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BOOK REVIEWS

type of casting technology separately. Peng apparently realizes this critical division and uses chapter 7 to address matters of design, while chapter 8 deals with technological questions. It is clear that two-dimensional openwork first appeared on Chinese bronzes during the Late Shang (thirteenth–eleventh centuries B.C.) and Western Zhou (eleventh–eighth centuries B.C.) periods, but was likely cast with section-moulds. Moreover, Peng argues that the driving force behind the rise of lost-wax castings in China was probably the creation of three-dimensional interlace as a realization of the previous two-dimensional ones. This theory is certainly worth serious consideration, but the author does not explain how this design penetrated into the bronze repertoire of the Eastern Zhou states or when lost-wax casting was first employed in producing it.

On the other hand, the technology of lost-wax casting was likely transmitted to the Central Plains via the northern zone, stretching from Xinjiang and Gansu in the West to Liaoning and Jilin Province in the East. This theory, opposing the southwest route of transmission or local invention theory previously preferred, is supported by well-dated archaeological finds. The author highlights the importance of northern Hebei in this process because bronzes found in this region reveal zoomorphic finials which are also commonly found in southern Siberia and were probably made by lost-wax casting. Though it is not completely clear in which manner these earlier and stylistically different lost-wax casting pieces affected the later Eastern Zhou metal workers in areas further south, it is certainly an important place of origin for this exotic technology.

After finishing these chapters, readers may find themselves still lacking conclusive answers to most of the questions surrounding the debate on the lost-wax versus piece-mould technology. This problem, I think, largely stems from the incapability of current technical methods to identify lost-wax casted objects. Though artifacts with three-dimensional openwork interlace have been generally accepted as an indicator of lost-wax casting, there is still much uncertainty when investigating two-dimensional openwork, deeply cut, or zoomorphic shaped artefacts. In chapter 9, the author raises the question whether or not lost-wax casting can even be exclusively associated with interlaced openwork (p. 167). He gives the example of bronze waterfowl statues from the mausoleum of the First Emperor of Qin, which were confirmed to be items made via the lost-wax casting process but lacked interlaced openwork. Is this a sign that lost-wax casting was introduced into China more than once and consequently adapted to the Chinese traditional bronze production system in more than one way? As we only have very few confirmed lost-wax cases, I would be more cautious in providing conclusive remarks on transmission routes or diachronic development sequences for this technology. This is certainly not to devalue Peng's work. I believe, based on the contents of this book, that researchers can finally put aside previous disputes and move forward to more culturally significant questions, thereby joining the effort to develop new investigative tools for answering these questions.

Bronze Weapons of the Qin Terracotta Warriors: Standardisation, Craft Specialisation and Labour Organization. Xiuzhen Li. Oxford: BAR Publishing, 2020. BAR International Series, 2992, Archaeology of East Asia, vol. 3. 221 pp., 36 tables, 137 figures (color and black and white). Paperback £57, ISBN 9781407316901; e-book free, ISBN 9781407356020.

Reviewed by Donald B. Wagner, *Nordic Institute of Asian Studies*

Among the wealth of amazing finds at the tomb of the First Emperor of China in Xi'an, Shaanxi, some 40,000 bronze weapons have been found, including crossbow triggers, arrows, shafted weapons, and swords. This book is a massively detailed study of this material with the specific goal of learning how weapons production was organized and the extent to which products were standardized. Thousands of artifacts were measured very precisely with digital callipers, and statistical studies of the measurements, together with studies of the inscriptions on many of the artifacts, give important insights into both questions. The same author has also participated in studies of the specific bronze alloys used (Martinón-Torres et al. 2014), but this aspect is barely touched on here (pp. 94–97).

An introductory chapter gives a broad account of the history of the state and empire of Qin and the archaeology of the First Emperor's tomb complex. Chapter 2 and chapter 3 lay out the theoretical and practical bases for the study of standardization and labor organization from artifacts alone, without the aid of any archaeology of the workshops themselves.

Chapter 4 considers the inscriptions found on many of the artifacts. These can include dates, names of offices, names of persons, and some marks of unclear function. Information from the inscriptions, studied comprehensively, allows the construction of organizational diagrams of the hierarchies in some production units. These fit well with the conclusion of the statistical studies that production was organized "in semi-autonomous units – or a cellular production system – rather than as a flow-line production" (p. 137).

Each of chapters 5 through 7, on crossbow triggers, arrowheads, and ferrules and long weapons, begins with an extensive review of the literature on the artifact types under consideration. Though this study has the particular aim of investigating aspects of production organization, it incidentally provides much more information on the individual artifacts than we are accustomed to seeing in Chinese archaeological reports.

In chapter 5, 229 crossbow triggers (out of 262 excavated) are classified, measured, and subjected to statistical analysis. Each is composed of five parts: three moving parts and two bolts. Each part is classified into three or four types; the differences between the types appear to be stylistic rather than functional. The parts were cast to exacting dimensional tolerances, generally less than a mm, so that they could be assembled without much adjustment. Microscopic scratches indicate that some small amount of filing was necessary to make the fit.

Dealing with 37,348 arrowheads necessitated developing a robust sampling strategy (chapter 6). After a preliminary pilot study, the strategy chosen was to concentrate on those arrows that were found in groups of 90 or more, clearly corresponding to the "bundles" of arrowheads in crossbowmen's quivers. Six arrowheads were randomly selected from each of 262 bundles. This permitted measuring variability within bundles and between bundles.

The arrowheads consist of a tip and a tang. The tang was cast first and the tip was then cast onto it. Traces were found in a few cases of a bamboo shaft into which the tang was inserted. The tips showed an "extraordinary degree of standardization" in their dimensions across the entire sample (p. 94). This suggests immediately that the proper functioning of the crossbow demanded precise standardization, though extensive experimentation would be needed to explore this aspect.

Alloy analysis of the tips shows very little variation within bundles, but a somewhat larger variation between bundles. The tangs provided weight and a firm attachment to the shaft, but standardization was clearly less important here: they show much greater dimensional variation, although again smaller variation within bundles. All this suggests again cellular production, though the author declares herself less certain of this particular conclusion (p. 97).

The arrowheads provide a clue to the vexed question of iron in the First Emperor's tomb. Iron tools were found at a stone-dressing site associated with the building of the tomb (Wagner 1993:206–209), but the only iron artifacts found in the entire tomb complex itself were two arrowheads with a bronze tip and iron tang (p. 86) and an iron spearhead (p. 108). Two different explanations are most often suggested for this almost total lack of iron: either that iron was more costly than bronze or that it was common, but was avoided in this tomb because it is not permanent (iron rusts). I have always favored the second explanation, since the First Emperor was clearly obsessed with permanence, as demonstrated for example by having placed stone inscriptions on mountaintops describing his accomplishments and (according to later legend) sending explorers out to find an elixir of immortality.

Thousands of bronze–iron arrowheads, very similar to the bronze–bronze arrowheads, have been found in Chinese sites from the Warring States period and perhaps even earlier (see "Table of sites and remains" pp. 164–295, column 3; Barnard and Satō 1975:119); I believe it is correct to say that very few arrowheads made entirely of bronze, or perhaps none at all, are known in Chinese archaeology outside of this tomb complex. The bronze–iron arrowheads have the bronze tip cast onto the iron tang, just as the tips of the arrowheads in this study were cast onto bronze tangs. It is difficult to see a practical reason for the division of an arrowhead into two bronze parts (but see pp. 94–95), but it could be explained if we suppose that, within an ongoing, very large-scale production of bronze–iron arrowheads, bronze tangs were substituted for iron tangs to meet the demands of an obsessed Emperor for his tomb.

Measurement of 126 ferrules, classified in three types, indicates close uniformity of outer dimensions but less uniformity of inner dimensions for each type. This is no doubt because the outer mould for the ferrule would have been used repeatedly, while the core would have been made separately for each casting. Foundrymen prefer a crushable mould-core because castings shrink as they solidify. At the other end of the long weapons, spearheads and dagger-axe heads were too few for statistical study, but the studies here of these artifacts do give more information on this type of artifact than we have otherwise had. One entire halberd was found, with ferrule, wooden shaft, spearhead, and dagger-axe head; its total length is 2.87 m.

Appendices (pp. 151–221) give the details of dimensions, inscriptions, and exact find location of each of the hundreds of artifacts treated in the study. The conclusions to this study concerning standardization and production organization are general and rather tentative, but they will no doubt have a place in future wider studies of Qin production based on epigraphy, historical sources, and excavations of workshops. The great contribution of the book is its study and extended demonstration of a complex of methods to approach these questions. Its intensive study of the artifacts themselves will be widely useful in Chinese archaeology.

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Kingly Splendor: Court Art and Materiality in Han China. Allison R. Miller. New York: Columbia University Press, 2021. xii + 348 pp. Hardcover US $65, ISBN 978-0-2311-9660-4.

Reviewed by Margarete M. Prüch, *Institute of East Asian Art History, Heidelberg University*

Kingly Splendor: Court and Materiality in Han China is a masterful and thought-provoking book. It provides new insights in the well-researched era of the Western Han dynasty, mainly concentrating on the first sixty years of the dynasty (202–161 B.C.E.). Miller focuses on the archaeological evidence, especially the materials found in Han period tombs, written