'Han' Ji & the obsolescence of bronze weapons

The bronze dagger-axe still remained in use for a short time during the Western Han dynasty, as it is depicted in West Han art. Its extremely rare appearance in Eastern Han graves (Yang 1992) I would consider as tomb items only (*mingqi:* for 'use' by the deceased). Bronze weapons at that time were long since obsolete. Han period *ge* were closest to the appearance of Qin ge with a long hu but often a very long nei also. This nei was sometimes sharpened. Figure 2, as shown in the initial introduction & shown above, is an example of Han dagger-axe of a functional design. As such this represents the final use of a fully mature form of dagger-axe weapon before they vanish from combat.

A new & very different weapon, also called a *ji*, became the main polearm of the Western & Eastern Han period. This was the Iron Age successor of both the bronze *ge* & 2 piece *ji.* For ease of understanding I will refer to this type of weapon as a “Han ji” due to its very different nature, although the actual origins are slightly earlier in the late Warring States period.

Figure 61: iron Ji halberd of late Warring States style.

The dagger-axes disappearance is roughly contemporary with another break with the ancient style of warfare. During the Western Han dynasty chariot formations vanished from the battlefield. Chariots went into a decline from the late Eastern Zhou but they were still used both in the Qin dynasty and beginning of the Han dynasty as there is both historical and archaeological evidence for this. The possible reasons for their final obsolescence are varied; it is quite likely that there were many contributing factors. Chariots in the Western Zhou to Spring & Autumn period were just as much about show as about military efficiency. Elaborate extra fittings and bronze decoration show the vehicles to also be part of a culture that mixed ceremony/ritual with war & sport. In the Warring States period as the nature of inter-state war became more *outcome* focused rather than *conduct* focused the chariot was both simplified structurally and the mechanical design of the halter & wheels improved. (So & Thorp 1993.) At this time the most elaborate & weighty fittings were abandoned. The chariot was still an expensive item but apart from redesigns which may have improved its effectiveness the small & stocky stature of the native ponies may have been better suited to act as chariot teams. As the territories of the various Warring States expanded, especially as Qin & Chu penetrated into the south of China, the terrain became less suitable for chariot warfare. In the Spring & Autumn period with battles at an agreed time and place the chariot would perform well, but the southern style of warfare relied more on infantry based forces (Rawson 1980).

In the 4th century BC the Zhou first adopted cavalry archers, traditionally attributed to the will of King Wuling of Zhao. This was controversial as it was seen as against Zhou custom to emulate the ‘Hu' nomads of the north. Worse still it required the adopting of Hu nomadic dress. The Chinese had defined themselves as a cultured people who wore certain clothes and their hair in a certain fashion. The trappings of the mounted nomad were barbarism personified.

The wearing of trousers by the Hu nomads is another example of the broad homogeneity amongst steppe cultures. Trousers were much more suited to both a cold climate and a mounted lifestyle. This was no conciliation to Zhou cultural conservatives. Numerous features show the Hu to be a Scyth-Siberian branch of Eurasian nomadism. Trousers are also recorded as worn by Western Scythians in the 5th century BC by the Greek historian Herodotus. A comparison between Scythian saddles from the site of Pazyryk (5th century BC) & the saddles of cavalry in the Buried Army confirms a steppes inspiration for Chinese cavalry (Michaelson 2007). King Wuling was therefore condemned for such revolutionary pragmatism. He put it well when he said: *"..a talent for following the ways of yesterday is not sufficient to improve the world of today*" (Di Cosmo 2002) No doubt connected to this revolutionary idea, a new artefact appears during the Eastern Zhou period: The bronze belt hook. This was naturally required for a people that would begin to wear trousers. Belt hooks became a common item in China, not restricted to cavalrymen, they also became objects of adornment for those with the wealth to have their belt hooks gold gilded or inlaid with glass, jade or silver.

With the formation of the Qin Empire in 221BC and then establishment of the Han dynasty in 212BC Chinese armies were to begin an even greater expansion of territory beyond the central plains. Han China's contemporary 'barbarian' enemies in the south & southwest required combat on terrain completely unsuitable for chariot based warfare, such as rivers, contours and vegetation. On the northern frontier there was the serious threat of the swift mounted archers of the nomadic Xiongnu cavalry. Even massive Chinese armies based on infantry and attacking chariots had shown themselves to be too cumbersome in matching the initiative of large formations of nomadic horsemen ('*Hu*' barbarians). In Qin times these Hu barbarians were still fragmented tribes and were successfully driven from the Ordos region by General Meng Tian. Soon after a new nomadic empire united under a 'Chan-Yu' {Wades Giles '*Shan-yu*'} named Modun became a serious threat to Han China. In the early Western Han period the Emperor Gaozu (206-195BC) had personally suffered a military defeat when his army was lured by a feigned retreat and then cut off by a large Xiongnu force: "*When the Han came to power, Gaozu ...was surrounded at Pingcheng, and put in great danger. Taizong ... was forced to submit to the humiliation of presenting tribute*."[52]

A political solution & generous treaties were used by the Chinese to appease the powerful Xiongnu steppe empire whom thereafter were treated as equals. It was recognised, for a period covering generations, that China lacked the right resources to fight the Xiongnu warriors on their own terms. Only political solutions and long term subversive strategies were realistic (Di Cosmo 2002). During the reign of Emperor Wudi (141BC-87BC), Han China was ready to openly abandon such treaties & diplomacy. The resources available to Wudi were due only to generations of consolidation by his predecessors, and his wars still heavily burdened the country. Cavalry-based Chinese forces were needed to conduct swift campaigns against these nomadic horsemen, and more crucially horse breeding to cover heavy losses in massive steppe & desert campaigns. Efforts were made to increase Imperial horse reserves, encourage breeding, both to raise numbers and improve the bloodstock of physically small ponies. Exports of horses were forbidden. Exemptions to military service were offered to those who bred horses. Imperial pasturelands were created. By the end of Jingdi's reign there were 300,000 horses available for future campaigns [53]. Han historians record loses on campaigns that justify these preparations in depth.

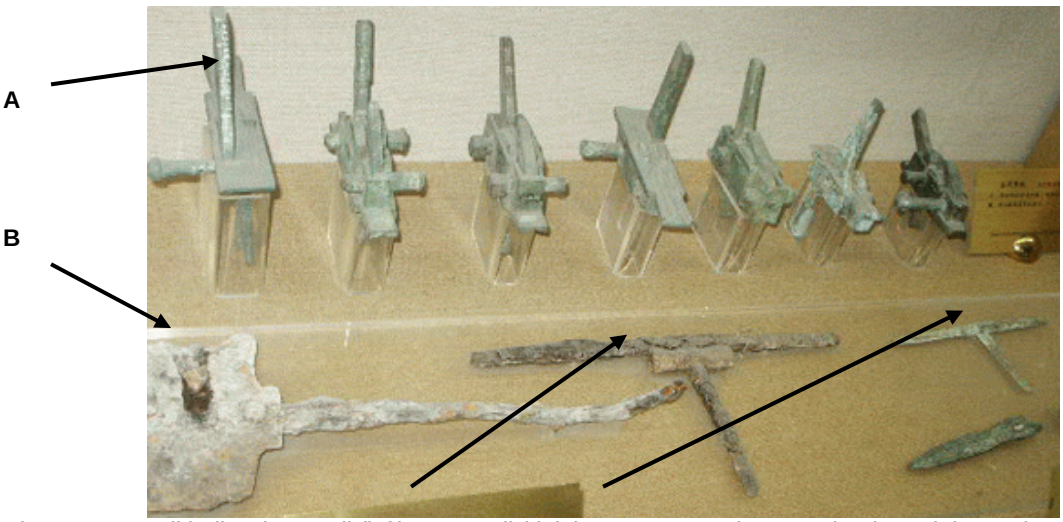

*Figure 62: Han ji halberds. Iron ji (left). Bronze ji (right). Bronze crossbow mechanisms (**A**). Iron buckler {guo xiang} (**B**).*

In contrast to dagger-axes and chariots of the ancient period we then see a change to new weapons and light cavalry forces. Miniature ceramic warriors dating from the early West Han period at Yangjijang near Xian show that such light cavalry were armed with either bows, with quivers on their backs, or with halberds [54]**.** Comparing the ratio of cavalry to infantry/chariots in the Qin buried army, the statistical information from Han buried armies shows a growing percentage of cavalry.

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52) John E. Hill: 'The Western Regions according to the *Hou Hanshu*'.2003.
53) Victor Choi: 'Horses For Eternity'. 2007
54) Carol Michaelson: 'Gilded Dragons'. 1999.

Chariots are represented in some early West Han ceramic armies [55] but show a comparatively diminishing presence. In the same buried army that surrounds Emperor Jingdi's (157BC-141BC) tomb we have no examples of dagger-axes amongst swords, spears, and other weapons, all of the halberds in Yangling tomb are of iron & of the “Han ji” type. Thus the dagger-axe was not to be found in a Han buried army from the mid second century BC.

Just as the dagger-axes long history on the battlefield drew to a close so did the battlefield chariots role as a combat formation. Certain types of chariot fittings that were used for centuries are longer found after the West Han period. Chariots depicted in Han tomb lintel art simply represent nobles on hunts, although some chariots may still have carried drums and banners for battlefield communication. Han Generals still carried titles such as “General of Chariots & Cavalry” but the forces historically recorded in late-West Han campaigns are comprised of infantry, crossbowmen, cavalry & even Hu nomad auxiliaries. By the Eastern Han period the ‘chariot’ title remained, but was given as an honorific to non-military men & palace eunuchs, a sinecure of no real responsibility [56]. The chariot was no longer a basis for a military formation nor was it buried with nobles as an expression of might since it did not represent armies of the period. The final demise of the ge as a weapon of war is closely followed by the end of this chariot era.

Figure 63: Han bronze ji. Length 27cm.

Figure 64: Iron ge from the 2nd century BC.

A major reason for the demise of *ge* quite separate to the decline of the chariot was that steel would finally replace bronze weapons during the early to mid West Han period. Great advances were made in the workmanship of iron and the quantities in which it was produced. The significance of this is because the 'Han' *ji* has a form more suited to manufacture via iron working. The complex silhouette of the dagger axe was more suited to casting. Weapon steels were wrought into shape by hand so this is reason enough to redesign & simplify the standard halberd for mass output from iron foundries. Figure 61 is a rare iron type where perforations were added to an iron blade. Such a shape would require a mechanical press and then working of holes through forged iron, a more difficult task & one that can be seen to mimic the perforations that were routinely produced on cast bronze weapons, specifically *ge*. There is scant evidence for attempts at making iron *ge*. One example of such an experiment was found in the tomb of the King of Nanyue in Guangong (64). The blade angle and the setting of the counter-balanced blade (a form of *nei*) means this is not a *ji*.

Weapon steels required skilled artisans who controlled the amount of carbon in the iron and altered the microstructure of the blades by tempering and quenching. The qualities of superior steel were well appreciated, as sword blades were inscribed with declarations of the number of times the steel was tempered. Bronze technology for blades had long since reached the limits of their potential. In contrast the steel industry was up to a very high standard & output by the late West Han. Steel production was made into a government monopoly during the reign of Wudi. The decline of bronze weapons would have been steady throughout the early West Han based on the diminishing numbers of bronze swords across early to mid West Han graves (Yang 1992). For a short time bronze *ge* & Han-style bronze *ji* would be wielded by warriors in combat. Eventually only steel weapons & only the *ji* would be carried to battle. Early steel & bronze had existed side by side for centuries before the Han period. The use of steel for weapons was far from universal amongst Zhou states nor was such steel of consistent quality. In the Han period this changed. To understand the persistence of bronze weapons in China the qualities of the earliest steel should be examined. Early ‘steel’ was not comprehensively superior to bronze during the late Eastern Zhou period. I will discuss this in a later section on iron & bronze metallurgy.

The Han period represents a belated end to ancient styles of warfare. The Han had new materials, new tactics & new weapons. Amongst these was the new ji weapon. It is shown in Han-era art as being used by a cavalryman to drag another horseman from their saddle (Cheng & Zhong 1991). The spear-like point and projecting side blade would make this a good weapon to either face horsemen, or to be wielded by horsemen. Such contemporary art of its use from horseback suggests the point perpendicular to the shaft was driven into the side of the enemy and used like a fisherman’s gaff to topple the enemy from their mount.

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55) Wu Xiaocong: ‘Han Yangling Museum’ 2004
56) Rafe de Crespigny: ‘Later Han Military Organisation’. 1996

In the context of the Xiongnu threat there is a well preserved discussion on Han military capabilities.

The Han Shu records the councillor Chao Cuo (晁錯) advising Emperor Jingdi on military strategy :

平陵相遠，川谷居間，仰高臨下，此弓弩之地也，短兵百不當一。兩陳相近，平地淺草，可前可後，此長戟之地也，劍楯三不當一。萑葦竹蕭，中木蒙龍，支葉茂接，此矛鋋之地也，長戟二不當一。曲道相伏，險阨相薄，此劍楯之地也，弓弩三不當一。

*The plains between hills, large valleys around a river, slopes of hills, these are bow and crossbow country. Even one hundred short weapons could not oppose one of them. When two armies are close to each other, flatlands with scarce vegetation, where one can move forward and backward, these are **ji halberd** country. Three swords (jian) and shields could not oppose one of them. Reeds and bamboos, where plants and trees cover the earth, where branches and leaves are close to each other, this is short metallic spear (yan) country. Two long polearms could not oppose one of them. Winding paths which hide armies, narrow gullies and obstacles, this is sword and shield country, three bows or crossbows could not oppose one of them*."…..[57]

The ji halberd is also mentioned during Chao Cuo's comparison of Xiongnu & Han military strengths. As warfare in the Eastern Zhou had revealed there were limitations to the use of chariots. Chao Cuo explains that in the presence of ditches and gullies, streams & rivers, hills or bush one footsoldier is worth 2 chariots but on an open unobstructed plain however one chariot was worth 10 infantry (Yang 1992). The crux of the military problem was however the Xiongnu, a nomadic people born into a saddle and mounted archers of excellent ability. In facing them Chao Cuo noted their equestrian skill & archery which the Chinese could not rival. Even the nomad's ability to withstand a savage climate & hardships was credited to them. The Han military was superior in certain aspects over the nomads:

"*Given flat ground* {the Han light chariots & charging cavalry 輕車突騎 [58]} *could throw the Hsiung-nu {Xiongnu} mass into confusion: strong crossbows and **long halberds** could strike at a distance and the Hsiung-nu found them irresistible: equipped with stout armour and sharp swords of various types, and crossbows, the Chinese serviceman could advance in formations of five to ten men which the Xiongnu could not confront; they could concentrate volleys of arrows on a target in a way that the leather armour or wooden protection of the Hsiung-nu could not withstand: and, finally, the Hsiung-nu were no match for the Chinese when fighting dismounted or at close quarters*."(Psarras 2003).

In quoting Chao Cuo, Yang Hong's & Sophia-Karin Psarras' translations differ in that the former only mentions chariots the latter only mentions cavalry. This is an important point as both chariots *and* cavalry were still in use during the early West-Han (as this amended passage states). Chao Cuo's passage supports the point made by Di Cosmo that the Han military was still in a period of transition before Wudi's era, in contrast Psarras suggests the Han has sufficient cavalry to confront the Xiongnu before the reign of Wudi. I am of the opinion that given the strain that Wudi's war placed on Han China that Di Cosmo is closer to the truth in that the Han required consolidation and preparation in depth before meaningful war was possible. While Chao Cuo was certainly optimistic, since the elusiveness & mobility of the Xiongnu was as much a problem as their mounted skill, the passage provides good account of the equipment of the Han. Iron lamellar armour, powerful leg loaded crossbows (which could outrange an arm drawn composite bow) and steel halberds and long bladed steel swords. The Xiongnu were not inclined to stand and fight such formations but one infamous Wudi-era battle shows Chao Cuo correct:

"....{*Chief Commandant* } *Li Ling...led his troops {30 days into the steppe}...and arrayed them, ordering the front ranks to bear {polearms} and shields and the rear ranks to bear bows and crossbows. At the sound of the drum they were to advance; at the sound of the bell they were to stop. The Huns attacked, and Li Ling's footmen awaited them unflinchingly, while a thousand cross-bows, which outranged the Hun {recurve} bows, were discharged at the Huns. The effect was terrible; the Huns fled to the mountains"* (Legge 1898).

Before Wudi's reign the Han had been required to use non-military means to manage the Xiongnu. The Heqin treaty was a subversive strategy where nominal peace was secured by extending gifts to the Xiongnu leadership. Han maidens presented for marriage were seen as a means to soften the sensibilities of their ruling house. The frontier was garrisoned and periodic incursions by very large Xiongnu forces were endured by the Han who mobilised in response to each raid. Several times it is recorded that by the time Han forces mobilised in numbers to drive away large raiding forces the Xiongnu had already drawn back over the frontier with booty and captives. Wudi was able to use all the resources built up by the peace his forebears gained and struck the Xiongnu across the frontier. The economic strain of pursuing war with the Xiongnu was lamented & debated in ancient times and the war was not immediately conclusive:

"…*{Sima Qian} gives a picture of the economic calamities that came upon his country while Emperor Wu was exhausting the reserves accumulated during the peaceful reign of Emperor Wen. The Emperor drained the country...The wastage in the army was especially great...In 129 B.C {defeats}...lost 7000 men. In 123...more than 3000 cavalry were killed or surrendered. In 121 {defeats}....lost most of 4000 men. In the strenuous campaigns of 119 {steppes campaigns caused losses} by the ten-thousands, and more than a hundred thousand army horses were worn out and died. In 103, Li Kuang-li lost eight to nine-tenths of....of several ten-thousands of men. In 102, Chao P'o-nu was captured {along} with 20,000 men. In 101, Li Kuang-li brought back from Ferghana only ten thousand-odd out of sixty thousand men. In 99, he again returned, having lost six to seven-tenths of a much larger force. In that year all but 400 of Li Ling's 5000 famous foot-soldiers were destroyed*...{etc}." (Legge 1898).

Wudi did not live to see the final breaking of Xiongnu power. He left many issues behind for the Emperors that followed him, but his belligerency had succeeded in fragmenting what was a formerly united steppes empire.

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57) The HanShu: extract from the 19th Biography. Translation by Francois Charton.

58) Yang Shao-Yun: personal correspondence.

59) Donald Wagner: 'Early Iron in China, Korea & Japan. 1993.

Not until the late reign of Emperor Xuan (74-49BC) after losing much territory to repeated Han offensives was the Xiongnu confederacy facing internal fragmentation. Once driven from their expansive grasslands the pastoralist Xiongnu Empire was in crisis. From the Han Shu:

…"In the past, the Huns many times made border raids and the people were injured by them...{now}...Various [Hun] kings simultaneously set themselves up and divided [the Hun realm between] five Shan-Yü. In turn they attacked and fought with each other.... the [Hun] flocks and herds have been largely destroyed...and their people are hungry and starving.... Because of these...disturbances...Shan-Yü Hu-su-lei....surrendered [to Us]....Shan-Yü [Hu-han-hsieh] called himself [Our] subject....The northern borders are at repose and have no military concerns." (Legge 1898).

The 'ji' which became standard within this grim context was to remain the most important polearm or "long handled weapon" during the Han dynasty (Yang 1992.)

The first appearance of this style of halberd occurred in the late Warring States period and included both a perforated type (see figure 61) and a simpler form, often with a bronze cap which joined the shaft to the blade. This second type of iron was standard during the Han period (see figure 62). It had been used at the final stages of the Warring States period by the state of Yan and made in early steel [59]. Being forged as a single object it might be compared too the West Zhou style of *ji*, but had a unique appearance. Examples of this new type of *ji* were found within a mass grave of 22 soldiers of the state of Yan, along with iron armour, swords and crossbows, dating from the late 3rd century BC. For states like Yan, which made weapons of iron, the *ji* is more suited to weapon production than the form of the bronze *ge*. This is probably an important reason the Han adopted this design from Yan state. Apart from ease of output there is an economic case for switching to iron *ji*. While the quality of Yan steel is a separate issue, iron ore is typically a more abundant resource hence cheaper as a base material. Bronze compositions as used by ancient Chinese in comparison required 3 metals to be mined and then combined into an alloy, (copper, tin & lead). We can then add supply of raw material to a list of reasons that iron *ji* would come to replace bronze *ge*.

The common 'Han' ji returned to a right angled side-blade and would be more a puncturing instead of hooking weapon. This basic form of *ji* was then used for over four centuries. In the post Han period the standard *ji* of this sort faded from use and more commonly the side projecting blade was *upturned* to create a second thrusting point. The period of weapons development after the Han dynasty is however beyond the present scope of this article. Some examples of Han ji exist with angled & upturned blades and even one published example that appears like a mix of both *ge* & *ji* which used a more open angled side projection (Cheng & Zhong 1990). Like the unusual form of figure 64 we can infer that the persistence of the basic *ji* with a sideways projecting blade over such a long period of time shows Han military minds were satisfied with this form as the standard.

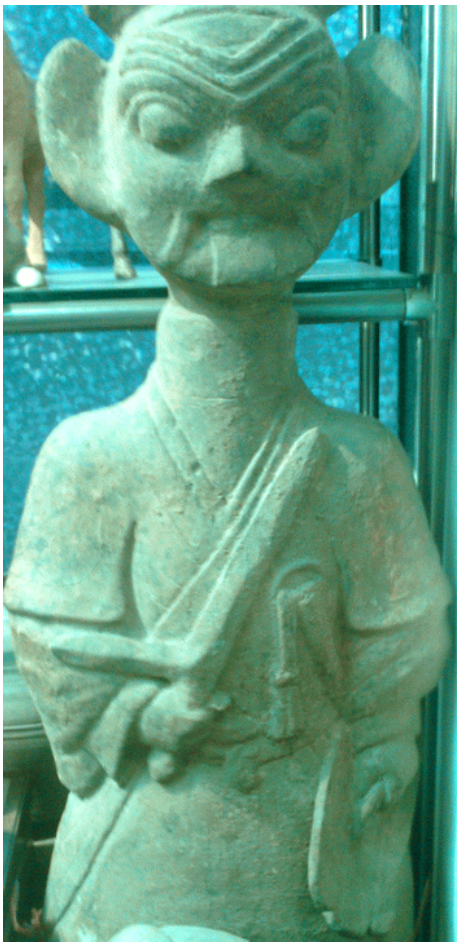

Figure 65: Han period figure with hand halberd

Another unusual variation on the *ji* halberd is a hand halberd of much the same form. As shown in Han art we can see that it was gripped in the manner of a sword. A depiction of combat in Han-era art shows this hand halberd being used along with a special sort of iron shield, a buckler called a "gouxiang" which had a hook &/or a spike. A portion of a corroded iron hook-shield can be seen in figure 62. This very curious looking tomb guardian (figure 65) can be seen to be holding one of these hand halberds, along with a shield. He also has a ring pommeled dao (with tassel) tucked into his belt. This creature (?) is in a lively Sichuan style, such distorted features are emphasised so that they instill fear into malevolent spirits. This tradition of semi-human tomb guardians began in the Eastern Zhou period.

Pole-mounted bronze *ji* had a similar form to iron *ji* but there is one difference. Iron *ji* are typically larger. In the Eastern Han period these steel *ji* were larger still. Some immense blades of 60cm in length (Yang 1992) would then be almost twice the size of similar bronze examples. A Chinese museum specimen here shows such a large ji example (figure 66) alongside swords in the region of 80-100cm. In the early West Han the scaled-down weapons of a miniaturised buried army at Yangling provide consistent evidence the iron *ji* were not so immense at this early date. The larger size available to weapons made of steel was another advantage over bronze. Making a long iron blade is not inherently more difficult than making a short blade, but casting long blades of bronze risks cooling in the mold and the chance of flaws. Bronze *ji* are most often around 30cm in length across their greatest axis. My own feeling is that other than those occurring in the early West Han period the rest should be considered as tomb objects (*Mingqi*: for funerary use). This is my feeling for Han bronze weapons in general. They relate to the mortuary industry. Only the earliest Han bronze *ji* would be likely to have seen battle as the Han inherited a limited iron industry from the Qin dynasty where iron was used for purposes other than weapons.

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59) Donald Wagner: 'Early Iron in China, Korea & Japan. 1993.

While bronze *ji* can appear suitable for use in warfare their smaller size and the more effective & cheaper iron alternative would quickly make such bronzes obsolete. Bronze *ji* do preserve much better than ancient iron weapons and so act as a good representation of the form of Han halberds.By the mid-West Han period warriors were armed with steel weapons, bronze persisted only for arrowheads and crossbow mechanisms due to it superior casting abilities. With steel being produced in huge volumes at many Imperial foundries there is even evidence for the export of wrought iron steel plates (heat decarburized steel) to ancient Korea from such production (Wagner 1993). Weapons in Han style that are rendered in bronze commonly have features that suggest they were never intended for use; very light cross sections are quite common.

Figure 66:
Massive iron ji.

Han *ji* of bronze from anything but the early West Han period are therefore representations of more earthly {iron} weapons. The prestige & lustre of bronze led to its continued use in the Iron Age by people wealthy enough to commission objects for tombs. The production of grave goods was crucial for people who believed the afterlife was a material mirror image of life. The wealthy wanted to take their lifestyle with them. "*Chinese tombs were microcosms of the world known in life*" [60]. Meeting this demand was a 'mortuary industry'. With the competition for resources that would otherwise serve the living there were official Imperial regulations on the quantities of bronze that were allowed to be used in tombs according to the social rank of a given individual. Since full sized & functional bronze weapons were buried in the Eastern Zhou period, with less evidence for miniaturization at that time, the consistency of light bronze weapons in Han tombs is related both to this cultural belief, demanding objects for the afterlife, and the worldly concerns of Empire. Bronze coins were one basis of the Han economy (along with silk & grain) so these economic restrictions help us understand the existence of Han weapons of otherwise impractically light construction. Emperor Wendi (180BC-157BC) lamented that providing tomb furnishing for the dead could impoverish families. Prohibitions on the use of jade, silver & bronze for burial with the dead were then put in place by the benevolent & frugal Emperor (So & Thorpe 1993). This prohibition is why the famous tomb of Lady Xin, marquise of Dai, yielded masses of miraculously preserved silk objects and lacquerware. The extreme care with which her tomb was sealed at Mawangdui was based on Chu culture tomb construction and the huge inventory of silk was due to furnishing a burial within the bounds of an Imperial edict.

Wendi was sincere in his concern. As he contemplated his own death and funeral he announced:

"*We have heard it [said that], of all [plants and animals] that sprout from or are born to any of the beings in the world, all of them, it seems, have to die. Death is a law of Heaven and Earth, and the nature of things. [Then] how could it be [so] greatly lamentable? [But] in the present age all esteem life and hate death; they elaborate burials, thereby ruining their estates; they perform a rigorous mourning, thereby injuring their health. I disapprove of this very much.....Do not make a display of chariots or soldiers' weapons, and do not send people to wail and lament in the palaces or halls*".....{The Han Shu records:}…"*When he constructed the Pa Tomb, he altogether [used] objects of pottery and did not allow the use of gold, silver, copper, or tin as ornaments. He took advantage of [the rise of] the hill [where] his [grave was built], and did not raise a mound [upon his tomb].".…*

Wendi's concern was not shared by his peers and the scale of the expense & resources committed for Imperial tomb construction amazed people even in ancient times. From an appendix of the HanShu*:*

"Emperor Min [AD313-317] asked [So] Ch'en, "How is it then that there are so many things in the Han tombs?" [So] Ch'en replied, "When the Han [dynasty] Sons of Heaven had been on the throne for one year, they made their tombs. The tribute and taxes of the empire were divided into three parts: one provided for the ancestral temple; one provided for [the entertainment of] guests; one provided for the tomb. The years that the Emperor Wu of the Han [dynasty] enjoyed were many and long; when he died, the Mou Tomb could not contain any more articles and its trees were already two spans [in circumference]. The `Red Eyebrows' [a group of bandits, ca. 23 A.D.] took the articles from the tomb, but could not diminish them by half. Today the decayed silk is still left there, and the pearls and jade have not yet been exhausted." …(Legge 1898).

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60) Jessica Rawson: 'The First Emperor. China's Terracotta Army. 2007.

Figure 67: Han bronze ji. Length: 27.5cm

In confirmation of this the locality surrounding Wudi's tomb has still yielded celebrated artifacts in modern times, even without any exploration of the tomb itself. From this we see just how grand such tombs were, how much expense was involved. Naturally those beneath the Emperor sought to follow this fashion as best they could. Nobles and people of progressively lower ranks then strove to outfit tombs according to their station. Peripheral pits around the tombs of the wealthy reveal that miniaturisation was common in the Han mortuary industry. Of bronze weapons, and for those operating within restrictions according to social rank on the volume of bronze allowed, we then have lighter full-sized weapons or scale miniaturized weapons. I can also outline why I am convinced my own example of a ji (figure 63) and likely many other similar such pieces (figure 67) are *mingqi* items, rather than ever intended for use, based on an associated Han artefact.

Figure 68: Han sha. Length: 29 cm.

Sha & Mingqi

The weapon above is a form of Han polearm called a Sha 鎩. This example was made as a pair, which seems a popular practice. The partner weapon has suffered from burial compression. It had lost the crossgaurd and the blade is fractured, but it is the same. I am certain such sha were never intended for fighting as figure 68 has several points that make this improbable. Bronze weapons appear to be luxurious substitutes for Han steel weapons. The battlefield versions of sha were a similar steel blade with a more robustly constructed bronze guard cast around it, using the benefits of the steel edge and the casting abilities of bronze in one. The sha gives some protection to the wielder and is superior in this way to both the spear and *pi:* a double edged sword-spear (Cheng & Zhong 1990). While some bronze sha may be more robust Stephen Selby is also of the opinion his example, figure 69, is *mingqi* also. Both these bronze sha have a conspicuous loop, perhaps for a tassel. Other bronze sha are comparable to these in form & size. In contrast a detached sha guard (figure 70) of more substantial construction has the appearance of the style cast around a steel blade. In that instance it appears the blade was iron/steel and fitted with a tang onto a wooden pole with rhomboidal cross-section. The bronze piece covered the junction. [61]

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61) Stephen Selby: personal correspondence.

The sha is classified as a type of pi weapon in a Song edition of the Eastern Han dictionary: the Shuowen Jiezi.

鎩：鈹有鐔也。从金殺聲。("*sha: a pi that has a sword's crossgaurd on it. Contains the metal radical and sounds like* '**sha**' [kill]") [62]

The pi 鈹 was a weapon which first appeared in the Eastern Zhou period and was like a double edged shortsword (*jian*) on a spear pole. The sword blade had a tang, rather than an integral hilt, which could slot into a pole and was then pinned through the tang. The sha evolved from the pi rather than an ordinary spear. The bronze Han sha have a socket, more like a spear, but it seems likely steel sha had the more conventional tang. As evidence of an evolution from a pi weapon a transitional Eastern Zhou sha in a private collection shows just how the sword-spear with tang evolved into the slender sha with the swept forward crossgaurd. Figure 71 is certainly an Eastern Zhou weapon as the narrowing of the blade is a feature of the short thrusting sword of that period and was not present on Qin or Han swords, nor Qin or Han pi. Such a weapon is robust & entirely practical. This is the ancestor of the Han sha of steel, and the Han Mingqi. sha of bronze.

Figure 69: (above) Han sha.
Figure 70: (left) robust sha guard.
Figure 71: (below) Eastern Zhou sha.

Of the various types of sha just outlined I will now explain why I believe a bronze such as figure 68 was never intended for fighting. Since I could examine my own sha closely I could see the blade is slender and light, but still potentially functional. One common feature of Mingqi is also that the blade does not seem to have been ground down into a functional and sharp edge in the way a combat weapon can be. What conclusively shows it is impractical for function as a weapon is when I examine the socket. It is cast extremely thin and the socket shows a pole for slotting into this weapon at this location was only 15mm in diameter. Of many other socketed weapons of the Eastern Zhou, spears etc. their sockets are a third as broad again or much more at this point, and sufficient in strength to use in battle.

A thin pole such as this sha was attached to was too slender to take rigors of combat.

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62) Yang Shao-Yun: personal correspondence

The thinness of the bronze socket means a potential for breakage under stress, as I can see occurred on one comparably thin-walled spear socket I have examined. The sha also has several air bubbles visible on the surface, tiny holes from gasses trapped in the liquid bronze. One such hole goes through the socket wall. While these holes are tiny, less the 1/2 a millimetre, and not uncommon on ancient bronzes, they look to me like they could cause critical failures in the structure when such a light weapon is subject to stress or impact. A robust cast sword might survive with a few tiny bubbles in the bronze but this would be a real weakness for such a light piece as this sha. This feature of cast bronze is one reason long slender bronze swords are less practical than long slender iron swords, and also why it was important for a bronze artisan to minimise gasses that were trapped in liquid bronze before the casting of an object. The sha socket is show below. Two features of note are the variation of thickness along the wall of a socket (a minor imperfection common in many ancient castings) and the presence of partly mineralised wood along the interior wall. This shows that the mingqi weapons of this type were still attached to poles before burial.

Figure 72: Sha socket with wood fused to the mineral corrosion.

Since mingqi were created to smaller scale or were a lighter in construction it means their poles, such as belonging to this sha, were more slender than that used in combat. Excavated poles for mounting combat *ji* in the West Han period were a length of 2m (Yang 1992). This is a less cumbersome length than the longest poles of the Eastern Zhou, but still offered a polearms greater reach when compared to 'short handled weapons' such as swords. The bronze *ji* (figure 64) would have been on a similarly slender pole as the sha above since it appears to be from the same cache as the pair of sha, and likely made by the same hand. There is a distinctive & atypical earth encrustation on the three associated pieces (ji & 2 sha). The surface corrosion was consistent between them which indicates a similar bronze alloy and environmental conditions. The cross section of their blades, the manner of the polishing (consistent ancient abrasion marks) and general feel all indicates the items are part of a single hoard from the same location. Although the bronze *ji* does feel practical its association with the sha leads me to believe that it, and most other bronze Han weapons of similar appearance, are lightweight objects and not intended for use. It also means such weapons, based on the sha socket, were put onto smaller slender poles & if these were proportionate, length to diameter, as much as a quarter shorter than battlefield versions, i.e: perhaps 1.5m long *mingqi* polearms.

In discussing the poles that such weapons were mounted on there are 2 aspects of ancient polearms that show their own evolution and the influence of fashion across the long history of *ge* & *ji*: Pole cross-sections and pole decorations.

The poles for weapons used in ancient China could be a strong bamboo, or a hardwood, or even hardwood which was then covered with bamboo strips, bound by cord & lacquered (Yang 1992.). Such composite poles have the benefit of strength and durability….and beauty. Examples of poles painted with curving or geometric decorations and then lacquered in the manner of ornate lacquerware have been unearthed from ancient tombs. While spears could have a simple circular cross-section the poles of some dagger-axes & *ji* & pi-spears had either an oblong-egg shaped or tear-shaped cross section. This can be seen by examining the shapes of bronze caps which decorated the base of these poles and the consistency of this cross-section.

There is a logical benefit to some of the shapes which became clear when I examined a *ji* artefact in my possession and considered the styles of bronze finials that fit at the bottom of a weapon shaft (called "*zun*").

Eastern Zhou ji & surface features of ancient bronze

The *ji* below is remarkable for several reasons. It has unfortunately lost the tip portion of the dagger-axe blade due to a break in ancient times. There is also tin-oxide corrosion and loss to the edges along the artefact. The form can still be seen to be quite unusual. It is, in my opinion, likely to date from the Spring & Autumn period. The blade has an obvious riser which is consistent with swords & dagger axes of the period. The rearwards tang '*nei*' used on dagger-axes is not needed for binding since the *ji* is socketed. In this instance the *nei* had been sharpened. Being a one-piece *ji* this is of a type more popular during the Western Zhou period but the piece is not likely to be so early. The sharpened rear is not in the manner which occurred in the late Warring States period either, it has a single axe bevel instead of the normal double-edge (see figure 55). Being Eastern Zhou, one piece & socketed, it is not a sort I have previously seen published. Having a socket on his piece does give some information about the pole it was mounted on.

The *ji* also has traces of wood, plant roots, cord binding, and crystallisation of the mineral patina which provides other forms of information. The earth encrustation is not like a typical silt-like alluvial yellow soil found on many Chinese bronzes. My feeling is it may not have been buried in such a deep strata as most other bronzes, as plant roots are rare on bronze weapons. A specific geological region may explain this atypical soil appearance but this bronze has been close enough to the surface to be imprinted with fine root patterns and hence closer to the 'topsoil'. The plant roots were in contact long enough for minerals to form around them, now the organic matter is long gone but form of the roots is preserved.

Figure 73: Ji halberd.

This halberd was socketed then pinned at the spear portion & also bound via perforations to a wooden pole at the dagger-axe portion. Small traces of wood on the side of other dagger-axes do survive around perforations, hu & nei. The wood grain on this *ji* shows the pole was a hard wood rather than bamboo. The location of 2 small patches of wood suggests the *hu* inner edge was slotted *inside* the pole with the actual pole being larger in diameter than the socket above the hu. By this I mean a suitable channel was formed in wood below the socket, and the hu slid into this while a final portion of the pole was shaped to fit the socket also. This would have required extra preparation of the pole, with a significant guiding channel for the hu to slide into the wood when socketed. It suggests the pole was broader than the socket alone would suggest. At the uppermost hole for binding traces of the original cord can be seen in the soil. These are not mineralised and would likely crumble if touched with a pin. No longer organic, they are just a form held by the soil. Nearby is a white-opaque amorphic mass which is possibly cerrusite or calcite {calcium carbonate}. Around the masses are also rods of a fibrous white crystal in tight clusters (see figure 76).

One intriguing feature of ancient patina is even a limited range of minerals can form in quite diverse textures and hues on the same object. Cerrusite is lead-based corrosion, due to the presence of lead in the bronze alloy. Fragile rod-like formations are also seen on geological specimens of cerrusite. Another similar looking opaque/white material, which instead forms from the soil rather than the bronze itself, is calcium carbonate, but calcium carbonate does not form in the same fibrous manner. The most common mineral that forms on Chinese bronze is malachite {copper carbonate}. For this reason Chinese scholars use the expression 'Green Bronze' for ancient bronze.

"青銅器"

A broad mix of colours can appear on ancient bronzes when the minerals cuprite & azurite also combine to create a mix of vivid green, red & blue in close association. Each mineral can potentially crystalise and produces its own geometric form. Cuprite cystrals {copper oxide} are especially attractive, being angular and ruby-red. A great variety of minerals form on bronze, or affix from the soil, but a comprehensive account of patina formation is not my intention here.

Organic materials which were in contact with the bronze surfaces also supply evidence on the situation the object resided within at burial. Wood from sword scabbards, cord from binding, corrosion products from iron, contact with other objects revealed by imprinted shapes, and the individual strands of coarse vegetable fibres or fine silk can be seen in woven textiles held by a patina. The weave of those preserved textiles which have been fully mineralized, also known as "pseudo-forms", survive through contact with corroding bronze. Minerals leech into and replace the organic form.

The surface of ancient bronze therefore preserves many features that would otherwise not survive.

Figure 74:
Plant root psuedoforms on ji halberd. Mineralised remains of formerly organic material. Nei of figure 72.

Figure 75:
Mineralised silk cord with wood atop preserved on the handle of an Eastern Zhou bronze sword.

*Figure 76: patina on ji halberd. Fibrous mineral masses (**A**). Traces of a coarse cord used in binding (**B**). Hu of figure 72.*

Figure 77 shows the atypical sharpened bevel of the rearward facing 'axe' on the *ji* (figure 73). This socket can also be seen as a compressed oval shape. The wooden poles cross section can be deduced as something like a tear-shape with the sharper angle towards the dagger-axe blade. Past the socket & toward the *yuan* is a raised shape on the bronze which abuts with the wooden pole of this shape. This completes and would match the shape of an egg or tear-drop shaped cross-sectioned *zun*. Zun were finials attached at the base of weapon poles also have this same shape. This reveals dagger-axe poles had a consistent cross-section, top and bottom. To make sense of this I will show some *zun*, and their sockets.

In combat such a pole shape meant the rounded part would be in the palm with the fingers gripped around the more acute (but still rounded) end. The blade could by feel always be turned out in the striking position by the touch alone due to this shape. In a thrusting spear a circular cross-sectioned pole would suffice but for the dagger-axe an angular pole meant a warrior shifting in combat, or adjusting his grip would always feel naturally how to present the weapon with the point facing at a striking angle.

Not all poles appear to have a consistent shape all the way along the pole. While it would be intuitive there are completely round zun that fit onto matching pi-spears. Such pi appear to have oval cross-sections close to the blade yet round at the lowest portion. Figure 69 shows an oval pole slotted into the area of a sha guard which is comparable to a pi. The detail 78 is of the sha artefact shown in figure 71. Its guard is also quite comparable to the detached ‘robust’ sha guard: Figure 70.

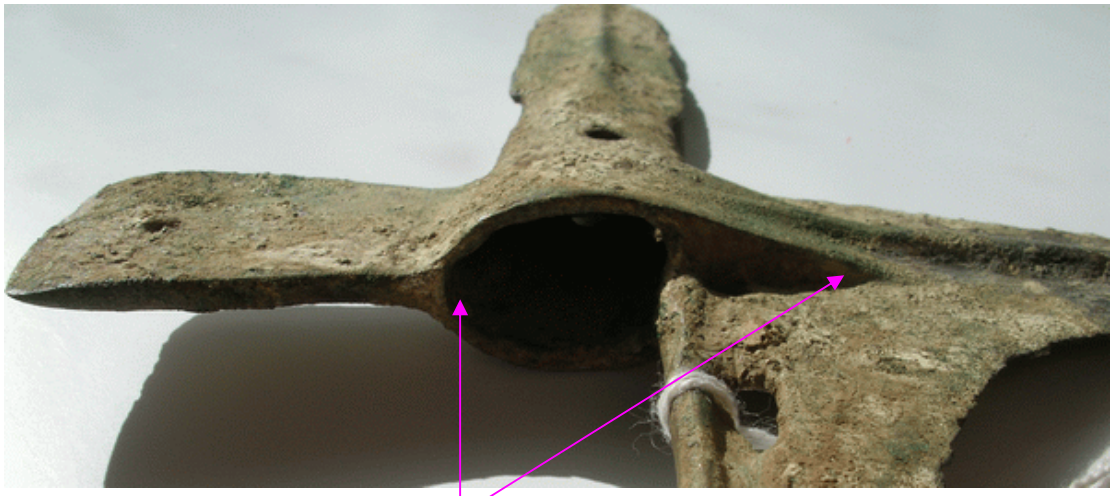

Figure 77: “tear drop” pole cross-section of ji {Figure 63}.

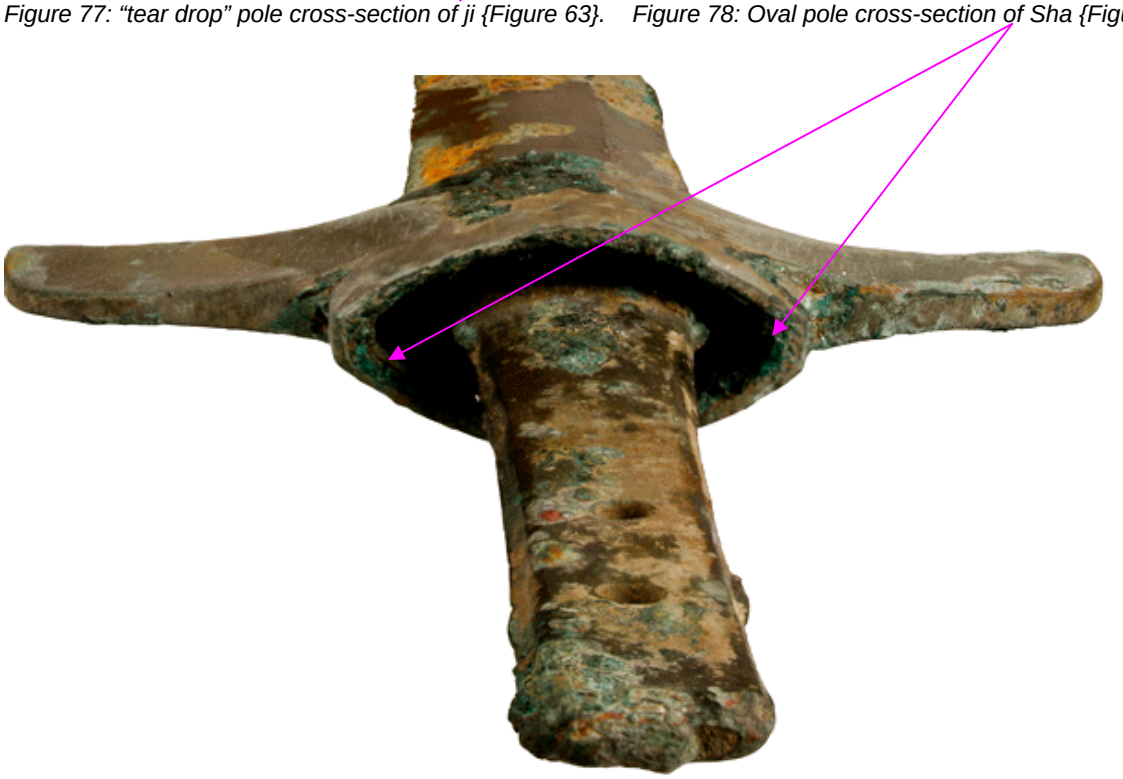

Figure 78: Oval pole cross-section of Sha {Figure 61}.

Zun pole finials

Zun 鐏 decorated the base of weapons poles during the Eastern Zhou & Han period. These took the form of bronze caps which were shaped to fit the cross section of the pole they were mounted on. Other types of ornaments were mounted at the top of the poles above weapons. An ornament of the upper sort, from the Warring State period, was shown earlier (figure 51). The bird finial with head turned to look over its back was also used in the West Han period as ornamentation for ge. The original motif was popular in Chu state (Rawson 1980).

The Han-era dictionary Shuowen Jiezi mentions both *zun* & *dun* pole finials:

鐏：柲下銅也。从金尊聲 ("zun: *the bronze at the bottom of a weapon's shaft. Contains the metal radical and sounds like 'zun'* ['respect']").

錞：矛　柲下銅，鐏也。从金　聲。("dui {or **Dun**}: *the bronze at the bottom of spear and ... shafts; a [type of] zun. Contains the metal radical and sounds like ...* .")

Unfortunately, there are two lacunae in this line, and one of them relates to how the character is pronounced.

錞 is also sometimes written as 鐓.

These two characters have multiple pronunciations ('chun', or 'dui', or '**dun**'). The distinction is based on the flat bottom of the dun style of finial [63], contrasting with the longer & narrowing base of the zun. The shape of the zun is possibly a visual metaphor for the tall wide mouthed bronze cups also called 'zun' This character may be a combined phonetic & ideogram.

The distinction made above, contrasting a longer & narrowing base of the *zun* to the flat bottom of the *dun* is the one I will adopt here.

The use of ornaments to decorate weapon poles goes back at least as far as the Neolithic Longshan culture. Battle-axes blades of jade with matching jade pole finials have been uncovered (Forsyth 1995).

During the era of early bronze weapons there are also examples of bronze pole finials. The depictions of ge wielded by Shang warriors shown earlier in this article, and even archaic ge pictograms, have a distinct branching to the poles base. This feature resembles a trident in form. Intricate Shang pole finials in the form of an eagle claw have been found that fit this otherwise enigmatic feature (Loehr 1956).These eagle claws are rendered in a quite realistic fashion. This type of finial was not used in later dynasties. It can be surmised that claw finials went out of fashion as it was a motif with cultural meaning to the Shang apart from such claws being a comparatively complex fitting to manufacture.

The addition of plainer cap-like finials to weapon poles became increasingly common during the Eastern Zhou period. These *zun*, and later *dun*, became fashionable in a variety of styles. They were mounted on axes, dagger-axes, ji, spears & pi shafts. The finials of the later type used surface decoration to add interest rather than having ungainly silhouettes. There were however many varieties along the theme of a bronze cap and some still had projections or crooked shapes for visual boldness. Another style of finial, such as unearthed in Eastern Zhou burials in Shangdong province, is notable for having a surface with large studs spaced out across it. These Shangdong examples are paired upper & lower fittings and identified as *shu* [64]. These finial pairings being called *shu* rather that *zun* or *dun* suggests they were capped on either end of a pole which was then used as a staff weapon. Stud projections then may have been both for effect & aesthetics. S*hu* is a name applied to a pyramidical thrusting point mounted like a spear, sometimes with heavy spiked fittings below. Examples of such polearms were found in the tomb of the Marquis of Zeng in 1978 and were dated to the middle of the Eastern Zhou period. *Shu* are then a certain type of bronze tipped weapon used for thrusting and striking.

If cap-like finials in pairs can be called *shu* it raises the question of distinction between ornamental fittings & striking surfaces. What was the function of *zun?* Differences that the Shangdong *shu* finials display when compared to *zun* or *dun* finials mounted with halberds is those '*shu*' have a socket with a purely circular cross section, some are studded, the tops are slightly bulbed and the base finials narrow only slightly and are mostly flat bottomed.

The bronze *shu* which topped weapons poles of the Qin Terracotta Warriors also loosely resemble *dun* but are purely weapon points in that case. The Qin *shu* have a simple point formed on the cap, formed with three steep sides, which visually connects them to the preceding era of 'pyramidical spear' *shu* of the 5th century BC. Their cross sections too are circular.

Even with *zun* finials a dual purpose of decoration and striking function is still possible in some instances. For the purposes of distinction then where the appearances of *shu & zun* are similar we can distinguish according to their position on the pole and/or potential combat function. Some zun which do seem to be very suited to offensive purposes are associated with the Dian culture of Yunnan province. Simple caps which narrow to a single point are on display at regional museums (at Yuxi & Kunming). 4 examples at the Kunming Museum are attributed to the Dian site at Jinning (Shizaishan) and were clearly useful as striking points.

Similar plain bronze zun with very suitable striking points existed in ancient China. One quite plain bronze finial mounted at the base of a spear shaft Yang Hong calls a *dun* and the author explains its role as "*protect{ing} the end of the {shaft}..as well as…used for fighting*." (Yang 1992.)

Figure 79: Spiked pole finial

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63) Yang Shao-Yun: personal correspondence

64) 刘延常 穆红梅 梁法伟:山东省新泰市周家庄周代墓葬;出土兵器的初步研究. 2003-2004

When we see very plain examples, or those that seem to have a suitable striking surface, then we can make such a conclusion. Supporting this notion are bronze finials, in the form of a bronze spike, which are known to have existed on the bottom ends of Greek hoplite spears. Called *sauroter* (lizard killers) their use is still debated. Potentially they could finish wounded enemies on the ground as troops advanced over them, or they could be used to strike if the spear was broken. Other suggestions are that they could be used to set hoplite spears in to the ground, or simply stabilise the weapon end of the spear. These are equally possible uses for a sharp pointed style of *zun*. It really seems common sense that those finials on halberds whose form lent themselves to a combat purpose would at times have been employed at such a purpose.

The finest examples of East Zhou *zun* however are quite obviously ornamental additions to poles for the purposes of beauty and decoration, and some are such great artworks that there need be no other intention beyond this.

In the Warring States period, with the development of fine inlay of silver, there began to appear beautiful inlaid specimens distinct to the earlier styles which had used elaborately cast decorations. Han *dun* also could display detailed surface enhancements with inlaid silver in cloud patterns. Inlay of silver is a feature of other bronzewares of the Han period as plainer forms of bronze competed in decoration with the painted designs available on luxury lacquerware. Silver was chosen more often than gold, as silver is very ductile and silver wire can be worked with ease. The Han appear to have favoured *dun* as finials. The Han military was reorganized and armed with different styles of weapons during the early West Han period. The *zun* type of finial disappears roughly contemporary with the ge. The plainer *dun* then becomes the standard. Preceding final obsolescence are examples of Han-era *ge* with *dun* finials within the tomb of the King of NanYue showing a transitional period in the 2nd century BC where ge had circular cross sectioned poles.

For individual warriors of high social rank their combat weapons could reflect their personal status. While the top of a pole contained a weapon (perhaps also decorated) the bottom caps of the poles were freer to display fine art or stylised shapes. While some *zun* or *dun* are plain figures 80 to 81 below show either inlay of silver or decorations which arise from a pattern worked into the casting of the bronze. Figure 81 shows a matching pair of zun with a beast face design, examples of which have been dated to the 6th century BC (Rawson 1980). The poles for this pair were 2.3cm along the broadest axis of the tear-shape which suggests the pair may be ceremonial if the poles slender dimension was consistent along its length.

The Han used bronze caps on the base of their weapon poles which were a different design to those more popular in the Eastern Zhou. Their *dun* were mostly in the form of stylised segments of bamboo in a cylinder shape. The socket shape of these was consistently an oval, to contrast with the ‘tear-shape’ which was common on East Zhou ge finials. Figure 82 shows a Han-style *dun* & the two *zun* in scale. The measurements are 11.3cm for the dun, 13.8cm for the large zun and 9cm in length for the silver inlaid zun. Their sockets are shown beside, top to bottom in the same order. The typical oval shape of the *dun* is visible while more acute narrowing on one side of the 2 *zun* shows the suggestion of the ‘tear-drop’ shaped pole. Such cylindral and flat bottomed *dun* were already used in the Warring States period, as evidenced by one quite plain Qin *dun* which has the name of the infamous minister Shang Yang on it along with the date of 343BBC. (Yates 2007). Another later *dun* pole finial (like a cylinder) being used by the Qin is shown along with wooden remains of a weapon shaft which was uncovered with the Terracotta Warriors (Zou 1991.) This same sort of *dun* was then used by the Han. The stylised bamboo segment is also quite similar to bronze tubes which once decorated parasol poles on chariots.

Figure 80: Eastern Zhou zun: Left, inlaid with silver. Right, decorated surface and silhouette.

Figure 81: pair of Eastern Zhou zun. (left & above) Sockets. Arrows indicate 23mm diameter.

Figure 82: Han/Qin style dun alongside Eastern Zhou zun (below at left).

<u>Sockets for each at right above</u>: Top, dun. Middle & bottom, zun.

Iron & Bronze metallurgy.

For a period covering centuries both iron weapons and bronze weapons co-existed within China.

While bronze casting almost certainly emerged from within Neolithic China as a locally developed technology there is compelling evidence that iron working was introduced to China via central Asia & the steppes [65]. Before manmade iron there was some metalworking of naturally occurring meteoric iron during the Shang dynasty & Western Zhou period. Such meteoric iron can be identified as extraterrestrial due to its high nickel content (Yang 1992.) Heavenly iron was worked into blades that were attached onto bronze axes & dagger-axes. These would of course have been much esteemed. The true Iron Age does not fully begin in China until the Eastern Zhou period, many centuries later. Figure 83 shows a bi-metallic weapon from a preceding experimental phase on display in the Shanghai museum. Both meteoric and smelted iron was found at a notable early site called Sanmenxia in Henan. The first smelted iron would have fulfilled the same role as rare meteoric material, essentially an exotic substitute for the heavenly variety. Smelted iron was not a material which would revolutionise society at that time. The unusual ge in figure 83 is one of these early pieces from the Sanmenxia site. This bi-metallic construction is in the manner of meteoric iron weapons of the Bronze Age. Sanmenxia was dated from between the late West Zhou to the early Spring and Autumn period, which is consistent with the style of this dagger-axe.

Heavenly iron may have created an interest in man-made iron but the physical properties of such early wrought iron would not have matched the best bronze. I believe that such items were more for prestige than to provide any benefit in combat. Even superior meteoric iron blades would only be as strong as the point of bonding. The joining of this iron blade to the bronze body lacks the robust & functional appearance of later Dian culture iron bladed swords with their tangs cast inside bronze hilts. Whatever the nature of the iron here this ge would have primarily been made to be seen, rather than used in battle.

Figure 83: Bronze dagger-axe with iron blade. Late West Zhou/early Spring & Autumn period.

The earliest wrought iron objects in peripheral China were found within the area of modern Xinjiang province, with a conservative dating to the 8th century BC but possibly earlier. Qin state (on the western flanks of ancient China) also has some of the earliest securely dated iron objects within the Zhou sphere, dated to the 6th century BC. These were luxury items, including elaborate short swords with lost wax cast gold hilts.

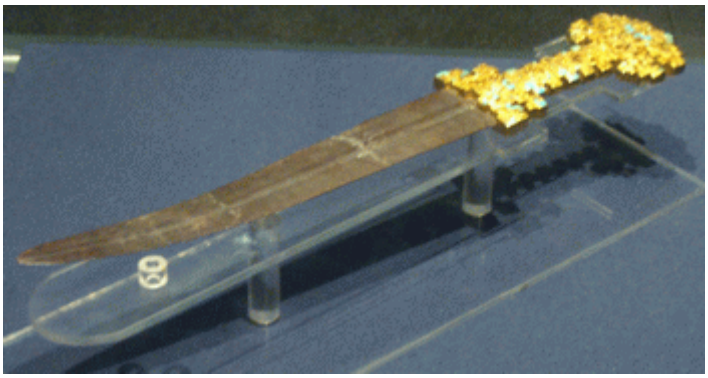

Figure 84: Qin iron dagger with gold hilt with turquoise inlay. Spring & Autumn period.

The form of some of the curved knives in these iron bearing Qin graves suggests a possible steppe connection (Wagner 1999) while conspicuous use of gold would suggest an influence of steppe nomads (Michaelson 2007). It needs to be stressed that despite the presence of iron in these Spring & Autumn period Qin graves that bronze weapons were still used by Qin state to defeat the other Warring States. Even those states armed with iron weapons were defeated by Qin before the end of the 3rd century BC.

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65) Donald Wagner: 'The Earliest Use of Iron in China'. 1999.

Qin political and social organisation is credited as a reason for their final success. Whatever advantages lay in iron weapons and armour they were not enough to defeat the armies of Qin who fought with their bronze halberds and whose crossbows fired bronze tipped bolts. As such we can see that the paradoxically early encounters of Qin with iron weapons like figure 84 fill a role as prestige pieces only. Testing of one such Qin short sword showed the iron to have 0% carbon, hence physically softer than bronze. Bronze was not physically inferior to these early wrought iron weapons. Despite Qin states early experience with iron it was not a technology that was developed to replace bronze weapons.

From a beginning as a luxury object, perhaps a substitute for prestigious meteoric iron, the technology slowly filtered through China. Even at the close of the Eastern Zhou period iron was not yet ready to completely replace bronze. Testing of iron weapons dated to the end of the Warring States period showed blades which were produced in such a way that it produced quite a soft microstructure for a steel, and were not better than a good bronze. The mechanical properties of such wrought iron were not qualitatively superior to bronze in hardness [66] although iron was less likely to break under stress. This explains why such early steel weapons were used alongside more typical bronze *ge* without simply outclassing them. Archaeology shows us that three centuries after Qin rulers first looked upon iron blades the Qin state still worked some iron but did not see fit to replace its bronze weapons.

Iron objects have been found in association with Qin terracotta figures but the items were mundane tools like axes or hatchets. An iron axe belonging to a terracotta stableboy was found in a pit to the east of the First Emperors tomb in 1982. Other axes of iron were found to the northwest in 1981 excavations [67], yet the weapons of the terracotta warriors and also Qin weapons that have been found at other locations in China, are made of bronze. The manufacture of bronze weapons was highly regulated by the Qin state. Inscriptions on weapons with the Buried Army show that the halberds include many different production runs many years apart, some dating to the last years of the Warring States period. The usage of iron for making mundane tools with bronze still retained for combat weapons suggests that bronze was still more highly regarded for edged weapons by the Qin state.

Iron technology as Chinese applied it was initially better placed to revolutionise the production of farm implements rather than supercede bronze weapons. The ancient Chinese pioneered the production of cast iron agricultural tools. The casting of iron implements was only possible because of the high temperature cupola furnaces unique within ancient China. The invention of cast iron is presently attributed to the south of China, specifically state of Wu (Wagner 1993) which had less access to copper deposits than other states. These tools were of cast white iron, very high in carbon content, which means a very hard object, but also brittle. Such iron was unsuitable for weapons so it benefited an agrarian economy but not a military. Cast white iron was a cheaper alternative to bronze tools. Once iron was known to Chinese it is perhaps not surprising the expertise of bronze casting would lead to experiments with cast iron, or that extremely effective furnaces might lead to the accidental discovery of cast iron.

The very high temperatures required to cast iron were not available in other iron working cultures, who instead worked with hammering sponge iron, or blooms, in a pasty state to form tools or weapons. Initially it was wrought iron, made in this fashion, which entered China from Western frontiers. Even after many centuries the level of adoption of an iron industry as a complete alternative to bronze was quite uneven across the various competing states (Yang 1992.). In the Warring States period certain states are mentioned in the histories as wielding remarkably sharp weapons or wearing iron armour, but weapons alone did not decide a victor and they were extinguished nonetheless. Even amongst states that used iron weapons, bronze was still retained for the casting of ge as well as crossbow mechanisms and arrowheads. The slow decline of bronze seems counterintuitive when iron is normally perceived to outclass bronze, but apart from the technical reality there are other cultural factors. Chinese did not have a cultural background which emphasised wrought metallurgy and instead had developed fine bronze casting to great perfection. This is likely why both Chinese &' Western' bronze & iron working developed along two different general directions: The Western artisans applied hand working techniques on cast bronze while the Chinese used their casting technology on iron.

In the Eastern Zhou period the ability to create a liquid iron allowed new techniques, such as puddling liquid iron and stirring it (*stir-fried steel*) to remove impurities from the iron to make true steel, but the quantities produced were still small. Most weapons excavated in a mass grave of Yan soldiers showed the weapons to be a folded wrought iron rather than folded mid-carbon steel. The steel industry was still in its infancy (Yang 1992). Analysis shows the uneven carbon content between folded layers. Technology had improved dramatically by the era of '100 time tempered' (true steel) weapons of the Han dynasty. Only in the Han period was there industrial output of highly refined weapons-grade steel. A technique for producing a wrought iron straight from the blast furnace had been developed in the Western Han period. In the later part of the Han era there was even true mid-carbon steel being produced by blending pig iron & wrought iron directly within a furnace.

The soldiers armed with iron weapons in the late Warring States period did not have iron weapons that were able to purely outclass bronze. One benefit for those that did choose to develop iron for weapons was that their iron swords could easily be made much longer the bronze swords. The long bronze swords that appear in the Qin Buried Army then are likely mimicking or competing with long iron swords of rival states like Yan but I am not convinced that such high tin bronzes were a good material for making long slender swords. When Chu state graves contain iron swords as long as 1.4m there would have been some pressure on bronze casters to at least match such intimidating blades. 90cm bronze swords in the Buried Army were found with general and officer figures while ge were still the common soldiers weapon.

Bronze was literally reaching the limits of its practical use at the time Qin were producing these long bronze swords. The gradual transition from bronze to iron continued apace as iron working skill increased, and the physical limits of bronze were tested.

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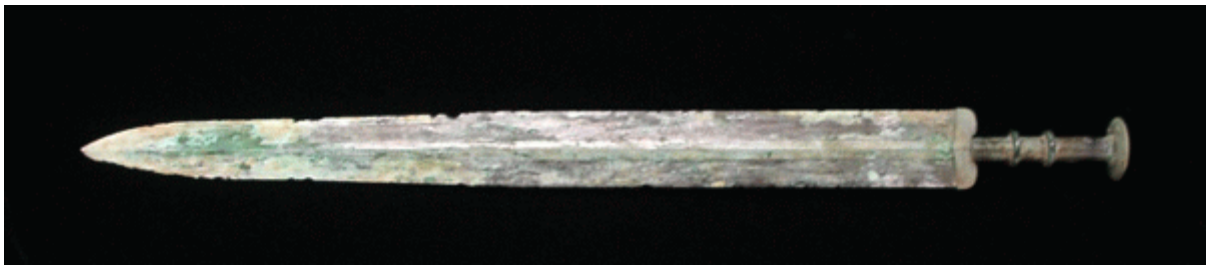
66) Donald Wagner: 'Iron & Steel in Ancient China'. 1993.

67) Manying Ip, Duncan Campbell, Gillian Chaplin: 'The Buried Army of Qin ShiHuang'. 1986.

Although knowledge of manmade iron appears to have filtered from westwards, Chinese developed new techniques and technology by adapting pre-existing methods. The peculiarities of Chinese metallurgy, being the use of ultra-high temperature furnaces and fine casting in multi-sectional molds, may also explain two otherwise odd features of Chinese bronze weapons: High percentages of tin are common in weapons. There is also a lack of evidence for work hardening of their edges. Chinese weapons for which I have compositional figures put certain bronzes in the upper limits of practical alloys for a weapon. Many Chinese bronze weapons have a composition of around 15% tin [68].

A tin % above 15% creates a very hard and sharp bronze but one more prone to break rather than compress or deform during stress. A 20% tin bronze (like Qin swords were constructed with) will have a very hard sharp edge but is very much less robust against impacts. In the West there was a method of 'work hardening' of blade edges which allowed for much sharper and harder edges than the base alloy would possess. This required skillful hand working with techniques depending on the alloy and knowledge and control over appropriate metal temperatures. A well hardened bronze edge could be produced and worked wafer thin and the blade itself need not be brittle.

Chinese seem to have abandoned the wrought bronze of the earliest Neolithic experiments and concentrated on casting, while developing a uniquely sophisticated industry they then apparently missed this important technique. High tin % bronzes were instead used for sharp edged weapons, swords being most notable for high tin percentages. Significantly high tin% bronzes are also more difficult to work harden, which had implications for the direction of metallurgy in China: It made the technique less likely to be discovered. A unique Chinese solution to the problem of combining durability/tensile strength with a hard edge was the manufacture of bi-metallic bronze swords.



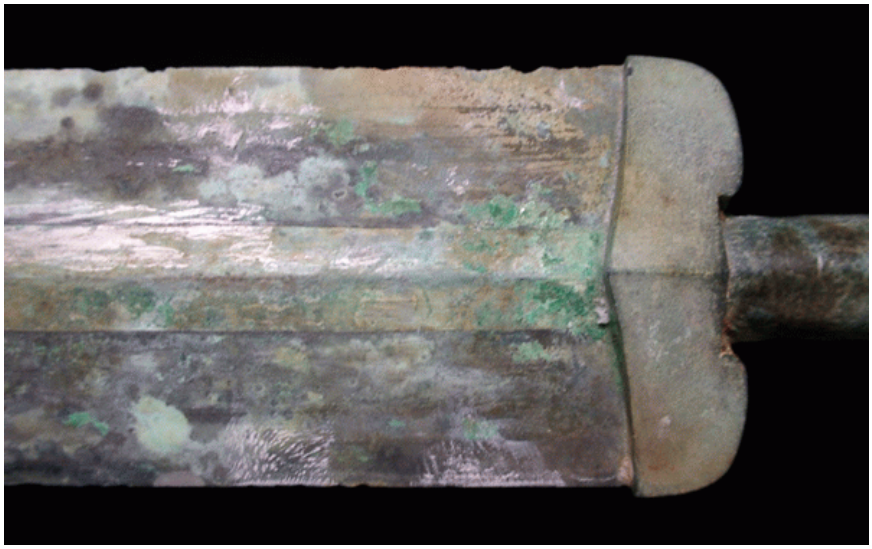
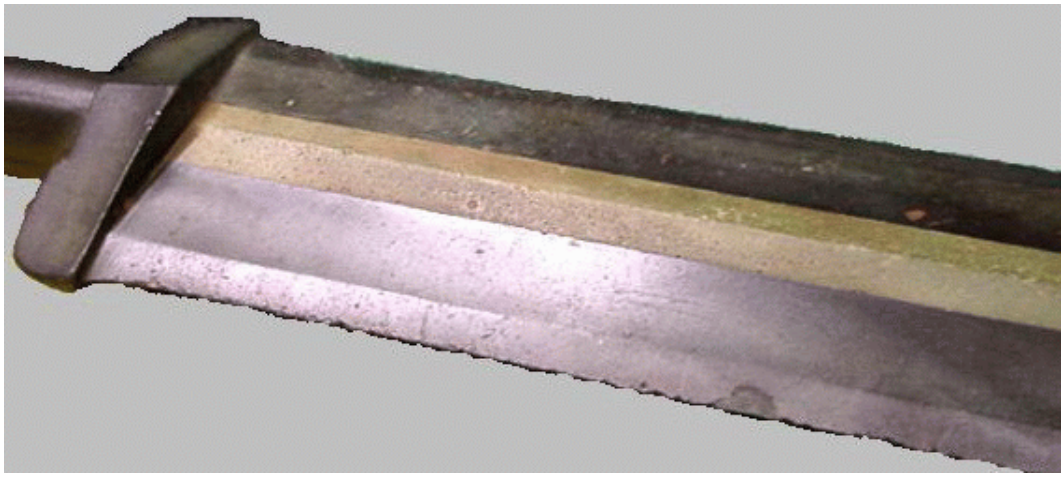


Figure 85: Bi-metallic sword from Anhui Province. 63cm long/797grams. Both in its weight & dimensions as well as construction this sword is impressive. Contemporary bronze swords were seldom over 50cm long.

(left) Detail of the same sword with precision of edge casting visible.

Figure 86: Detail of another bi-metallic sword showing typical appearance of tin edges with copper spine visible.



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68) David A. Scott, Jerry Pondany, Brian B. Considine: ‘Ancient & Historic Metals; Conservation & Scientific Research.’ 1991.

The Chinese bi-metallic sword of the Bronze Age was a bronze spine with a separate casting of the high tin % edges onto the weapon which thereby avoided the risk of catastrophic breakage.

A normal copper bronze is more likely to take stresses without breaking but did not have the hardness of high tin bronze. A normal blade could not be sharpened so fine so a seperate higher tin% edge meant a more lethal blade. By avoiding a high tin % through the cross section, the bi-metallic Chinese sword of this type had the best features of both compositions. The katana for instance was made over 1,500 years after this date but its fame is based around a similar principle, a low carbon steel inner spine with greater impact resistence with a higher carbon harder outer edge for tensile strength & hardness.

In destructive testing of a modern 10% tin bronze sword severe striking stress could deform (i.e bend the sword) but did not break the blade. A higher tin % sword is more likely to crack instead of deform. This was the challenge that bronze casters of these weapons worked with. The apparent omission of work-hardening in China would seem to be a symptom of the unique properties of Chinese technology, as were the solutions.

Such magnificent swords were being made by the YuYue in the early 5th century BC but bi-metallic swords are comparatively rare. We can speculate this is due to the extra effort in such production compared to the quantities of swords needed to be supplied for war. A bi-metallic bronze sword made by casting of harder sword edges on to a separate bronze spine may have simply been too complex to manufacture when arming the huge masses of common soldiers. Certain workshops of the rival states whose fame for excellent weapons are preserved in the ancient histories may have produced such wonderful blades. Ancient sword connoisseurs existed as we know that King Zheng of Qin, who later became the First Emperor, possessed a sword of foreign make which was valued for its quality. This foreign-made sword was then used as a metaphor for his pragmatic employment people of ability that came from outside the state of Qin. Remarkable swords were admired by rulers of the rival states, just as such weapons are admired by people viewing them in modern museums. This is not reflective of the more practical realities of the era. We need to consider that the average car on our present roads is not a limousine. Museums might be potentially misleading.

More typical bronze swords of the Warring States style, even more so than ge of the same period, have a surprisingly high tin % based on the analysis available. The figures for bronze swords often approach 20% tin. Chinese pushed the limits of blade practicality with these higher tin % swords but presumably for short swords actual blade clashings or armour impacts were seldom. Such short swords are depicted in art as being used in grappling situations so a sharp blade may have been more desirable in close & lethal struggles were a coup-de-grace strike must count. Even if the compositions have a certain enigma we can be sure they served their owners well and were fit to the task.

Work hardening was also less likely to be exploited by Chinese artisans as ancient bronze in China typically contained lead. Since Chinese made very fine castings lead was almost standard in the alloy. It meant the liquid bronze flowed much better through a mold but it also meant a softer bronze (Bavarian 2005.) This also points to why certain techniques might have been less likely to have suited Chinese bronze. Lead reduces the effectiveness of cold working a blade edge compared to a non lead-bronze. A high tin % would make harder bronzes but made work hardening even more difficult, with cold working impossible in the upper tin % that Chinese swords & dagger-axes are often attributed. It may have been possible to remove the brittleness of high tin bronze by heating and quenching [69] but to date there has been no evidence or suggestion the ancient Chinese used or knew this technique.

"*The exclusive use of casting by the early Chinese metalworkers may have been due to the poor malleability of these alloys*". (Bavarian & Reiner 2006.) There was naturally a clear understanding of the different types of bronze produced by different volumes of lead or tin as this manipulation was especially crucial to the craft of Chinese bronzecasting but "*..the ancient Chinese do not seem to have worked or hammered cast bronzes (infact, many of the Chinese bronze compositions are difficult or impossible to work by hammering), the only method available to them for changing the properties of the bronze was altering its composition.*." (Scott, Pondany, Considine 1991)

By the Spring & Autumn period a document called the 'Artifactors Record' had a section on "Six Formulas of the State of Qi" which gave the ratio of tin & copper for bronze bells & tripods, mirrors, swords, ge & ji, axes & arrowheads (Yang 1992). The ratio however does not seem to fit what we know about ancient bronze as there is rather less evidence of control for objects like bronze vessels and there are other oddities to the formula. The figures provided have a margin within of 20-25% tin for ge & ji or 25-33% tin for swords. This beggars belief. Rather than an object like a 10% tin bronze this formula would create instead a 'white bronze'. The given ratio from this ancient text should not be taken as gospel, nor the percentage calculated from it. It is unclear whether the ratios meant pure tin & copper each, or an alloy with lead already included. Yang Hong uses both interpretations in his chart, hence the percentage range. Despite this the document is clearly of limited value. The Artifactors Record reveals a clear knowledge over the value of a given alloy, but does not present a practical composition. The calculations from it regarding weapons appear almost 10% higher than testing supports. I tend to regard it as no more reliable than other figures and quoted quantities in ancient Chinese histories which are used (or rather misused) routinely. Likewise, the implication are more important than accepting it as a pure fact. Despite the dubious proportions it reveals one principle which scientific compositional analysis confirms. Certain types of bronze items do have compositions which fall within a certain range. The ancient Chinese desired certain properties in an item and controlled the alloy accordingly.

In the production of weapons the alloy composition was crucial. Unfortunately the much greater attention paid to analysis of ancient bronzes through the study of ritual vessels would seem to offer far less insight into the nature of the bronze casters craft, and their control over composition of a bronze. Bronze vessel can have huge variations on the percentage of lead or tin, by tens of a %, and even with a large base sample it has not been possible to make conclusions over the large variations, such as dating a vessel by its compositional analysis (Bagley 1977). Unlike the huge variance of bronze vessels it has been shown, in general support of the Artifactors Record, that certain types of object are generally clustered under a certain type of bronze alloy (Bavarian & Reiner 2006). High tin % bronze mirrors (white bronze) where created due to the ability of a white bronze to have a fine polish and have a reflective surface.

The very high lead % of Yan state knife-money may either be due to the colour of the bronze produced ('grey') or simply that a lead bronze may have been cheaper to use as a currency. The Artifactors Record fails as a universal standard for anticipating a bronze composition; as well it should given the long history of bronze casting and the many centres of production. There is also reason to believe some bronzes were re-cycled and hence the caster may not always have known the precise proportions, nor may it have been important.

Weapons however are quite different given their function as a life or death tool that must take the stress of striking bone, or potentially another weapon or hard surface. Empirical knowledge of a bronze alloy & its qualities would be crucial. The very small amount of accessible material on analysis of ancient Chinese weapons is a regrettable fact. A rather small sample specifically on ge & ji is available through the English language publication of Yang Hong (Y), 2 ge with analysis in the Shanghai museum (SM), the Chinese text "Ancient Chinese Bronzes" [70] by Zhu Fenghan (Z) and one independent analysis* (see below) which I have combined here.

object	Copper%	Tin%	Lead%
West Zhou ge (Y)	82.72	13.61	0.78
West Zhou ge (Y)	**87.44**	**10.75**	0.1
West Zhou ge (Y)	**73.38**	12.1	**12.41**
West Zhou ji (Y)	85.42	12.84	0.26
West Zhou ge (Y)	84.31	11.65	**0**
Warring states ge (SM)	79.61	15.57	3.4
Warring States ge (SM)	80.74	**18.09**	0.17
Warring States ge* [71]	83.57	15.53	0.02
East Zhou ge (Z)	80.49	18.75	0.72
East Zhou ge (Z)	79.66	16.23	3.44
East Zhou ge (Z)	76.93	13.33	8.47
East Zhou ge (Z)	79.93	13.69	4.21

Some variation is visible even within this small sample. I have set the upper and lower percentages **bold**.

The higher tin % of the Warring States ge may suggest attempt to push the limits of sharp edged and hard bronzes at that time. The % of lead varies from a tin-bronze of 0% lead to another with 12% lead. Assuming this result is not an error from the testing method the 12% lead ge would have a much softer edge than the former. Weapons would naturally want to have low amounts or lead, since only a tiny amount is required if intended to aid casting, but "parade weapons" might be an exception this principle of low lead in weapons (Scott, Pondany, Considine 1991).

While these are not quite as skewed towards a high tin % as the similarly small sample of tested bronze swords I am aware of it does confirm a trend of >10% tin in dagger-axes. These weapons would be capable of holding a sharper cutting edge but at the same time were more likely to chip or break instead of compacting an edge or deforming through critical stress. Other elements in the alloy of >1% I have not included as these are normally impurities of an ore rather than a product of an artisan, although certain ores may have been favoured.

In closing I will discuss another aspect of the testing of the dagger-axe which came as a result of authentication. On the table above the Warring States dagger-axe marked "*" is from an unpublished analysis of a privately owned piece. Compositional analysis was done at the same time as metallurgical examination of the internal corrosion. A C14 dating/carbon dating was made of the remains of a shaft which belonged to this weapon. The actual weapon was a two-piece *ji* halberd, and it also had a bronze *zun* mounted on the same pole. The remains of the shaft are shown here before the commencement of a preservation process (figure 87).

The original waterlogged shaft was restored after years of stabilisation and treatment. The organic material of the pole was C14 dated to 400 BCE - 200 BC (sample number, 0611-6A) which is consistent with its Warring States period dating. The metal of the bronze *ge* was tested for internal corrosion and was confirmed as an ancient bronze rather than a modern forgery. The *nei* of the dagger-axe also contained an inscription, which is not visible in these images. This ancient inscription has had the characters translated into a modern equivalent [72] "Dan1 Que4 Tao3(?) zuo4 yong4 ge1 san1 qian1". *Dan Que Tao* is interpreted as a name: Que Tao of Dan. While the less mysterious characters *zuo yong* might often be interpreted as 'made for his use' on such weapons perhaps the phrase might be perceived less personal than that. *Ge san qian* means 'Three thousand dagger-axes'. Que then may have had 3,000 ge produced under his authority. The phrase might be a matter-of-fact record: "Que Tao of Dan: produced {for his} use: Dagger-axes three thousand."

Both the spearhead and dagger-axe had been pattern-tinned, meaning tin was applied by a flux to the cast bronze surface to produce a decorative effect. The spearhead has simple tin stripe patterns while the dagger-axe was tin spotted. The original golden lustre of this bronze and the wooden shaft has both been preserved remarkably well despite more than two millennia. The images of the pole here show that this *zun* & the wooden pole were in the typical tear-dropped shaped cross section for halberds of the period.

The purpose of such a detailed investigation is to spot modern forgeries masquerading as artefacts.

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69) Jeroen Zuiderwijk: Personal correspondence
70) Zhu Fenghan : "Ancient Chinese Bronzes". Nankai University Press.
71) Melanie Roy: personal correspondence. EPMA testing by Oxford Materials Characterization Services.
72) Stephen Selby: personal correspondence.

Figure 87: Ji halberd. Spear, dagger-axe, zun & lacquered hardwood pole before restoration.

Figure 88: Bronze fittings from Warring States ji weapon.

The ge on a pole with zun attached (figure 89) was in contrast found to be a modern forgery through a similar examination. The *zun* & *ge* proved to be modern metal with an artificial corrosion atop once a tiny cross-section of the bronze was inspected. The compositional analysis of the bronze was almost exact to the ge in figure 86-87 (15% tin & >1% lead) yet it was essentially a young face which had put on make-up to look like an old person. The surface of the metal of the *zun* suggested the object was cast from a mold made from an original ancient object. Under magnification there were signs of the air bubbles trapped by the mold which remained as features above the surface. The forgery is however quite useful for this article in that it show a lacquered pole with black & red designs decorating the surface, a zun in position, and a good copy of a Warring States ge mounted atop. Despite artificial corrosion on the surface of this weapon it represents how the ge appeared when carried into battle by warriors during the Eastern Zhou period.

Reproductions by experimental archaeologists working with bronzes of authentic composition (see figure 90) perhaps show one reason why bronze had a lasting appeal. The weapons made ready for battle would have been highly polished as evidenced by marks of fine abraders on ge surfaces. Polished bronze weapons of typical alloy compositions would have a bright golden lustre. This is the appearance of the bronze that an ancient warrior utilised. I can only imagine the splendid appearance which would be presented by an ancient army that marched with the proverbial “ten thousand halberds” carried aloft.

Figure 89: Modern copy of an ancient ge. Zun & ge on lacquered pole.

Figure 90: Modern reproduction of a European bronze socketed axe.

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