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A.A. Tishkin and Y.V. Frolov
Altai State University,
Pr. Lenina 61, Barnaul, 656049, Russia
E-mail: tishkin210@mail.ru; frolov_jar@mail.ru

Bronze Age Axes from the Forest-Steppe Altai*

This article describes a series of Bronze Age metal axes from the forest-steppe zone of the Altai. Most are random finds without definite cultural or chronological attribution. We provide a detailed description of four specimens from Bor-Forpost, Mamontovo, Karpovo, and Severny, owned by various museums of the Altai Territory. The chemical composition of alloys is assessed by X-ray fluorescence spectrometry. Results are discussed with reference to bronze metallurgy, sources of copper ore, and typological parallels. The chronology of each type of axe is tentatively evaluated in the context of Middle and Late Bronze Age cultures of the Ob-Irtysh watershed and adjoining regions.

Keywords: *Altai, forest-steppe, Bronze Age, axes, alloys, X-ray fluorescence analysis, chronology.*

Introduction

So far, a sufficiently representative series of twelve shaft-hole axes of the Bronze Age has been found on the territory of the forest-steppe Altai, which indicates that this region was one of the areas where that type of object was widely used. Information on nine axes makes it possible to mark on a map the locations where they were discovered (Fig. 1). The forest-steppe Altai includes the Pre-Altai plain, the Biysk-Barnaul Depression, the Pre-Ob Plateau with the adjacent Kulunda Steppe, and the Ob-Chumysh Highland (Tishkin, Gorbunov, Kazakov, 2002: 4), and can be considered a specific resource and environmental area with great cultural and historical significance in the Metal Ages (Tishkin, 2007).

This article intends to present and analyze data on several metal axes that reflect an important aspect of the material culture of the Bronze Age in the south of Western Siberia. This data make it possible to see in more detail the morphology, the ornamental decoration, and production technique of shaft-hole axes on the eastern part of the territory where this category of objects were found. The most complete descriptions are provided for four axes found in various areas of the Altai Territory near the villages of Bor-Forpost, Mamontovo, Karpovo, and Severny**. These materials either have not been

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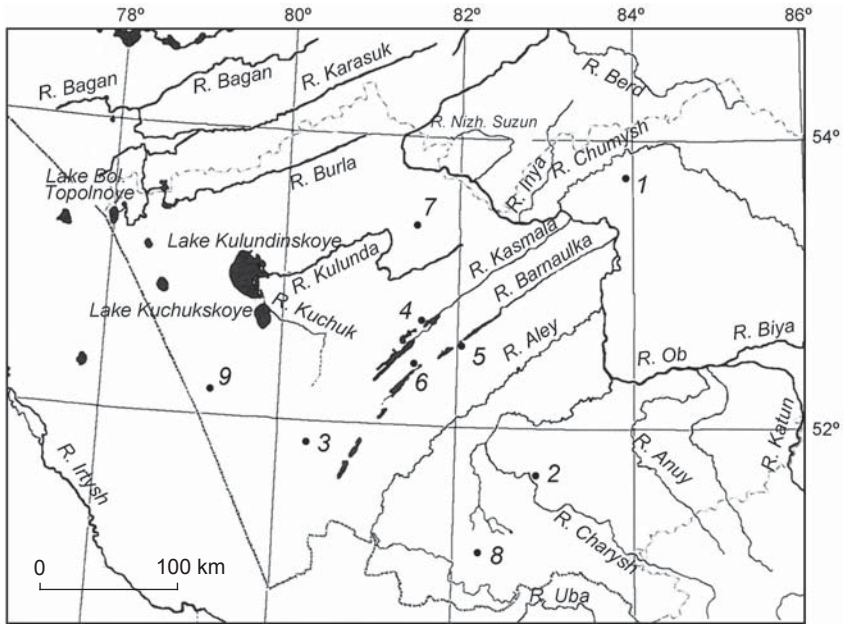

Fig. 1. Map showing the locations where metal axes have been discovered on the territory of the forest-steppe Altai.

1 – village of Severny; *2* – village of Karpovo; *3* – village of Bor-Forpost; *4* – village of Mamontovo; *5* – village of Urlapovo; *6* – settlement of Krestyanskoye IVa; *7* – village of Tyumentsevo; *8* – Zmeinogorsk mine; *9* – village of Klyuchi.

previously published or they required adjustment, since their descriptions and illustrations in the preliminary reports revealed substantial inaccuracies.

Description of the axes

Before the analysis of the findings, it would be useful to provide their detailed description (Table 1).

The axe from the vicinity of the village of Bor-Forpost (Volchikhinsky District of the Altai Territory) (Fig. 2, 3)* was kept in the village school until the late 1980s, and then was transferred to the V.M. Komarov District Museum of Local History (OF, No. 306) in the village of Volchikha. This axe was an accidental discovery.

A part of its blade is missing (Fig. 2, *1–3*; 3, *1–3*). Most likely, it was broken off already in ancient times. In its current form, the place of the breakage was sharpened using a modern grinding machine (Fig. 3, *1–3*). The surface of the object is covered with oxides. The spots of active corrosion of malachite and red-brown colors are visible on one side, and mature patina of brown color is visible on the other side of the object. These features reflect the fact that the axe was located in the soil until it was discovered. In some places, the object shows abrasions and traces of abrasive, which appear on the blade and on the upper edge of the shaft (Fig. 2, *1–3*; 3, *1–3*). These features are associated with the modern actions of the finders of the axe.

The axe was cast in a bipartite mold. Casting seams are clearly visible on the blade and on the shaft (Fig. 2, *3*, *4*, *8*). The seam was hammered out on part of the blade (Fig. 2, *3*). A casting defect appears on the butt; most likely it resulted from incomplete filling (a misrun), and a distinctive loop-like crested protrusion turned out to be not fully formed (Fig. 2, *1*, *2*, *5*). One more defect is a hole (Fig. 2, *6*) in the shaft (1.2 × 0.4 cm in size). The butt was battered in the process of the axe's use (Fig. 2, *5*).

The surface of the axe is uneven and porous. The ornamental decoration on the shaft is slurred, and in some places it is not visible at all. This feature indicates that the mold for manufacturing the object was made by imprinting an already existing axe in wet clay. Precisely this method resulted in the above defects. Two small, shallow funnel-shaped recesses are visible inside the shaft; one is directed towards the blade, and the other towards the butt (Fig. 2, *7*; 3, *4*). Similar defects have been previously observed in other objects of this kind. These are probably blowholes formed during crystallization of the metal (Tishkin, Frolov, 2015: 139), but this suggestion requires special analysis.

The hexagonal blade gradually flattens and expands towards the cutting edge (Fig. 3, *3*, *a–c*). The shape of the shaft hole is oval (Fig. 2, *3*, *4*; 3, *3*, *5*). The upper edge

*The drawings of the four published axes were made by A.L. Kungurov.

Table 1. **Parameters of shaft-hole axes**

Place of discovery	Mass, kg	Length, cm		Width / thickness of the blade, cm			Sizes of the shaft at the center, cm			Sizes of the hole, cm	
		total	blade	at the shaft joint	in the center	at the cutting edge	Height	Width	Thickness	bottom	top
Bor-Forpost	1.134	19.0	12.3	3.9 / 3.5	3.5 / 2.2	4.4 / 1.2	7.0	6.9	4.0	4.6 × 3.3	5.4 × 3.5
Mamontovo	1.196	23.4	16.3	4.1 / 3.3	3.9 / 2.2	4.5 / 1.2	7.8	6.4	4.5	–	4.9 × 3.3
Karpovo	1.736	25.1	17.2	4.6 / 3.3	4.2 / 2.1	5.7 / 0.9	7.5	7.0	4.9	4.3 × 3.2	4.7 × 3.5
Severny	1.329	22.2	13.5	4.0 / 4.3	2.8 / 3.3	5.5 / 1.1	6.3	6.2	4.9	4.0 × 3.1	4.7 × 3.1

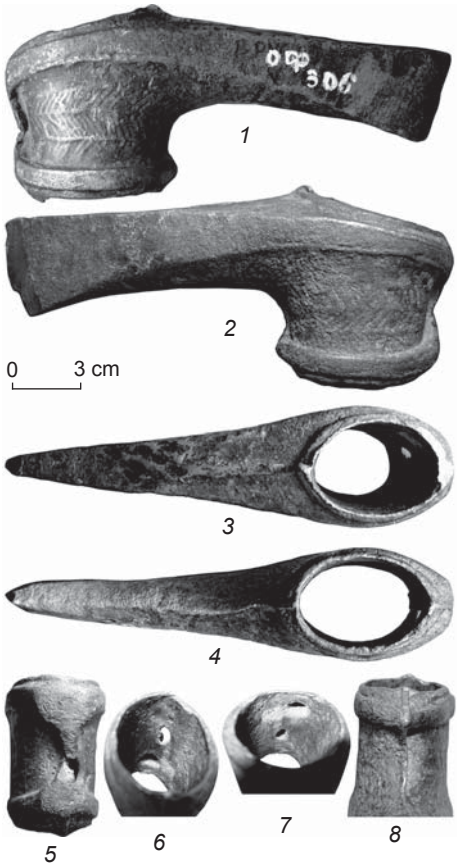

Fig. 2. Bronze axe from the vicinity of the village of Bor-Forpost.

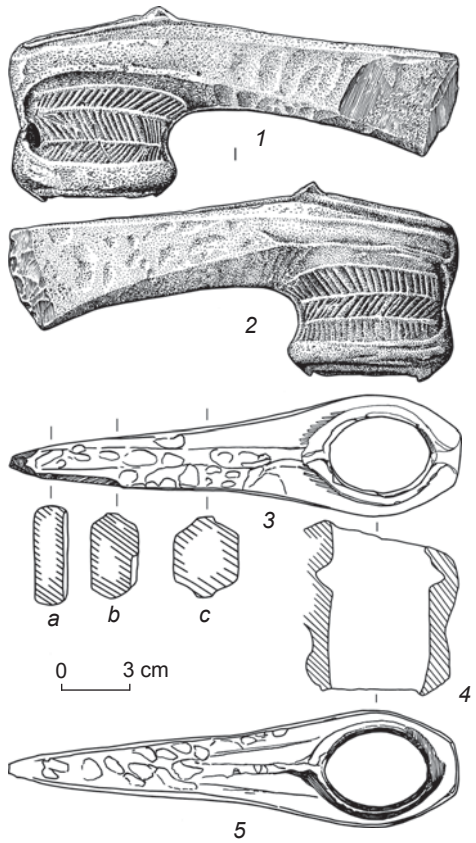

Fig. 3. Drawing of an axe from the vicinity of the village of Bor-Forpost.

of the shaft is inclined towards the butt (Fig. 2, *1*, *2*; 3, *1*, *2*, *4*). Two "bands" are clearly visible on the top and bottom edges of the shaft (Fig. 2, *1*, *2*; 3, *1*, *2*). These bands have subrectangular profile with ridges, which are not clearly defined. The band on the upper edge of the shaft extends from the butt (its average width is 1.1 cm, and 1.3 cm in the center) to the blade, thereby forming its lateral surface, the cheek. The butt of the axe is reinforced with a crested protrusion (Fig. 2, *5*) showing a casting defect. This "crest" is a continuation of bulging bands on the outer walls of the shaft. In the process of manufacturing the axe, the artisan apparently failed to produce a loop-shaped projection that appears on similar axes. The outer walls of the shaft are decorated with an ornamental pattern of three bands (decorative borders) filled with rows of slanting lines (Fig. 2, *1*, *2*; 3, *1*, *2*).

The axe from the vicinity of the village of Mamontovo (Mamontovsky District of the Altai Territory) (Fig. 4, 5) is kept in the Mamontovo District Museum of Local History (OF, No. 5642). It was found before the 1980s probably on the territory of this village (Ivanov G.E., 2000: 35).

The object has a defect that most likely originated from a misrun in the shaft. Furthermore, in the process of the axe's use, a part of the shaft at the bottom must have broken off and is missing (Fig. 4, *2*). The use of the axe in the ancient times is manifested by sharpening of the blade (up to 5 cm wide), as well as notches and spalls on the cutting edge (Fig. 5, *1*, *2*). There are wear traces on the loop of the butt (Fig. 4, *5*). The surface of the object is covered with small cavities, which probably indicates that it was cast in a clay mold. Stains of active corrosion of malachite color are visible in some places.

The object was cast in a bipartite mold, which is confirmed by the casting seam on the blade, the shaft, and inside the loop on the butt. The seam on the "back" and "belly" of the blade was in part roughly hammered (Fig. 4, *3*, *4*). A recess of subrectangular shape with irregular edges was found inside the shaft (in the direction of the blade) (Fig. 4, *6*; 5, *4*); its depth is about 1 cm; its size on the surface is 1.0 × 0.6 cm.

The axe blade at the shaft is hexagonal in cross-section (Fig. 5, *2*, *b*, *c*). The shape of the hole is oval (Fig. 4, *3*, *4*; 5, *3*, *6*). The upper edge of the shaft is inclined towards the butt (Fig. 4, *1*, *2*; 5, *1*, *2*, *4*). At the bottom and at the top its edges are reinforced with two bulges ("bands"). The upper band on each side is smoothly transformed into the side face of the axe forming the cheek. A loop of arched shape is located on the butt; its width reaches 1.1 cm (Fig. 4, *2*, *5*; 5, *2*, *4*). The loop is connected to the band and extends for 2 cm (from the shaft to the highest non-battered part). The inner sizes of the loop are 2.8 × 0.8 cm. The shaft of the axe is decorated with a pattern of four bands (decorative borders) filled with rows of slanting lines (Fig. 4, *1*, *2*, *4*, *5*, *7*; 5, *1*, *2*, *5*). The ornamental decoration partly expands to the "belly" of the blade (Fig. 4, *4*, *7*; 5, *6*).

The axe from the village of Karpovo (Krasnoshchekovsky District of the Altai Territory) (Fig. 6, 7) is kept in the Altai State Museum of Local History (OF, No. 18906). It was discovered in the vegetable garden of one of households of the village in the early 1990s. The finder of the object assumed that the axe could have been brought together with the soil from the area of the town of Shemonaikha (East-Kazakhstan Region, the Republic of Kazakhstan), which in our opinion is unlikely (Frolov, 1996: 91–92).

The object is well preserved; it only shows some wear on the blade and on the shaft. The surface is covered with brownish and sometimes dark green patina (Fig. 6). The corner of the semi-oval cutting edge of the blade is broken

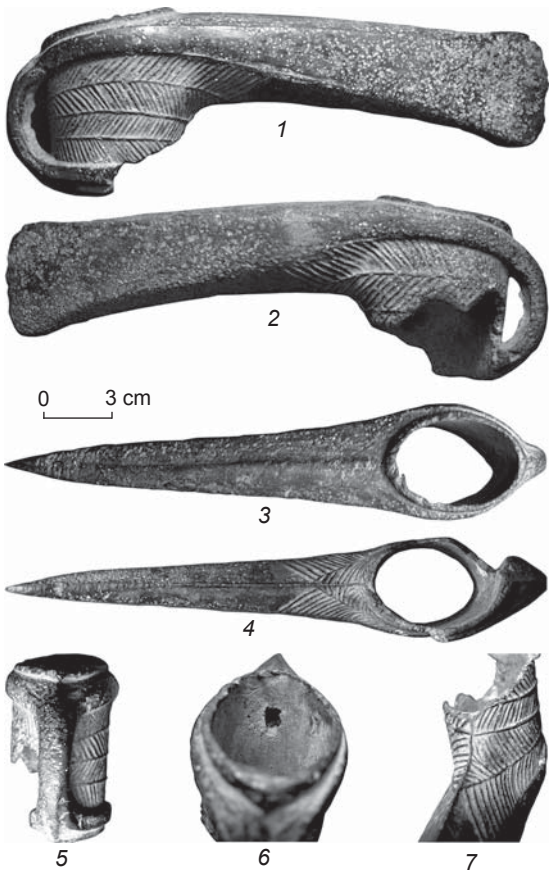

Fig. 4. Bronze axe from the village of Mamontovo.

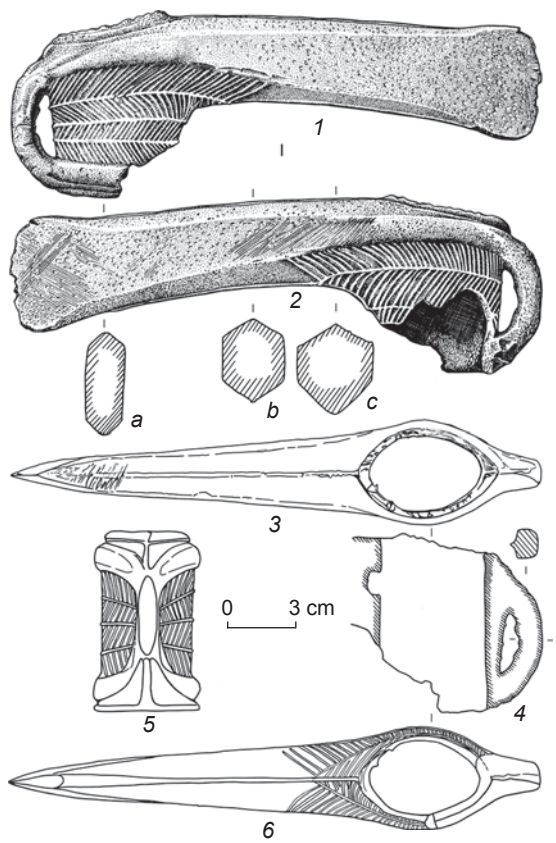

Fig. 5. Drawing of an axe from the village of Mamontovo.

off. The blade was sharpened; one edge of the blade is worn out more than the other edge (Fig. 6, *1*, *3*; 7, *1*, *3*). There are wear traces in the upper part of a crest-like protrusion on the butt (Fig. 6, *6*).

The axe was probably made using a wax model, as evidenced by the traces of dents treated manually, and other typical features (Fig. 6, *1*, *3*; 7, *1*, *3*). The casting was carried out in a bipartite mold. The casting seam is visible on the shaft (Fig. 6, *9*), on the "back", and on the "belly" of the blade (Fig. 6, *4*, *5*). There is a distinctive funnel-shaped recess inside the shaft on the side of the blade (Fig. 6, *7*, *8*).

The pentagonal blade gradually flattens and expands towards the cutting edge (Fig. 7, *1*, *a–c*). The shape of the hole is oval (Fig. 6, *4*, *5*; 7, *4*, *5*). The upper edge of the shaft is inclined towards the butt (Fig. 6, *1*, *3*; 7, *1*, *3*). At the bottom and at the top, its edges are reinforced with two bulges ("bands"). The top band is a thin line in relief; the bottom band is bipartite; a longitudinal groove is visible in the middle. A short "crest" of subrectangular shape appears on the butt of the axe; its size is 6.1 × 1.0–1.2 cm (Fig. 6, *1*, *3*; 7, *1*, *3*). It is slightly flattened in the center. A hole is absent. The shaft on both sides is decorated with the pattern of a diagonal cross formed by two lines in relief (Fig. 6, *1*, *3*; 7, *1*, *3*). A tamga-like symbol in the form of a "bird" also appears on the shaft near the beginning of the blade (Fig. 6, *2*; 7, *2*). Two or three more short slanting notches can be seen slightly lower.

The axe from the vicinity of the village of Severny (Pervomaisky District of the Altai Territory) (Fig. 8, 9) is kept at the Altai State Museum of Local History (OF, No. 11887/1). It was found in the early 1960s on a sand dune near the forest (Umansky, 1967: 99).

The surface on one side of the axe is covered with brownish and green patina and shows numerous cavities—the traces of active corrosion (Fig. 8, *1*; 9, *1*).

The axe was cast in a bipartite mold, which is manifested by a casting seam on the butt and on the blade (Fig. 9, *3*, *4*) where it was ground down in some places. The defects appear in a number of places. There is a "bulge" on one side of the blade (Fig. 8, *2*; 9, *2*). Attempts were made to remove it by grinding, but because of its large size it was not removed completely. The same but less pronounced defect also appears on the shaft. A casting defect can be seen on the edge of the hole, which has irregular outline (Fig. 8, *2–4*).

The axe shows traces of use. The butt is heavily battered (Fig. 8, *6*). The metal in this location was hammered down, which resulted in the irregular mushroom-like shape of the heel protrusion on the "crest". The surface shows numerous notches (Fig. 8, *1*, *2*; 9, *1*, *2*). An accumulation of such notches appears on one cheek of the blade, possibly indicating that the axe was used as an anvil. The notches are particularly numerous at the joint of the shaft and the blade. One may get the impression that

Fig. 6. Bronze axe from the village of Karpovo.

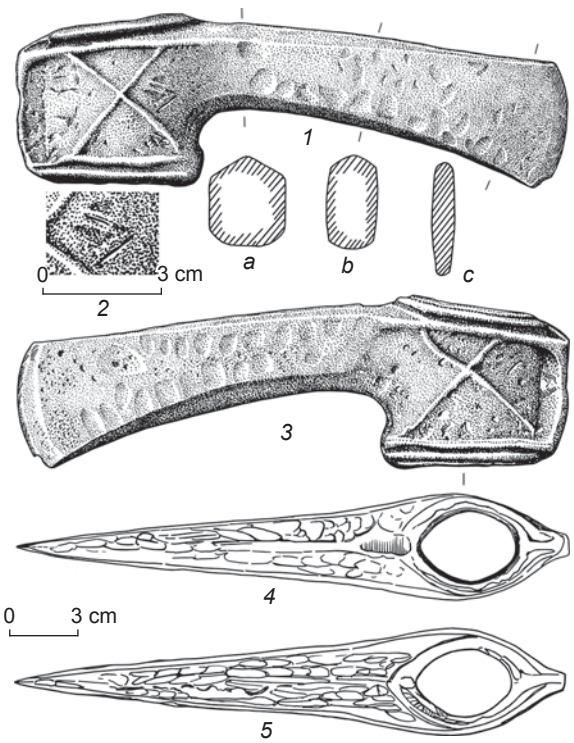

Fig. 7. Drawing of an axe from the village of Karpovo.

Fig. 8. Bronze axe from the vicinity of the village of Severny.

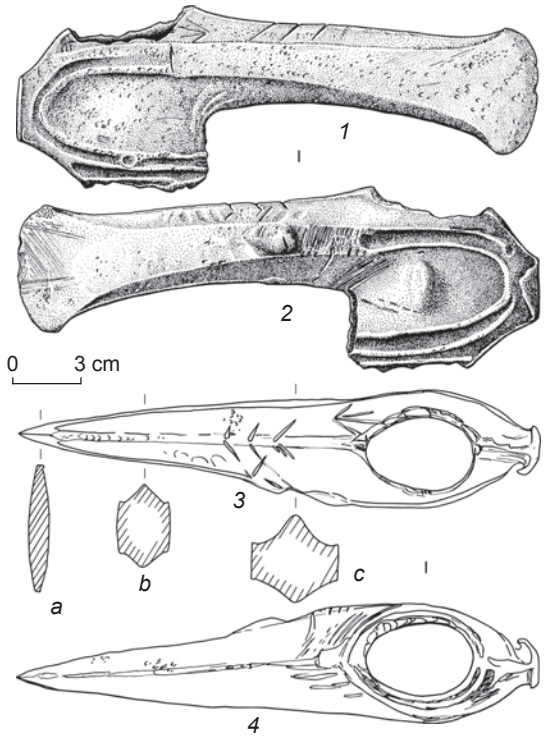

Fig. 9. Drawing of an axe from the vicinity of the village of Severny.

several blows were made on this area by a tool with a wide blade. It is possible that one of the blows resulted in the spalling of metal from the edge of the shaft. The cutting edge of the axe shows traces of sharpening and notches. Numerous small chipping is especially noticeable on the heel and the toe of the blade. A funnel-shaped recess is visible inside the hole on the side of the butt, similar to those observed in the previous axes. Its upper size is about 1.5 × 1.0 cm; the depth is 3 cm. The place where a sample of metal was taken by drilling is located next to the recess.

The blade narrows in a basically symmetrical way from the shaft to the cutting edge (Fig. 9, *3*, *a–c*) and is hexagonal in cross-section. The facets are slightly concave. The shape of the hole is oval (Fig. 8, *3*, *4*; 9, *3*, *4*). Along the edges of the hole, the shaft was reinforced by double ridged "bands", which make an oval forming the small crested protrusion of the butt; in their upper part they transform into the side face of the blade (Fig. 8, *1*, *2*; 9, *1*, *2*). Another band appears along the lower edge of the shaft. The width of the bands ranges from 0.9 to 1.2 cm. The butt was reinforced by small "crest", having a heel-shaped protrusion in the middle—a rounded striker 2.9 × 2.1 cm in size, which has acquired a mushroom-like shape in the process of its use (Fig. 8, *3*, *4*, *6*).

On the axe, notches can be seen that form tamga-like symbols. Several of the notches are made on the "back" of the blade and form a herringbone pattern (Fig. 8, *5*; 9, *3*). The tamga-like symbol of an arrow with an additional line is visible on the cheek of the blade near the shaft (Fig. 8, *1*, *5*; 9, *1*, *3*).

Using a portable X-ray fluorescence spectrometer ALPHA SERIES™ (Alpha-2000 model, made in the USA), the chemical composition of alloys of the above four axes was studied at the Altai State University (Table 2). The "Analytical" mode was used for these studies. Tests were made on parts of the objects where the oxides were removed.

Table 2. **Results of the X-ray fluorescence analysis, %**

Place of discovery of the axe	Test No.	Cu	Sn	Pb	Fe
Bor-Forpost	2225-04-2015	86.40	13.27	0.33	–
Mamontovo	3325-04-2015	71.93	27.81	0.10	0.16
Karpovo	604-04-2015	86.88	13.06	0.06	–
Severny	918-04-2015	75.71	23.86	0.05	0.38

The analysis shows that all the axes were made of bronze. Nominally, two objects stand out with an increased and decreased tin content. It is possible that these differences are of cultural and chronological nature.

Discussion

The greatest number of shaft-hole axes from the territory of the forest-steppe Altai originated from the areas near the ribbon-like pine forests and from the north-western foothills (Fig. 1–10). These are the objects found in the vicinity of the villages of Mamontovo (Ivanov G.E., 1982: Fig. 2, *1*; 2000: Fig. 2, *5*), Urlapovo (Kiryushin, Ivanov, 1996: 84, fig. 2), Klyuchi (Papin, Fedoruk, Shamshin, 2006: 86–87, fig. 5), Bor-Forpost (The V.M. Komarov District Museum of Local History, OF, No. 306), Tyumentsevo (Tishkin, Frolov, 2015), Karpovo (Frolov, 1996: 91–92, fig. 1, *2*), at the settlement of Krestyanskoye IVa (Ivanov G.E., 2000: 25–26, fig. 7, *1*), as well as the axe from the territory of the Altai (Zmeinogorsk mine?) from the collection of P.K. Frolov (State Hermitage, coll. No. 1122-84) (Avanesova, 1991: Fig. 13, *50*). In the Ob region, such objects were found near the village of Lyalino (Lyanino) (Museum of Archaeology and Ethnography of Siberia at Tomsk State University, coll. No. 2822) (Gryaznov, 1956: 20, fig. 5, *1*) and the village of Severny (Umansky, 1967: 99). Two axes from the collection of L.I Shrenk (Museum of Anthropology and Ethnography, No. 35-11, 35-14) originate from the territory of the Altai (Avanesova, 1991: Fig. 13, *54*, *55*). This group of objects can be nominally supplemented by two pickaxe-like shaft-hole tools found in the Altai on an old roadway (Fig. 10, *10*) and in the Zmeinogorsk mine (Fig. 10, *9*) (Levitsky, 1941: 14, fig. 5; Kiryushin, Shulga, Grushin, 2006: 47–48, fig. 3, *1*).

According to the terminology used by the majority of scholars, the above axes and other similar objects discovered on the territory of the forest-steppe Altai belong to several varieties of shaft-hole axes (Kuzmina, 1966: 11; Avanesova, 1991: 11; Agapov, 1988: 85; Ivanov S.S., 2014: 94; Grishin, 1971: 23). The cultural and chronological attribution of different types of such

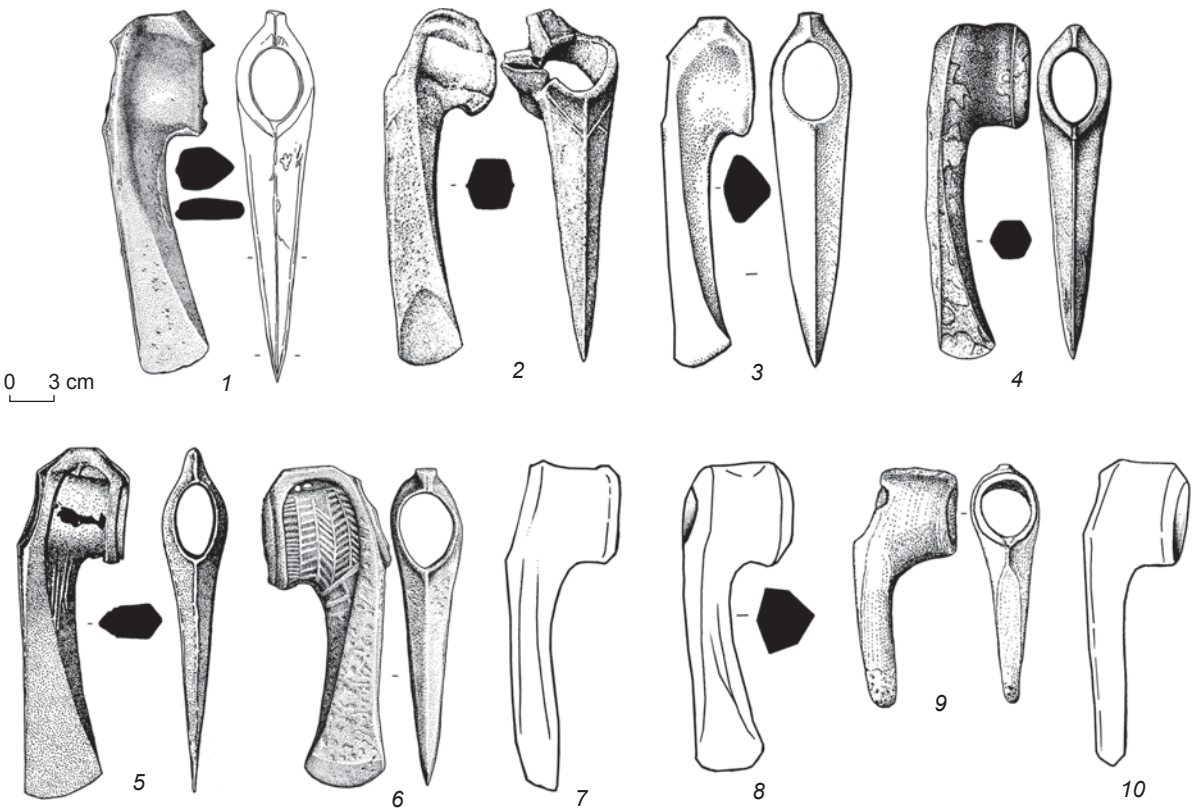

Fig. 10. Shaft-hole tools from different areas of the forest-steppe Altai.
1 – village of Tyumentsevo (after: (Tishkin, Frolov, 2015: Fig. 2, *2*, *4*)); *2* – village of Klyuchi (after: (Papin, Fedoruk, Shamshin, 2006: Fig. 5, *1*)); *3* – village of Lyalino (Lyanino) (drawing after: (Avanesova, 1991: Fig. 13, *52*)); *4* – settlement of Krestyanskoye IVa (after: (Ivanov, Isaev, 1999: Fig. 1, *1*)); *5* – village of Urlapovo (after: (Kiryushin, Ivanov, 1996: Fig. 2)); *6* – vicinity of the town of Zmeinogorsk (collection of Frolov, State Hermitage, No. 1122–84); *7*, *8* – Altai (collection of Shrenk) (drawing after: (Avanesova, 1991: Fig. 13, *54*, *55*)); *9* – Zmeinogorsk mine (after: (Kiryushin, Shulga, Grushin, 2006: Fig. 3, *1*)); *10* – Altai (the Zolotushinsky or Zmeinogorsk mines) (drawing after: (Avanesova, 1991: Fig. 13, *53*)).

tools is complicated by the fact that a substantial part of them are accidental finds not associated with specific assemblages.

On the basis of the typological analysis, N.A. Avanesova suggested a relative chronology of the evolution of shapes exhibited by shaft-hole axes. In her opinion, the earliest are the "smooth shaft-hole" axes (type A); somewhat later are the axes "without a crest, with bulges at the edges of the shaft" (type B), and the final stage of development is represented by axes "with a crest" (type C) (Avanesova, 1991: 11–15). Avanesova connected the chronological changes in the morphology of axes with the selection of the most advanced forms of shaft and blade, the desire to reinforce the shaft and butt by adding "bands" at the edges and a "crest" at the heel (Ibid.: 16). Avanesova correlated the shaft-hole axes of type A with the Petrovka and Early Alakul assemblages, type B—with the Fedorovka culture (Ibid.: 12–14), and type C—with the Late Bronze cultures (late stage of the Andronovo cultural entity) (Ibid.: 15). However, this smooth model is far from being that straightforward.

According to the classification of Avanesova, the axes found in the Altai belong to type B (3 objects) and C (8 objects). Type B is represented by the find from the settlement of Krestyanskoye IVa (Fig. 10, *4*) and two objects from the collection of Shrenk, originating "from the Altai" (Fig. 10, *7*, *8*) (Avanesova, 1991: Fig. 13, *54*, *55*; Ivanov G.E., 2000: 26, fig. 7, *1*). Notably, the axe from the settlement of Krestyanskoye IVa and one axe from the collection of Shrenk show weakly defined crest-like protrusions on the butt, which brings them closer to the objects of type C. G.E. Ivanov dated this settlement to the end of the second millennium BC and attributed it to the circle of sites with cordoned pottery (Ivanov G.E., 1998: 101; 2000: 26). In addition, Ivanov argued that objects of type B, which Avanesova correlated with the Fedorovka assemblages, coexisted with shaft-hole axes with the "crest" (Ivanov G.E., 2000: 26).

In turn, V.I. Molodin believed that axes with a "crest" and articulated butts, which have been found in Baraba, must have been widely used in the Andronovo period. He explained his conclusion by their similarity with pendants in the form of miniature shaft-hole axes, which were found at the Andronovo (Fedorovka) burial grounds (Molodin, Novikov, Sofeikov, 2000: 162; Molodin, Ermakova, 2009: 336). It is important that the pendants from the sites of Stary Tartas-4 (Molodin, Novikov, Grishin, 1998: 297, fig. 2, *b*; Molodin, Novikov, Zhemerikin, 2002: 60–61, fig. 10) and Lanin Log (Avanesova, 1991: 14, fig. 13, *63*) particularly accentuated the axe morphological features of a bulge resembling "bands" on the shaft, and a protrusion ("crest"?) on the butt. It is possible that these details were the most significant features of the actual shaft-hole axes for the artisans who created these adornments. Therefore, it was the axes with the "crest" that were the prototypes behind the production of pendants originating from the Andronovo (Fedorovka) burials of Siberia.

It should be emphasized that although the relative chronology of different types of shaft-hole axes is not so clear-cut, the general sequence of advancements in these tools proposed by Avanesova is still quite acceptable. The objects found in the vicinity of the village of Tyumentsevo, Lyalino (Lyanino), and Klyuchi show transitional forms between types B and C (according to the classification of Avanesova) (Fig. 10, *1–3*). The common features of their morphology include weakly defined "bands" along the edges of the shaft with no clear facets in relief, which continue into a small "crest" of rounded shape without a hole. They show a combination of rounded "bands", as in the objects of type B, and crested protrusion on the butt, typical of type C (according to the classification of Avanesova). The shape of these axes shows similar details to those found in the pendant from Stary Tartas-4. Therefore, based on their morphological features, they cannot be definitively attributed to the Andronovo period or the Late Bronze period. These axes represent a transitional form between the Andronovo objects without a "crest" and the crested axes of the Late Bronze Age, which have expressed ridge-like "bands" along the shaft and the butt, as well as loops on the butt.

Crested axes with ridge-shaped "bands" must have been later than the previous group, since they are more advanced. "Bands" with pronounced facets gave extra rigidity to the walls of the shaft. Such objects have been found near the villages of Urlapovo, Mamontovo, Bor-Forpost, and in the vicinity of Zmeinogorsk (collection of Frolov) (Fig. 2–5; 10, *5*, *6*). The common morphological features of this group include ridge-shaped "bands" in relief reinforcing the edges of the shaft and forming the arch ("crest" or loop) on the butt. All objects of this type, found on the territory of the forest-steppe Altai, have ornamental décor on the shaft in the form of matching bands in relief (decorative borders) filled with slanting lines, or, as is the case with the axe from the village of Urlapovo, vertical lines in relief on the bottom face of the cheek of the blade (Fig. 10, *5*). Numerous parallels to these axes, known from Kyrgyzstan, Kazakhstan, and Xinjiang, also confirm a stable combination of these morphological traits (Avanesova, 1991: Fig. 11, *27–30*, fig. 12, *35–39*; Ivanov S.S., 2014: Fig. 3, *5*; Bekhter, Khavrin, 2002: Fig. 1, *11*, *17*).

Scholars who have studied the ornamental decoration of shaft-hole axes of the above group, have compared it with pottery decoration, in particular with the herringbone pattern (Avanesova, 1991: 15; Ivanov S.S., 2014: 97–100). However, we should emphasize one significant difference between the herringbone patterns on pottery and similar decoration on tools. On the axes, the slanting lines forming the herringbone pattern are separated by horizontal lines and constitute closed decorative borders.

Such décor does not occur in pottery. It can be assumed that the decoration on the axes imitated rope or leather wrapping. The presence of only horizontal lines without filling in the space between them on the shafts of some objects indicates a greater significance of this element compared to the rows of slanting lines. Therefore, the interpretation of the ornamental décor as consisting of matching decorative borders filled with slanting lines in imitation of the fastening of the axe to the haft seems to be more preferable.

The axe found in the vicinity of the village of Severny is close to the latter group (Fig. 8, 9). However, a number of morphological features (double "bands", a striker on the heel, the blade sharply expanding towards the cutting edge) make it possible to view it as a separate item. Avanesova also identified a special sub-group (C3) with other similar axes (1991: 15, fig. 9, *c3*). The find from the village of Karpovo also stands out among other shaft-hole axes (Fig. 6, 7) both in terms of its morphology and manufacturing technique. This axe shows clear signs of using a wax model. Its decoration in the form of intersecting lines in relief on the shaft is also unique and possibly imitates the attachment to the wooden haft. This may indicate the relative antiquity of this object.

In general, crested axes with ridge-shaped "bands" and loops to a greater extent can be associated with the Late Bronze period. Following N.A. Avanesova, S.A. Agapov (1988) dated shaft-hole axes with a "crest" to the time of the Sargary-Alekseyevka culture. Other scholars believed that such objects belonged to the final stage of the Bronze Age (Bekhter, Khavrin, 2002: 75).

Most shaft-hole axes from the territory of the Altai reveal similar manufacturing traditions, manifested by the presence of numerous casting defects. Casting seams, places of breakage of the casting gate, and other defects were intentionally not eliminated. Most traces of hammering and grinding occurred during the use of the axes. The casting defects inside the loops on the butts of the axes are very telling. Artisans intentionally planned to produce the loops in a number of axes. Loops in some axes are well elaborated (for example, on the axe from the village of Mamontovo (Fig. 4, 5)), and only small holes can be seen in other axes because of casting defects (Fig. 10, *6*), while in other axes the loops are completely closed by the lapping of metal (Fig. 10, *1*, *5*). It would have been easy to eliminate this defect, but this was not done, and the loop lost its functionality. It is possible that there was some ban on the secondary treatment of objects after their manufacturing.

Conclusions

Shaft-hole axes are often used as indicators in cultural and chronological attribution of archaeological sites in the Eurasian steppe belt and the adjacent areas. Several scholars noted that the boundaries of their distribution on the territory of Western Siberia coincided with the eastern area of the Andronovo cultural and historical entity (Kuzmina, 1966: 12; Avanesova, 1991: 11; and others). The main problem with using this group of material sources is that the majority of these metal objects are represented by accidental finds, while only a small number of axes have been found at burial grounds and settlements. In this situation, mapping becomes an effective method of establishing the geographical range where various types of axes occurred. This method makes it possible to conduct the analysis at different levels of comparison. Such work has been done for the forest-steppe Altai. In terms of the number of discovered shaft-hole axes (12 objects), this region stands out from all of Western Siberia. It is possible that part of the finds is associated with the eastern part of the sites of the Sargary-Alekseyevka culture (Agapov, 1988). It seems no accident that most of axes from this territory exhibit the late forms with the "crest", where pronounced ridges on the "bands" (the reinforcements of the edges) are present.

Shaft-hole axes that have been discovered in the Altai are typical objects of the Bronze Age, which have also been found in various regions of Kazakhstan, Kyrgyzstan, Xinjiang, and Western Siberia. Their morphology shows transitional features typical of axes used both by the Andronovo cultural and historical entity and by the cultures of the Late Bronze Age (primarily, the Sargary-Alekseyevka culture). The presence of different types of shaft-hole axes is an additional testimony to the complexity of the transformation of cultures on the territory of the forest-steppe Altai at the end of the Bronze Age, which deserves a separate study. A study of the entire array of bronze axes from the forest-steppe Altai according to a unified program and using X-ray fluorescence analysis would be desirable for further productive studies.

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