, and He (1999) |
| Yuchisi | p | – | – | Wang (1995), Wang and Jia (1998) |

NOTE: g, grain; p, phytoliths; i, impressions; f, foxtail millet; b, broomcorn millet; x, unspecified millet.

been grown under stress, and therefore we are keeping open the possibility that it was grown in dry fields.

Millets are the only other cultigens present in significant quantity, but they occur at lower density than rice. Broomcorn millet is rare, found mainly in pit H93. Foxtail millet accounts for 94% of the millets and is found throughout the site. One common type of millet-tribe seed in the samples is morphologically identical to foxtail millet but significantly smaller.

Two bread wheat grains have been identified. Neither has been AMS-dated; however, one is from inside a Longshan pot in pit H42 while the other is from a deep posthole near pit H65. These grains appear to be the oldest examples of wheat so far found in eastern China. Undated wheat is reported at the Erlitou-period (ca. 1900–1500 BC) Zaojiaoshu site in Luoyang, Henan, along with possible barley (Ye 2000). The photograph of possible barley from Zaojiaoshu (Ye 2000: pl. 22) does not illustrate a grass, and therefore barley is not yet confirmed from Longshan or its immediate successor, Erlitou.

Seeds identical to those of wild soybean are found in most contexts (table 2, fig. 5). The specimens (about 6.0 by 4.0 by 3.6 mm) are significantly smaller than the earliest known domesticated soybeans (Crawford and Lee 2003). Wild soybean grows throughout north-central China (Hymowitz and Singh 1987) in disturbed habitats. Although seed size distinguishes domesticated from wild types in collections postdating 1000 BC, size should not be the sole distinguishing trait of cultigen soybeans. Wild soybean pods naturally split to discharge the beans whereas domesticated ones do not. No pods have been recovered, nor do we expect to find any, and therefore we cannot categorically identify the beans as wild. Nevertheless, if soybean was not purposefully grown as a crop at Liangchengzhen it was probably productive as a result of local anthropogenesis. Soybean seeds are reported from at least eight other sites in China; most postdate the Longshan (Ye 2000), and all are small.

Adzuki bean occurs in flotation samples from layers near pit H65 and from the G022 ditch. The seeds are smaller (4.0 to 4.2 long by 3.1 to 3.3 mm wide) than those of the modern cultigen but larger than wild adzuki and are in the size-range of similar beans from the Daundong site, South Korea (Crawford and Lee 2003:91), that we suggest are an early cultigen. This is the first report of this bean from Neolithic China, and until we have larger samples from a broad geographic area we can only indicate that the plant was present in Liangchengzhen anthropogenic habitats. Wild adzuki bean is widely distributed in East Asia (Yamaguchi 1992).

The most common weedy annuals represented in the samples are millet-tribe grasses. Two main morphological types are present: a green foxtail type and a panicgrass type. The two are distinguished primarily on the basis of embryo size. Embryos of the former extend more than half the length of the grain whereas embryos of the latter are significantly shorter. Specimens with hulls attached are green foxtail grass, distinguishable on the basis of the surface pattern of the hulls. Other weedy plants are rare in the samples but may also have been utilized as sources of greens and grain.

## SPATIAL DISTRIBUTIONS

Variation in the contextual distribution of plant remains has an impact on intersite comparisons as well as on an understanding of the function of structures and plant processing. As many as 30 crop-processing steps have been identified in Turkey and correlated with archaeological samples in North Wales (Hillman 1984). We are not yet able to do this type of detailed analysis; however, significant patterns are evident, although their meaning is not yet clear. Large Longshan settlements tend to have residential areas including elite and lower-class houses, pits containing refuse, ritual pits, and larger features (such as walled enclosures and surrounding ditches that may have been moats). In the main excavation area at Liangchengzhen, context types are diverse but appear to be mainly domestic. The two samples from trench T022, from a ditch that is a possible moat and from a nearby house foundation, may also represent domestic waste.

Charred seed assemblages in the seven context types summarized in table 2 have significant differences. The

TABLE 2
*Summary of Liangchengzhen Flotation Samples*

| | Scientific Name | Activity Surfaces | Burials | Houses | Cultural Levels | Post-holes | G022 | Pits: A | Pits: B | Pits: C | Pits: D | Pits: Total | Inside Pots | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of samples | | 15 | 12 | 19 | 43 | 8 | 3 | 36 | 9 | 88 | 89 | 222 | 49 | 322 |
| Volume (liters) | | 123 | 52.6 | 193 | 400 | 50 | 13 | 172.3 | 31.3 | 358.7 | 665.1 | 1,217.4 | 119.5 | 2,049 |
| Cultigens | | | | | | | | | | | | | | |
| Broomcorn millet | *Panicum miliaceium* | 1 | – | – | – | – | 1 | 9 | 1 | – | 1 | 11 | 3 | 13 |
| Foxtail millet | *Setaria italica* subsp. *italica* | 1 | – | 2 | 39 | 75 | 194 | 47 | 1 | – | 27 | 75 | 2 | 386 |
| Small foxtail millet | – | 1 | – | – | 14 | 6 | 32 | 51 | 4 | – | 5 | 60 | 1 | 113 |
| Foxtail/broom-corn millet | – | – | – | – | – | – | 3 | – | – | – | – | 0 | 0 | 3 |
| Bread wheat | *Triticum aestivum* | – | – | – | – | 1 | – | – | 1 | – | – | 1 | 1 | 2 |
| ? Cereal | – | – | – | – | 1 | – | – | 1 | – | – | – | 1 | 2 | 2 |
| Rice | *Oryza sativa* | – | 4 | – | 26 | 1 | 55 | 343 | – | 2 | 27 | 372 | – | 458 |
| Weedy plants | | | | | | | | | | | | | | |
| Bean family | Fabaceae | – | – | 2 | 5 | – | 1 | – | – | – | 12 | 12 | 0 | 20 |
| Adzuki bean | *Vigna* sp. | – | – | – | 2 | – | 7 | – | – | – | – | 0 | 0 | 9 |
| Soybean (wild?) | *Glycine soja* | 2 | 1 | – | 4 | – | 8 | 11 | 2 | 1 | 1 | 15 | 2 | 30 |
| *Cassia nomame* | – | – | – | – | – | 1 | 3 | 792 | 2 | – | – | 794 | 4 | 798 |
| Amaranth | *Amaranthus* sp. | – | 1 | 36 | 1 | – | – | 2 | – | 2 | – | 4 | – | 42 |
| Aster family | Asteraceae | – | – | 2 | – | – | – | – | – | – | 1 | 1 | – | 3 |
| Chenopod | *Chenopodium* sp. | 1 | – | 1 | 4 | 1 | 7 | 3 | – | 1 | 1 | 5 | – | 19 |
| Knotweed | *Polygonum* sp. | – | 2 | – | 1 | – | 1 | 7 | – | 2 | 2 | 11 | – | 15 |
| Mustard family | Brassicaceae | 2 | – | – | 10 | – | 14 | 13 | 3 | – | – | 16 | – | 42 |
| Purslane | *Portulaca* sp. | – | – | – | 1 | – | – | – | – | – | – | 0 | – | 1 |
| Weedy plants: grass | Poaceae | | | | | | | | | | | | | |
| Barnyard grass | *Echinochloa crusgalli* | – | – | – | – | – | 5 | 3 | – | – | – | 3 | – | 8 |
| Barley tribe | Hordeae | – | – | – | – | – | 8 | – | – | – | 1 | 1 | – | 9 |
| Wild foxtail-grass type | *Setaria* sp. (?) | – | 1 | – | 27 | 3 | 117 | 106 | – | 1 | – | 107 | 3 | 255 |
| Wild panic-grass type | *Panicum* sp. (?) | 1 | 3 | – | 51 | 7 | 20 | 229 | 2 | 0 | 2 | 233 | 13 | 315 |
| Millet tribe | Paniceae | 23 | 2 | 60 | 346 | 3 | 34 | 7 | 1 | 3 | 730 | 741 | 1 | 1,209 |
| Fleshy fruit | | | | | | | | | | | | | | |
| Hackberry | *Celtis bungeana* | – | – | – | – | – | – | – | – | – | 1 | 1 | 1 | 1 |
| Cherry | *Prunus humilis* | – | – | – | – | – | – | – | – | – | 1 | 1 | – | 1 |
| Nightshade family | Solanaceae | – | – | – | – | – | – | – | – | – | 1 | 1 | – | 1 |
| Other plants | | | | | | | | | | | | | | |
| Cattail | *Typha* sp. | – | – | – | – | – | – | 8 | – | – | – | 8 | 3 | 8 |
| Sedge | Cyperaceae | – | – | 3 | 6 | – | 14 | 63 | – | – | 3 | 66 | 2 | 89 |
| Spurge family | Euphorbiaceae | 2 | – | – | 3 | 1 | – | – | – | – | 1 | 1 | – | 7 |
| Unknown | – | – | 2 | – | 36 | 25 | – | 327 | 42 | 1 | 2 | 372 | 6 | 435 |
| Unknown | – | 8 | 4 | 5 | 26 | 4 | 283 | 95 | 0 | 11 | 51 | 157 | 8 | 487 |
| Unidentifiable | – | 21 | 4 | 2 | 39 | 2 | 40 | 20 | 12 | – | 110 | 142 | – | 250 |
| Total seeds | | 63 | 24 | 113 | 642 | 130 | 847 | 2,137 | 71 | 24 | 980 | 3,212 | 52 | 5,031 |
| Seed Density (no./liter) | | 0.51 | 0.46 | 0.59 | 1.61 | 2.60 | 65.15 | 12.40 | 2.27 | 0.07 | 1.50 | 2.64 | 0.44 | 2.46 |

highest density of remains including all classes of plants is in the ditch (level 4). Intermediate densities occur in pits, postholes, and cultural levels. Among the pits, group A, mainly represented by H65 and 93, has the highest density of seeds, particularly rice. Pit H93 has an abundance of ash that, along with its multilayered stratigraphy, indicates that, while probably a long-term storage pit, it later accumulated refuse. Group C has very few seeds, but these contexts are associated with a group of house walls, and the function of the pits here is difficult to assess. Activity surfaces, burials, and houses have low seed densities, particularly of cultigens. Among the few seeds in these contexts, wild grasses predominate. Pots occur in all contexts and have the lowest density of remains. A range of seed types is found in them. Pots likely contained few if any charred remains when they were disposed of.

The fact that the contexts with the highest densities

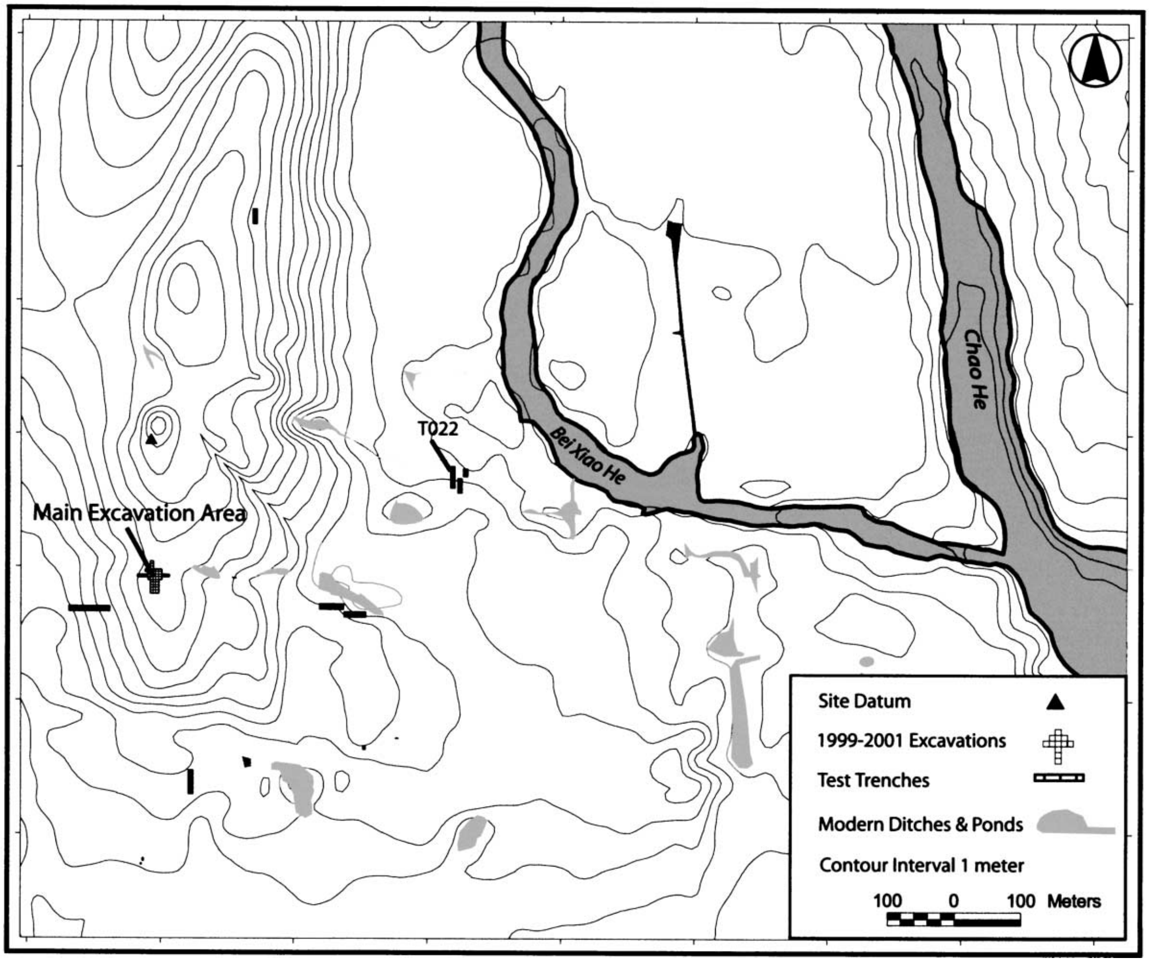


FIG. 2. *Liangchengzhen site core area, showing location of main excavation area and trench T022.*

of charred seeds are in cultural levels, among group A samples associated with few structural remains, and in a ditch indicates that charred seed disposal tended to occur outside architectural structures. Weeds tend to be distributed throughout the site while crops are not. Crops are obviously food, so food remains may have a distribution distinct from other plant remains. We cannot rule out the possible food use of some of the weedy grasses, but it seems unlikely. In Senegal, for example, pearl millet coexists with swarms of hybrids of the cultigens with weedy and wild forms (Harlan 1989*a*). Although farmers recognize these hybrids as significant, they are not harvested for food. Wild grasses in Africa tend to be used in nonagrarian contexts (Harlan 1989*b*). A more likely explanation is that some of the remains are from spent dung fuel disposed of outside the structures. Grasses, grass stem fragments, and wild legumes are, in some cases, likely the remains of dung, especially when little wood charcoal is present (Miller 1984). Cultigen seeds have a significantly lower representation in dung samples (Reddy 1999). Seeds of wild grasses, chaff, and grass stem fragments are found in samples from the southern units as well as in the ditch sample. The almost complete absence of wood charcoal from the flotation samples indicates that wood was not an important fuel. The higher density of weed seeds in structures is consistent with the remains' being of fuel rather than food.

## DISCUSSION AND CONCLUSIONS

Flotation samples from Liangchengzhen clearly represent an agricultural economy that produced rice, millet, and probably wheat. Other potential crops include soybean and adzuki bean. Anthropogenic weeds associated with agriculture are common. Rice appears to have played a much more significant role in the Shandong Longshan economy than previously suspected. From the limited perspective of the raw weight and density of the rice and millet seeds, it may have been more economically important than millet at Liangchengzhen. The implications of these findings are important, because the assumption until recently has been that broomcorn and foxtail millet were the major and possibly the sole grains in most areas of northern China. Rice can be grown in

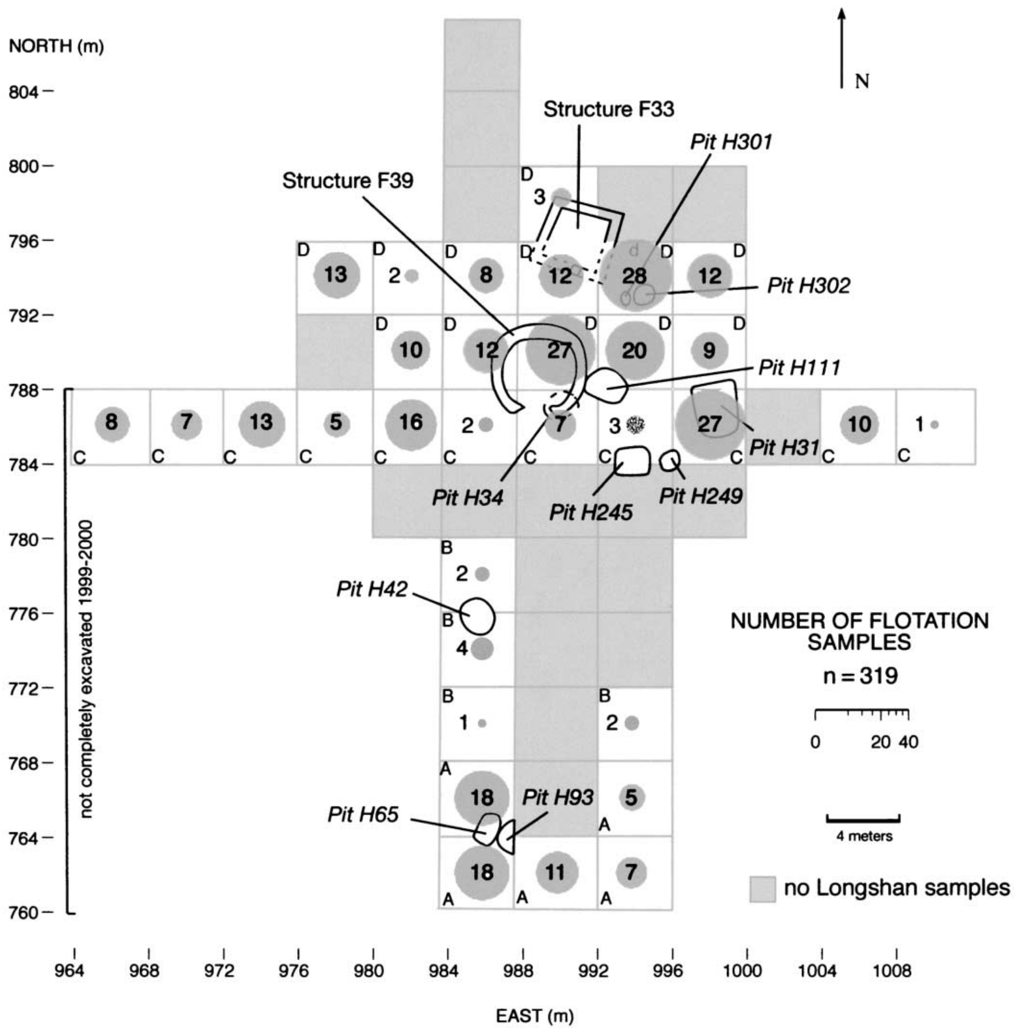


FIG. 3. *Liangchengzhen site, main excavation area, showing numbers of flotation samples by grid unit.* A, B, C, *and* D, *spatial groupings of pits. Hundreds of pits, structures, and burials in different cultural layers are situated here.*

northeastern China today, so there was probably no climatic impediment to its being grown at Liangchengzhen, particularly because until the late Longshan it may have been warmer than today. The climate may also have been considerably wetter during much of the Longshan, when the monsoon belt had apparently shifted north, leaving South China drier than today (Zhou et al. 2004:47). A cooling and drying trend seems to have developed during the late Longshan period, ca. 2000 BC (Kong et al. 1999: 62), probably representing the local end of the Hypsithermal or Holocene Optimum. In some areas the warm period may have persisted. Textual and material evidence for plants and animals adapted to warm, moist conditions has been found farther north and west of Liangchengzhen at Anyang, the last capital of the Shang dynasty (ca. 1200–1046 BC [Qiu and Cai 2001]). Climate is difficult to reconstruct because of the degree to which anthropogenesis affects the mid-Holocene pollen record today (Zhou et al. 2004:47).

The dominance of foxtail millet over broomcorn millet in the samples probably indicates that broomcorn millet was not important to the lower Huang He valley Longshan people. Contemporary agriculture varies as both elevation and aridity increase with distance from the coast. Rice is important today only in the south and east sectors of the Longshan region. Although millet is rare in the region today, broomcorn millet was historically more important in the west while foxtail millet was common in the east. Rice is present at the Longshan Shantaisi site in Henan but in insignificant quantities (Crawford, Leng, and Lee 2001). Broomcorn millet is much more abundant at Shantaisi than at Liangchengzhen. We suggest that historical crop distributions had developed by Longshan times in the Huang He basin.

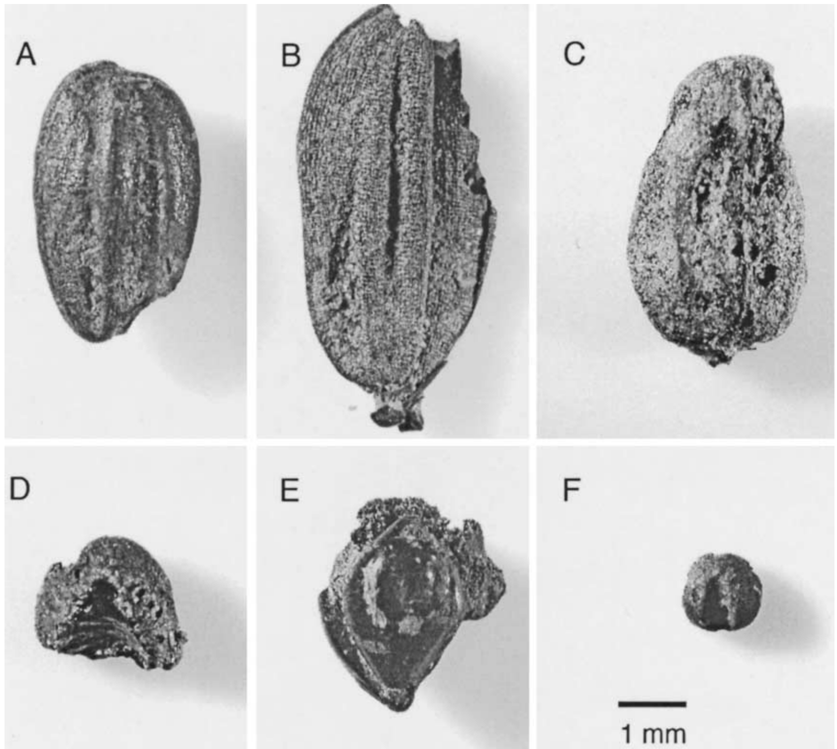


FIG. 4. *Cultigens.* A, *rice grain;* B, *rice hull;* C, *wheat;* D, *broomcorn millet;* E, *broomcorn millet popping from hulls;* F, *foxtail millet.*

Overall, crop remains occur at about one-third the density of weedy plant seeds, particularly grasses. A few contexts contain mainly cultigens, while others contain mainly weeds and still others have both. Intersite comparisons will need to take into account such contextual variation. The types of remains recovered in and near areas where food was regularly prepared and consumed by households will differ from those found where periodic or ritual events were carried out. Few crop remains are found inside structures. Food preparation such as steaming or boiling may work against the preservation of grains after cooking, and ceramic tripod vessels suitable for steaming grains or preparing gruels are common at Liangchengzhen. The relatively low density of cultigens throughout the site (excluding H93) may mean that we are recovering mainly the charred waste from grain processing (tail grain, weed seeds, chaff) or the waste from fuel.

Few economically important wild plants are represented in the samples. In egalitarian communities with mixed economies such as the Sakushu-Kotoni River site in Japan, a wide range of wild plants is represented, although cultigens and weedy annuals still dominate the plant remains (Crawford 1986). Some of the weeds such as chenopod and knotweed have edible and productive seeds and greens. In the central mountains of Taiwan, chenopod was planted in foxtail millet fields (Fogg 1983: 100). Early agricultural regimes may have differed from modern analogues in including some of these plants as crops. A few seeds of wild, fleshy fruits are represented, but their use is difficult to assess. Most are productive in anthropogenic habitats.

Crops such as hemp (*Cannabis sativa*) and Chinese cabbage (*Brassica chinensis*), reported from Neolithic sites in northern China (Chang 1976, Crawford 1992, Underhill 1997), have not been found at Liangchengzhen. Although mustard-family (Brassicaceae), seeds have been recovered, they are in poor condition and difficult to identify more specifically. Residue analysis of pottery suggests that rice was used for the preparation of alcohol (Chinese-American Rizhao Liangcheng Region Collaborative Archaeological Team n.d.).

Not only does rice appear to have been more significant for eastern Longshan people than previously suspected but the presence of wheat foreshadows more modern agriculture based on both rice and wheat. Wheat is rare at Liangchengzhen and was likely just being introduced to the region. Without earlier samples for comparison, we cannot know whether rice, first domesticated in the Yangzi Valley, was also new to the Liangchengzhen Longshan people. Judging from its abundance, it probably had become a significant resource in Shandong at an earlier time. Introduced crops can, of course, have a significant impact. Maize, for example, was introduced to existing agriculture in the North American Midwest. Production increased as a result and

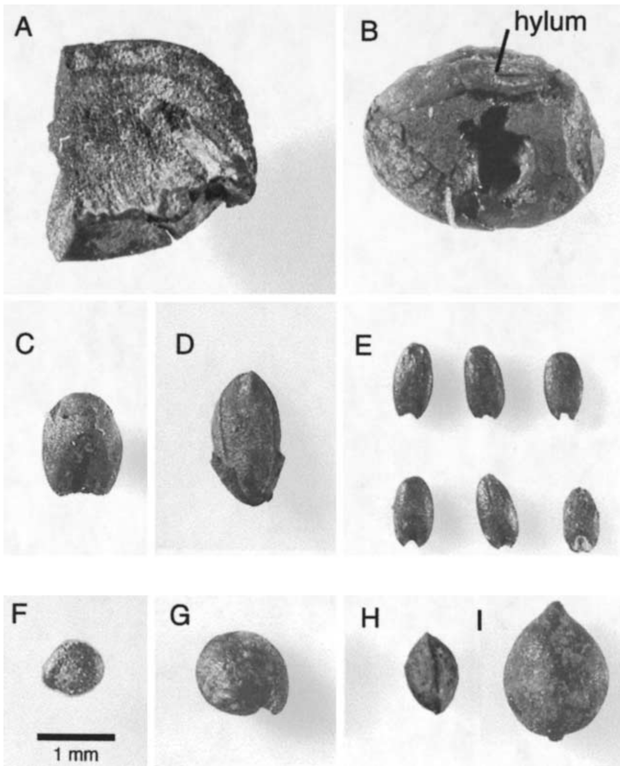


Fig. 5. *Weedy plant seeds.* A, *wild (?) adzuki;* B, *wild-type soybean;* C, *wild foxtail-type grass;* D, *wild green foxtail grass in hulls;* E, *millet tribe (panic-grass-type?);* F, *purslane;* G, *chenopod;* H *and* I, *knotweeds.*

maize became a significant crop by AD 800, signaling intensification that supported complex socioeconomic systems such as the Mississippian (Fritz 1992, Kelly 1992). Initially, maize added to the balance of crops, but by AD 1400 it was the predominant one. Diversification is effective in risk reduction, but subsequent specialization in a few dominant crops can increase risk. The low diversity of crops at Liangchengzhen suggests that specialization was developing. To what extent increased production and risk management are evident there is a question we hope to address. Socioeconomic processes during the Middle and Late Neolithic such as expanding regional exchange systems may have facilitated the introduction of new crops to the area. The expansion of rice agriculture and the introduction of wheat during the Late Neolithic no doubt represent increased contacts among peoples from different areas.

An issue requiring further examination is Late Neolithic site formation processes in Shandong, including which activities of the site's inhabitants (such as various food-processing methods and cooking technologies) could have caused some plant remains to be preserved by carbonization while others were not. The fact that there is distinct spatial variation in the densities of preserved carbonized seeds at Liangchengzhen argues strongly for the value of systematically collecting large quantities of flotation samples from diverse areas during excavations of late prehistoric sites in China. Our continued analyses of these samples in conjunction with other remains will help us to understand the nature of the subsistence economy at the regional center over time. One issue that we will address further, utilizing data on size, type of soil, and the nature of other remains such as different kinds of ceramics, is functional variation among the numerous pits and surfaces.

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# Dung in the Desert: Preliminary Results of the Negev Holocene Ecology Project[1]

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In their investigations of caves and rockshelters in the Near East, archaeologists studying prehistoric times have all too often had to deal with the accumulated dung of thousands of years of sheep and goat herding. The solution has generally been summary—the dung is removed as quickly as possible, with little or no documentation, collection, sampling, or analysis (but see Simms and Russell 1997, di Lernia 2001 for significant exceptions). This is unfortunate. Preliminary results of analyses of Negev Holocene rockshelter deposits, pri-

 0011-3204/2005/4602-0007$10.00

1. The Negev Holocene Ecology Project, a joint endeavor of the Department for Historical Ecology of the Severtsov Institute for Ecology and Evolution of the Russian Academy of Sciences, the Mitzpe Ramon Science Center, and the Archaeological Division of Ben-Gurion University, has been supported by grants from the Russian Academy of Sciences, the Israel Ministry of Science and Technology, and the Mitzpe Ramon Science Center. We thank E. Mazor and B. Krasnov for arranging the research in the Negev Desert. We are very grateful to I. Khokhlova and G. Shenbrot for their help. This research was funded by Blaustein Institute for Desert Research and Ramon Science Center (Israel), the Russian Fund for Basic Research (Grant No 03-04-49323), and the Russian programs "Origin and Evolution of the Biosphere," "Scientific Basics of Conservation of Biodiversity of Russia," and "Fundamental Basics of Biological Resources Management." We are grateful to the licensing authorities, the Israel Antiquities Authority, and the Israel Nature Preserves and Parks Authority for both permission to conduct the research and gracious help in carrying it out. We also thank six reviewers for CURRENT ANTHROPOLOGY for comments that helped us to strengthen this report significantly.