Sanyangzhuang: early farming and a Han settlement preserved beneath Yellow River flood deposits

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The authors present the discovery of a Han period farming site sealed beneath 5m of flood deposits, where courtyard houses have been excavated belonging to the Western Han Dynasty and Wang Mang period (c. 140 BC–AD 23). Preservation is exceptional, both at the village of Sanyangzhuang itself and, by dint of satellite reconnaissance, over a vast landscape contemporarily covered by the flood. Deep profiles show that here land surfaces of the Neolithic and Warring States periods also lie buried. The potential for the study of the early agricultural sequence and a deeper knowledge of Han society is truly outstanding. The discoveries also offer a vivid account of the way a settlement was overwhelmed by flooding.

Keywords: China, Huanghe, Neolithic, Warring States, Han, Western Han, Wang Mang, farming, Han building compounds, river systems, flooding

Introduction

The Han Dynasty (202 BC–AD 220) administered one of the world’s great empires, rivalling its western contemporary, Rome. Much is known about the Han from contemporary histories and from recent archaeology, but much of this information focuses on the imperial court and the activities of ruling elites or military authorities. At a time when trade along the Silk Road was enlarging contacts between China, South Asia and the Mediterranean world, we have very little archaeological knowledge about the everyday lives of the people in eastern China.
China who underwrote the imperial economy and produced the goods that were the focus of this fabled trade route. Archaeologists studying the Han era working in the Yellow River floodplain have focused almost exclusively on the royal cities of Chang’an and Luoyang, or on the excavation of thousands of Han-era tombs. Research on small settlements outside of the royal cities is nearly non-existent. Recent excavations at the remarkably well-preserved Sanyangzhuang site, however, provide an extraordinary opportunity to understand rural life during terminal Western Han times.

The geological setting

The Yellow River (Huanghe) has been the dominant force shaping the landscape and influencing human and natural environments in the Sanyangzhuang area. It flows through the easily eroded loess plateau of central China, bringing down massive quantities of sand, silt and clay that are deposited to form the alluvial plain east of Luoyang (Liu & Liang 1989: 223–4). The Yellow River has flooded its banks and shifted its position several times. As the river channel aggrades and channel gradients become increasingly steep, avulsions (natural break-outs) occur, or, in some instances, human breaches of dikes and levées (Cen 1957; Hsu 1980: 103; Xu, Fuling 1989; Wang, Yulei 2008).

For much of the Holocene the Yellow River flowed north from Luoyang to discharge into the Gulf of Bohai (Xu, Fuling 1989; Ye 1989: fig. 1) (Figure 1). The river was confined to the western edge of the Central Plains up to the end of the first decade of the first millennium AD. As the river channel aggraded and gradients increased, the river began shifting eastward. This process was probably accelerated by increasing sediment associated with human-induced erosion in the loess plateau (Ren & Zhu 1994; Xu, Jiongxin 2003; He et al. 2006; Huang et al. 2006). By Han times, the river frequently flooded the lower regions of Henan, Hebei and Shandong provinces (Sima 1959: 1409).

The archaeology of Sanyangzhuang

Sanyangzhuang is located north-west of the modern channel of the Yellow River in Henan Province (Henan 2010). The site was discovered in the course of digging an irrigation canal in 2003 and thereafter defined by coring and several c. 12m-deep profiles that extend back into deposits of Pleistocene age (Figure 2). These strata indicate that the Yellow River floodplain was marked by episodes of stability indicated by well-developed palaeosols, alternated with episodes of large-scale flooding (Figure 3). Four pre-Han palaeosols have been identified. The lower two, dated respectively to the Early and Middle Holocene, appear to be entirely natural. The next two palaeosols are ridged cultivation horizons, dated by ceramics in the fill to the Late Neolithic or Early Bronze age (Figure 3: 2a), and to the Warring States period (Figure 3: 3). The Han occupation of the site developed on the surface of a flood deposit following the Warring States occupation. The Han remains are covered by 3m of sediment from a massive Yellow River flood that catastrophically buried the site. Two more metres of overburden accumulated after the Han-era flood. (Figure 4).
Investigation

We followed a three-part strategy for the investigation of Sanyangzhuang. First, an intensive programme of hand-operated coring was used to sample the subsurface remains in the area immediately around the site (Figure 2). To date, 1km$^2$ has been sampled at 4m intervals using split-spoon augers with a c. 200mm-long sample tube (the Luoyang spade). Each excavation extended to the Han level, which is easily identified by its colour and texture. In each core, the presence and absence of remains is noted by stratigraphic level.

Second, six stratigraphic profiles were excavated. The deepest reach c. 12m below the surface while the others expose the stratigraphy overlying the Han occupation (Figures 3 & 4). Each profile was dug by hand and has been documented using standard geoarchaeological descriptive methods. Multiple samples for pollen and sedimentary analysis have been taken from these profiles.

Finally, three areas where buildings had been located during excavation of the irrigation ditch were opened by hand, exposing an area sufficient to document the architectural remains and to reveal surrounding features, such as fields and wells (Figure 2). Structures took the form of courtyard residences, termed compounds. The smallest excavation exposed c. 400m$^2$ (compound 1), while the work in compounds 3 and 4 uncovered more than
Figure 2. Map of the Sanyangzhuang site area showing known Han-age cultural features, areas of coring and the location of profiles.

1200m². The average depth to the ground surface on which these compounds were built is 5m below the modern ground surface.

Excavations extended to the upper level of the architectural remains (usually the top of the roof tiles) or to the level of the then contemporary ground surface (Figure 5). Overlying flood deposits peel off the Han surface, which makes recognising the surface easy. Sanyangzhuang has preserved features rarely seen at most sites. Human and animal prints have been recovered from the fields and activity areas around compounds 2 and 3. The hoof prints appear to be of horse or mule. Compounds 2, 3 and 4 had trees growing immediately outside of their compound walls. Casts of the tree stumps indicate that they were 100–200mm in diameter and relatively evenly spaced. Fossilised leaf casts recovered from the north end of compound 3 show that both Mulberry (*Morus* sp.) and Elm (*Ulmus* cf. *parvifolia*) were grown (Figure 6). Outside the compounds we exposed ridged fields, remains of cart tracks, human and animal foot/hoof prints, casts of trees and leaves, activity areas, wells and latrines.

Because of concerns about preservation, excavation of the compounds did not penetrate beneath the top of the architectural remains, which means we have not exposed living surfaces within rooms or spaces that were covered by a roof or by roof-fall. Following excavation and documentation, three of the four compounds were covered with sand to stabilise and protect them. A museum building was constructed over the remaining compound 2.
Figure 3. Part of the stratigraphic profile at Sanyangzhuang showing palaeosols and intervening Yellow River (Huanghe flood [HHF]) deposits: 1) Middle Holocene (top of strata is 8.8m below ground surface [bgs]); 2) Late Middle Holocene (2b) with Neolithic/Early Bronze Age field (2a); 3) Warring States; 4) Han occupation level.
Figure 4. Sample of the post-Han stratigraphy, showing the stage 1–3 flood deposits with the Tang midden that developed in and on a natural palaeosol on its surface (scale is in 100mm increments).
Results

Two residential compounds and associated features have been fully excavated (compounds 2 and 3) and two (1 and 4) partially exposed, along with agricultural fields and segments of a Han road. Compounds 2 and 3 have a similar layout (Figure 7), although there are minor variations. Each compound consists of a rammed-earth outer wall enclosing tile-roofed buildings again constructed of rammed-earth and set around several open courtyards. The compounds are rectangular, roughly 12–15m long and 7–9m wide and each has its main axis oriented in the same direction. A well is situated on the south side of the compound while a latrine is on the north side. There is a primary structure, consisting of a rectangular building with internal partitions built out from the compound wall and at least one detached building at the south end of the compound. Both compounds 2 and 3 have a gate set in the south side of the boundary wall. Compound 2 has a gatehouse adjacent to the gate. Compounds 2 and 3 have two open courtyards, the largest of which is on the south side of the compound; an inner courtyard is separated from the first by a wall and the main room of the primary building opens onto this second courtyard. Compound 3 is unusual because it has a ditch partially enclosing the compound on the east and west sides.
In compounds 2 and 4 rammed-earth building walls were set on fired-brick foundations roughly 0.6m (three to four courses) wide. This may be the case in the other compounds but we have not excavated through the rammed-earth remains to determine these details. In compound 2 there is a round stone column base about 1.75m south of the edge of the wall of the primary structure. This column base is surrounded by collapsed roof tile, suggesting the column supported a roofed, open veranda attached to the primary structure but still inside the wall that defined the inner courtyard area.

Each building had a gabled roof covered with ceramic roof tiles composed of interlocking pan and plate tiles. Some buildings had single incline roofs while others had double incline roofs with a ridgepole. Roofs were presumably constructed of rafters with a lattice of purlins to support the roof tiles. In the south-east corner of compound 1, within one of the courtyards, we discovered orderly stacks of unused pan and plate tiles, suggesting the occupants were undertaking repairs to the house. Nearby we found a sink-like depression to pug mud for the clay to make roofing. In compound 2 we found four eave tiles (wadang) decorated with the characters yi shou wan sui (‘longevity’) (Figure 8). The composition of these four characters and their layout on the wadang are unique to Sanyangzhuang.

The wells located on the south side of compounds 2 and 3 were lined with fired bricks stacked in an overlapping, herringbone pattern. Around the mouth of the well in compound 2 was a 3.2 × 2.5m prepared earth well pad approximately 50–90mm above the ground surface and partially covered with fired bricks. We suspect that this well pad supported a wooden housing for a pulley such as are commonly depicted in Han-era stone reliefs or as
Figure 7. a) Sketch map of compound 2; b) sketch map of compound 3.
Figure 8. Wadang (eave tiles) in compound 2: a) tiles in situ; b) photograph of intact wadang, length = 35mm.
ceramic miniatures placed in Han tombs as spirit articles (mingqi) (Guo 2010). A pavement of bricks and tiles leads from the well to the gate. There are broken pottery jars, a pottery sink, a pottery basin, a grinding stone and a round stone mortar scattered around the well.

About 5m west of the well in compound 2, we discovered the remains of a warp-weighted loom. This is made up of four supports, each consisting of four stacked bricks arranged in a 1.25 \times 1m rectangle. In the middle of these four supports there is a line of loom weights, consisting of brick and stone fragments smoothed on the ends and abraded in the middle.

A brick latrine was excavated at the north end of compound 2. This was composed of a rectangle of bricks stacked around a sloping pit. There was only a \sim 10\text{mm} thin layer of black soil at its base, suggesting it had recently been cleaned out. A pile of collapsed roof tiles on the west side of the lavatory is presumed to be the remains of the roof of the privy. Similar structures at the north of compounds 3 and 4 are also presumed to be lavatories.

Artefacts at Sanyangzhuang are found where they rested at the time the site was abandoned. For example, in compound 2 we found a large metal cauldron within the inner courtyard and a drum-like stone threshing roller was immediately next to the inner compound wall. Within the building we hypothesise is a kitchen where we can see the remains of several ceramic vessels; an iron axe and stone mortar rested against the wall of this building, while two stone grinding mills and the remains of a pottery jar were discovered in the courtyard adjacent to this building’s west wall (Figure 5, n◦1–3). The well in compound 2 had a large ceramic jar immediately on its west side and a large sink or basin on its east side.

Most artefacts consist of agricultural tools or domestic utensils and are made of stone, ceramic or metal (iron or bronze). Stone tools include large grinding stones, mortars and querns (Figure 9a & b). A large stone head for a trip-hammer has also been recovered. Ceramic bowls, cups, jars, pans and perforated steamers have been found (Figure 9c & d). Metal tools include iron basins and kettles, as well as ploughshares, scythe blades, axes, knives and unidentified fragments. A bronze horse fitting was recovered, but this metal is otherwise quite rare. Three copper alloy huoquan coins were found in the courtyard of compound 2 and a half coin came from compound 3.

The wider site

Probing using Luoyang spades shows that there are ten additional agricultural compounds similar to the ones already exposed by excavation, making 14 so far. Architectural remains west of the excavated compounds extend over 1ha. These remain partially lie below mausolea attributed to the mythical thearchs Zhuanxu and Di Ku. This is much too large to be a single compound and it is possible that this feature is some form of ritual or ceremonial structure, but at present this is only speculation. Probing indicates that the agricultural compounds are widely but irregularly spaced. Furthermore, the compounds were surrounded by cultivated land. In compounds 2, 3 and 4 the ridged fields come to within 2m of the compound boundaries. In compounds 2 and 3 there is an open, cleared activity area on the south side of the compound walls that extends 15–20m south of the wall.

Our close spaced probing also allowed us to locate Han-era roads. These are identified by their distinctive texture, compaction and linear pattern. Based on their width we have
identified three types of roads — main roads roughly 20m wide, secondary roads about half the width of the main road, and paths that are only a couple of metres wide and connect compounds to larger tracks. A portion of one of the secondary roads was exposed near compound 2 (Figure 10). This road consists of a compacted surface about 8m across and wide enough for a wheeled cart or chariot. Multiple wheeled vehicle tracks define the road but it is otherwise not an obviously constructed feature.

We have also located the remains of a walled community c. 2.6km south-east of Sanyangzhuang. The remains of a rammed-earth wall, roughly 700m long, are visible today standing 2–3m above the modern surface. Probing at the base of this wall indicates that it is buried approximately 5m below the surface, which suggests that it is contemporary with the Han deposits at Sanyangzhuang.
Figure 10. The Han-era secondary road near compound 2.
The chronology of the Sanyangzhuang site

The excavated compounds at the site date to the terminal Western Han Dynasty and Wang Mang period (c. 140 BC–AD 23) (Henan 2010). Because there is no natural palaeosol, we believe the ground surface on which the Han-era Sanyangzhuang site was found was occupied immediately after a flood had buried the fields of the Warring States period. The precise date when the Han occupation was established is unclear but based on the ceramic vessels and architectural tiles we believe it was in the middle of the Western Han, or c. 140–130 BC. The huoquan coins were first circulated in AD 14 (Ban 1962: 1184) and were not minted after AD 40 (Zhongguo kexueyuan kaogu yanjiusuo Luoyang qu kaogu fajue dui 1959). These coins provide a terminus post quem for the flood event, but evidence suggests the flood happened well before these coins were last minted. First, all of the artefacts at the site are in Western Han styles. The pottery, roof tiles and other objects show no evidence of Eastern Han stylistic or technological characteristics. The herringbone walls of the wells in compound 2 parallel those of the well at the late Western Han Sandaohao site, Liaoyang city, Liaoning Province (Dongbei Bowuguan 1957). Furthermore, the excavated wadang show similarities with those unearthed at Chang’an (Liu 2000: 325–38) and which are dated to the middle and late Western Han Dynasty (Wang 1982). Therefore, we believe that the Sanyangzhuang community was established in the late Western Han Dynasty and buried by a massive flood, at or soon after AD 14, and no later than the establishment of the Eastern Han Dynasty in AD 23.

The end of Han Sanyangzhuang

Topographic mapping, using satellite-based altimetry, and augmented with coring and stratigraphic observations, indicates Sanyangzhuang is near the centre of a complex alluvial fan that was initiated as an avulsion from a now relict Yellow River channel north-east of the city of Hebi (Figure 11). The sediments immediately above the Han settlement represent a fluvial deposit nearly 3 m thick, representing a catastrophic flood. This deposit consists of an initial fine-grained massive deposit (stage 1) that gradually transitioned to a silt loam/silty clay loam (stage 2) and then abruptly shifted to a laminated silt and silty clay stratum (stage 3) (Figure 4). Although we have divided the flood into three stages, these simply represent differences in sediment texture and reflect the evolution of a single continuous flood. There are no interruptions in the flood sediments; once the flood was initiated by the avulsion of the Yellow River it continued unabated until the riverbank was repaired.

Sediment-rich water infiltrated houses and deposited mud as a blanket across the site area. Even though the flood energy increased slightly in stage 2, the inundation was gentle and buildings collapsed into these sediments as the standing water weakened rammed-earth building material, allowing structures to essentially melt into the watery slurry. Roofs seem to have collapsed onto and over the buildings but in a few cases they were offset from the underlying features, suggesting they settled at an angle. The initial stages of flooding, with their fine-grained mud, sealed the archaeological remains from any disturbance by subsequent higher energy flooding and locked the cultural deposits in their primary context at the time of the flood.
The flood caught the residents off-guard and forced a rapid abandonment of the site. The abundance of archaeological remains, including artefacts across a wide range of size and functional classes, suggests the inhabitants did not have time to selectively remove their possessions in advance of the inundation. Tools are found in functional contexts — next to the well, adjacent to and within structures, against the walls within courtyards — indicating rapid abandonment. The distribution of loom weights in a line within the frame of the loom shows that fibres were under tension when the site was abandoned. While large, heavy artefacts, such as grinding stones and stone mortars, might be expected to be abandoned, small artefacts, such as coins were also left behind, along with ploughs, axes, scythes and other agricultural implements critical for future production. The inhabitants fled the site leaving behind most of their possessions. Although not a definitive sign of a hurried departure, in compound 1 the presence of neatly stacked and separated pan and plate tiles demonstrates the inhabitants were planning for the future — in this instance re-roofing a structure — which is hardly behaviour of a community anticipating an impending threat.

Historical records (Ban 1962: 4127) indicate there was a major flood in the North China Plain during Wang Mang’s reign. This flood is said to have begun in AD 11 and the breaches in the levee were not repaired until AD 69/70. While floods were frequent occurrences in the North China Plain, the event (or events) noted in the Han Shu coincide very closely with the physical evidence from Sanyangzhuang, leading us to suspect the
historical records are largely accurate in this regard. Some Western historians have accepted the conclusion that flooding caused the demise of Wang Mang’s brief reign (Bielenstein 1986: 242–4; Hansen 2000: 135; Kruger 2003: 142–3; De Crespigny 2007: xvi, 196; Tanner 2009: 111). This analysis is not a settled matter because the historical documents are at best ambiguous, both in regards to the nature of the flooding and to the causes of Wang Mang’s fall from power (Dubs 1955: 112–24; Yu 1956). Now, however, we can unquestionably document that flooding across the North China Plain during Wang Mang’s time was extensive and catastrophically disruptive at the local if not regional level. How this flooding affected Han economy and politics during Wang Mang’s time is yet to be decided, but this work provides new evidence to use in conjunction with existing historical documents and provides an opportunity to reconsider existing arguments about the fall of Wang Mang and the re-establishment of the Eastern Han. Furthermore, our research provides an opportunity for testing the hypothesis that flooding at the end of the Western Han may have led to the large-scale population movements out of the Yellow River Valley documented in the Han censuses of AD 2 and AD 140 (Bielenstein 1947, 1986, 1987).

Following the Han flood there was a significant hiatus in human use of the site area. During this time, the upper surface of the Han flood deposit was stable and a natural, organically enriched palaeosol developed. People had moved back to the site area by at least Tang times (AD 618–907) and disturbed the upper surface of the Han flood/natural palaeosol, leaving anthropogenic deposits across much of the site area.

Conclusion

We know — or think we know — much about daily life in Han China (Loewe 1968; Pirazzoli-t’Serstevens 1982). Extensive historical records (e.g. Ban 1962), coupled with graphic information recorded in mingqi — clay models left in tombs — or on bricks, tomb murals and even textiles, provide a remarkable record of Han life. These data, however, are often disconnected from their social contexts. Moreover, the historical records have often been used uncritically and lead to an assumption that Han society and economy was largely uniform across the breadth of the empire. While there is an abundance of Han-era archaeology, almost none of this work has focused on documenting rural life, especially in an area far removed from the dynastic capitals.

Sanyangzhuang was catastrophically buried by a massive flood at or soon after AD 14. Although the flood caused the abandonment of the site, it preserved the archaeological record in a primary context to a degree not seen before in China. Because it is so well preserved, work at Sanyangzhuang provides an unparalleled opportunity for archaeologists and historians to study the structure and organisation of Han households and community in one part of the empire. The site was occupied during a time of considerable prosperity. Rural compounds are widely dispersed, with habitations situated within agricultural fields. These domestic agrarian compounds were joined by paths and roads, and the settlement system was evidently articulated at a higher level with one or more nearby walled towns or small cities and a local kiln for the production of ceramics. The compounds were well built and substantial, with extensive investment in architecture (brick foundations, roof
tiles, deeply dug brick-lined wells). Evidence from the excavated compounds indicates some material culture disparities within the community. Compound 2 seems to be slightly larger than the rest, with more artefacts (especially large stone tools for grinding and pounding) and unique eave tiles (wadang).

This variation, however, is not so great as to suggest significant social differences among members of the community. The inhabitants of the region were using iron tools for a number of purposes, including agricultural tools and domestic objects. Agricultural production was intensively focused on row-crop cultivation using draft animals to pull large, iron ploughs and conforming in general to the field system described in the historical records (Hsu 1980). The presence of mulberry leaves and the remains of a loom hint that textile production may have been an important component of the domestic economy and provides tantalising evidence that the site is an example of the basic economic nodes forming the network that created the Silk Road and on which the Han Dynasty was built.

Because of the remarkable preservation at Sanyangzhuang, we now have opportunities to investigate social organisation within and between households: how cropping systems and field management evolved and were maintained, how agricultural technology was used, and how local economies functioned are among the many possibilities this site has to offer. Although plant and animal bone remains are not preserved, preliminary research using carbon isotopes in the soils indicates there is considerable potential for investigating changes in agricultural practices. In addition, geoarchaeological work at the site shows that there are at least two more well-preserved buried fields (and nearby, we presume, the contemporary habitation sites) dating to the Warring States and Late Neolithic or Early Bronze Age. Below these cultural levels are Middle and Early Holocene deposits that promise to yield important palaeoenvironmental information about the evolution of the Central Plains.

Analysis of satellite-derived topographic mapping indicates that the flood that buried Sanyangzhuang deposited a sediment fan covering c. 900km² (Figure 11), thus possibly preserving a vast Han-era landscape. We have at present only a small window into the archaeology of a rural Han community, but these data suggest that there is a wealth of opportunity for scholars who study the Han and other imperial systems. Furthermore, the sealed landscape provides an opportunity to correlate archaeological, historical and palaeoflood records in order to understand how changes in the Yellow River affected the arc of Chinese history.

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