Abstract

Alongside the thousands of terracotta warriors discovered in the tomb complex of the first emperor of China were tens of thousands of bronze weapons, including arrowheads and crossbow triggers, lances, spears, halberds (and the ferrules associated with them), swords and a few other special types. This quantity and quality of bronze weaponry provides an extremely rare opportunity to investigate patterns of standardisation and labour organisation within a single, very large and intentional assemblage as well as to consider the role of bronze production during the Qin period (325–206 BC), which marks perhaps the most crucial early stage in Chinese political unification.

This book draws upon extensive measurements, typological analysis and related statistical treatment, as well as a study of the spatial distribution of those bronze weapons found in the most extensively excavated part of the tomb complex (the five easternmost trenches in Pit 1). Metric data and statistical assessment of inter- and intra-group variation (e.g. coefficients of variation) suggest interesting patterns with regard to relative degrees of standardisation. A combination of geographic information systems (GIS) and point pattern analysis is used to assess formally any spatial patterning in the weapons and their analytical attributes, which then also provides further information about the labour organisation behind the production, transportation and placement of weapons as they were moved from the workshop and/or arsenal to the funeral pits. Combining these insights with those obtained from inscriptions found on some of the weapons and from ancient documents, this project investigates what technologies and crafting behaviour affected weapons production and labour organisation in a centralised imperial system.

This research project fills a gap in the study of mass production, the behaviour of craftspeople, and related logistical organisation in ancient China and, for the first time, provides empirical data by analysing systematically the types, dimensions and spatial patterns of Qin bronze weapons for the Terracotta Army in the Emperor Qin Shihuang's tomb complex.

1

Introduction

1.1. Introduction

In the 1970s, three pits containing thousands of terracotta warriors and horses were discovered in the tomb complex of Emperor Qin Shihuang (秦始皇 259–210 BC) near Xian, China. Qin Shihuang was the first emperor of what can be considered as the first unified Chinese state. In 221 BC, he established the Qin Empire (221–206 BC) following a series of military campaigns in central China. Considered by many as a ruthless autocrat, he was nevertheless a political, economic and military innovator and sought immortality by building a vast tomb for his afterlife that he modelled after an underground empire, guarded by an army of terracotta warriors (Institute and Team, 1988; Yuan, 1990, 2014; Lindesay and Guo, 1998; Portal, 2007; Loewe, 2007; Rawson, 2007).

Together with the life-sized terracotta warriors, a large number of bronze weapons, such as swords (剑), spears (矛), lances (铍), dagger-axes (戈), halberds (戟), hooks (钩), ceremonial weapons *Su* (殳), triggers (弩机), arrows (镞), and ferrules (镦), was discovered in the three pits located to the east of the tomb mound. For example, within the 2,000 square metres fully excavated to date in Pit 1 (the five easternmost trenches), over 40,000 individual arrows were discovered (some found in bundles and some loose). Besides these, 486 other bronze weapons were unearthed (Institute and Team, 1988:249). Although a considerable amount of research has been conducted on the terracotta warriors themselves in terms of manufacture, detailed sculpturing, polychrome paints, and military battle formation (Yuan, 1990; Wang 1994; Ledderose, 2000; Blansdorf et al., 2001; Portal, 2007; Khayutina, 2013), as well as birth of the Qin Empire (Pines et al., 2014), comparatively less attention has been paid to the weapons assemblage.

This comparative lack of attention is surprising given the fact that the quantity and quality of bronze weapons discovered in the tomb complex provides a great deal of information about Qin mass production methods, metallurgical know-how, labour organisation and even the behaviour of individual craftspeople. These bronze weapons were all cast using models and moulds, and finished by filing, grinding and polishing of their surfaces (Li et al., 2011). Most of the bronze weapons were well preserved after being buried for more than 2,000 years; some of the blades, particularly those of swords and lances, appear to have undergone an anti-rust treatment, because they still had metallic lustre when found in the pit of the terracotta warriors. But this still poses a mystery for arguments raised in recent decades (Han et al., 1981; Yuan, 1990; He, 1996; Zhang et al., 2011; Martinón-Torres et al., 2019), and it seems neither chromium nor soil have played an important role in well preserving such weapons. Some of the Qin bronze weapons were discovered in other archaeological contexts, but those finds remain pieces of evidence isolated from the contexts of tombs and battlefields. The availability of such a large quantity of Qin bronze weapons from one depositional context makes it possible to conduct a systematic study into the standardisation and labour organisation of bronze production in a very specific political and ideological setting. The spatial arrangement of the weapons, the inscriptions on some of them, the metrical and typological variation they exhibit, their manufacture traces, and their chemical composition are all very important dimensions offering complementary information.

This book is based on my PhD research, initiating a broader project carried out between the Emperor Qin Shihuang's Mausoleum Site Museum and the UCL Institute of Archaeology, which aims to reconstruct the Qin bronze industry that produced these weapons. The research addresses issues such as the supply of raw materials, casting technology, production processes, quality control and monitoring, as well as offering insights into the large amount of labour and organisation needed to produce and place the bronzes in the pits within a limited period of time (246–210 BC). The goal of this book is to develop the study of bronze specialisation and standardisation in Chinese archaeology by carrying out the systematic typological and spatial analysis of this large assemblage of bronze weaponry from Pit 1 of the Terracotta Army within the Qin tomb complex and to analyse the archaeological, metrical and spatial data alongside other relevant patterns. This study provided theoretical and methodological vision for continuing archaeometric research carried out by the Sino-British cooperative team.

1.2 Research review and defining research questions

1.2.1 Previous research on the bronze weapons

Over the past three decades, in addition to basic typological and historical research on this large quantity of bronze weapons (Institute and Team, 1988; Yuan 1990; Wang 1994), Chinese archaeologists and scientists have also undertaken research on three other main aspects. These are: **a**) the interpretation of the inscriptions and their implications for the organisation of weapons production during the Qin period (Yuan, 1984, 1990; Huang, 1983, 1990; Liu and Jiang, 2006); **b**) the military functions of the weapons, their placement in an army battle formation in the pit and the military strategy they imply (Qin, 1975; Qin and Zhang, 1983; Liu, 1986; Dang, 1987; Bai, 1994;

Yates, 2007; Yang, 2017); **c**) the casting technology and chemical composition (Wang, 1980a, 1987; Yuan et al, 1981a, 1981b; Han et al., 1983; Yuan and Cheng, 1986). Previous research has particularly addressed the specific types of Qin bronze weapons from a historical perspective or has carried out scientific analysis on a limited number of samples. However, relatively little research has been undertaken on the standardisation of production and its relationship with craft organisation (for exceptions, see Wang, 1980a; Yuan et al., 1981a, 1981b).

Thus, a few previous publications address to the topic of standardisation, but the subject has not benefited from a systematic and comprehensive approach so far. Yuan Weihua et al. (1981a) investigated the bronze casting and processing technology, and based on a relatively small number of analytical samples, suggested that the similarity of the weapons in terms of chemical composition was a reflection of high levels of specialisation and standardisation. Wang Xueli (1980a) offered discussion on these topics and noted that the moulds used for the mass production of bronze weapons in the Qin Dynasty were normally made from two pieces fixed together, but that the casting methods were slightly different for different kinds of weapons. For example, the sprue on a sword, spear or hook was at the end of the handle, but the bronze arrows were made in an overlapping mould where the tangs were cast in a first stage, then the arrowheads cast onto them in a second stage. The chemical composition of the bronzes also varied according to the function of the weapons. For example, the swords needed sharpness and resilience, while the arrows had to be sharp but hard-pointed; consequently, the tin content of swords appears lower than that of the arrows. In another paper, Wang Xueli (1987) also presented a detailed list of the standardised aspects of the bronze weapons:

- the length of the arrowheads, arrow tangs (bronze) and arrow shafts (wood or bamboo) was consistent;
- all parts of the crossbow triggers were assumed interchangeable;
- the bronze swords were exactly symmetrical from the spine to the blades, which indicates standardisation in mould production.

The supervision, quality control, and system of rewards and punishments behind the production of Qin bronze weapons have also been discussed, using the inscriptions on the weapons as well as bamboo slips and ancient written documents as sources (Yuan et al., 1981b; Wang, 1987; Li and Gao, 2010).

Overall, previous research has offered a general overview of the standardisation and labour organisation prevalent in the production of bronze weapons during the Qin period, based on a relatively limited number of samples. However, to date there has been a lack of robust data collection and systematic, large-scale analysis for assessing the degree of standardisation, a dearth of sound archaeological theory, and few if any attempts to interpret any spatial pattern of technological variation in the pit. Overall, there has been very little discussion as to what kind of systematic research is most appropriate for a large assemblage of weaponry, integrated with theoretical models of specialised production, in an early complex society.

Craft specialisation and standardisation have been widely discussed from theoretical perspectives in the Western archaeological literature (for details see Chapter 2). They have been considered in relation to such issues as the origins of food surplus, leisure time, and population growth (Boas, 1940) and to the rise of social complexity (Rice, 1981; Clark and Parry, 1990). Other researchers have concentrated on defining the term 'specialisation' (Muller, 1984; Tosi, 1984; Costin, 1986; Stark, 1991); establishing parameters to identify types and degrees of specialisation (Earle, 1981; Costin, 1991); exploring the relationship between standardisation and specialisation (Clark, 1986; Torrence, 1986; Rice, 1991; Costin and Hagstrum, 1995; Roux, 2003); and proposing techniques for assessing the degree of standardisation (Eerkens and Bettinger, 2001). However, these Western publications rarely consider Chinese materials. In recent years, some scholars from China and the West have begun to study craft specialisation in the production of Shang and Zhou bronzes and other objects (Bagley, 1995; Underhill, 2002; Li, 2007; Sun, 2008). Related studies have also been conducted on the manufacture of the Qin terracotta soldiers (Ledderose, 2000), on the construction projects and investment of labour (Shelach, 2014), and on the Qin standardised artefacts for administrative and propaganda purposes (Sanft, 2013; 2014), but no similar analysis has been carried out on the production of Qin bronze weapons.

The use of spatial statistics (Bevan and Conolly, 2006) to offer insight into labour organisation in production and the logistics of placement in the pit will be another question that needs to be tackled in this research. The spatial distribution of each type or subtype of bronze weapons will be characterised and related to the possible past technological processes, crafting behaviour and labour organisation. Consideration also needs to be paid to the fact that these bronze weapons were not found in a workshop or arsenal, related directly to a production context, but in a funeral pit where they were arranged to match the battle formation of the terracotta warriors (Institute and Team, 1988; Yuan, 1990). The weapons' spatial distribution therefore has been affected not only by workshop processes, but also by storage organisation, transportation to and placement in the pit, and the battle array of the Army (Bevan et al., 2013).

For this particular project, the study of the Qin bronze weapons will go beyond previous work, and include systematic analysis on a large number of samples and related spatial statistics, to be incorporated within a broader theoretical framework. This book will also bring together both qualitative and quantitative data, as well as some preliminary archaeometric results.

1.2.2 Defining research questions

Against this background, this study sets out to explore three main questions:

- What does the degree of metric variability and standardisation in bronze weapons tell us about technological processes and workshop organisation during the Qin Dynasty?
- What is the spatial distribution of bronze weapons in Pit 1 of the Emperor's tomb complex? How does this relate to actual battle formations, weapons production and craft organisation during the Qin Dynasty?
- What was the role of political influence in the production process?

To tackle these questions, five types of data may be used: inscriptions on the weapons, dimensions and other typological features, spatial patterns, chemical composition, and manufacturing techniques. This book will mainly focus on the archaeological perspective, including inscriptions, dimensions, typology and spatial patterns, contextualised with broader archaeological and historical information. These results are integrated with archaeometric data on chemical composition and manufacturing techniques published as journal papers (Li et al., 2011; Li et al., 2014; Martinón-Torres et al., 2014).

1.3 The Emperor and his tomb complex – defining the temporal and spatial context

1.3.1 The Qin Dynasty and Emperor Qin Shihuang

By the time that King Ying Zheng (嬴政) of the Qin state, later known as the Emperor Qin Shihuangdi, unified China in 221 BC, the Qin state was already more than 600 years old and had experienced a long historical development both as a clan and as a kingdom (Historical Records: Basic Annals of Qin 史记· 秦本纪). The Qin people had been recognised by the Zhou king as a minor subordinate clan at the upper reaches of the Wei river (a branch of the Yellow River), on the northwest borders of the present-day Gansu province, which was responsible for breeding horses for the Zhou (Yates, 2007; Gansu Institute of Archaeology, 2009; Zhao, 2014; Teng, 2014)). Within twenty-five years of becoming king, Ying Zheng was able to eliminate all six other powerful states by military force, and established the first empire of China (Fig. 1.1). Bronze weapons are considered to have been one of the most crucial factors in his military success (Yuan, 1990; Yates, 2007, 2009). Before we turn to discussing the production of these weapons, it is useful to discuss the origins of the Qin Empire and the background to its military supremacy.

There are two modern views regarding the origins of the Qin. One claims that this group emerged from the

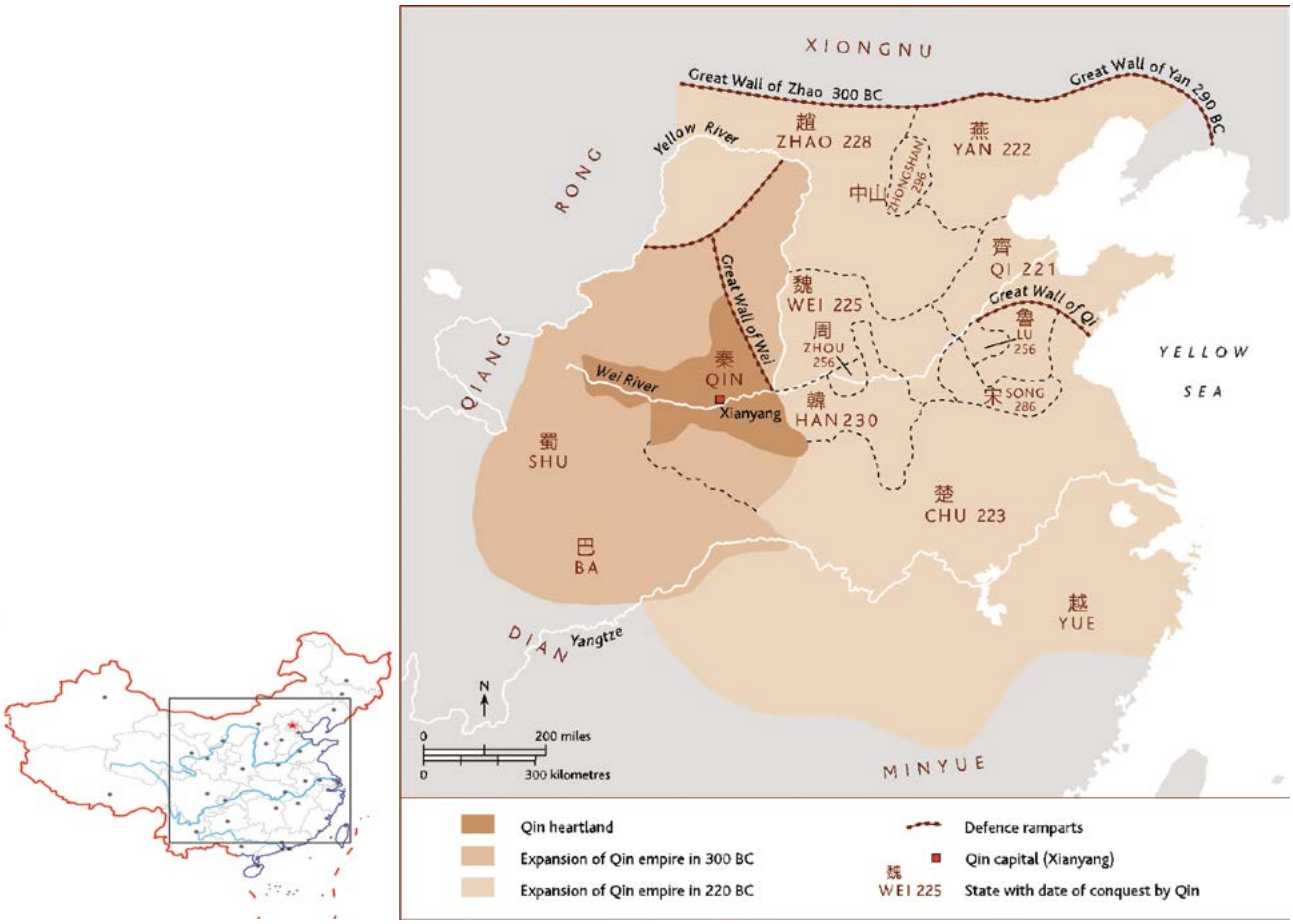


Fig. 1.1. Map of the Qin Empire (right-hand map courtesy of the British Museum).

indigenous peoples of east China, while the other states that they were descendants of the Rong, a so-called western barbarian people (Yates, 2007; Zhao, 1987, 1989, 2014; Li, 2011). According to Shiji (Historical Records: Basic Annals of Qin史记· 秦本记), Qin's ancestor was *Nuxiu* (女脩), who swallowed a bird's egg and gave birth to a son named *Daye* (大业). Daye's son was *Dafei* (大费), who is said to have helped *Yu* (禹), a legendary king of the Xia Dynasty (about 2100 BC), to harness a flood in central China. Recent archaeological excavations in Gansu province have revealed much about early Qin cultural and ritual practice, and show that Qin cultural traditions were different from those of the Rong, and closer to those found in central and eastern China (Collaborative Team, 2008; Zhao, 2008; Gansu Institute of Archaeology et al., 2008). The archaeological discoveries provide crucial evidence that suggests cultural similarities and political proximity of Qin to the Zhou Dynasty (Teng, 2003; Shelach and Pines, 2005; Falkenhausen, 2006: 29–73).

In 770 BC, the king of the Western Zhou was forced to move from Zhouyuan, in the lower Wei River valley (present-day Shaanxi province), to Luoyang, middle reaches of the Yellow River (present-day Henan province) (Yates, 2007). Qin Xianggong (秦襄公), a duke of Qin, was successful in battle and escorted the Zhou king Ping (周平王) in the move to Luoyang. As a duke, he was entitled to establish a Qin territory as part of the Zhou Dynasty, in the western part of China (Lin, 1981). He gradually expanded eastward, occupying the original Zhou domains.

The Qin state experienced fluctuations of fortune during its 500 years of development between 770 and 221 BC. Even though the state became weak after Duke Mu (秦穆公659–621 BC), Shangyang's (商鞅a reformer of the Qin, 385–338 BC) innovations during the rule of Duke Xiao (秦孝公361–338 BC) made it prosperous again (Loewe, 2007; Pines, 2009, 2012). These innovations were considered to lay the foundation for the Qin finally to become a major force among the seven kingdoms that then composed China. Shangyang, also known as Gongsun Yang, acted as the senior official of the Qin government from 359 to 350 BC, and he was permitted to institute many reforms. Groups of five families were bound together, and were jointly accountable for the actions of each other in a legal context. Crimes committed by any member of the whole group were reportable by other members. If this reporting was not done, the whole group was held accountable, i.e. guilty of the same crime that the individual had carried out. As a further extension of the collective concept, one male was taken from each household to form a military squad of five. These five people were also held responsible for each other's safety. If they lost a man, they were required to capture the head of an enemy in exchange. It is conceivable that around this time, the Qin state established an army of conscripts (Yates, 2007). The Qin government also instigated a system of seventeen ranks or grades for all male members of the population. Previously only aristocrats held such ranks. There was recognition that rank based on merit or the capability of the individual was as great or of greater value than inherited rank. Individual talent could be exploited for the benefit of the government, and that in turn bestowed rewards (Loewe, 2007, 2010; Pines, 2009, 2012). Higher rank was awarded for battle successes, manifested by beheading an enemy and reporting it to the army headquarters. Further reform was introduced to the agricultural part of the economy. Farmers were encouraged to cultivate arable land lying fallow, and a new taxation system that promoted agricultural development was created. These policies stimulated grain production to feed both the army and an increasingly complex administrative bureaucracy (Yates, 2009).

Further innovations also changed the organisation of bronze production and a system of craft supervision was established. This information is reflected in the inscriptions carved on some of the bronze objects. One of the earliest examples is a bronze ferrule (the metal cap on the bottom end of the long wooden handle of a spear, lance or halberd) that was excavated from a Qin tomb in Xianyang, capital of the Qin. The fourteen-character Chinese inscription translates as "Shanyang supervised the making of this ferrule in the 19th regnal year (343 BC)" (Yates, 2007: 34). Some of the Qin bronze weapons and bronze ritual vessels made before the Shanyang period were found with cast or carved inscriptions, but most of their contents pertained to who owned it or for what purpose it was produced. No such inscriptions were added to show who had been in charge of the production and which craftspeople had been involved.

In the decades following Shangyang's and Duke Xiao's deaths in 338 BC, a series of rulers built on their legacy and expanded Qin territory by force to the east, south and north, incorporating peoples and territories that had very different cultural and social customs. Qin Huiwen (秦惠文王) proclaimed himself king in 325 BC, and this is generally considered to be the official start of the Qin kingdom. The Bashu (present-day Sichuan province) region was conquered, and subsequently convicts, settlers and officials were sent to the south-west to occupy the land and exploit its extensive natural and mineral resources (Sage, 1992), which may well have later provided the main raw material for Qin bronze weapons. The state of Qin became increasingly keen on annexing other kingdoms with the ultimate aim of establishing a supreme empire (Guo and Wang, 2000).

Ying Zheng was born at the right time after the long development from Qin clan to kingdom. He succeeded to the throne at the age of thirteen in 246 BC. However, ruling authority was initially exercised by the Chancellor Lu Buwei (吕不韦) until 238 BC, when Ying Zheng (Qin Shihuang), then 22, assumed control of state affairs and immediately stripped the minister of his power. With the assistance of a new chancellor, Li Si (李斯), he carried out a series of reforms to develop agriculture and the military. He had the Zhengguo Channel built for irrigation and encouraged famers to have their own land. He adopted Li Si's military strategy, known as "a silkworm devouring a

mulberry leaf" and eventually he conquered the other six states and unified China in 221 BC (Historical Records: Basic Annals of the First Emperor of Qin 史记· 秦始皇本纪；Lin, 1981; Lindesay and Guo, 1998).

The emperor set about enacting many reforms to consolidate his empire. To strengthen the northern border, he sent slaves and criminals to build the line of defence now known as the Great Wall. Roads radiating from Xianyang, the capital, were built linking the former Yan, Qi, Wei and Chu areas. He also standardised the script used for writing, and introduced a circular copper disc with a square hole in the middle as the standard coin to be used across the empire. Equally important reforms were the standardisation of weights and measures, and the codification of the law. Even the gauges of wheeled vehicles were standardised. These reforms benefited both the economy and cultural exchange during the period (Lindesay and Guo, 1998; Snaft, 2013).

In the long history of the Qin, the production of bronze weapons also went through several stages of development. As mentioned above, after Shangyang's innovation, some bronze weapons were carved with an inscription that would allow the maker's work to be properly scrutinised (物勒工铭). In other words, this was a form of quality control and accountability. According to the inscriptions carved on the bronze lances and halberds discovered from the pits of the terracotta warriors, these were mainly produced from 244 to 228 BC, during the reign of King Ying Zheng but before the unification. After the unification, the ancient documents recorded that "weapons from all over the empire were confiscated, brought to Xianyang, and melted down to be used in casting bells, bell stands and twelve men made of metal. These last weighted 1,000 piculs (1 picul ≈ 60 kg) each and were set up in the palace" (Rawson, 2007: 129). The first emperor of Qin had the bronze weapons melted down in order to put an end to warfare in the newly established empire, and, from these historical sources, it also seems that the Qin bronze weapons were used to recast the bronze statues lined up in front of the Qin palace (Yuan, 1990). However, from an archaeological perspective this appears not to be the case, especially in light of finding such a great quantity of Qin bronze weapons in the Emperor's tomb complex.

1.3.2 The tomb complex, the terracotta warriors and the bronze weapons

According to the *Siji* (Historical Records: Basic Annals of the First Emperor of Qin 史记•秦始皇本纪), Emperor Qin Shihuang was apprehensive about the prospect of death. He tried hard to find an elixir that would make him immortal, but at the same time commissioned the building of his mausoleum. Construction work on this began in the year he became king, 246 BC, and continued for about 40 years, even after his death in 210 BC. The chancellor Lu Buwei took charge of the earlier stages, and the next chancellor, Li Si, was in charge of later stages. Only the fall of the dynasty itself in 206 BC brought work on the elaborate funerary complex to a halt (Yuan, 1990; Lindesay and Guo, 1998; Portal, 2007; Duan, 2011).

The mausoleum is located at Lintong, with Mount Li to the south and the Wei River to the north. Interior and exterior ramparts were built around the edges of the tomb mound. Some traces of the wall are still visible on the surface of the ground. The mound itself was about 115 metres high when it was first built, a truncated pyramid shape, and covered with evergreens. Beneath it, an underground palace in which the remains of Qin Shihuang were buried is thought to lie. As described by Sima Qian in *Historical Records* (《史记》), the First Emperor's tomb chamber reproduced in minute detail the universe over which he expected to rule.

> From the time the First Emperor first took the throne [in 246 BC] work was begun [on his mausoleum] at Mount Li. After he had won the empire, more than 700,000 conscripts from all parts of the country laboured there. The labourers dug through three subterranean streams which they sealed off with bronze in order to make the burial chamber. This they filled with [models of] palaces, towers, and the hundred officials, as well as precious utensils and marvellous rarities. Artisans were ordered to install mechanically triggered crossbows set to shoot any intruder. With mercury the various waterways of the empire, the Yangtze and Yellow Rivers, and even the great ocean itself were created and made to flow and circulate mechanically. The heavenly constellations were depicted above and the geography of the earth was laid out below. Lamps were fuelled with whale oil so that they might burn forever without being extinguished…Finally, trees and grass were planted [on the tomb mount] to make it appear like a mountain. (translated by Hearn, 1980)

The tomb mound has not been excavated so far, but the relatively high concentration of mercury in the soil attested by scientists gives some plausibility to aspects of the description written by Sima Qian (Chang and Li, 1983). The surrounding pits and tombs in the mausoleum complex were not mentioned in the *Historical Records*, and have been discovered by a combination of chance, archaeological survey and excavation (Fig. 1.2).

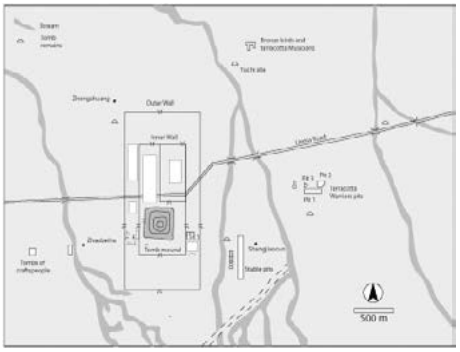


Fig. 1.2. Tomb complex of the Emperor Qin Shihuang (after figure 1 in the Excavation Report, Institute and Team, 1988: 2).

Archaeological excavations carried out during the past four decades have been primarily focused on the surrounding pits and tombs. The three pits with the terracotta warriors and horses of Emperor Qin Shihuang are the most famous archaeological finds in the mausoleum complex. In addition, approximately 600 further pits and tombs have been noted and attested to by archaeological surveys in the area of the mausoleum (Yuan, 1990). To date, only a relatively small number of pits and tombs have been excavated, but they include a pit containing bronze chariots, pits with stables, a pit of terracotta officials, a pit of terracotta acrobats, a pit with a stone armoury, and a pit of bronze birds (Museum and Institute, 1998; Museum of Emperor Qin Shihuang's Terracotta Army, 1998; Shaanxi Institute and Museum, 2000, 2006, 2007; Yuan, 2002; Duan, 2011).

The abundant contents of the surrounding pits and tombs are made in a variety of different materials. The life-sized terracotta warriors, officials, and acrobats; roof tiles; bricks; and some containers are all made of clay. Large amounts of body armour and helmets are made from limestone. Metal objects are also one of the main burial finds in the mausoleum complex, and include the thousands of bronze weapons, two sets of bronze chariots; about forty bronze birds; bronze tripods; bronze bells, coins, mirrors, and weights; iron implements; and gold and silver ornaments (Yuan, 2002; Duan, 2011).

The bronze weapons studied in this particular project originated mainly from the five easternmost trenches of Pit 1, which is one of three pits designed to house the army of terracotta warriors and located about 1.5 km east of the burial mound (Figs. 1.2 and 1.3). Pit 1, the largest of the compound, was partially excavated during the 1970s. To date, almost 1,100 terracotta figures have been restored in the five easternmost trenches (Fig. 1.4), covering 1,000 square metres of the pit. Due to the partial excavation in the past decades, the sampling bronze weapons have been limited to the five easternmost trenches of Pit 1, which was one-fifth of the military formation of this Terracotta Army. However, over 40,000 variety of bronze weapons have been found from such a small section of the pit to provide rich data for quantitative analysis in this book.

According to the density of the figures found to date, it is estimated that the three pits contain about 6,000 terracotta warriors and horses in total. The warriors are of several types: infantry, archers, officials and charioteers. In addition to Pit 1 mentioned above, Pit 2, excavated with trial trenches in the 1970s, contains a battle formation which includes archers, cavalrymen, charioteers and infantrymen. Archaeological work carried out in 1994 mainly concentrated on above the roof layer of this pit. In the archer section the excavation continues, and several well-preserved kneeling archers decorated with bright pigments have been unearthed in recent years (Museum of Emperor Qin Shihuang's Terracotta Army, 2009). Pit 3, the smallest one, is assumed to be the headquarters of the army in the other two pits. It contains only one chariot drawn by four horses and 68 terracotta figures (Yuan, 1990; 2002).

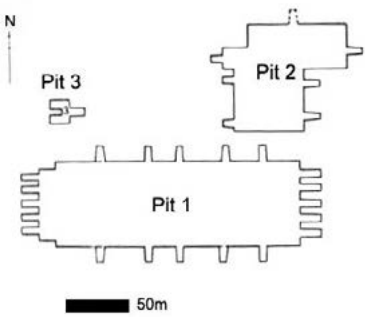
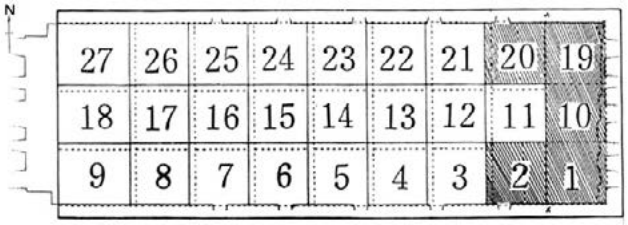


Fig. 1.3. The layout of three pits containing the terracotta warriors (after Figure 2 in the Excavation Report, Institute and Team, 1988: 5).

(a)



(b)

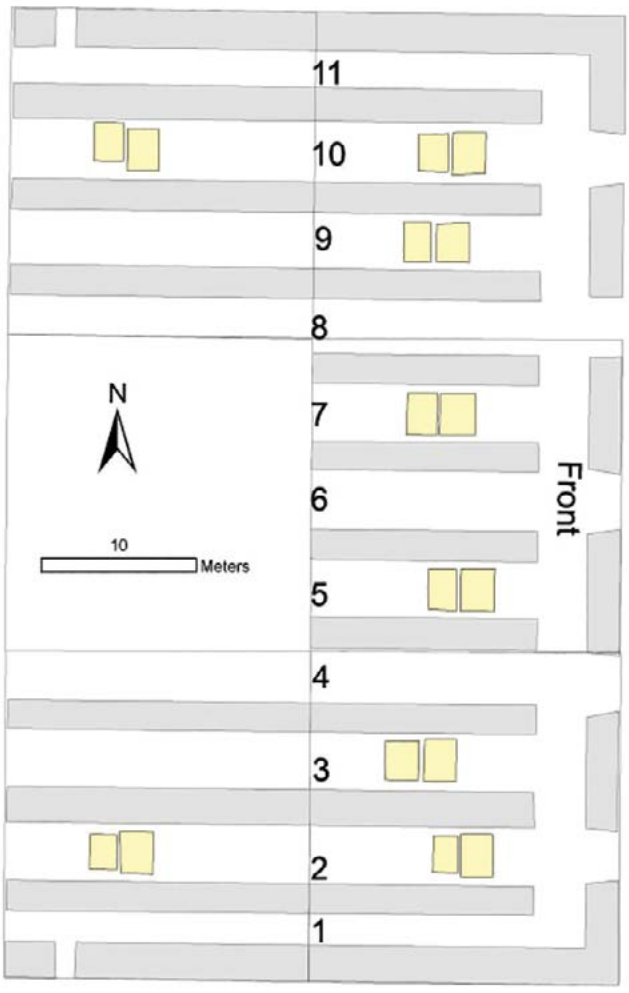


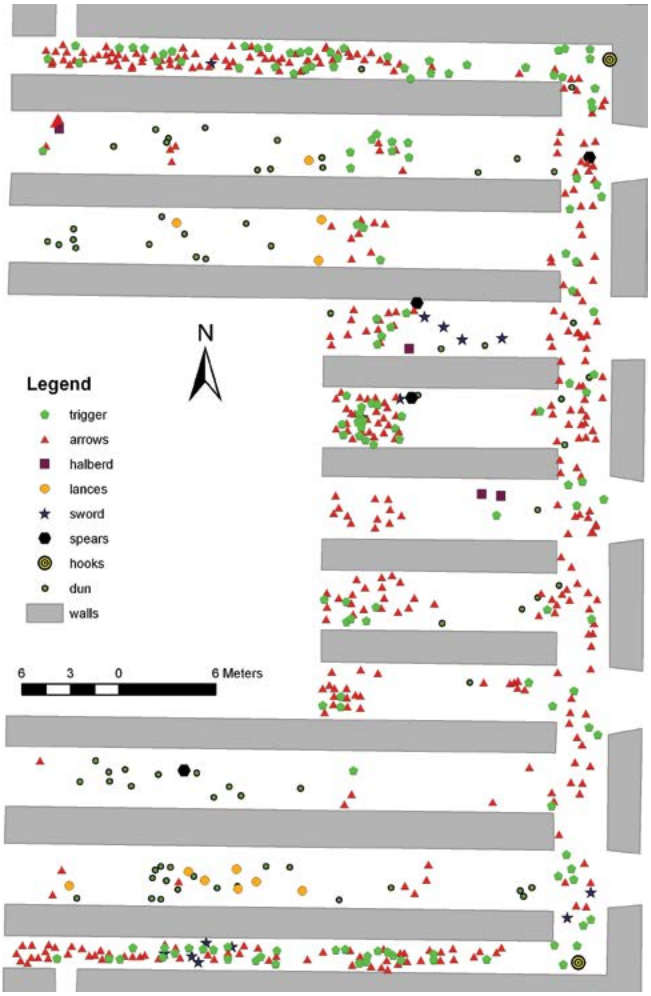
Fig. 1.4. Pit 1: (a) the five easternmost trenches are hatched (1, 2, 10, 19, and 20; after Figure 5 in the Excavation Report, Institute and Team, 1988: 10), and (b) the corridor numbering for the five easternmost trenches (yellow areas are those with chariots).

The weapons (or parts thereof) recovered include over forty thousand arrows (loose or in bundles) and several hundred other weapons such as crossbow triggers, swords, hooks, lances, spears, dagger-axes, halberds, and honour weapons (*Su*), as well as ferrules that were presumably placed on the butt ends of the long weapons (Fig. 1.5). The arrangement of the weapons in the pits is assumed to match a typical Qin battle formation. For example, arrows were mainly unearthed from the front and flank corridors where crossbowmen and/or archers were located, and long weapons, such as lances and spears, were discovered in the middle of the pit.

(a)

(b)

(c)



(d)

Fig. 1.5. (a) A selection of bronze weapons (image courtesy of Xia Juxian); (b) terracotta warriors discovered in Pit 1 (images courtesy of Xia Juxian); (c) spatial distribution of the terracotta warriors; (d) spatial distribution of the bronze weapons.

Some weapons have long inscriptions, which offer information about supervisors, officials, craftspeople, workers, and the year in which the weapons were produced. Other weapons only have a simple inscription, such as numbers or the name of the main workshop, *Sigong* (Yuan, 1990). The inscriptions bearing chronological information show that these weapons were mostly made before the Qin unification, during the period when seven kingdoms existed in China, engaged in a constant state of war (the period is accordingly known as the Warring States era 475–221 BC). These kingdoms not only competed against each other in terms of the size and organisation of their military forces, but also in the production of bronze weapons of sufficient quality and quantity to overpower the others, and it was the Qin state that eventually unified China with its strong military forces and bronze weaponry. In this sense, the information on the Qin weapons obtained in this project may also be relevant for future studies comparing the weapons technologies of different contemporary kingdoms.

1.4 Chapter summaries

This book is divided into eight chapters: the present introduction (Chapter 1); theoretical framework (Chapter 2); methodology (Chapter 3); a study of the inscriptions (Chapter 4); the main body of results from the metric and spatial analysis of the Qin bronze weapons (Chapters 5 to 7); and a broader discussion and conclusion (Chapter 8).

Chapter 2 covers the theoretical concerns of the research. It first reviews the past literature on the definition of standardisation, the factors affecting it, and the approaches allowing the assessment of the degree of standardisation. I propose that the concept of standardisation is relevant for a whole range of aspects of the bronze weapons production and can be approached by considering technological operational processes, specialised learning of certain skills, the sensory limitations of craftspeople, and labour organisation. I also argue that the spatial pattern of the bronze weapons could be employed to trace back aspects of workshop organisation and coherent activity areas associated with the placement of the weapons into the pit.

Chapter 3 focuses on methodology. It explores methods for data collection, data input and data management, as well as the models for statistical and spatial analysis.

Inscriptions on the bronze weapons offer basic information about the organisation of production, and are considered in Chapter 4. Some long sentence inscriptions on the lances and halberds provide data on the craft organisational structure during the Qin period, and shorter inscriptions can be interpreted as corresponding to simple count, weapons assembly, quality control, and/or the name of the workshop.

Chapters 5 to 7 present the detailed studies carried out on each type of weapon, namely triggers, arrows and long weapons. These chapters aim to evaluate these three main categories of bronze weapons statistically and spatially, and to reconstruct the model of labour organisation involved in such mass bronze production during the Qin period. The relative degree of standardisation is assessed, and a discussion is presented concerning the extents of standardisation and the extent to which they are affected by the human senses and by labour organisation. I argue that, on the basis of typological, metrical and spatial analysis, the triggers were produced by cellular production with a small room of batch mixing. The bronze arrows do suggest cellular production according to the chemical composition tested by portable XRF (Li et al., 2014; Martinón-Torres et al., 2014a).

Chapter 8 returns to overall questions of standardisation and labour organisation, and analyses the motivations behind such priorities. This chapter also aims to establish a model for interpreting the other sites and objects from the Emperor Qin Shihuang's tomb complex. The further potentials and limitations of the methodology employed in this book are appropriately discussed, and questions are raised about the wider spatial and temporal contexts. Given this overall structure of the research, it is to theoretical issues that the next chapter turns.