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EARLY METALLURGY OF EASTERN XINJIANG

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Abstract: This paper examines the form and chemical composition of metal artifacts of three successive cultures of the Hami region. The metal artifacts of the Tianshanbeilu culture are rather diverse in both type and material; body ornaments are dominant, whereas tools and weapons are quantitatively modest. The typological composition and the predominance of body ornaments made of tin bronze, pure copper, and arsenic copper are reminiscent of the Karasuk culture in the Minusinsk Basin and the Siba culture in the Hexi Corridor. Apart from the bulk metal types, there are gold, lead, and antimonial copper. The metal artifacts of the succeeding culture of Yanbulake are morphologically derived from Tianshanbeilu. In the subsequent Heigouliang culture, apart from old types of metal artifacts inherited from the Yanbulake culture, there are a number of new types of artifacts that are morphologically derived from nomadic cultures in the Eurasian steppe. In the cultures of Yanbulake and Heigouliang, the use of tin bronze, arsenic copper, and pure copper prevailed. The source of minerals, especially tin, which is used throughout the three successive cultures, awaits further investigation.

Keywords: Xinjiang, Bronze Age, Early Iron Age, metallurgy, Eurasia

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ДРЕВНЯЯ МЕТАЛЛУРГИЯ ВОСТОЧНОГО СИНЬЦЗЯНА

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Аннотация: В статье исследуются форма и химический состав металлических артефактов трех последовательных культур региона Хами. Металлические артефакты культуры Тяньшаньбэйлу весьма разнообразны как по типу, так и по материалу; украшения преобладают, а орудия труда и оружие немногочисленны. Такой типологический состав и преобладание украшений из оловянной бронзы, химически чистой меди и мышьяковистой меди напоминают Карасукскую культуру в Минусинской котловине и культуру Сыба в Ганьсуйском коридоре. Кроме основных металлов присутствуют золото, свинец и сурьмяная медь. Металлические артефакты последующей культуры Яньбулак морфологически происходят от Тяньшаньбэйлу. В последующей культуре Хэйгоулянь, кроме старых типов металлических изделий, унаследованных от культуры Яньбулак, существует ряд новых типов артефактов, которые морфологически происходят от кочевых культур Евразийской степи. В культурах Яньбулак и Хэйгоулянь продолжается преобладание оловянной бронзы, мышьяковой меди и химически чистой меди. Источник минерального сырья, особенно олова, которое используется во всех трех последовательных культурах, еще ожидает исследования.

Ключевые слова: Синьцзян, бронзовый век, ранний железный век, металлургия, Евразия

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Introduction

Eastern Xinjiang, which is coterminous with the Hami region, is comprised of the eastern terminal of the Tianshan Mountains, flanked by the Hami Basin to the south and the Barkol Plain to the north. The limited moisture traveling far from the Atlantic Ocean is captured by the soaring peaks of Tianshan to produce lush forest and grassland in the northern foothill of the Tianshan Mountains and the Barkol plain. However, the Hami Basin, subject to scorching sunshine and meager precipitation, is a desert. Underground streams flowing from

the peaks of Tianshan give rise to a few oases in the Hami Basin, which become important stops on what is now known as the ancient Silk Road, connecting to the Turfan oasis to the west, and the Hexi Corridor to the east via a path through the Tianshan Mountains.

The curtain of modern archaeology in the Hami region was lifted in the 1920s when the Sino-Swedish Expedition investigated a number of prehistoric sites [Bergman, 1939; De Chardin and Young, 1933]. After 1949, archaeological survey was renewed in tandem with small-scale excavations [Chen and Zhang, 1999: 3]. For several decades, however, the excavation materials were dated within the chronological framework of Central China, thus, the painted pottery, characteristic of the prehistoric and early historic sites of this region, was erroneously taken to be contemporaneous with the Yangshao culture (4900–2900 BC) of the Neolithic Age. It is only since the 1980s when large-scale excavations were conducted at a number of prehistoric cemeteries and settlements that the painted pottery-producing sites were assigned to the Bronze Age and the Early Iron Age [Chen, 1987; Chen and Zhang, 1999: 5]. Although these sites have been excavated, the protracted publication of most of these excavated materials has significantly hindered research. Several scholars have reviewed the meager materials ever published [Han, 2007; Zhang, 2010; Guo, 2012: 42–57], but a preliminary chronology was established only recently [Zhang et al., 2016].

Between 1943 and 1256 BC, an assortment of exogenous metal artifacts, analogous to those of the Karasuk culture (1400–830 BC) in the Minusinsk Basin and the Machang (2250–1950 BC), Siba culture (2050–1530 BC) in the Hexi Corridor¹, emerged at the cemetery of Tianshanbeilu of the toponymic culture². Painted pottery comparable with those of the Machang and Siba cultures was also found at the cemetery. It is surmised that a group of immigrants from the Hexi Corridor, who brought metallurgy and painted pottery to the Hami region, established this culture. What followed was the Yanbulake culture of 1300–900 BC with a collection of metal artifacts of largely the same types but stylistically altered and a type of painted pottery that is unprecedented in Hami or the surrounding regions. In the subsequent Heigouliang culture (900–200 BC), a new group of metal artifacts, mainly ornaments and horse harnesses of nomadic cultures from the Eurasian steppe, entered the Hami region to join the earlier repertoire. Once again, no stylistic precedents for the pottery wares have been found in Hami and the surrounding regions.

The form and composition of prehistoric metal artifacts of the Hami region have been examined by various scholars [Mei, 2000; Qian, 2006; Ling, 2008]. The origin and development of metallurgy during the three cultures have also been addressed [Zhang et al., 2016]. These studies, however, fail to provide an extensive study of the metal artifacts. In 2013, the authors examined a large portion of the metal artifacts stored in the Hami Museum and analyzed their composition with portable X-ray fluorescence. These artifacts were unearthed from several

¹ The dates of the Machang and Siba cultures are a combination of two AMS ¹⁴C reports [Zhang, Zhang, Wang, Lu, Chen, Wang, 2015: 38–45; Yang, Zhang, Oldknow, Qiu, Chen, Li, Cui, Ren, Chen, Wang, Dong, 2019: 2045].

² In the recent years, 41 AMS ¹⁴C dates were acquired to delineate the chronology of the Tianshanbeilu cemetery as 1943–931 BC. Among the 706 tombs exposed at this cemetery, 490 were assigned with the aids of typological and stratigraphic data to four phases, 1943–1672 BC, 1660–1408 BC, 1385–1256 BC, and 1214–1029 BC [Tong et al., 2020: 8–9]. Phase IV, as indicated in a previous study of the authors, is assignable to the Yanbulake culture [Zhang et al., 2016: 7].

major cemeteries that are representative of the three cultures, but the study below is far from exhaustive. A good number of better-looking artifacts, however, had been taken to Urumqi to be displayed in the galleries of the Xinjiang Museum and the Xinjiang Institute of Cultural Relics and Archaeology, and were not available for study. The extant collection in the Hami Museum can still be considered, however, a good representation of the complete collection. This paper will characterize the metal artifacts of the Hami region diachronically based on the acquired morphological and compositional data.

The Tianshanbeilu Culture

To the Tianshanbeilu culture can be ascribed only the toponymic cemetery near the Hami city (Fig. 1). During the expansion of the city from 1987 to 1997, 706 graves were exposed at this cemetery. The graves are densely placed, occasionally cutting into each other. These are simple pit graves with single interments and comparatively rich funeral goods, including a ceramic pot and an array of metal artifacts, bone objects, pearls, and cowrie shells. Some of the graves are lined with mud bricks of 1–2 m long and 0.6–1 m wide. The painted pottery from this cemetery is extremely reminiscent of the Machang and Siba cultures in the western Hexi Corridor. An abundance of metal artifacts was uncovered; the majority is presently kept in the Hami Museum. There is no precise count so far but in 2013, the authors examined 1355 items. To this date, the excavation report of this important cemetery has not been published. Only two batches of them, 32 and 36 items respectively, have been published [Institute of History..., 2001: 80; Lü, Chang, Wang, 2001: 182–183]. The metal artifacts of the Tianshanbeilu cemetery, typologically speaking, are highly diverse.

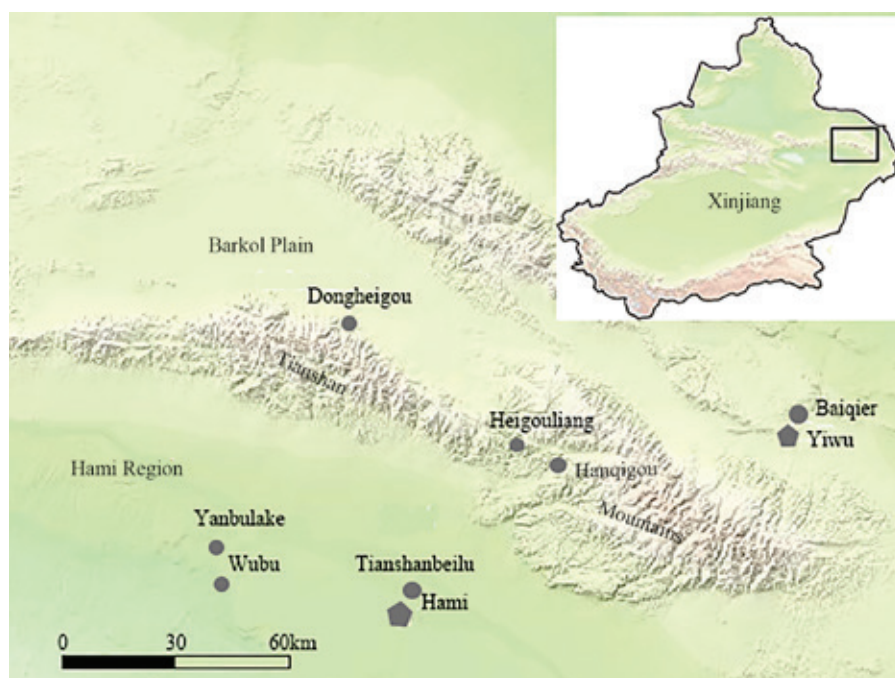


Fig. 1. Locations of the prehistoric sites

Рис. 1. Расположение доисторических памятников

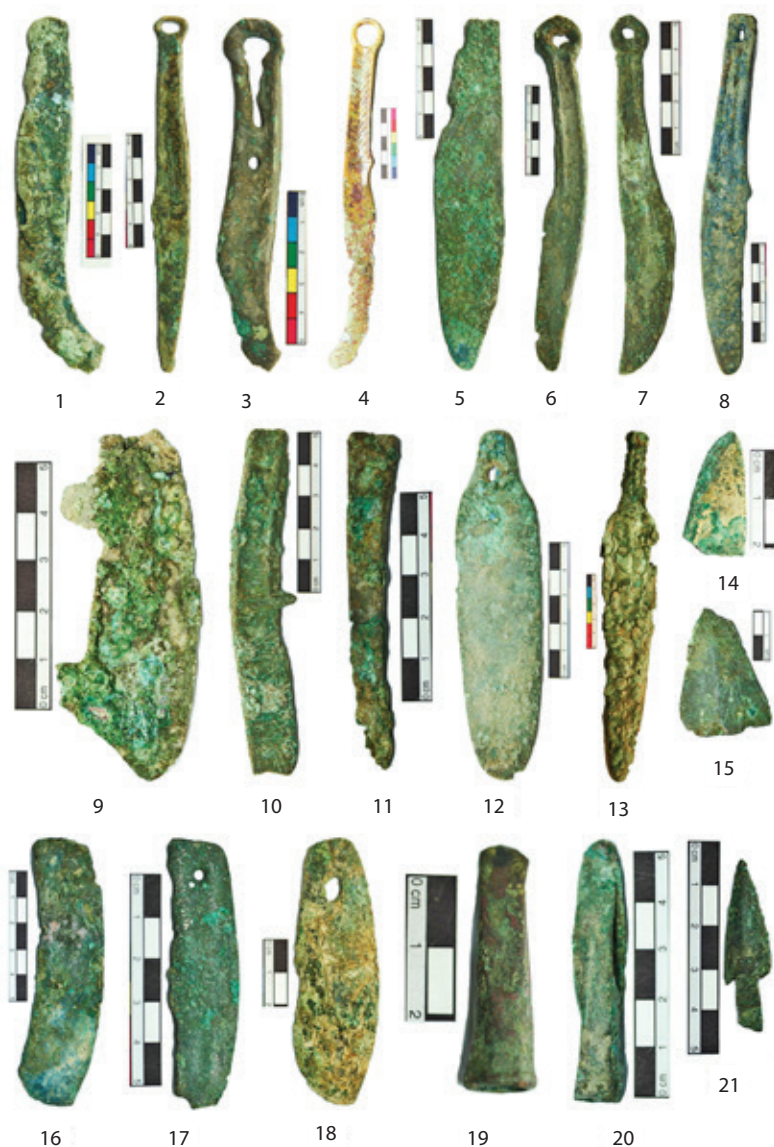


Fig. 2. Metal artifacts of the Tianshanbeilu culture (I): 1–11 – knives; 12–14, daggers; 15 – spearhead; 16–18 – sickles; 19 – chisel; 20–21 – arrowheads. 1. M14: 2; 2. M66; 3. M144: 3; 4. M146: 2; 5. M319: 1; 6. M341: 22; 7. M649: 2; 8. M383: 4; 9. M375: 9; 10. M635: 1; 11. M145: 10; 12. M384; 13. M626: 2b; 14. M43: 9; 15. M101: 5; 16. M270; 17. M287: 4; 18. M340: 5; 19. M341: 13; 20. M307: 15; 21. M71: 15

Рис. 2. Металлические изделия культуры Тяньшаньбэйлу (I): 1–11 – ножи; 12–14 – кинжалы; 15 – наконечник копья; 16–18 – серпы; 19 – долото; 20–21 – наконечники стрел. 1. M14: 2; 2. M66; 3. M144: 3; 4. M146: 2; 5. M319: 1; 6. M341: 22; 7. M649: 2; 8. M383: 4; 9. M375: 9; 10. M635: 1; 11. M145: 10; 12. M384; 13. M626: 2b; 14. M43: 9; 15. M101: 5; 16. M270; 17. M287: 4; 18. M340: 5; 19. M341: 13; 20. M307: 15; 21. M71: 15

Knives. 67 items. Only in one grave three items were found; in all other graves, only one item was uncovered. Most of these items are fragments; only a few pieces are intact. Of the intact ones, the smallest one is 11.5 cm long and 1.8 cm wide, and the largest one is 25.3 cm long and 2.1 cm wide. Only three items were uncovered from known context: at the right femur (M215: 5), at the pelvis (M312: 5), and at the waist (M441: 3)¹.

Long-blade knives. 49 items. They have long and thin blades but short hilts. All except for three are made of copper-based metals. The blades, as in the examples of M14:2, M319:1, and M145: 10, have a triangular cross section and are curved inward in the middle but bending outward at the tip (Fig. 2.-1, 5, 11).

Short-blade knives. 17 items. They have short and up-curving blades but long hilts with a center groove. As in the examples of M66, M144: 3, M341: 22, M649: 2, 383: 4 and M635: 1, they are sometimes equipped with cross bars and often topped with ring pommels (Fig. 2.-2, 3, 6-8, 10).

Double-hump knife. 1 item (M375: 9). It is a fragment of 7.1 cm long and 2.2 cm wide (Fig. 2.-9).

Celt. 1 item (stray find). It has a slender shaft extending toward a fan-like edge, with a half-moon-like opening. It measures 4.8 cm long (Fig. 8.-4).



Fig. 8. Metal artifacts of the Tianshanbeilu culture (VII): 1-3 – beads; 4 – celt. 1. M125: 35; 2.

M125: 27/2; 3. M194: 4; 4 – stray find

Рис. 8. Металлические изделия культуры Тяньшаньбэйлу (VII): 1-3 – бусы; 4 – кельт. 1.

M125: 35; 2. M125: 27/2; 3. M194: 4; 4 – случайная находка

¹ All the placements and quantities of metal artifacts in this paper are taken from the label tags written by the excavators.

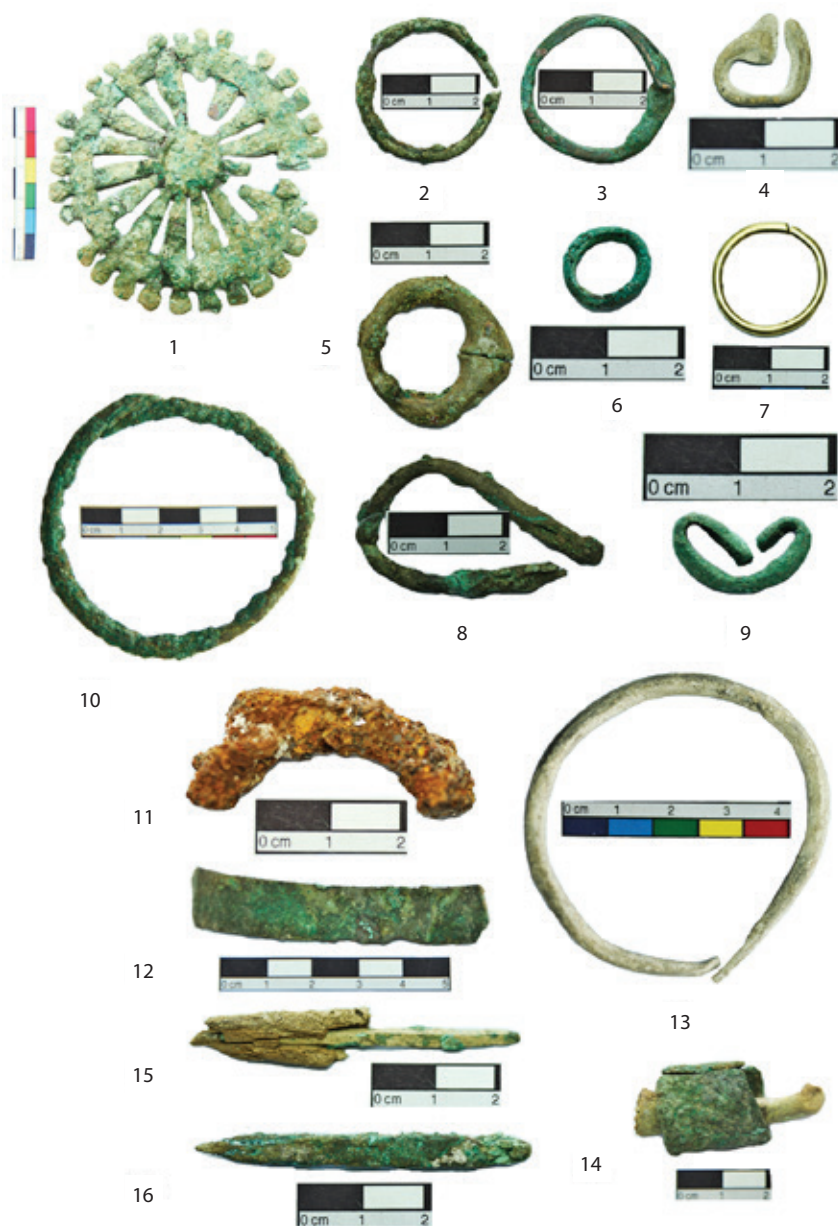


Fig. 6. Metal artifacts of the Tianshanbeilu culture (V): 1 – plaque; 2–9 – earrings; 10–13 – bracelets; 14 – fingering; 15–16 – awls. 1. M685: 1; 2. M2: 2; 3. M19: 1; 4. M261: 2; 5. M625: 1; 6. M7: 3; 7. M446: 2; 8. M670: 4; 9. M91: 2; 10. M5: 3; 11. M21: 3; 12. M298: 2; 13. M38: 3; 14. M542: 3; 15. M20: 13; 16. M92: 2

Рис. 6. Металлические изделия культуры Тяньшаньбэйлу (V): 1 – бляха; 2–9 – серьги; 10–13 – браслеты; 14 – кольцо (на палец); 15–16 – шилья. 1. M685: 1; 2. M2: 2; 3. M19: 1; 4. M261: 2; 5. M625: 1; 6. M7: 3; 7. M446: 2; 8. M670: 4; 9. M91: 2; 10. M5: 3; 11. M21: 3; 12. M298: 2; 13. M38: 3; 14. M542: 3; 15. M20: 13; 16. M92: 2

Sickles. 3 items. No handle. One (M270) is curved, 10.3 cm long and 2.6 cm wide (Fig. 2.-16). The other two (M287: 4, M340: 5) feature a curved blade and a hole at one end (Fig. 2.-17, 18).

Chisels. 2 items. The handle is absent on one (M330: 8), 6.1 cm long and 1.8 cm wide. The other (M341: 13), which was found at the right knee of the deceased, has a hollow shaft, 3.4 cm long and 1 cm in diameter (Fig. 2.-19).

Awls. 58 items. Made of iron, copper, or copper alloys, they are 1–16.3 cm long, 0.1–0.8 cm thick, and vary in quality (Fig. 6.-15, 16). They were found under the tibia, near the femur, the pelvis, the right face, and near the shoulder.

Daggers. 3 items. One (M43: 9) is the tip of a dagger (Fig. 2.-14). Another (M384) is an intact one that has a willow-shaped blade and a short hilt with a hole, 12.9 cm long and 3.1 cm wide (Fig. 2.-12). The third dagger (M626: 2b) also features a willow-shaped blade and three ribs, 23.6 cm long (Fig. 2.-13).

Spearhead. 1 item (M101: 5). Only the tip is preserved. With outstanding ribs in the middle, it is 5.2 cm long and 3.7 cm wide (Fig. 2.-15).

Arrowheads. 13 items. 12 of them are willow-leaf-shaped with hollow shafts. The longest one (M307: 15) is 5.3 cm long (Fig. 2.-20). A shorter one (M71: 15) has a hilt with a rectangular cross section, 4 cm long and 1.1 cm wide (Fig. 2.-21).

Bosses. 235 items. They are diverse in form and varied in size. In a given grave anywhere between 1 and 14 items could be found. Those discovered in context were found at the skull, shoulder, chest, arm, or leg. At times, they were used to cover the eyes of the occupants. For example, in Grave M53, it is placed on the left eye of the occupant. In Grave M311, it is on the right eye; the one placed on the left eye had slid off prior to excavation. In Grave M312, it is on the left eye. In Grave 483, they are on both eyes; and in Grave M552, on the right eye.

Disc bosses. Flat disc or semi-spherical, varying in thickness, sometimes with 1–4 holes for fastening, sometimes without them. 207 items. Their diameters vary from 1.6 cm to 9.2 cm. Some of them, as in the example of M40: 3, have a ring of holes or short lines on the perimeter (Fig. 3.-1).

Cocoon bosses. 2 items. As in the example of M400: 26, they are incomplete and small, varying from 1.2 cm to 1.5 cm (Fig. 3.-7).

Triangular bosses. 2 items. One (M17: 11) was originally placed upon a wooden object, 1.1 cm long. The other (M79: 6) has a hole at the center, 2 cm in diameter (Fig. 3.-3).

Fan boss. 1 item (M305: 5). It has a hole on the edge, 2.9 cm long and 2.3 cm wide (Fig. 3.-5).

Almond bosses. 10 items. Some of them, as in the example of M280: 7, have two or three holes for securing (Fig. 3.-4). One of them (M593: 6) is decorated with sunrays on the border. Their long diameter varies from 1.9 cm to 5 cm.

Irregular bosses. 5 items. Made of scrap bronze, finished with 1–2 holes. As in the example of M361: 9, they are 2.1–3.8 cm long (Fig. 3.-6).

Horn boss. 1 item (M683: 9). It has two horns and one hole at the center, 7.4 cm apart between the horns (Fig. 3.-8).

Semispherical boss. 1 item (M311: 14). It has two holes at the center and a diameter of 7.6 cm (Fig. 3.-2).

Conical boss. 1 item (M321: 3). It has a hole at the center and a diameter of 2 cm (Fig. 7.-7).

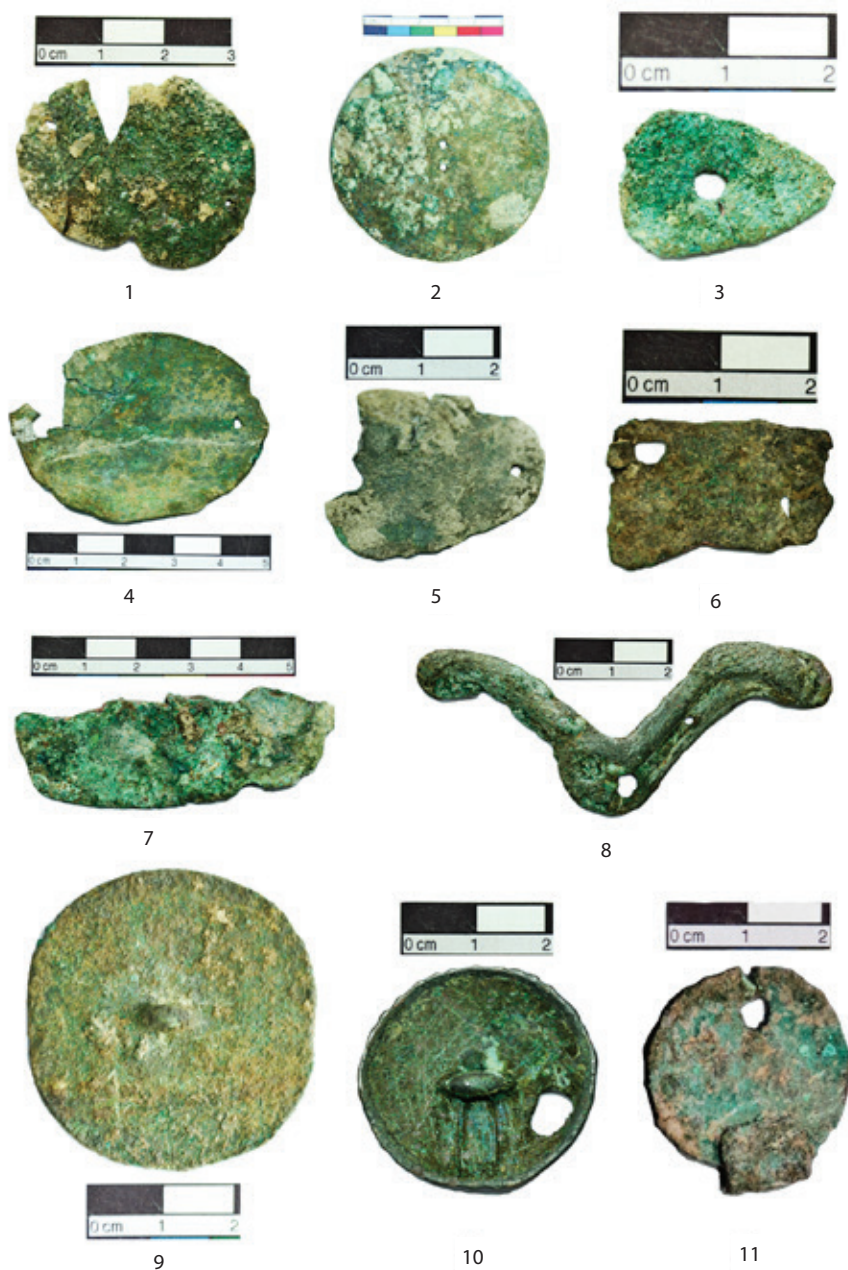


Fig. 3. Metal artifacts of the Tianshanbeilu culture (II): 1–8 – bosses; 9–11 – buttons. 1. M40: 3; 2. M311: 14; 3. M79: 6; 4. M280: 7; 5. M305: 5; 6. M361: 9; 7. M400: 26; 8. M683: 9; 9. M2: 6; 10. M15: 4; 11. M150: 3b

Рис. 3. Металлические изделия культуры Тяньшаньбэйлу (II): 1–8 – бляхи; 9–11 – пуговицы. 1. M40: 3; 2. M311: 14; 3. M79: 6; 4. M280: 7; 5. M305: 5; 6. M361: 9; 7. M400: 26; 8. M683: 9; 9. M2: 6; 10. M15: 4; 11. M150: 3b



Fig. 7. Metal artifacts of the Tianshanbeilu culture (VI): 1–2 – jingle bells; 3–7 – caps; 8 – imitation cowrie; 9 – clip; 10–12 – tubes; 13–14 – spiral tubes; 15 – spatula; 16 – beads. 1. M54: 5; 2. M10: 10; 3. M73: 10; 4. M78: 1; 5. M307: 14; 6. M460: 4; 7. M11: 6; 8. M363: 4; 9. M16: 5; 10. M1: 5; 11. M65: 4; 12. M349: 10; 13. M154: 2; 14. M597: 3; 15. M84: 4; 16. M48: 4

Рис. 7. Металлические изделия культуры Тяньшаньбэйлу (VI): 1–2 – колокольчики; 3–7 – колпачки; 8 – имитация каури; 9 – зажим; 10–12 – трубки; 13–14 – спиральные трубки; 15 – лопатка; 16 – бусы. 1. М54: 5; 2. М10: 10; 3. М73: 10; 4. М78: 1; 5. М307: 14; 6. М460: 4; 7. М11: 6; 8. М363: 4; 9. М16: 5; 10. М1: 5; 11. М65: 4; 12. М349: 10; 13. М154: 2; 14. М597: 3; 15. М84: 4; 16. М48: 4

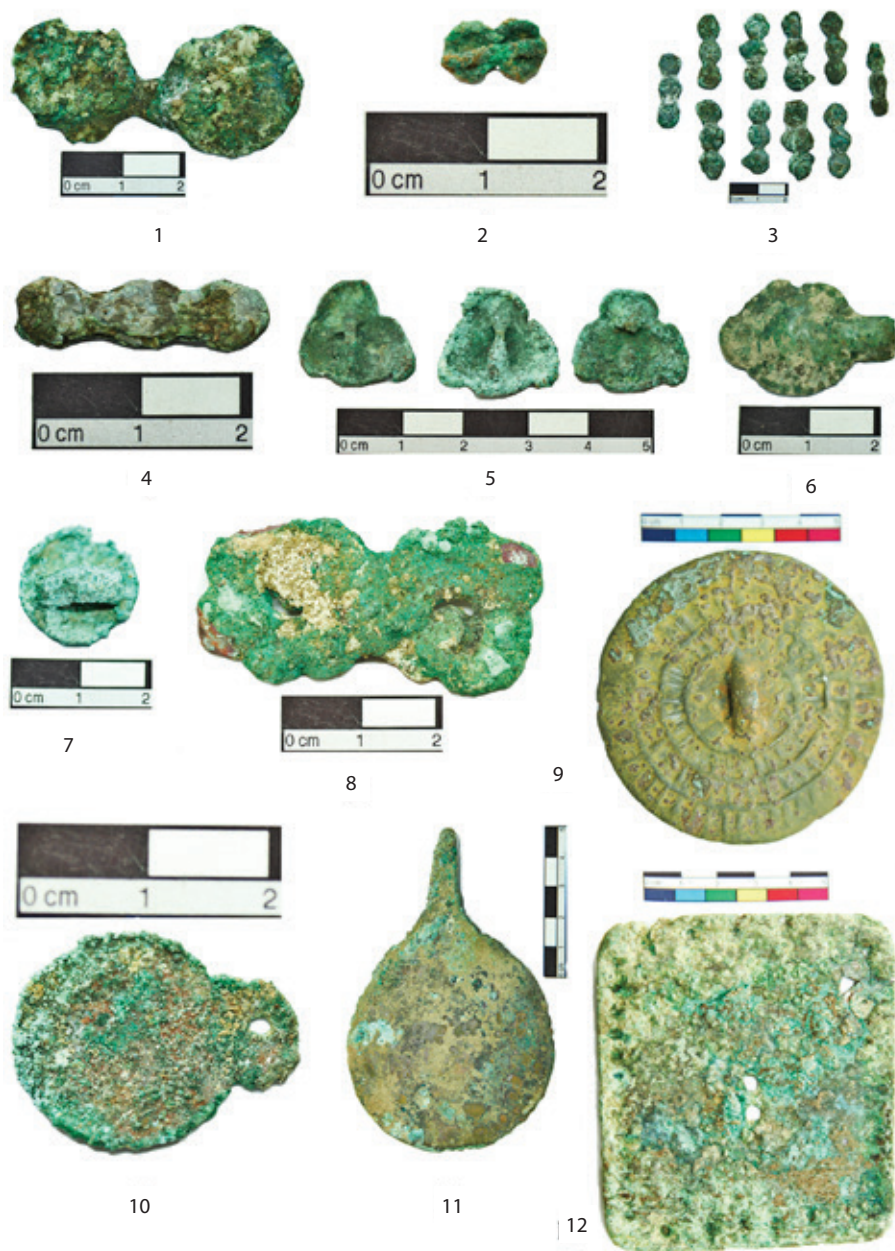


Fig. 4. Metal artifacts of the Tishanbeilu culture (III): 1–7 – buttons; 8, 12 – plaques; 9–11 – mirrors. 1. M15: 15; 2. M17: 16; 3. M126: 5; 4. M112: 3; 5. M50: 8; 6. M386: 1; 7. M25; 8. M3: 2; 9. M15: 13; 10. M91: 6; 11. M36: 2; 12. M400: 8

Рис. 4. Металлические изделия культуры Тяньшаньбэйлу (III): 1–7 – пуговицы; 8, 12 – бляшки; 9–11 – зеркала. 1. M15: 15; 2. M17: 16; 3. M126: 5; 4. M112: 3; 5. M50: 8; 6. M386: 1; 7. M25; 8. M3: 2; 9. M15: 13; 10. M91: 6; 11. M36: 2; 12. M400: 8

Plaques. 86 items. They are rather diverse in form, including S-shaped, rectangular, butterfly-shaped, and hoof-shaped. They are found in different quantities and in various positions, including the upper body, shoulder, waist, fibula, skull, under the elbow, hipbone, tibia, knee, right arm, and the leg of the occupants.

S plaque. 1 item (M3: 2). It is 4.3 cm long and 2.2 cm wide (Fig. 4.-8).

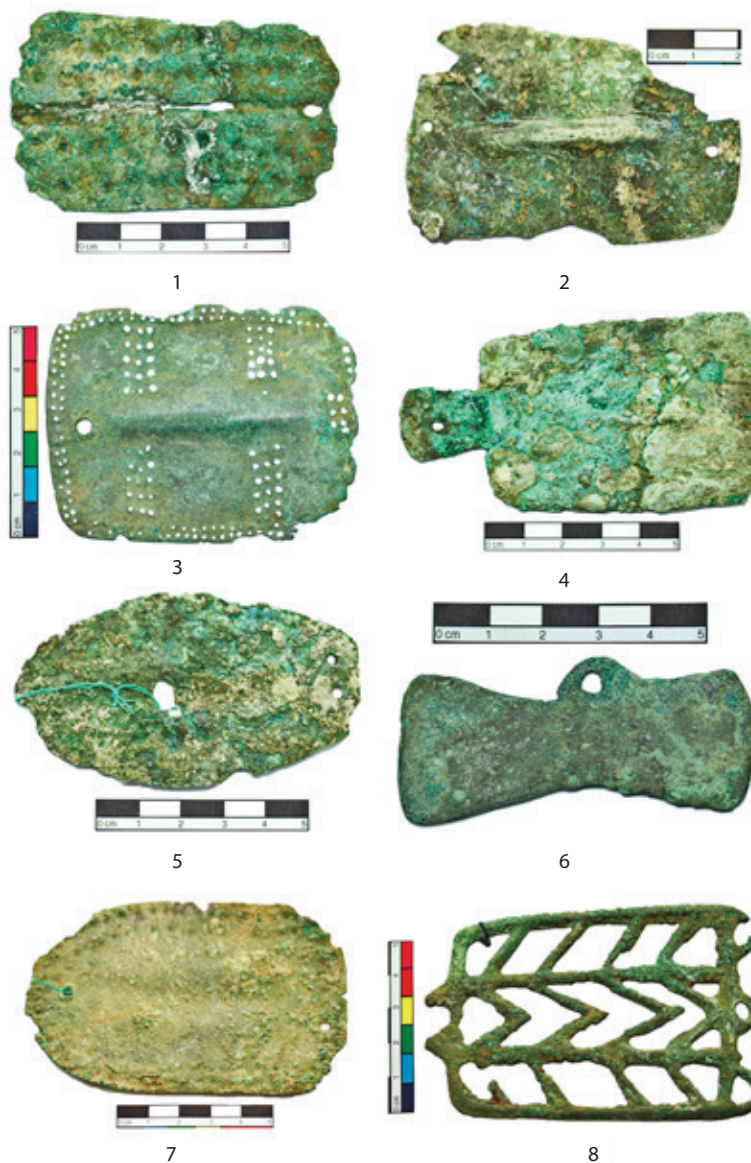


Fig. 5. Metal artifacts of the Tianshanbeilu culture (IV): 1–8 – plaques. 1. M16: 3; 2. M54: 4; 3. M80: 2; 4. M190; 5. M483: 24; 6. M536: 7. M589: 5; 8. M626: 2

Рис. 5. Металлические изделия культуры Тяньшаньбэйлу (IV): 1–8 – бляшки. 1. M16: 3; 2. M54: 4; 3. M80: 2; 4. M190; 5. M483: 24; 6. M536: 7. M589: 5; 8. M626: 2

Rectangular plaques. 58 items. More or less rectangular. Each of them, as in the examples of M16:3, M54:4, M80:2, has a longitudinal rib in the middle, a hole on each end, and one or two rings of indentation (Fig. 5.-1, 2, 3). Except for one grave (M16) yielding two items, all the other graves each offer one item. Most of them are 7.5 cm long and 4.7 cm wide, but there are a larger one that is 11.3 cm long and 4.2 cm wide, and a smaller one of 2.5 cm long and 1.6 cm wide.

Hoof plaques. 3 items. They have a rounded edge on one end and a straight edge on the other. One (M589: 5) has multiple indentations (Fig. 5.-7).

Butterfly plaques. 18 items. They occur either singly or in pairs. More or less rectangular, they are constricted in the middle, which gives them their butterfly shape, and have a loop at one side, as in the example of M536: 7 (Fig. 5.-6). Most are plain, except for one (M625: 3B), which has three grooves and a row of chevrons on either side, and another (M636: 1) is decorated with grids in relief.

Spade plaque. 1 item (M190). It has a rectangular handle, which has a hole for suspension, 8.2 cm long and 5 cm wide (Fig. 5.-4).

Square plaque. 1 item (M400: 8). It has two holes at the ends of one diagonal line, a row of punched indents along the four borders, 5.5 cm long and 4.9 cm wide (Fig. 4.-12).

Almond plaque. 1 item (M483: 24). It is in the form of fan, 8.7 cm long and 4.7 cm wide (Fig. 5.-5).

Openwork plaques. 2 items in nearly identical form. Rectangular in form, they have two columns of chevrons, one loop at one end, and three loops at the other. One (M626: 2) is 9.8 cm long and 6.2 cm wide (Fig. 5.-8); the other (unlabeled), partly damaged, is 7.6 cm long.

Wheel plaque. 1 item (M685: 1). Analogous to a wheel, it has centrifugal spikes, four of which are broken, 9.3 cm in diameter (Fig. 6.-1).

Buttons. They are commonly found in graves, and varied not only in form, but also in size. A string of buttons is found around the head.

Disc buttons. 4 items. As in the example of M2: 6, they are flat and equipped with arch grips like mirrors, but much smaller (Fig. 3.-9). They are 3.2–4.3 cm in diameter.

Small dome buttons. 208 items. Mostly 0.4–1.8 cm, but a few are up to 2.8 cm in diameter. Most are plain miniature buttons, but a good number of them, as in example of M112: 3, are decorated with a ring of sunrays (Fig. 4.-7). In addition, many bear the imprint of the stick core for casting the hole of arch grip. Apart from the common circular ones, there are also peach and pear ones. In Grave M267, they are found at the clavicle, jaw, hand, or under the head of the occupant; in Grave 266, they are found at the upper jaw, upon the eye, neck, left ear, under the skull, shoulder blade, or humerus of the occupant. In Grave M307, they are found at the waist and left shoulder. In Grave 317, they are found at left foot and forehead. In Grave M341, they are found under the neck, left wrist, left ankle, left and right ears of the occupant.

Large dome buttons. 117 items in total. Mostly 3–4.7 cm in diameter, but a few are 1.5–2.2 cm. But like the small dome buttons, they retain the imprint of the casting core for the hole of grip. Mostly plain; only a few, as in the example of M15: 4, are decorated with a ring of sunrays (Fig. 3.-10). They usually occur singly, but when they occur multiply, they are spread over many areas of the human body. In Grave M315, they are found on the right arm, chest,

the right shoulder, and the right eye of the occupant, a fact indicating that they are used to adorn various parts of human body.

Large double-piece buttons. 37 items in total. They are formed by joining two round buttons. Like the dome buttons, they have arch grips and imprints of the casting core for the hole of grip (Fig. 3.-11, Fig. 4.-1), as in the examples of M150: 3b and M15: 15. Mostly plain, some are decorated with a ring of sunrays. In most graves, they occur singly, but in Graves M190, M267, M311, M341, they are found at the femur, lower jaw, right elbow, right wrist, or forehead of the occupant, which means that they are used to adorn various parts of the human body. They are 2.1–4.9 cm long.

Small double-piece buttons. 19 items. These are the miniature version of the large double-piece buttons without arch grip on the back, as in the example of M17: 16 (Fig. 4.-2). They are normally 0.8–1.4 cm long, but some are 1.9–2.4 cm long. In a grave, they occur by the numbers of 1, 2, or 3.

Triple-piece buttons. 26 items. These are formed by joining three small round buttons in a row; very small in size, they are 2.4–2.9 cm long (Fig. 4.-3, 4), as in the examples of M126: 5 and M112: 3. Where the context is known, they occur at the head and waist (M126).

Triangular button. 1 item (M50: 8). It is 1.8 cm per side (Fig. 4.-5).

Tree-top button. 1 item (M386: 1). It is 2.6 cm long (Fig. 4.-6).

Mirrors. 65 items in total. They are roughly similar to bosses in form, but different in having larger sizes and flat surfaces. Most have an arch grip at the center of the back, whereas two items (M91: 6; M36: 2) stand out in having side handles (Fig. 4.-10, 11). While most are plain, a few items are decorated with three concentric rings of sunrays, as in the example of M15: 13 (Fig. 4.-9). They are 4.5–9.5 cm in diameter. The mirrors occur by 1 item, 3 items, and occasionally 11 items. They are found at the leg, upper body, on the face, at the head, or on the eye.

Tubes. 201 items in total. Rolled out of hammered tapes, they vary widely in size, and in workmanship. Most of them are thin and thoroughly corroded, as in the examples of M1: 5 and M349: 10 (Fig. 7.-10, 12). The long ones are 4.2–19.2 cm long, and 0.5–1 cm in diameter. They can be found at the hipbone, fibula, humerus, tibia, pelvis, knee, left arm, neck, leg, and waist. Mostly found singly, they sometimes occur in the groups of 2, 3, 4, 5, 7, 8, or 9. The short ones are comparatively short and thin, occurring singly in a grave, except for Grave M321, which yields 2 items. They are mostly 0.6–2.3 cm long, 0.4–1.4 cm in diameter. Only one is 13.3 cm (M349). Where the context is known, one (M137: 4-1) is located at the hip.

Spiral tubes. They are formed out of coiling tapes, the small sections of which are sometimes as components of bracelets, as in the example of M65: 4 (Fig. 7.-11). The intact ones are 4.4–7.5 cm long, and located at the femur, the leg, or on the chest, as in the example of M154: 2 (Fig. 7.-13). Altogether 58 items, they occur singly in most graves; only in M683 they occur by a set of 10 items.

Earrings. 308 items in total. They are made of bronze, lead, iron, or gold wires, which are uneven in thickness. Most are made of solid threads of 0.2–0.3 cm, but some are made of thin ones of 0.1 cm. Roughly in the shape of circles, they are fully closed or slightly open, sometimes stricken into fans at ends, as in the examples of M2: 2, M19: 1, M625:1, M7:3, M446:2, M91:2 (Fig. 6.-2, 3, 5, 6, 7, 9). Moreover, a few are triangular, as in the examples of M261: 2 and

M670: 4 (Fig. 6.-4, 8). They do not appear in all graves that are furnished with metal artifacts. However, when they appear, they often occur in pairs, near the two ears of the occupant, but in this case the two items are not necessarily identical in form. It is more common that they occur singly. Occasionally they occur in trio, or in 2 pairs, or 4 pairs. Their diameters vary from 0.9 cm to 5.3 cm. The single pair of gold earrings (M446: 2) found at this cemetery are nearly closed and 2.1–2.5 cm in diameter (Fig. 6.-7).

Bracelets. Altogether 107 items. A lot less in quantity than earrings, they are nevertheless more solid. Some are hammered flat, whereas the other items are round. One grave may yield 1 or even 3 or 4 items. They are mostly made of copper or copper alloy wire, as in the example of M5: 3 (Fig. 6.-10), but sometimes made of iron or lead wire, as in the examples of M21: 3 and M38: 3 (Fig. 6.-11, 13); yet one item (M298: 2) is made of copper or copper alloy tape (Fig. 6.-12). Their ends, which are usually crossed, are tapered yet in some cases flattened. These are generally made of one round of wire, but one item (M311: 20) is made of three rounds. In addition, some are made of small beads. In some graves, they are found at the wrist. Their sizes are located anywhere between 4.4 cm and 8 cm, thickness between 0.4 cm and 0.7 cm.

Clips. 41 items in total. Usually made of lead wires, as in the example of M16: 5 (Fig. 7.-9), they are sometimes made of copper or copper alloy wires, but all in the form of letter T with two parallel tongs. They occur usually singly in graves, but sometimes in pair. In three graves, they are found at the head, or the mastoid process. They vary from 2.5 cm to 5.2 cm in length, and 0.1–0.3 cm in thickness.

Fingerings. 2 items. It is bent of a copper or copper alloy wire. One is actually found on a finger, 2 cm in diameter, and 2.2 cm long, as in the example of M542: 3 (Fig. 6.-14).

Beads. Altogether 827 items. They are mostly used for making bracelets, but sometimes for headdresses. A grave may yield up to 9 bracelets. Some of the beads are cut out of the spiral tubes, and assembled together with spiral tubes. Some bracelets are made of a mix of round, spiral metal beads, and bone beads. When the context is known, beads are found near the neck, upper arm, and right wrist of the occupants. They occur in various forms: ball, ring, tube, and water-drop.

Ball beads. Altogether 351 items. Generally spherical in shape, they often carry casting seam, as in the example of M125: 27/2 (Fig. 8.-2). As components of bracelet, they have small holes for passing thread. All made of copper or copper-based alloys, they occur in the groups of 1, 2, 3, 7, 8, 9, 12, 13, 15, 16, 23, 27, or 32. In one grave, the occurrence of 1 bracelet is common, that of 2 bracelets less so, but in Grave M125, 9 bracelets occur. They also vary widely in size; the common ones are 0.5–0.7 cm in diameter, whereas the occasional large one is 1.7 cm.

Ring beads. 311 items. They are generally made of bent short wires or tapes, as in the example of M48: 4 (Fig. 7.-16). A bracelet may be comprised of 1, 2, 3, 4, 5, 6, 7, 9, 12, 14, 16, 17, 20, 21, 26, 31 or 32 beads. In a grave it may occur 1, 2, or 3 times. They are found at the skull or the right wrist. While the majority of them are circular, a few are pentagonal. Their diameters vary from 0.6 to 1.1 cm, and their lengths from 0.2 to 1.1 cm. In Grave M602, they are combined with 65 bone beads.

Tube beads. 105 items in total. These are short tubes, 0.3–2.3 cm in length, 0.4–1.2 cm in diameter, as in the example of M125: 35 (Fig. 8.-1). Normally they are rolled out of sheet, but

in a few cases coiled out of tape. Yet 1 item (M378: 3) is made in the form of tooth. Most often they occur singly, in pair, or in groups of 5, 8, 9, 13, and 14.

Water-drop beads. 60 items in total. They are rendered in the form of water drop, but some approximate the form of wheat grain with a vertical groove, as in the example of M194: 4 (Fig. 8.-3). They occur only in four graves, in the groups of 2, 4, 12, 20, or 21. Roughly produced, they retain casting seam. They are 0.6–0.8 cm in diameter, and 0.6–1 cm long.

Jingle bells. 5 items. One (M10: 10) is fragmentary; its stem is crushed flat, but three horizontal bulges are visible, 4 cm long (Fig. 7.-2). Another (M54: 5) is characterized by a rope stem and a cup, but it has two casting defects (Fig. 7.-1), 9.8 cm long. The third (M361: 7) is found at the right kneel.

Caps. 9 items. Often one end thicker than the other, they are possibly used for holding rope or stick (Fig. 7.-3–6), as in the examples of M73: 10, M78: 1, M307: 14, M460: 4. They are 1–2.4 cm long and 0.4–1.2 cm in diameter.

Imitation cowrie shell. 1 item (M363: 4). It is made in the form of almond with a long cut in the middle, 3.7 cm long, 1.4 cm wide (Fig. 7.-8). Not coincidentally, a real cowrie shell, a maritime good far away from Tianshanbeilu, is found in Grave M393.

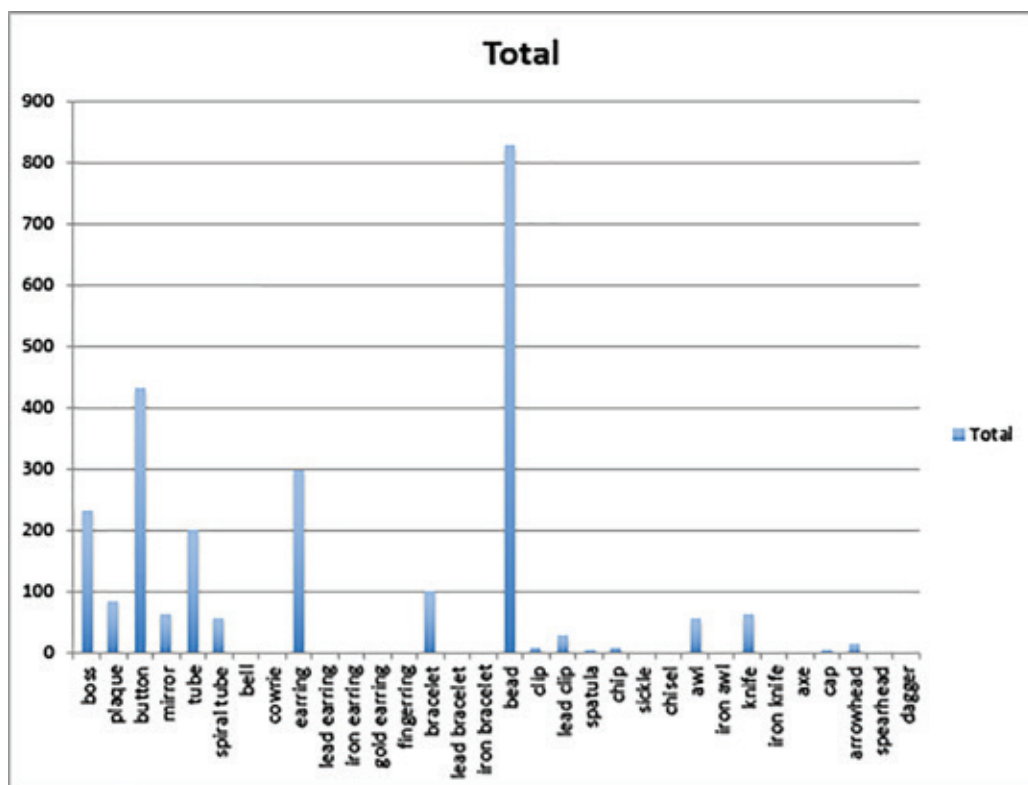


Fig. 9. Quantities of types of the Tianshanbeilu metal artifacts

Рис. 9. Количество типов металлических изделий культуры Тяньшаньбэйлу

Although the data set presented here is incomplete, it offers a good picture of the diverse types of metal artifacts at Tianshanbeilu (Fig. 9). The quantity of tools and weapons (knife, awl, chisel, sickle, arrowhead, spearhead, dagger) is rather modest, 146 in total. Knives and awls are the most numerous items, whereas the other types of tools and weapons are relatively few. By comparison, ornaments are abundant. There are a large number of beads, bosses, plaques, mirrors, tubes, spiral tubes, earrings, and bracelets, amounting to between 50 and 800 for each. This suggests that they might have been staple accessories. They are diverse not only in form, but also in material. Apart from copper and copper alloys, lead and iron are used to make these ornaments.

It has been argued that the metallurgy of the Hami region is derived directly from the Siba culture in western Hexi Corridor, but ultimately from the Karasuk culture in the Minusinsk Basin and Tuva, rather than locally born [Zhang, 2017: 107–108]. This is because to date no Neolithic sites have been found in the Hami region, and the metallurgy of this period is unambiguously exogenous. When we examine the Bronze Age cultures of the surrounding regions, the ensemble of the metal artifacts of the Tianshanbeilu culture showcases multiple sources of inspiration. There is an analogous dagger with three ribs (Fig. 2.-13) at the Andronovo culture site of Myrzhik in Kazakhstan [Kadyrbaev and Kurmankulov, 1992: 59]. Most of the ornaments, tools, and weapons are comparable with those of Siba and Karasuk. The striking predominance of body ornaments among the assemblage of Tianshanbeilu is likewise reminiscent of Siba and Karasuk. The popular assumption that the metallurgy of Tianshanbeilu is derived from the Andronovo culture in Kazakhstan is not grounded [Mei, 2000: 38]. The signature assemblage of Andronovo metal artifacts, consisting of willow-leaved dagger, shaft-hole axe, foil bracelet, and snail-shaped earring, is absent among the Tianshanbeilu metals. The metallurgy of Tianshanbeilu therefore has not much to do with Andronovo, but rather with the Karasuk culture.

The metal artifacts of Tianshanbeilu are, however, not imports of the Siba or Karasuk cultures. A great number of them exhibit local traits. The buttons bear the imprint of the casting core, which, together with the mold, are used for casting the small grip. Ring-topped knives and mirrors differ from the Siba and Karasuk counterparts in having very long blades. In addition, certain types of objects of the Karasuk culture such as triangular pendants do not occur at Tianshanbeilu, whereas other metal objects of the Tianshanbeilu culture such as rectangular plaques and butterfly plaques do not occur among the Siba and Karasuk metals. Artifacts such as sunray discs, chevron-shaped objects, humpbacked knives, and spiral tubes are unique to the Tianshanbeilu metals. While some traits of the Tianshanbeilu metals indicate that they derive their inspiration from Siba and Karasuk prototypes, others are suggestive of local innovations. These lines of evidence suggest that these metals are produced locally.

The Yanbulake Culture

Several cemeteries, as well as a few graves at the sites of Tianshanbeilu, Fuzhisuanchang [Zhang, Chang, 1998], Nanwan [Chang 1985; Xinjiang Institute of Archaeology, 1987], Wubu [Xinjiang Institute of Cultural Relics and Archaeology, 1992], Baiqier [Tulahun, 2005], Aisikexiaer [Xinjiang Institute of Cultural Relics and Archaeology, Hami Region Cultural Relics Administration, 2002], Lafuqiao [Xinjiang Institute of Cultural Relics and Archaeology 1984], Yaer [Hu, 2015], Sayituer [Xinjiang Institute of Cultural Relics and Archaeology, 2014;

Hu, 2015], and Hanqigou [Xinjiang Institute of Cultural Relics and Archaeology, Hami Region Cultural Relics Administration 1996, 1997] can be attributed to this culture. While the sites are dispersed in the ranges of Tianshan and the area to its north, they are mostly concentrated in the oases in the Hami Basin. In general, these cemeteries contain much lesser graves, and offer much lesser metal artifacts. The Yanbulake and Wubu collections in Hami Museum were likewise examined by the authors in 2013. As in the case of the Tianshanbeilu metals, a small number of fine pieces are dispersed in Xinjiang Institute of Cultural Relics and Archaeology, and Xinjiang Museum in Urumqi and unavailable for this study, which is admittedly not exhaustive.

The Yanbulake cemetery is located on a small terrace 60 km to the west of the Hami city. In conjunction with a small walled settlement nearby, it was discovered in the 1950s. It was excavated in 1958, when 14 graves were discovered. These graves, found below the gravel surface, are small pit graves, some of which are lined with mud-bricks. They produce a few funeral goods. In 1986, another 76 graves were excavated [Xinjiang Uighur Autonomy Region Cultural Ministry Cultural Relics Department, Xinjiang University History Department Cultural Relics and Museology Training Program, 1989]. The metal artifacts uncovered from the cemetery, however, are more limited in quantity and less diverse in form than those from Tianshanbeilu.

Buttons. 15 items. Morphologically identical to those of the Tianshanbeilu culture but smaller in size, as in the examples of M33: 3 and two unlabeled items (Fig. 10.-2-4). Most are 1.1–1.4 cm in diameter, but the largest ones are up to 1.9 cm. 4 of them are miniature buttons; they are thin and light. Yet 2 have the imprint of the core for casting the arch grips, as in the example of M33: 3 (Fig. 10.-3). Most of them are plain except for three that are decorated with a ring of sunrays, as in the example of an unlabeled item (Fig. 10.-2). The arch grips are soldered or pre-cast to the main bodies. Apart from circular ones, there are also triangular and pentagonal ones.

Bosses. 3 items, all thin and fine pieces. One (M48: 1) is partially preserved, over 4 cm in diameter (Fig. 10.-6). The other two are 1.3–1.9 cm long and 0.9–1.5 cm wide, as in the example of M68: 8 (Fig. 10.-7). They occur singly or in pairs.

Rectangular plaque. 1 item (M41: 1). It is thin and light, measuring 4.4 cm long and 1.6 cm wide (Fig. 10.-8).

Mirror. 1 item (unlabeled). It is a round flat disc with an arch loop on the back, measures 3.8 cm in diameter (Fig. 10.-14).

Earring. 15 items. Most are circular. They are made of copper or copper alloy thread, as in the example of M76: 6 and M18: 1 (Fig. 10.-11, 13). A few have flat hammered ends, as in the example of an unlabeled item (Fig. 10.-12). 3 of them are cast in a spiral. Apart from the regular ones, a pendant is attached to 2 of the earrings, as in the example of another unlabeled item (Fig. 10.-15). They are 1–3.9 cm across, and 0.2 cm thick.

Bracelets. 2 items. One (M37: 2) is partially preserved, measuring 0.2 cm thick (Fig. 10.-16); the other (unlabeled) is comprised of 3 tubular beads and 11 round beads, 8.1 cm long (Fig. 11.-1).

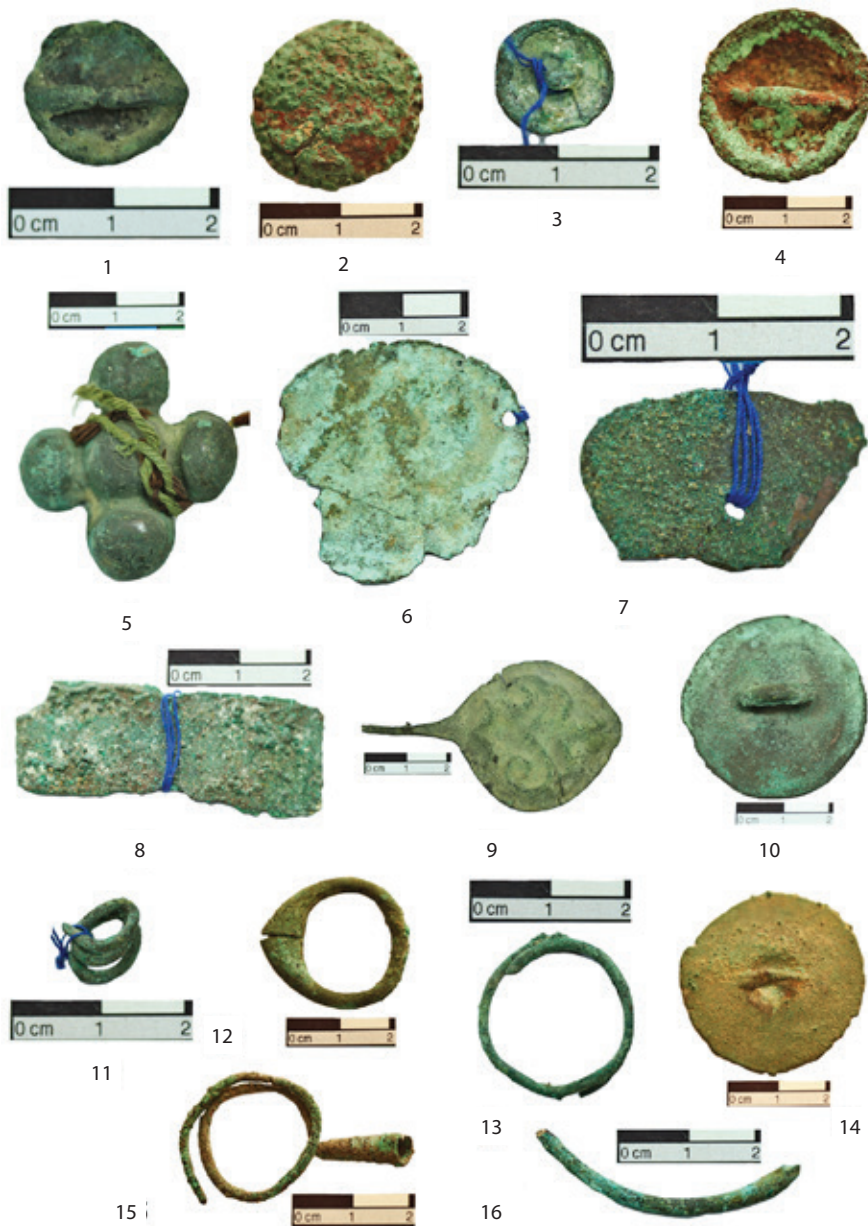


Fig. 10. Metal artifacts of the Yanbulake culture (1): 1–5 – buttons; 6–7 – bosses; 8–9 – plaques; 10, 14 – mirrors, 11–13, 15 – earrings; 16 – bracelet. 1, 5, 9, 10. Wubu; 2, 4, 12, 14, 15. Yanbulake; 3. Yanbulake M33: 3; 6. Yanbulake M48: 1; 7. Yanbulake M68: 8; 8. Yanbulake M41: 1; 11. Yanbulake M76: 6; 13. Yanbulake M18: 1; 16. Yanbulake M37: 2

Рис. 10. Металлические изделия культуры Яньбулак (1): 1–5 – пуговицы; 6–7 – бляхи; 8–9 – бляшки; 10, 14 – зеркала, 11–13, 15 – серьги; 16 – браслет. 1, 5, 9, 10. Убу; 2, 4, 12, 14, 15. Яньбулак; 3. Яньбулак М33: 3; 6. Яньбулак М48: 1; 7. Яньбулак М68: 8; 8. Яньбулак М41: 1; 11. Яньбулак М76: 6; 13. Яньбулак М18: 1; 16. Яньбулак М37: 2



Fig. 11. Metal artifacts of the Yanbulake culture (II): 1 – bracelet; 2 – tubes; 3 – bead; 4–5 – caps; 6 – knife; 7 – burin; 8–9 – jingle bells; 10 – celt; 11–13 – arrowheads. 1, 2. Yanbulake M3; 3. Yanbulake T12; 9; 4. Yanbulake T10; 11; 6. Yanbulake M47; 5; 1, 5, 7, 11–13. Yanbulake; 8–10, Wubu

Рис. 11. Металлические изделия культуры Яньбулак (II): 1 – браслет; 2 – трубки; 3 – бусина; 4–5 – колпачки; 6 – нож; 7 – резец; 8–9 – колокольчики; 10 – кельт; 11–13 – наконечники стрел. 1, 2. Яньбулак МЗ; 3. Яньбулак Т12; 9; 4. Яньбулак Т10; 11; 6. Яньбулак М47; 5; 1, 5, 7, 11–13. Яньбулак; 8–10. Убу

Tubular ornaments. 4 items. They are 2.2–4.7 cm long and 0.6–1.1 cm in diameter. They are found in pairs in two of the graves, as in the example of M3 (Fig. 11.-2).

Beads. 9 items, all tubular. They are 0.4–1.6 cm long, and 0.5–0.7 cm in diameter, and occur singly or in pairs, as in the example of T12: 9 (Fig. 11.-3).

Cap. 1 item (T10:11). It resembles those of the Tianshanbeilu culture in form, 1.6 cm long and 0.8 cm in diameter (Fig. 11.-4).

Knives. 4 items, all narrow and long. One of them (M47: 4, 5) is 2.5 cm long and 0.6 cm wide (Fig. 11.-6). Another one is partially preserved. Thin and light, it is finished with a small hole, 4.5 cm long and 1.8 cm wide. The third one, also thin and light, includes a ring-pommel. The fourth one is made of iron, 10.1 cm long.

Burin. 1 item (unlabeled). It is spade-shaped, topped with a wooden hilt, 7.8 cm long (Fig. 11.-7).

Arrowhead. 6 items. Three items (all unlabeled), unlike those of the Tianshanbeilu culture, are made in the form of spearhead with hollow shaft, 2.7–3.8 cm long (Fig. 11.-11–13). The shaft of one (M6: 2) contains remnants of wood, rendered in the form of hand, 2.7 cm long and 1 cm wide. Another two items (both unlabeled) are chisel-shaped and flanked with two wings, whose forms are unprecedented in the Tianshanbeilu culture (Fig. 11.-11, 13). They measure 2.3–2.4 cm long.

Unknown object. 1 item. It is round at one end, and drilled at the other; it is also flat on one side, possibly attached to another object, 6 cm long.

The Wubu cemetery is located to the south of Yanbulake in a small oasis. 114 graves were excavated in the 1980s, but only the materials of two graves (M151, M152) have been published [Xinjiang Cultural Relics Affairs Administration, Xinjiang Institute of Cultural Relics and Archaeology 1999; Lü, Chang, Wang, 2001]. The graves are pit graves, some of which are lined with mud bricks. Thanks to the dry environment, wooden logs, and needle grass (*Achnatherum splendens*) mats covering the opening have been found. The metal artifacts in the collection of Hami Museum are rather limited in quantity.

Five-piece button. 1 item (unlabeled). It has 5 semispherical bosses and a diameter of 3.3 cm long (Fig. 10.-5).

Button. 2 items. Dome-shaped, they have long arch grips, as in the example of an unlabeled item (Fig. 10.-1). They measure 1.5 cm and 2.4 cm in diameter respectively.

Peach-shaped plaque. 1 item (unlabeled). It is made into the peach shape, decorated with impressed motifs, and attached with a loop, 6.2 cm long (Fig. 10.-9).

Earrings. 2 items. One of them is made of copper or copper alloy thread into the shape of a droplet 1.9 cm long. The other has intersecting ends; it measures 1.6 cm long.

Mirror. 1 item (unlabeled). A flat round disc 4 cm in diameter (Fig. 10.-10).

Jingle bells. 5 items. Three of them have woolen yarn, 3.8–5.2 cm long, threaded through holes around its circumference, as in the case of an unlabeled item (Fig. 11.-9). The other two also have elongated perforations, measuring 4.2 cm in length, as in the example of another unlabeled item (Fig. 11.-8).

Shaft-hole axe. 1 item (unlabeled). Well preserved. It has a flared edge and a socket into which a wooden stick is inserted. It is 4.1 cm long (Fig. 11.-10).

The metal artifacts of the Yanbulake and Wubu cemeteries are representative of the Yanbulake culture. In comparison with those of the Tianshanbeilu culture, the diversity is significantly reduced, possibly related to the drastic drop in quantity (Fig. 12). On the one hand, there are fewer types of artifacts — the clip, chisel, sickle, spearhead, and dagger are

absent — on the other hand, the diversity of the types of staple objects such as buttons and earrings declines. There are no objects made of gold or lead.

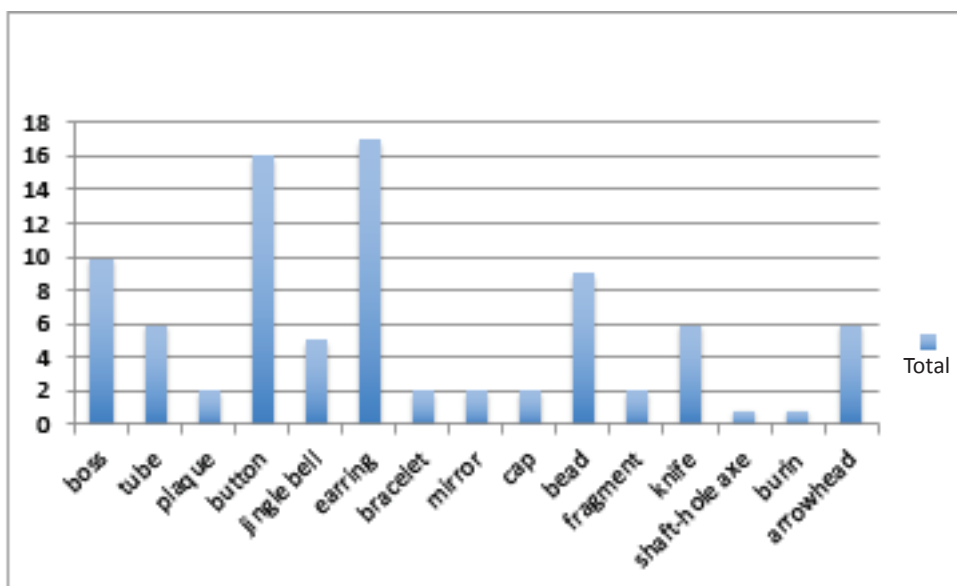


Fig. 12. Quantities of types of the Yanbulake metal artifacts

Рис. 12. Количество типов металлических изделий культуры Яньбулак

The majority of the ensemble of the Yanbulake metals shows continuity from the Tianshanbeilu culture, following its use of personal ornaments such as plaques, earrings, buttons, tubes, and beads. The predilection for body ornaments persists, but certain types of artifacts, such as the large plaques and spiral tubes of Tianshanbeilu disappear. Most types appear to evolve from the Tianshanbeilu prototypes. As a general trend, the artifacts, which include buttons, knives, bosses, and jingle bells, become smaller and cruder in quality; it may be considered a period of stylistic degeneration.

This, however, does not suggest that the Yanbulake metals do not exhibit traits of technical innovation. The buttons, for instance, have larger holes for passing threads; most of them are free of the casting defect, that is, the imprint of the casting core. The tubes and the unique rectangular plaques are still used during the time of Yanbulake, but they are much less prevalent. The workmanship of Yanbulake items declines significantly. The jingle bell from the Wubu cemetery is a later and simpler version of the Tianshanbeilu items, without the trumpet-like mouth and the linear ornament of the latter. In the meantime, a number of new types appear, which include the five-piece button, the pear-shaped plaque, the earring with pendant, and several types of arrowhead and burin. These ornament types are too unique for us to identify the origin of inspiration for their forms.

The Heigouliang Culture

The cemeteries of Heigouliang, Shangmiaoergou [Autonomy Region Cultural Relics Survey Office, Hami Region Cultural Relics Expedition, 1991; Hami Region Cultural Relics Administration, 1998], Dongheigou, Sheyuegou [Xinjiang Institute of Cultural Relics and

Archaeology, Northwest University Cultural Heritage Conservation and Archaeology Center, Hami Region Cultural Relics Bureau, 2014], Liushugou [Hu and Zhang, 2014], Xiagou [Xinjiang Institute of Cultural Relics and Archaeology, Northwest University Cultural Heritage Conservation and Archaeology Center, Hami Region Cultural Relics Bureau, 2014], and Tuobeiliang [Northwest University Cultural Heritage Conservation and Archaeology Center, Xinjiang Institute of Cultural Relics and Archaeology, Hami Region Cultural Relics Bureau, 2014] may be attributed to this culture. These sites are all located on the foothills of the Tianshan Mountains rather than in the oases of the Hami Basin, which suggests that its populations give up agriculture and practice pastoralism only. The Heigouliang cemetery is located on the ancient path cutting through the Tianshan Mountains from the Hami Basin to the Barkol Plain. A survey conducted in 1993 led to the discovery of four clusters of graves. Unlike the pit graves of the previous two periods, these graves are kurgans of the Eurasian steppe type, consisting of stone-piled mounds, measuring 2–7.5 m across, under which pit graves or catacomb graves are found. This type of grave structure has been found at the Hanqigou cemetery where funeral goods of the Yanbulake culture are also located. In 1993 and 1994, 64 graves were excavated at Heigouliang. A different set of funeral objects uncovered from this cemetery, including lacquerware, iron artifacts, show wide-range cultural interaction. Unfortunately these materials have not been fully published; only an informal preliminary report is available [Xinjiang Institute of Cultural Relics and Archaeology, Hami Region Cultural Relics Administration, 1991]. Most of these metal artifacts are stored in Hami Museum; some are published in the museum catalog [Hami Museum, 2013].

Bosses. 22 items. Made of copper, copper alloy or iron. They are mostly flat discs or trumpet-shaped, with a hole at the center, as in the examples of M31:11 and M10:5 (Fig. 13.-1, 2). They vary greatly in size: the largest one is 4.6 cm in diameter; the others are 1–2.1 cm in diameter. One of them is semispherical, made of iron, and 4.2 cm in diameter. A rectangular item (M28: 7), which has one hole at each end, is 3.9 cm long (Fig. 13.-4). A few items are made of scraps and holes are drilled for securing, as in the example of M4: 1b (Fig. 13.-3).

Buttons. 10 items. There are three types. The first is a round disc furnished with a high arch grip. There are two of these, 1.9 cm in diameter with grip of 0.9 cm high, as in the example of M9:21 (Fig. 13.-8). The second type is a deep round box decorated with a beak in the front, and a long and high grip on the back, as in the examples of two items under the same label of M4:3 (Fig. 13.-9–10). There are four of these, 2.6 cm in diameter. And the third is a semi-spherical top with a broad brim, as in the example of M10: 8 (Fig. 13.-7). There are three of these, 1.5–3.5 cm in diameter. The buttons come in pairs except in two graves.

Plaque. 1 item (M4: 1). It is a flat disc in the form of a bird, showing the beak, front claw and wing (Fig. 13.-11). It has six holes for securing, 38 cm long and 2.5 cm wide.

Mirrors. 8 items. Unlike those of the Tianshanbeilu and Yanbulake cultures, the mirrors of Heigouliang are characterized by the presence of a side handle. The handle is preserved on three of these items. As in the examples of M22: 6 and M12: 6, they are round with a hole in the middle and cast together with the main body (Fig. 13.-15, 16). The handle, which is broken off and lost, is attached to the main body by soldering or riveting, as in the example of M43: 11 (Fig. 13.-14). The intact mirrors are 5.6–6.5 cm in diameter. It should be noted that the abovementioned three mirrors are tinned.



Fig. 13. Metal artifacts of the Heigouliang culture (I): 1–6 – bosses; 7–10 – buttons; 11–13 – plaques; 14–16 – mirrors. 1. Heigouliang M31: 11; 2. Heigouliang M10: 5; 3. Heigouliang M4: 1b; 4. Heigouliang M28: 7; 5. Dongheigou M12: 8; 6. Dongheigou M12: 37; 7. Heigouliang M10: 8; 8. Heigouliang M9: 21; 9. Heigouliang M4: 3; 10. Heigouliang M4: 3; 11. Heigouliang M4: 1; 12. Dongheigou M13: 7; 13. Dongheigou M15: 3; 14. Heigouliang M43: 11; 15. Heigouliang M22: 6; 16. Dongheigou M12: 6

Рис. 13. Металлические изделия культуры Хэйгоулян (I): 1–6 – бляхи; 7–10 – пуговицы; 11–13 – бляшки; 14–16 зеркала. 1. Хэйгоулян М31: 11; 2. Хэйгоулян М10: 5; 3. Хэйгоулян М4: 16; 4. Хэйгоулян М28: 7; 5. Дунхэйгоу М12: 8; 6. Дунхэйгоу М12: 37; 7. Хэйгоулян М10: 8; 8. Хэйгоулян М9: 21; 9. Хэйгоулян М4: 3; 10. Хэйгоулян М4: 3; 11. Хэйгоулян М4: 1; 12. Дунхэйгоу М13: 7; 13. Дунхэйгоу М15: 3; 14. Хэйгоулян М43: 11; 15. Хэйгоулян М22: 6; 16. Дунхэйгоу М12: 6



Fig. 14. Metal artifacts of the Heigouliang culture (II): 1 – mirror; 2–3, 5–6 – earrings; 4, 9–10 – pins; 7–9 – handles; 11 – belt hook; 12 – beads; 13–14 – caps; 15 – needle; 16–17 – awls; 18–21 – knives. 1. Dongheigou M54; 2. Heigouliang; 3. Heigouliang M14; 4. Heigouliang M9; 5. Dongheigou M11; 6. Dongheigou M1; 7. Heigouliang M7; 8. Heigouliang M10; 9. Heigouliang M4: 4b; 10. Heigouliang M4: 27; 11. Heigouliang M25: 23; 12. Heigouliang M14: 11; 13. Heigouliang M3: 7; 14. Heigouliang M10: 12; 15. Heigouliang M37: 17; 16. Heigouliang M9: 20; 17. Heigouliang M9: 22; 18. Heigouliang M1: 7; 19. Heigouliang M8: 2; 20. Heigouliang M10: 4; 21. Heigouliang M15: 12

Рис. 14. Металлические изделия культуры Хэйгоулян (II): 1 – зеркало; 2–3, 5–6 – серьги; 4, 9–10 – шпильки; 7–9 – ручки; 11 – крючок для ремня; 12 – бусы; 13–14 – колпачки; 15 – игла; 16–17 – шилья; 18–21 – ножи. 1. Дунхэйгоу М54; 2. Хэйгоулян; 3. Хэйгоулян М14; 4. Хэйгоулян М9; 5. Дунхэйгоу М11; 6. Дунхэйгоу М1; 7. Хэйгоулян М7; 8. Хэйгоулян М10; 9. Хэйгоулян М4: 4b; 10. Хэйгоулян М4: 27; 11. Хэйгоулян М25: 23; 12. Хэйгоулян М14: 11; 13. Хэйгоулян М3: 7; 14. Хэйгоулян М10: 12; 15. Хэйгоулян М37: 17; 16. Хэйгоулян М9: 20; 17. Хэйгоулян М9: 22; 18. Хэйгоулян М1: 7; 19. Хэйгоулян М8: 2; 20. Хэйгоулян М10: 4; 21. Хэйгоулян М15: 12



Fig. 15. Metal artifacts of the Heigouliang culture (III): 1–2 – knives; 3–6 – arrowheads; 7–8, 16 – daggers; 9 – bit; 10 – cheek-piece; 11 – jingle bell; 12–14 – buckles; 15 – necklace; 17 – ring. 1. Heigouliang M20: 8; 2. Dongheigou; 3. Heigouliang M4: 2; 4. Heigouliang M4: 11; 5. Heigouliang M17: 17; 6. Heigouliang M31: 8; 7. Heigouliang M25: 24; 8. Heigouliang M11: 12; 9. Heigouliang M10: 1; 10. Heigouliang M21: 5; 11. Heigouliang M11: 23; 12. Heigouliang; 13. Heigouliang M10: 2; 14. Heigouliang M40: 6; 15. Dongheigou M11: 10; 16. Heigouliang M28: 14; 17. Heigouliang M26: 7

Рис. 15. Металлические изделия культуры Хэйгоулян (III): 1–2 – ножи; 3–6 – наконечники стрел; 7–8, 16 – кинжалы; 9 – удила; 10 – псалий; 11 – колокольчик; 12–14 – пряжки; 15 – ожерелье; 17 – кольцо. 1. Хэйгоулян M20: 8; 2. Дунхэйгоу; 3. Хэйгоулян M4: 2; 4. Хэйгоулян M4: 11; 5. Хэйгоулян M17: 17; 6. Хэйгоулянь M31: 8; 7. Хэйгоулян M25: 24; 8. Хэйгоулян M11: 12; 9. Хэйгоулян M10: 1; 10. Хэйгоулян M21: 5; 11. Хэйгоулян M11: 23; 12. Хэйгоулян; 13. Хэйгоулян M10: 2; 14. Хэйгоулян M40: 6; 15. Дунхэйгоу M11: 10; 16. Хэйгоулян M28: 14; 17. Хэйгоулян M26: 7

Earrings. 5 items. All are assembled out of multiple components. One (unlabeled) is comprised of two bronze tubes, two large rings, and two small rings, all of which are strung up with a silver wire. It measures 5.3 cm in length (Fig. 14.-2). The other earrings are made of copper or copper alloy. One item (M14) is comprised of one band and two rings hung from it, 1.3 cm long (Fig. 14.-3). Another (unlabeled) has two rings, one bead, and a pendant 3.2 cm long. The third one (M14: 5) has three rings and a pendant 3.1 cm long; the last two (M9: 4, M38: 14) are comprised of one ring and one hook, 5.2 cm and 2.7 cm long respectively.

Necklace. 1 item (M11: 10). It is comprised of carnelian and gold foil tubes, and faience beads (Fig. 15.-15). The carnelian beads are bi-conical.

Pins. 6 items, their forms vary. One (M4: 4b) has a mushroom top at one end and a flat body, 5.5 cm long and 0.3 cm wide (Fig. 14.-9). Two (M9) have flat ends that measure 2.2 cm and 2.9 cm long respectively (Fig. 14.-4). The fourth (M6: 8d) has a thick end and a slender body, 8.8 cm long. The fifth (M14) is a partially preserved long bent wire of 3.1 cm in length. The sixth item (M4: 27) has a disc cap and a long thin pin, 6 cm long (Fig. 14.-10).

Handles. 2 items. One item (M7: 10) is a solid triangular loop, possibly broken off from a cauldron, 3.5 cm long each side, and 0.5 cm thick (Fig. 14.-7). The other one (M10: 8) is likewise originally a part of a larger object, 2.1 cm long and 1.9 cm wide (Fig. 14.-8).

Belt hooks. 2 items. One (M9: 7) is comprised of a flat plaque with a hole at the end for securing, and a beak-like hook extended from it. It is 3.6 cm long and 0.8 cm wide. The other item (M25: 23) is tinned, comprised of a flat body and a tapering hook and 2.2 cm long (Fig. 14.-11).

Beads. 6 items. Five of them are conical tubes, 0.7 cm in diameter and 1.2–1.5 cm long, as in the example of M14: 11 (Fig. 14.-12).

Clip. 1 item. Only a half is preserved, 3.1 cm long.

Caps. 12 items, they occur in two types. One (M3: 7) is a tube with a disc-like top, and the other (M10: 12) a conical tube (Fig. 14.-13–14). Both types could have been used for holding horse whips. Similar in size, they are 0.9–1.7 cm long, and 0.5–0.9 cm in diameter. In two graves they occur singly, and in two other (M3, M10) by the numbers of 3 and 5.

Awls. 8 items, made of copper/copper alloy or iron. One (M9: 22) is 5.1 cm long; the other (M9: 20), topped with a wooden handle, 5.5 cm long (Fig. 14.-16–17).

Needles. 3 items. Topped with holes, they are 3.8–6 cm long, as in the example of M37: 17 (Fig. 14.-15).

Knives. 25 items. 12 are made of copper/copper alloy. Thin and slender, much like the modern medical lancet for surgery, they are nevertheless rather diverse in form. One (M1: 7) has a long hilt (Fig. 14.-18), another (M10: 4) also long hilt but with a hole (Fig. 14.-20), the third (M15: 12) a broad hilt and a hole (Fig. 14.-21), and the fourth (M20: 8) a slender blade (Fig. 15.-1). Among them, 8 are found singly in 8 graves, 4 in pair in 2 graves. The intact ones are 4.8–12 cm long, and their blades are 0.8–1.1 cm wide. 13 items are made of iron, as in the example of M8: 2 (Fig. 14.-19). They occur in two types: one type, as in the example of M1: 7, is thick and broad, triangular (Fig. 14.-18); the other, as in the example of M10: 4 and M20: 8, are thin and slender, 9–13.6 cm long, 1–1.2 cm wide (Fig. 14.-20; Fig. 15.-1). In one grave they normally occur singly, but in Graves M8 and M14 they occur by the numbers of 3 and 4.

Arrowheads. 9 items. Also strikingly different from those of Periods I and II. Eight, as in the examples of M4: 2, M4: 11, M17: 17, have three lobes with hilt or hollow shaft hole, 3.5–5.4 cm long (Fig. 15.-3–5); together with stronger bows, they can shoot with greater power and accuracy than those having two lobes. One item (M31: 8) differs in having a thin body and a long hilt, and kept in a wooden case, 4.8 cm long (Fig. 15.-6). What is notable is that two items, as in the example of M17: 17, are tinned (Fig. 15.-5). They occur either singly or in pair.

Daggers. 3 items. Rather varied in style. One (M11: 12) is rather slender, 8.5 cm long, and 0.4 cm wide (Fig. 15.-8); another (M25: 24) is wider and thicker, featuring a prominent guard, 6.6 cm long (Fig. 15.-7); the third (M28: 14) differs in having a well-defined hilt and blade, 7.7 cm (Fig. 15.-16). The latter two are tinned.

Jingle bells. 4 items. As in the example of M11: 23, they are roughly cast and small, 1.7 cm long and 1.1 cm in diameter (Fig. 15.-11).

Cheek-piece. 1 item (M21: 5). It consists of two flat branches and a coiled section in the middle, with a hole at the center, 8.5 cm long and 0.4 cm wide (Fig. 15.-10).

Bit. 1 item (M10: 1). A wire has its two ends coiled into loops and its center bent, 0.4 cm thick and 15.7 cm long (Fig. 15.-9).

Buckles. 3 items. One (M40: 6) consists of two rectangular rings and a bent hook, 2.3 cm long, 1.7 cm wide (Fig. 15.-14). It is probably part of a belt. The second (M10: 2) is comprised of a circle and a triangle, but flat as a whole, 3.6 cm long and 2 cm wide (Fig. 15.-13). The third (unlabeled) is comprised of a dome cap and a five-hole column, 2.6 cm and 3.2 cm in diameter, 1.3 cm high (Fig. 15.-12).

Ring. 1 item (M26: 7). It is cast as one piece without any break, 2.6 cm in diameter and 0.2 cm thick (Fig. 15.-17).

At Dongheigou, a compound site consisting of a settlement and a cemetery, 5 stone structures and 12 graves have been excavated. The graves are also of the Eurasian kurgan type, featuring a stone-piled mound and a stone-lined pit grave underground, and sacrificial pits containing camels and horses around [Xinjiang Institute of Cultural Relics and Archaeology, Northwest University Cultural Heritage Conservation and Archaeology Center, 2007]. Metal artifacts that have been found from the site are not many.

Earrings. 5 items. All compound earrings, two items, as in the example of M11: 11, are each comprised of a gold wire, two turquoise tubes, and an agate bead, 6.1 cm and 5.8 cm long respectively (Fig. 14.-5). Another two items, as in the example of M1:3, made of copper or copper alloy thread, are comprised of a hook and an openwork case, 5–5.3 cm long (Fig. 14.-6).

Knife. 1 item (unlabeled). Topped with a ring pommel, the hilt and blade are well homogenized without distinction, 17.6 cm long (Fig. 15.-2).

Plaques. 7 items. One (M1: 5) is hexagonal, 2.5 cm long; another (M1: 8) is in the form of butterfly, 3.4 cm long; the third (M15: 3) is in the form of animal, the species of which is unknown, 5.5 cm long. Two are rectangular: one (M13: 7) is hammered out of gold foil, showing an animal in the form of tiger, 6.5 cm long (Fig. 13.-12); the other (M12: 30) of silver foil, showing a relief of deer, 6.5 cm long.

Mirror. 1 item (M54: 2). Oval in shape, it has a large arch grip, 6.2 cm long (Fig. 14.-1).

Bosses. 5 items. One is a quad-petal cut out of silver foil, 3 cm long. The second (M12: 1–5) is identical to M12: 37 in motif, but made of gold, 2.9 cm long. The third (M11: 6) is a gold

spiral horn of 1.1 cm in diameter. To this one may attribute a silver semispherical item (M12: 8) with embossed motifs of 2.3 cm in diameter (Fig. 13.-5), and a silver quad-petal item (M12: 37), 3.1 cm long (Fig. 13.-6).

Altogether, metal artifacts from 37 graves at Heigouliang and Dongheigou cemeteries are examined. Continuity and change are evident when they are compared with those of the Tianshanbeilu and Yanbulake cultures (Fig. 16). Several types of metal artifacts, including bracelet, tube, clip, chisel, sickle, tube, spearhead, and axe, disappear. In the meantime, ornaments such as boss, button, plaque, mirror, earring, jingle bell, and tools and weapons such as awl, knife, arrowhead and dagger remain in use. Some of these objects retain their forms, but others are significantly changed. For example, some bosses are crafted in semispherical form; they are large and furnished with one hole at the center. The buttons are mounted with bird motifs on the top. The mirrors have lateral handles that are either riveted to or cast with the mirror. The earrings inherit the compound type of Yanbulake, but carnelian beads are added. Knives are thin and slender, and reminiscent of modern medical lancets. The stylistic changes hint a new way of craftsmanship, which is better visible in new types of metal artifacts discussed below.

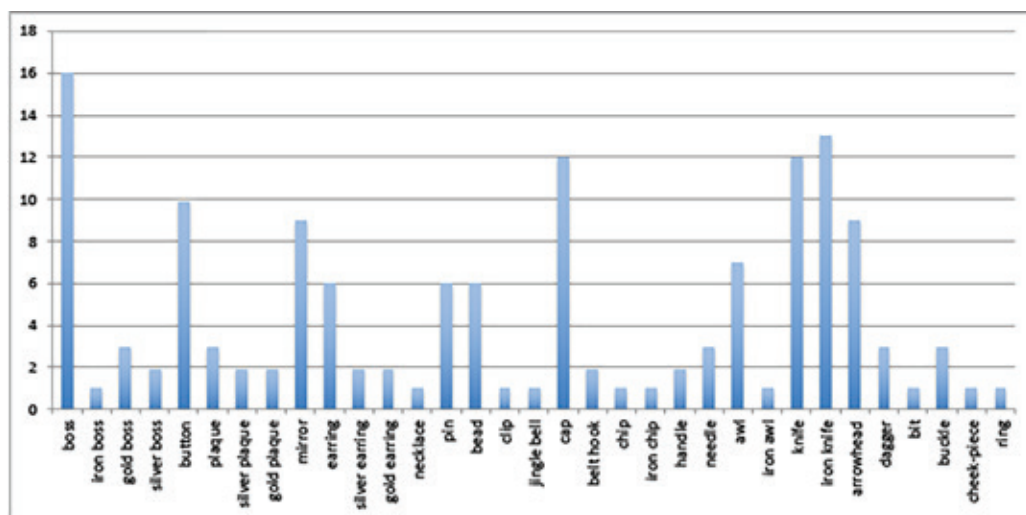


Fig. 16. Quantities of types of the Heigouliang metal artifacts

Рис. 16. Количество типов металлических изделий культуры Хэйгоулянь

The new types of metal artifacts, including animal-style plaques, belt hooks, buckles, horse bit, jingle bells, long-handled daggers, and ring-handles are introduced. The animal-style plaques are made of gold and silver foils and decorated with animal motifs. A three-lobe arrowhead allows it to shoot for greater distance and with greater precision. The horse bit, cheek-piece, and buckles are used for harnessing, manifesting the emergence of horse-riding. The solid ring handles indicate the presence of metal vessels, which are the earliest ones found in Xinjiang. Iron artifacts become predominant and replace bronze as material for making daggers, knives, bosses, which are previously crafted solely in bronze during

the second period. Moreover, a new technology of tinning is employed for the making of mirrors and arrowheads.

Where are the new types of metal artifacts from? Contemporaneous nomadic cultures have been discovered in the adjacent regions, including the Altai Mountains, Minusinsk Basin, and Tuva. The ring-handle and rivet-handle mirrors have been discovered in the Altai Mountains [Rybakov, 1992: Fig. 63.-45, Fig. 64.-25]. The triangular belt hooks, bird-formed plaques, and five-holed round buckles have been discovered in the Tagar culture cemeteries in the Minusinsk Basin [Rybakov, 1992: Fig. 84.-34, Fig. 88.-12, Fig. 85.-23]. The bird buckles have been discovered in all the three regions, but the ones with double rectangular rings have only been found in Tuva [Rybakov, 1992: Fig. 77.-36]; The wire bit and round buckles have also been found there [Rybakov, 1992: Fig. 75.-82, Fig. 82.-18]. There are likely multiple incoming sources of inspiration; it is reasonable to surmise that the population of Heigouliang is receptive to the metallurgy and crafts traditions of nomads in these surrounding regions. This is further attested by the stone-piled kurgans and the catacomb grave structure. Physical anthropologist Wei Dong and his colleagues have discovered a horse rider, indicated by deformed femure, among 45 human skeletons from the cemetery of Heigouliang [Wei et al., 2012]. No pottery wares of these three regions have been found at Heigouliang, which indicates that the population of Heigouliang only adopts certain cultural elements of the Eurasian nomads.

Composition of the metal artifacts

Since the 1990s, a number of archaeometallurgists have analyzed metal artifacts from cemeteries of the three successive cultures of Tianshanbeilu, Yanbulake, and Heigouliang. Mei Jianjun and Qian Wei tested 108 samples from the Tianshanbeilu cemetery, and found tin bronze (79), pure copper (12), arsenic copper (9), and others [Mei, 2000: 39; Qian, 2006: 38; Institute of History of Metallurgy and Materials University of Science and Technology Beijing, Xinjiang Institute of Cultural Relics and Archaeology, Hami Region Cultural Heritage Administration, 2001]. Such an array of composition is analogous to that of the Karasuk culture, but the prominence of the tin bronze makes it distinct from the latter. Mei Jianjun and Qian Wei gathered 12 samples from the Yanbulake cemetery for compositional analysis, and found tin bronze (5), pure copper (4), and arsenic copper (3) [Mei, 2000: 40; Qian, 2006: 72]. In general, the chemical composition of the tin bronze and its prominence in the assemblage are similar to what is presented in the Tianshanbeilu cemetery. Metal artifacts from the Wubu cemetery are negligible; Mei Jianjun took only 2 samples, and both of them are pure copper [Mei, 2000: 40]. Lastly, Mei Jianjun, Qian Wei, and Ling Yong collected 16 samples from the Heigouliang Cemetery, and identified tin bronze (8), pure copper (6), and brass (cu-zinc alloy, 2), which is a new metal type [Mei, 2000: 40; Qian, 2006: 78; Ling, 2008: 67]. It is not known whether it is originated among the steppe nomads.

In 2013, the authors acquired 1754 portable XRF testing points of metal artifacts from several cemeteries of the three periods (Fig. 17). It should be noted that most of the metal artifacts found in the Hami region are corroded, and since the authors were not allowed to clean the surfaces of the objects, the XRF data are somewhat problematic. Given the research constraints, the authors could only assess the metal artifacts on a large scale. During the analysis, the authors found cases of discrepancy. As noted above, previous researchers, i.e. Mei

Jianjun, Qian Wei, and Ling Yong, have already analyzed a good number of samples from the cemeteries in question, for which they used the methods of scanning electron microscope (SEM) and Energy-dispersive X-ray fluorescence analyzer (EDXA). For the most part, our result match theirs, but for a number of samples, the data are varied. For instance, where our analysis identifies tin bronze, they recorded arsenic copper. For the moment, it is difficult to identify the reason for these discrepancies.

Cemetery	Portable XRF
Tianshanbeilu	1399
Yanbulake	85
Heigouliang	91
Sum	1575

Fig. 17. Quantities of metal objects subject to portable XRF analysis

Рис. 17. Количество металлических предметов, подвергнутых портативному XRF-анализу

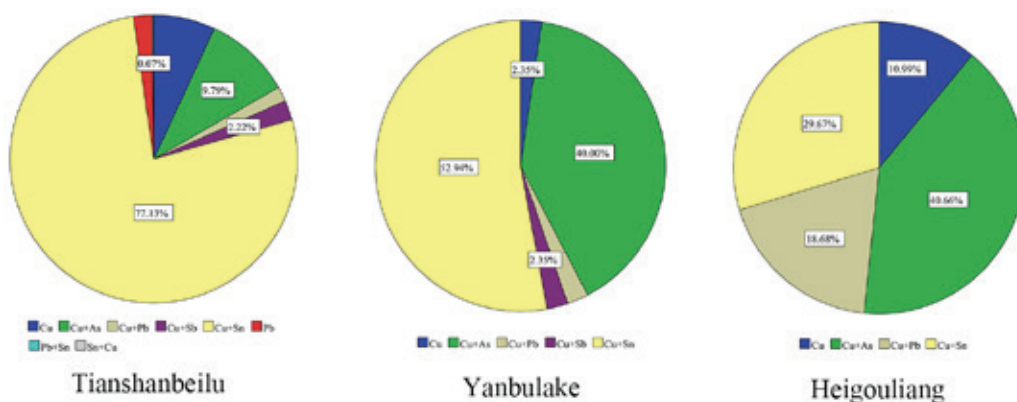


Fig. 18. Metal types of the Tianshanbeilu, Yanbulake, and Heigouliang cultures (based on the numbers of metal objects in Fig. 17)

Рис. 18. Типы состава металла культур Тяньшаньбэйлу, Яньбулак и Хэйгоулян (по количеству металлических предметов на рис. 17)

Nonetheless, the authors were able to extract some large patterns from the XRF data (Fig. 18). It is striking to see that the Tianshanbeilu metals are predominantly tin bronze, with a high percentage of 77. This is generally congruent with previous results obtained by Qian Wei, which was 68.5%. This ratio is a stark contrast with that of Karasuk metals, where arsenic copper is predominant. It supports the conjecture that Tianshanbeilu metals are locally produced. The metal artifacts of the Yanbulake and Heigouliang cultures are likewise characterized by the dominance of tin bronze and arsenic copper. If metal objects of Yanbulake and Heigouliang are also locally produced, they must have had access to stable sources of arsenic and tin. There is very limited chemically pure copper among the metal artifacts of all the three cultures. Lead copper alloy is prominent throughout the three periods.

The Tianshanbeilu metal artifacts are particularly diverse. Tin bronze is the primary type of metal, followed by arsenic copper and chemically pure copper. Apart from them, there are a few objects of gold (earrings), copper and antimony (beads), lead (clips), and lead tin alloy. The earrings are made of copper, copper alloy, lead and gold. The bracelets and pins from the Tianshanbeilu cemetery are made of lead. At the Yanbulake cemetery, tin bronze and arsenic copper are dominant, but antimonial copper, lead copper, and pure copper are present. At the Heigouliang cemetery, gold continues to be used for making earrings, necklace, and plaques, but arsenic copper, tin bronze, lead copper, and pure copper are the major metal types. Antimony is absent. It appears that tin bronze is the major type of metal throughout the three periods, although its use evidently declines over time.

Conclusion

Former research established a three-period chronology for the Bronze Age and early Iron Age of the Hami region, on the basis of which this paper provides a detailed analysis of the morphology and composition of the metal artifacts from cemeteries of the three successive cultures of Tianshanbeilu, Yanbulake, and Heigouliang. The result may be summarized as follows. The Tianshanbeilu cemetery of synonymous culture yields an extraordinary amount of metal artifacts that are extremely diverse in both form and composition. The striking predominance of body ornaments such as buttons and tubes among the metal artifacts from Tianshanbeilu is comparable with the Siba culture in western Hexi Corridor and the Karasuk culture in Tuva and the Minusinsk Basin. At the same time, however, they are characterized by some distinctive traits- the buttons have the imprint of core for casting the small grip. The ring-topped knives and mirrors do not seem to be direct imports from Siba or Karasuk either; they are different in form from their Siba and Karasuk counterparts. It appears that the forms of the Tianshanbeilu metal artifacts find inspiration among Karasuk prototypes, but they also embody local innovation. This suggests that these objects are produced locally. The PXRF data indicate a wide range of chemical composition. The predominance of tin bronze, pure copper, and arsenic copper resembles the composition of metal artifacts of the Siba and Karasuk cultures. There are, in addition, gold (earring), copper and antimony (beads), and lead copper products.

Nine cemeteries can be attributed to the Yanbulake culture. They are much smaller than Tianshanbeilu, and far fewer metal artifacts are found. The metal artifacts uncovered from the Yanbulake cemetery, however, showcase the continuous development of the Tianshanbeilu metallurgical tradition, albeit with new innovations. Personal ornaments such as plaques, earrings, and buttons and the predilection for body ornaments continue to be used but certain types of artifacts, such as butterfly plaques and spiral tubes of Tianshanbeilu disappear. As a general trend, the artifacts become smaller and cruder in quality. The Yanbulake metal artifacts, however, do not completely reflect inspiration from the contemporaneous Tagar culture of the Minusinsk Basin. Horse paraphernalia such as bit, cheek-piece, buckles, as well as animal style plaques and buttons are absent here. The PXRF data show two major types of metal: tin bronze and arsenic copper. There is a decline in the use of other metal types but iron becomes more popular.

The cemeteries of the Heigouliang culture also yield a limited number of metal artifacts. The materials used become increasingly diverse. Iron, which has already emerged in the

Tianshanbeilu and Heigouliang cultures, is particularly prominent in Heigouliang, although copper and copper alloy remain dominant. The object types change dramatically. Buttons are decorated with birds, and different from those of the Yanbulake culture. Knives approach the form of modern medical lancets. A few new types of objects, including animal-style plaques, belt hooks, buckles, horse bit, jingle bell, long-handled daggers, and ring-handles join the assemblage of this culture. It appears that the population of Heigouliang adopts new types from the nomads of the Eurasian steppe, although we cannot pinpoint a single region as the source of inspiration. As of the Yanbulake culture, the PXRf data continue to show two major types of metal: tin bronze and arsenic copper. The use of other types of metal declines, but iron becomes prominent.

The PXRf data show some large patterns. The Tianshanbeilu metals are predominantly made of tin bronze, and remarkably different from the Karasuk metals, lending support to the proposition of local production. The Yanbulake and Heigouliang metals are likewise mainly fabricated out of tin bronze and arsenic copper, which indicates staple supply of arsenic and tin. Lead copper alloy is also an important type of materials throughout the three periods; antimonial copper remains in use and during the second period. The origin of tin, lead, and antimony, therefore, becomes an outstanding question.

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