A Discussion on Early Metals and the Origins of Bronze Casting in China

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Keywords: early metal origin of bronze casting location of origin developmental stage developmental path

What are the origins of the very distinctive ancient Chinese bronzes? The question has long been debated among scholars and this paper attempts to investigate this difficult and demanding question by exploring the early metal objects discovered through archaeology throughout China. The term 'early metals' refers to all pre-Shang (pre-16th century BCE) metal objects found in China that are made of pure copper (hongtong 红铜, Cu), brass (huangtong 黄铜, Cu-Zn), arsenic copper (shentong 砷铜, Cu-As) and bronze (qingtong 青铜). The term 'bronzes' (qingtongqi) refers specifically to those distinctive pieces made of copper-tin (Cu-Sn), copper-lead (Cu-Pb) and copper-tin-lead (Cu-Sn-Pb) alloys.

I. Evidence: Early Metalworks Discovered through Archaeology

According to preliminary statistics, over 500 early metalworks have been found at over 50 locations in China. In terms of distribution, finds of early metals reach from Zhaogezhuang 昭格庄, Mouping 牟平, Shandong 山东 in the east to Yingwoshu 鹰窝树, Anxi 安西, Gansu 甘肃 in the west, and from Shijiahe 石家河, Tianmen 天门, Hubei 湖北 in the south to Dadianzi 大甸子, Aohan 敖汉 Banner, Inner Mongolia 内蒙古 in the north. The early metalwork can be arranged in four regional groups on account of their characteristic features, archaeological context, cultural evolution, and their geographical location. The only exceptions are those finds from Xinjiang 新疆 and Hubei, for which there is uncertainty about the date of the objects or the circumstances in which they were found. Each of these regions is considered below.

1. *The North-Western Region* (mainly Gansu and Qinghai 青海). The majority of early metal works come from this region, and their dates range from 2900–1600 BCE. These metal objects represent the Majiayao 马家窑 Type of the Majiayao Culture (c. 3100–2700 BCE), Zongri 宗日 Culture (c. 3600–2050 BCE), Machang 马厂 Type (c. 2300–2000 BCE), Qijia 齐家 Culture (c. 2050–1915 BCE), and Siba 四坝 Culture (c. 2000–1600 BCE) (Fig. 1).

Examples: (1) a Majiayao Type bronze knife, 12.5 cm in length, a tin-copper piece cast in a joint mould [findspot: Linjia 林家 Site, Dongxiang 东乡 County in Gansu, F20:18], dated to 2900–2740 BCE, this is the earliest known object made in cast bronze. (2) Zongri Culture copper earrings [findspot: Zongri tombs, Tongde 同德 County in Qinghai]. (3) Machang Culture bronze knives and copper awls [findspots: Liancheng 连城 Jiangjiaping 蒋家坪 in Yongdeng 永登 County, Zhaobitan 照壁滩 and Gaomuxudi高苜蓿地 in Jiuquan 酒泉 County, all in Gansu Province]. (4) Qijia Culture has rich finds of coppers: from 8 locations (including Huangniangniangtai 皇娘娘台, Wuwei 武威 County in Gansu) where metal artifacts have been found, including axes, chisels, knives, awls, drills, spoons, mirrors, finger-rings, chariot ornaments in various shapes, and rectangular-shaped decorations. 26 objects were tested: 22 were made of copper, 4 of bronze (Fig. 2). (5) Siba Culture: from 6 sites (including Huoshaogou 火烧沟, Yumen 玉门 County in Gansu), over 270 objects have been found, mainly socket axes, knives with double-edged blades, knives with a ring at the end of the handle, spears, arrowheads, ear-jewellery, finger-rings, bracelets, buttons, necklaces, finials in the form of four ram heads. 66 pieces tested: 30 copper; the four-headed ram finial was made of bronze. In term of casting techniques, only 4 pieces were wrought and the rest cast in moulds.

The North-Western group of coppers and bronzes

come from the greatest number of sites and are represented by the largest number of objects. Whilst there are many different forms, they are typically small decorative pieces, small tools, bronze mirrors, finials and other pieces with a religious function. The arrowheads, spears and other weapons appear quite late, probably after 2000 BCE. There are no musical instruments or ritual bronze vessels. Although there are some early bronzes, copper continues to dominate. A considerable amount of arsenic bronze was found among the Siba Culture finds (Fig. 3).

2. *The Northern Region* (mainly central and southern Inner Mongolia, including the southern and northern area of Mt. Yanshan 燕山; and western Liaoning 辽宁). Early coppers from this region include those of the Zhukaigou 朱开沟 Culture periods 3 and 4 (c. 1735–1565 BCE or slightly earlier), Xiajiadian 夏家店 Lower Strata Culture (c. 2000–1500 BCE), which usually dates 1900–1600 BCE. No coppers earlier than 2000 BCE are known.

Examples: (1) Zhukaigou Site, periods 3 and 4: 18 metal artifacts have been unearthed: chisels, awls, needles, arrowheads, bracelets, finger-rings, other rings. Knives and cutting tools are rare. The needle (T238③:1) was cast in tin-lead-bronze and later filed into shape. The bracelet is unique; analysis showed it was made of copper. Of 13 other pieces analysed, 8 were made of bronze, 5 of copper (Fig. 4). (2) Xiajiadian Lower Strata Culture: from 10 sites near Dadianzi, Aohan Banner, Inner Mongolia, over 100 metal artifacts have been discovered, mainly finger-rings, ear-jewellery, pierced pendants, knives, awls, arrowheads, bracelets, and finials. At Dadianzi 55 metal artifacts were unearthed, and all appeared to be made of bronze. Analysis of four bronzes

Fig. 1 Distribution of early metalwork in China

1. the North-Western Region 2. the Northern Region 3. the Coastal Region 4. The Central Plains Region

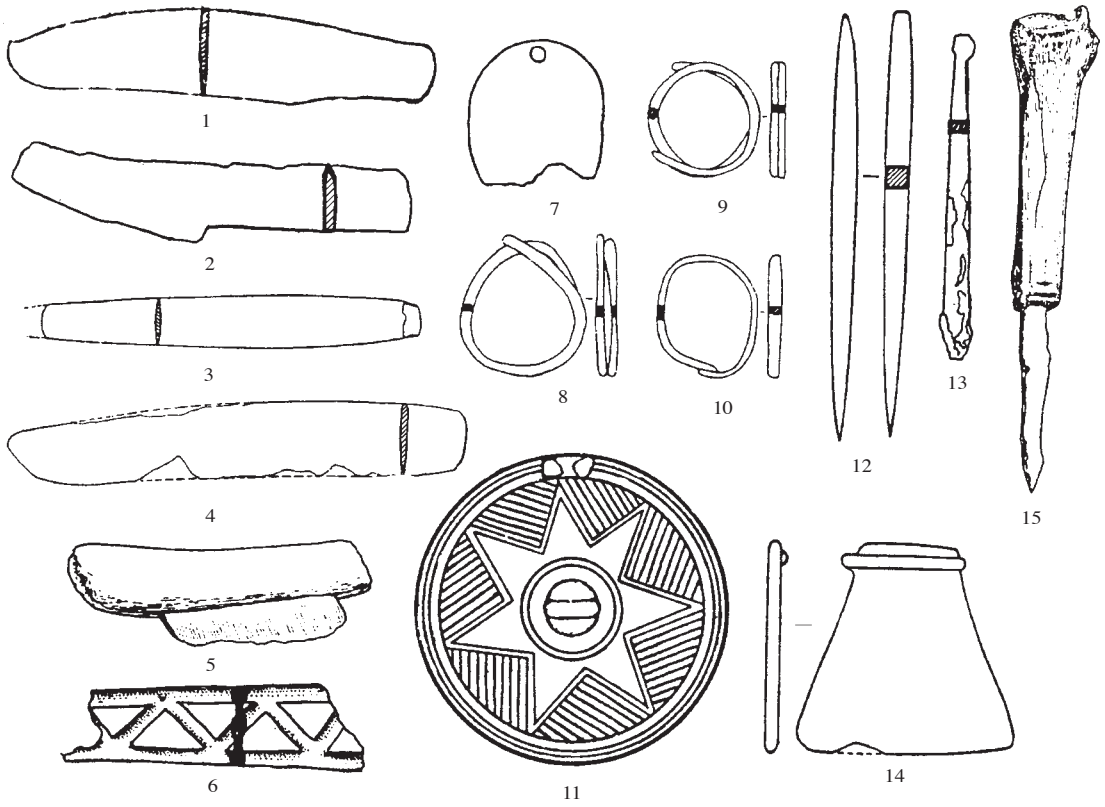

Fig. 2 Metal artifacts of the Majiayao, Zongri, and Qijia cultures

1. knife (F20:18 of Linjia in Dongxiang County, Majiayao Type) 2. knife (T17:5 of Huangniangniangtai in Wuwei) 3, 4. knives (M7:4 and M5:10 of Zongzhai in Huzhu County) 5. knife with bone stem (Weijiataizi in Linxia County) 6. ornament (H9:3 from Huangniangniangtai in Wuwei County) 7. ornament (H4:1 from Qinweijia in Yongjing County) 8–10. rings (M122:2 from Zongri in Tongde County, Zongri Culture) 11. mirror (M25 from Gamatai, Guinan) 12. awl (T6:2 from Qinweijia in Yongjing County) 13. drill bit ((Y3:7 from Huangniangniangtai in Wuwei County) 14. axe-shaped tool (H72:1 of Qinweijia in Yongjing County) 15. awl with bone handle (M7:6 from Zongzhai in Huzhu County) (Except noted, all others from Qijia Culture)

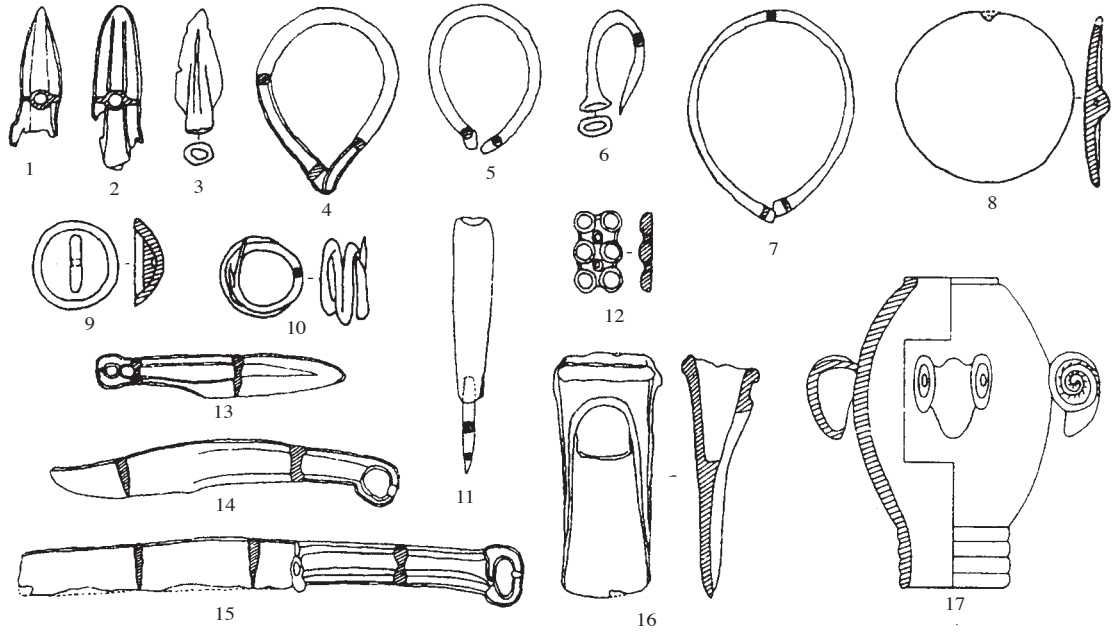

Fig. 3 Metal artifacts of the Siba Culture

1–3. arrowheads 4–6. earrings 7. bracelet 8. knob 9. button 10. finger-ring 11. awl 12. pellet ornament 13–15. knives 16. bucket axe 17. finial with four ram head

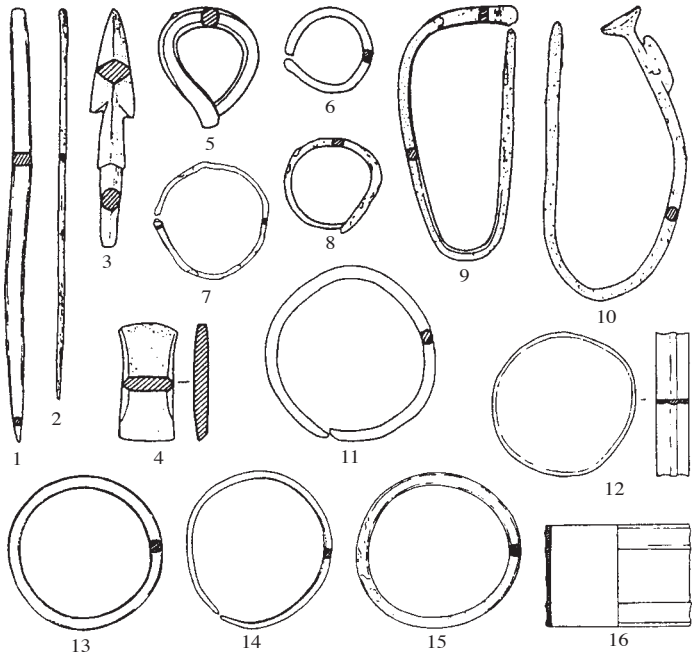

Fig. 4 Metal artifacts of the periods 3 and 4 of the Zhukaigou Culture
1. awl (H1044:1) 2. needle (T238 ③:1) 3. arrowhead (M4040:1) 4. chisel (T230:1) 5, 6. finger-rings (M4060:6, M6011:4) 7. bracelet (M4035:2) 8. finger-ring (M4003:1) 9, 10. ring shaped ornaments (C:190, C:189) 11. ring (M4003:3) 12–16. bracelets (M4035:1, M4007:1, M3028:1, M3019:3, M3028:2)

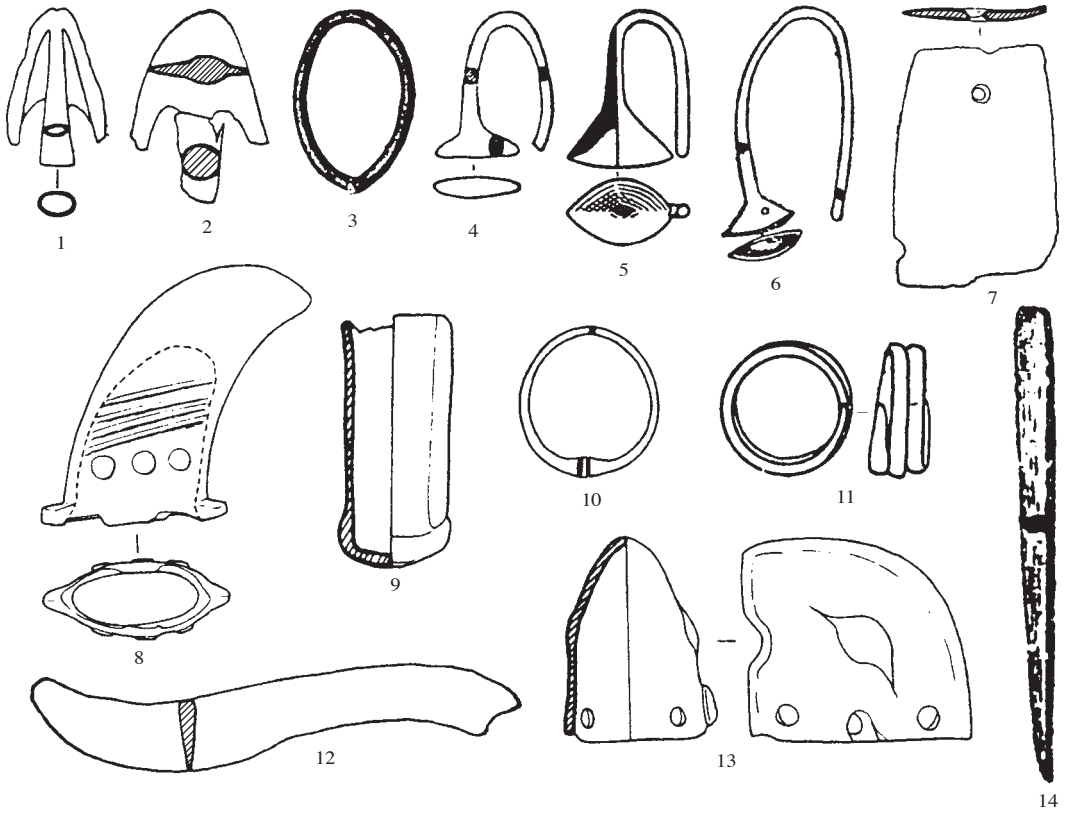

Fig. 5 Metal artifacts of the Xiajiadian Culture
1, 2. arrowheads (Datuotou in Dading County, T2 ④:1 from Zhangjiayuan in Jixian County) 3–6. earrings (M2010:2 from Sanyang in Weixian County, F4 from Zhangjiayuan in Jixian, J1:1 from Xiaoguanzhuang in Tangshan, T1 ③:7 from Weifang in Jixian) 7. pendant (T10 ②:335 from Dachengshan in Tangshan) 8. finial of cane (M43:12 from Dadianzi) 9. *dun*-shield (M715:15 from Dadianzi) 10, 11. finger-rings (M453:9 from Dadianzi, M2:2 from Liulihe) 12. knife (T2 ④:2 from Zhangjiayuan in Jixian) 13. ornament (M683:7 from Dadianzi) 14. awl (Xiao Yushulinzi in Ningcheng)

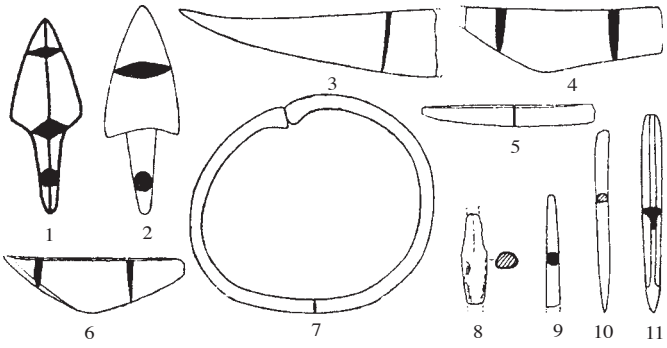

Fig. 6 Metal artifacts of the Longshan and Yueshi cultures
1. arrowhead (T1⑥:47 from Qingliangshan in Xiayi County) 2. arrowhead (T219⑦:30) 3–6. knives (T221⑦:21, T198⑦:5, T222 ⑦:45, 79H5:2 in Yinjiacheng) 7. bracelet (T216⑦:27 in Yinjiacheng) 8. strip ornament (T23②:14 from Yangjiajuan in Xixia; Shandong Longshan Culture) 9. awl (T258 ⑦:7 in Yinjiacheng) 10. awl (H37:29 from Zhaogezhuang in Mouping) 11. awl (T268 ⑦:4 in Yinjiacheng) (Except noted, all others from the Yueshi Culture)

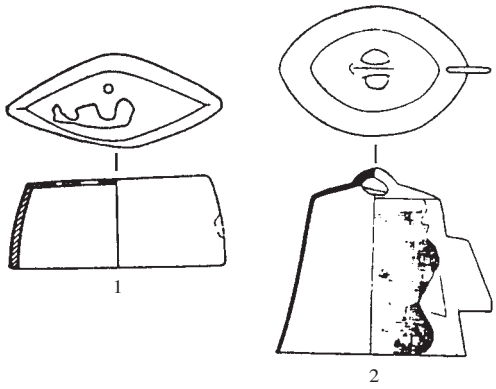

Fig. 7 Bronze bells of the Longshan and Erlitou cultures
1. M3296 from Taosi (Henan Longshan Culture)
2. VM22:11 from Erlitou (second stage)

from other sites showed that 3 were made of copper and 1 of bronze (Fig. 5).

To sum up, the Northern group of metals are characteristically small decorative pieces, small tools, small weapons, finials, and ritual pieces. There are no large metal weapons, or musical instruments or ritual bronze vessels. There are slightly more bronze objects than copper objects, which are no doubt connected with the later date of this group.

3. *The Coastal Region* (mainly Shandong and eastern Henan 河南). Early metals from this region include those of the Longshan 龙山 Culture and Yueshi 岳石 Culture, and date from 2400–1600 BCE.

Examples: (1) Longshan Culture: from 5 sites (including Sanlihe 三里河, Jiaoxian 胶县 County, Shandong), a small number metal artifacts have been discovered, and include copper awls, flat pieces and strips made of copper. Two fragments of awls from Sanlihe were analysed and were shown to be made of brass, with a date of 2405–2300 BCE. (2) Yueshi Culture: from 4 sites (including Yinjiacheng 尹家城, Sishui 泗水, Shandong), 18 pieces were found, including arrowheads, knives, awls, bracelets, and were dated 1900–1600 BCE. Nine pieces were analysed: 6 were made of bronze, 3 of copper. Three pieces from other sites were also tested, and were shown to be bronze (Fig. 6).

To sum up, the early metals of the coastal region come from several sites though are small in number. Most pieces are small tools, arrowheads, and decorative pieces. There are no musical instruments or ritual vessels. Most pieces are made of bronze, with a smaller number of pieces made of copper and occasionally pieces made of brass.

4. *The Central Plains Region* (middle reaches of the Yellow River and the eastern part of Guanzhong 关中 region, southern Shanxi 山西, central-western Henan 河南 and southern Hebei 河北). This region is rich in early metals. These include metal artifacts of the Yangshao 仰韶 Culture; the Longshan Culture and Erlitou 二里头 Culture of the Central Plains, which are dated 4500–1600 BCE.

Examples: (1) Yangshao Culture: at the Jiangzhai 姜寨 Site (Lintong 临潼, Shaanxi 陕西), and the Beiliu 北刘 Site (Weinan 渭南 County, Shaanxi), copper tubes, flat pieces and hairpins have been found, and analysis has shown that they are made of brass, dated 4500 BCE and 3900–3000 BCE, respectively. (2) Longshan Culture: metals have been found at four sites (including Pingliangtai 平粮台, Huaiyang 淮阳 County, Henan), including a copper bell (97.86% copper) dating to 2085 BCE (Fig. 7) found at Taosi 陶寺; a bronze fragment (tin-copper alloy) found at Wangchenggang 王城岗, dating to 1900 BCE or slightly earlier. (3) Erlitou Culture: metals have been found at five sites including Erlitou in Yanshi 偃师; and Dongxiafeng 东下冯 in Xiaxian 夏县 County (all in Henan). They are mainly tools such as knives, awls, chisels, adzes, saws, fish-hooks and spindle whorls, and weapons such as arrowheads, daggers and *yue*-battle-axes; and ritual pieces such as round plates, bells, decorative plaques with animal faces; and vessels such as *jue*-tripods, *jia*-

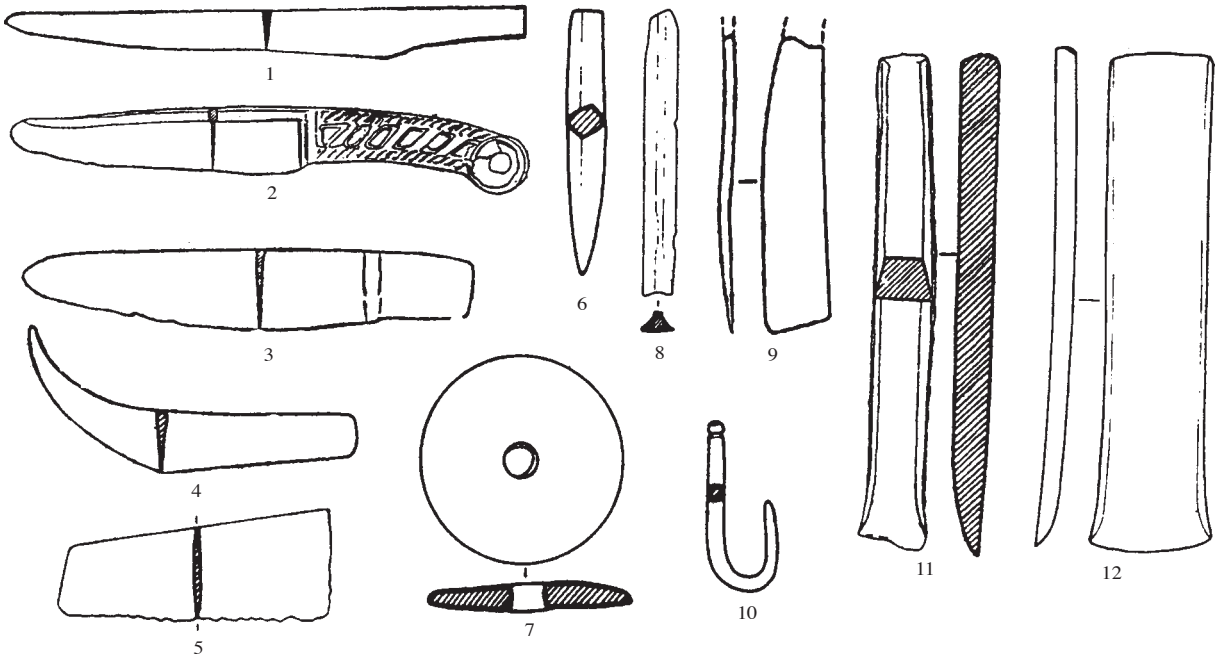

Fig. 8 Bronze tools of the Erlitou Culture

1. knife (VIM57:2) 2. knife with loop handle (IIIM2:3) 3, 4. knives (IIIM2:4, T1022④:19 from Dongxiafeng) 5. saw (IVH57:84) 6. awl (VH103:3) 7. spindle whorl (IVH58:1) 8. tool (IVH76:23) 9. knife (IVT21⑤:6) 10. fishing-hook (IVT6⑤:53) 11. chisel (H9:17 from Dongxiafeng) 12. adze (IIIF2:10)

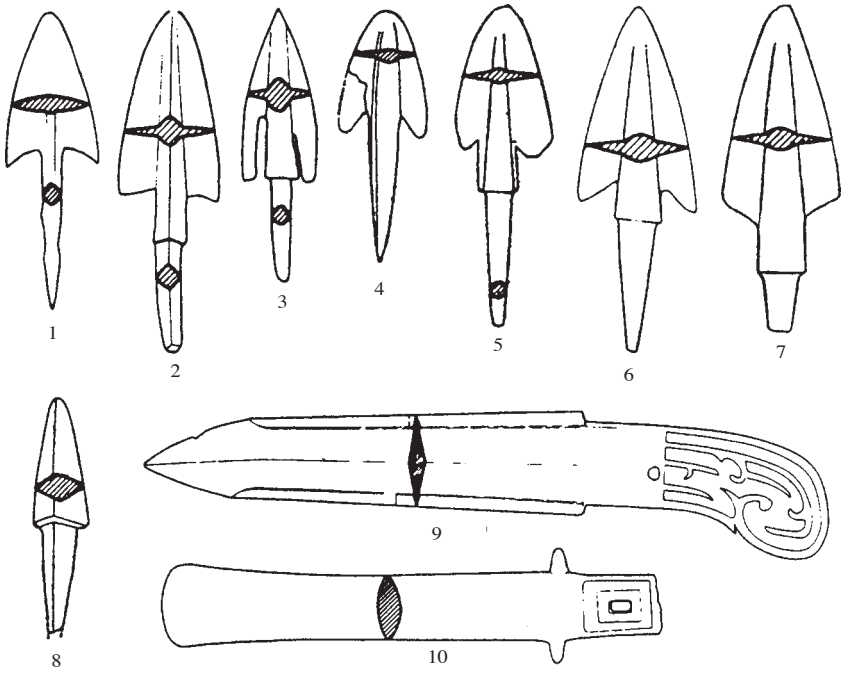

Fig. 9 Bronze artifacts of the Erlitou Culture

1–3. arrowheads (VT214③A:14, VH108:1, VT17⑤B:2) 4, 5. arrowheads (H531:1 and F597:17 from Dongxiafeng; the third stage) 6, 7. arrowheads (T4423③C:11 and T1022④:13 from Dongxiafeng; the fourth stage) 8. arrowhead (H525:14 from Dongxiafeng; the third stage) 9. *ge*-dagger-axe (VIKM3:2 from Erlitou; the third stage) 10. *yue*-battle-axe (VIKM3:1)

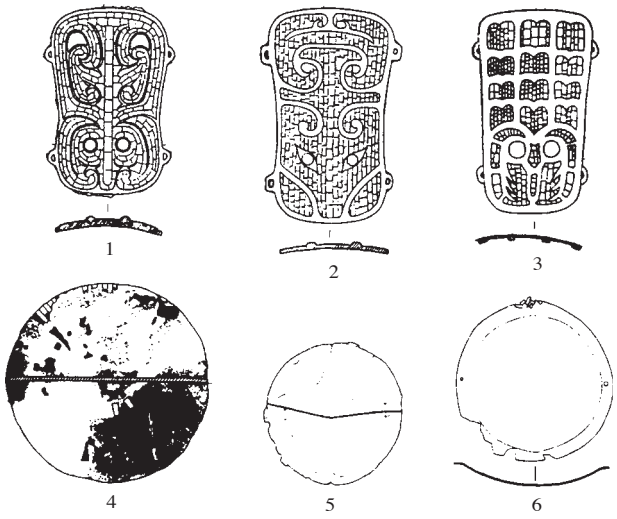

Fig. 10 Bronze artifacts of the Erlitou Culture
1. plaque inlaid with turquoise (IVM4:5; the second stage) 2, 3. plaques inlaid with turquoise (VIM11:7, VIM57:4; the fourth stage) 4. round ornament inlaid with turquoise (VKM4:2; the third stage) 5, 6. round artifacts (VIKM3: 16, VIKM3:17; the third stage) (all from the Erlitou Site)

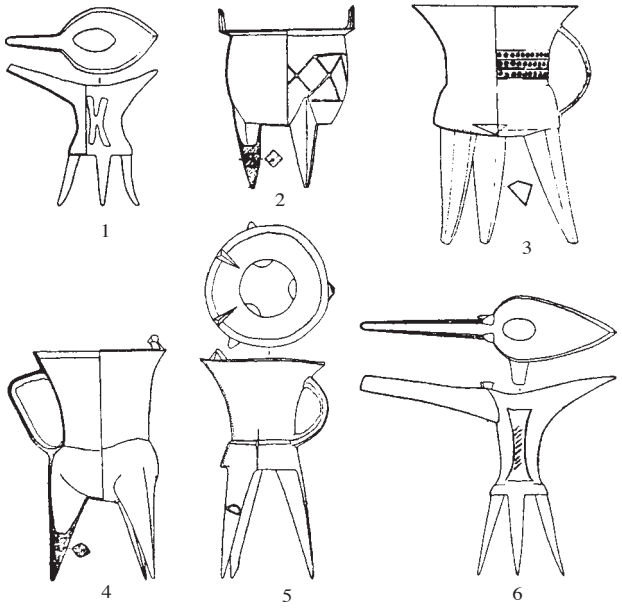

Fig. 11 Bronze vessels of the Erlitou Culture
1. *jue*-tripod (IIIKM6:1; the third stage) 2. *ding*-tripod (84VM1:1; the fourth stage) 3–5. *jia*-tripods (VCM:66, 87VM1:2, 84VIM9:1; the fourth stage) 6. *jue*-tripod (84VIM11:1) (all from the Erlitou Site)

tripods, *ding*-tripods and *he*-vessels. Forty-five specimens were analysed: 37 were copper-tin alloy bronze or copper-lead-tin alloy bronze; 7 were brass, and 1 was arsenic copper (Figs. 8–11).

To sum up, on the Central Plains metal production appeared very early, but underwent a rather slow period of development until c. 2000 BCE, when a period of swift development began. The metal artifacts include decorative pieces, tools, weapons, ritual vessels, and containers. In comparison, decorative pieces were not well developed in this region, especially when compared with the weapons, ritual vessels, and containers, which became the outstanding characteristic pieces of this region. As for the metal composition, brass, copper, and bronze were all used during the Yangshao and Longshan Cultures, but bronze was the main metal used in the Erlitou Culture.

II. Discussion: Origins and Early Development of Chinese Bronzes

When we look at the metalwork of these four regions, we find that the Northern Region is similar to the North-Western Region, not only in geographical distribution, but also that the early metals share many similarities. For example, the majority of metal objects are small decorative pieces or small tools; round finger-rings are found at Siba Culture sites and in the Xiajiadian Lower Strata Culture; the oval-shaped ear-rings found at Zhukaigou sites and in the Xiajiadian Lower Strata Culture are almost identical; the U-shaped ear-pieces found in the Xiajiadian Lower Strata Culture and at Siba Culture sites are clearly of the same type; and the arrowhead with a hole of the Siba Culture, has also been found in the Xiajiadian Lower Strata Culture. These similarities suggest the internal relations between the early metalwork of the two regions. However, these similarities are not seen in the metalwork of the Central Plains and Coastal Regions. For this reason, we can assume that the Northern Region metal production derived from, or at least related to that of the North-Western Region. The Central Plains and Coastal Regions have a very different geographical location in the middle and lower reaches of the Yellow River, and there are similarities between the bronze arrowheads and knives of the Yueshi Culture and those of the Erlitou Culture, again reflecting early relations between the two regions. For this reason, we can assume that the metal production of the Coastal Regions derived from, or belonged to the Central Plains region.

When we look at the metalwork of the North-Western Region and the Central Plains Region, it seems

that they follow two distinct systems. The earliest metal object of the North-Western Region is the bronze knife from the Linjia Site in Dongxiang County, Gansu, of c. 2900 BCE. The earliest metal objects from the Central Plains Region are the brass tubes and plates of the Jiangzhai Site in Lintong County, Shaanxi, of c. 4500 BCE. In terms of the types of metalwork found in the two regions, although both regions have yielded a considerable number of small tools, it is clear that small, decorative pieces were more developed in the North-Western Region, that mirrors and finials had very distinctive characteristics, and that there are no large weapons or ritual pieces or musical instruments or containers. In the Central Plains Region, the small, decorative pieces were not well developed, there are no mirrors or finials, but animal-head decorative plaques and ritual pieces, musical instruments and containers were all well developed with special characteristics. Even when the same type of object is found in both regions, for example arrowheads, there are very clear differences. In the North-Western Region we see many varieties of arrowheads with holes, and in the Central Plains Region we see many varieties of arrowhead with straight ridges.

As for the metal composition, copper-tin alloy appeared earlier in the North-Western Region, though there was a certain amount of copper, and there was fairly frequent use of arsenic copper at Siba Culture sites, though it is seldom seen in other regions. The earliest metal to appear in the Central Plains Region was brass, followed slightly later by copper, however, by c. 2000 BCE bronze took over as the main metal. It is clear then that the two regions enjoyed different systems of early metal production, and that each followed a different path of development. Thus, it is possible to propose four observations about the origins of Chinese bronzes.

1. The origins of ancient Chinese bronzes lie in two different regions: the North-Western Region and the Central Plains Region. We do not know if there were any mutual influences in the development process of early metals in the two regions, and it would appear that each region developed in its own way. Metal productions of the Northern Region and North-Western Region appear to belong to the same tradition, while those of the Central Plains and Coastal Regions appear to belong another different tradition. Of course, after 2000 BCE there were links between the metals made in the different regions, particularly after 1600 BCE, when the Central Plains was influenced by elements of the neighbouring cultures and at the same time the Central Plains influence on the latter was even faster.

2. The development process of early Chinese metals was different in the different regions, but there was a watershed date of c. 2000 BCE after which there was a much faster period of development, and each developed its own tradition. Before 2000 BCE the majority of early metalwork in each of the regions were decorative pieces or small tools, either cast or hammered. Development appears to have been faster in the North-Western Region, in the form of metal plaques and mirrors, and there was more frequent use of metals in the social life of this region. Development appears to have been somewhat slower in the Central Plains Region, and the use of metals in social life was limited. After 2000 BCE the North-Western Region continued to advance on its original path, and there were developments in the production of decorative pieces and small tools, and at the same time new forms appeared: arrowheads, socket-axes, finials, showing that early metal productions were moving to a maturity and towards a shaping of the tradition of the North-Western Region. In the Central Plains Region, there were developments in small tools, but more importantly, a number of new forms were developing: large tools such as adzes, chisels; weapons such as arrowheads, daggers and axes; and ritual vessels and musical instruments, such as bells, decorative plaques, *jue* and *jia* emerged, showing that the early metal production of the Central Plains Region was reaching maturity, and that the early Chinese bronze tradition represented by the Central Plains metalwork was taking shape.

3. There are three stages in the birth and development of early Chinese bronzes: (1) birth, c. 4500–2500 BCE, which relied on oxidised copper ores to smelt of copper alloys. (2) development, c. 2500–2000 BCE, when mostly copper was being smelted, gradually leading into the smelting of copper-tin alloy. (3) c. 2000–1600 BCE, the period of maturity, when mostly bronze was being smelted, and the techniques for casting bronze were established.

4. The development of metallurgy in early China generally can be seen as starting with a period of using a variety of copper alloys, developing into a period when copper was dominant, and finally into a period of bronze. In the North-Western Region, bronze was used from the first stage, copper was used during the period of development, and it was only during the period of maturity that bronze evolved as the major metal alloy. In the Central Plains Region, the earliest metalwork was

made of brass, but the period of development saw the use of both copper and bronze, and only in the period of maturity did bronze evolve as the major metal alloy. For this reason, early metallurgy in China can be seen as follows: the first stage saw the use of brass, bronze, and other copper alloys and pure copper at the same time. During the period of development copper was the most important metal gradually giving way to bronze, and during the period of maturity bronze became the major metal in use. As for the manufacture of metalwork, during the first and developmental stages cast and wrought methods existed side by side, and during the period of maturity casting was the major method of manufacture employed.

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