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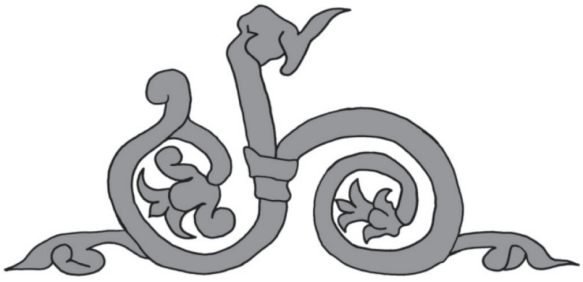

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Contents

The Bow and Arrow during the Roman Era*

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Abstract: The bow and arrow are not typical weapons to the Romans, but the flexibility of the Roman military system and its easiness to adapt made their adoption possible. In the Orient, archers were respected fighters, as the bow and arrow were used by those rich enough to afford expensive and efficient composite bows, which they usually used from horseback. In the western provinces of the Roman Empire the bow and arrow were typical weapons to lower social groups. In these areas people used simple bows, less efficient but easier to build and cheaper to buy.

Keywords: bow, arrow, simple bow, composite bow, shooting range.

As other weapons, the bow and arrow were not typical to the Romans, but were introduced to the Roman army under the pressure of populations that required different tactical approaches[1].

The bow was the easiest and oldest solution of transferring potential energy stored in the materials employed in its construction into kinetic energy, with the goal of propelling a projectile faster than is possible with the human arm[2].

According to the production technique and the materials employed, bows can be classified into three main categories: simple bows, made of a single wooden piece, tied with a string made of leather or sinew; bows strengthened with sinew in order to prevent them from braking and so as to increase their efficiency; and composite or reflex bows that combine layers of horn, wood, and sinew in order to ease a more efficient transfer of energy stored in the bow[3]. Among them, the simple and composite types were used in the Roman army, while specialists believe that bows reinforced with sinew were only used in the Near Orient[4].

All bows were built in order to resist both tension and compression forces and to return to the original position without significant distortion during release. Energy was thus efficiently transferred from the bow's limbs and the string into the arrow[5].

The simple bow (Pl. 1/1) isone of the first man-made mechanisms, fascinating through the fact that its simplicity generates a complex behavior[6]. This bow is typical through generating a slow velocity of the arrow as compared to the composite bow, and thus has a restricted shooting range[7].

In order for a bow to function at an optimum, the wood it is made of must possess increased elasticity, flexibility, and durability[8]. The mechanical properties of the simple bow show some weaknesses, mainly due to the characteristics of the fibers in the wood employed in its construction. Thus, in the case of a bow with limbs long enough for a good shot, the energy necessary for the limbs to detention requires more of the bow's potential energy than in the case of a composite bow with shorter limbs[9]. Thus, due to the oscillations of cord and limbs, the energy transfer into the arrow is inefficient[10]. The simple bow gradually looses in power over long use, due to the properties of the wooden fibers to stretch under continuous pressure. In order to preserve the strength of such a bow for a longer period, one has to apply as little as possible pressure upon the wood. This was achieved by bending the ends to

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* English translation: Ana M. Gruia.

1 Țentea 2012, 101.

2 Miller *et al.*1986, 180; Paterson 1966, 78; French *et al.* 2006, 533.

3 Miller *et al.* 1986, 179–180; Coulston 1985, 226; Feugère 1993, 212.

4 Rouault 1977, 63, 141.

5 Miller *et al.* 1986, 180.

6 French *et al.* 2006, 533.

7 Xenophon, *Anabasis*, 3.3.7.

8 Cartwright, Taylor 2008, 77, 82.

9 Paterson 1984, 109 *apud* Miller *et al.* 1986, 180.

10 Klopsteg 1947, *apud* Miller *et al.* 1986, 180.

the front and maintaining a minimum distance between the bow's string and body[11]. Also, when not used, the bow had to be unstrung.

It is difficult to shoot accurately with a simple bow, even more if it is a short one, since even the smallest variation in pulling the string triggers significant variation in the arrow's flight and speed[12]. Thus, in order to reach the same result in different moments with a simple bow, one needs different shooting angles and string stretching lengths. This reduced its efficiency, especially when the goal wasto hit a certain spot repeatedly. For this reason it may be said that in the case of simple bows used during Antiquity, precision was rather an exception than a rule[13].

In order to shoot an arrow at a satisfying speed and over an acceptable distance[14], a wooden bow must measure over 180 cm in length; only thus isit capable of sustaining a strong extension of the string. Nevertheless, this means the archer has to adopt a standing position and this reduces to minimum the possibility of performing tactical maneuvers[15].

Simple bows were employed mainly by archers recruited from the western provinces of the Empire, where they were part of the lower social classes. In the eastern provinces, the archers were respected fighters, many of the rich becoming mounted archers and thus affording expensive, efficient bows. Also, the oriental populations benefited from extensive training required by the use of bows both on horseback and on foot[16].

Oriental archers used "Turkish-type" composite bows[17], the most efficient ones of the time[18] that provided superior penetration power and were thus more effective despite their smaller size as compared to simple bows[19]. For this reason, composite bows were adopted by several populations of archers[20].

The composite bow (Pl. 2/1–3) transfers potential energy more efficiently to the arrow, since no energy is lost through the oscillation of the limbs which is typical to the simple bow. Also, while shooting a reflex bow, the place where the bow is held remains rigid, thus providing increased accuracy and fluency of action[21].

The composite bow can be drawn easier than the simple bow, thus more power can be obtained with less effort than with a simple bow having the same dimensions[22]. This characteristic provides the archer with the possibility of choosing between two tactics: throwing lighter projectiles over longer distances or shooting heavier projectiles that have an increased piercing capacity[23].

Making and using such a bow required superior skills for both the bowyer and the archer[24]. An archer needs regular training in order to use a bow efficiently and with complete control[25]. When training, an archer maintains his pose after shooting and watches the arrow until it reaches its target, but while fighting he has no time to loose between the shots[26]. The stronger the bow, the more skill was required of the archer[27].

Besides the central part made of a slender pieceof wood, reinforcement elements were also used in the construction of composite bows, made of (mainly) deer antler and bone.

The complementary properties of the materials used in the composition of the different segments of the bow, connected through gluing and tying, provide much bigger force of propulsion than that of other types of bows[28]. Thus, sinew withstanding intense bending and antler withstanding intense

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11 Grayson 1961, fig. 1a *apud* Miller *et al.* 1986, 181.
12 Miller*et al.* 1986, 181.
13 Miller*et al.* 1986, 181.
14 Ureche 2010, 36.
15 McEven 1978, 188 *apud* Miller *et al.* 1986, 182.
16 Bradbury 1985, 12.
17 Peddie 1996, 90.
18 Ruscu, Ruscu 1996, 216.
19 Bârcă 2009, 274.
20 Herodot, *The Histories*, 1.73 – on the Skythians using it; Pausanias, *Description of Greece*, 1.21.5–1.21.6.
21 Paterson 1966, 72–73; McEwen, McLeod1986, *apud* Miller *et al.* 1986, 187.
22 Coulston 1985, 247.
23 Miller *et al.* 1986, 187.
24 Bradbury 1985, 12.
25 Paterson 1966, 69.
26 McAllister 1993, 15.
27 Bivar 1972, 283.
28 Feugère 1993, 211; Dixon, Southern 1992, 53.

compression are connected on the opposite parts of the wooden core. The latter is made of non-resinous, not very hard wood, marked with grooves[29] dueto which the adhesive adhered better[30]. It was too thin to contribute significantly to the bow's power, but provided the surface on which the sinew and antler elements were glued and aligned in order to store and then release a maximum of energy[31]. Different types of wood could be used for the different sections of the bow's core[32].

The composite bow appeared in areas with insufficient wood to build simple bows and with a wide practice of horseback riding, thus requiring a type of bow with increased maneuverability[33]. Thus, the use of antler and bone became necessary in the attempt to build stronger bows. Sometimes, the use of such materials led to the production of larger bows, since the bone would have turned the wooden frame too rigid[34]. Usually, composite bows included seven bone items, two at each tip and three at the grip. Those at the ends were different in size, with the upper larger than the lower. The reinforcement elements on the grip were placed one on each side and one in the inner part of the bow. The use of bone and antler made the grip and the ends remain fix while the ballistics was taken over by the extremely flexible limbs[35].

As each layer was added, the bow was left aside until the adhesive dried completely before the next layer was applied, so as the entire manufacturing process could take more than a year[36]. The adhesive employed was very flexible and did not granulated in time; it was obtained from dried fish swimming bladders[37]. Antler elements were glued during winter, when the low temperatures and elevated humidity delayed the drying of the adhesive and provided better gluing. On the other hand, since the fibers obtained from sinew cannot be successfully applied on cold weather, this was usually done during the warm spring days[38].

Since the setting and removal of the string on a reflex bow was a delicate procedure, as the limbs might become twisted, bowyers were often the onesto set the string as well[39]. This was possible since bows of this type did not deform and did not lose power even if left strung for a long period[40].

For the setting of the string on a reflex bow the latter was sometimes heated in order to become more flexible[41]. During the same process, the limbs of a reflex bow were adjusted so that it became an extremely efficient weapon, with increased accuracy and strength[42]. Thus, with the string set in the beginning of a campaign, the bow was ready to be used even during surprise attacks[43].

Composite bows were expensive by comparison to other bows, since certain types of wood, antler, and bone were required and dueto the lengthy production process that might have lasted up to ten years for an excellent bow[44]. Dueto the long time required in the making of a bow, one can suspect that they were made in series of several hundreds[45].

There are two main types of reflex bows: Scythian and Hunnish. These were bows with double reflex, with the ends curved towards the shooting direction[46], while the grip was straight or a little curved[47]. The Hunnish bow included bone reinforcements in its construction, while the Scythian one had seven wooden reinforcements[48].

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29 Balfour 1897, 212.
30 Paterson 1966, 70.
31 Miller *et al.* 1986, 182.
32 Paterson 1966, 70.
33 Miller *et al.* 1986, 184.
34 Bârcă 2009, 276.
35 Bârcă 2009, 276.
36 Paterson 1966, 74–75 ; Klopsteg 1947, Latham, Paterson 1970, 8,McEwen, McLeod1986 *apud* Miller*et al.* 1986, 184.
37 Miller *et al.* 1986, 184; Paterson 1966, 72
38 Paterson 1966, 74–75.
39 Paterson 1966, 76; Klopsteg 1947, 90 *apud* Miller *et al.* 1986, 185.
40 Unlike the simple bow.Miller *et al.* 1986, 184.
41 Paterson 1966, 76, 82.
42 Paterson 1966, 76–77.
43 Miller *et al.* 1986, 185.
44 Anglim 2007, 82.
45 McEwen 1978 *apud* Miller *et al.* 1986, 182.
46 Bârcă 2009, 274.
47 Bârcă 2009, 275.
48 Bârcă 2009, 275.

When the bow was not used, the string could be detached in order for the wood to preserve its natural curvature. The unstrung bow is oriented opposite the curvature, as seen in the case of the Parthian bow from Yrzi[49] (Pl. 3/1). The bow could be stringed in the beginning of campaign or in the beginning of a battle[50]. For this, in the case of Hunnish-type bows (with bone and antler reinforcements), the archers bent their bow on their knees[51]. In order to attach the string to the other type of reflex bow, to the Scythian one, the bow was bent by pushing one hand against the upper end, while the stability of the lower part was ensured against one's leg. With the other hand, the archer would push the string loop over the reinforcement's string groove on the upper limb. A depiction of this stringing method decorates a vessel found inside the Scythian tumulus in Kul' Oba (Kerci, Crimea)[52](Pl. 4/1).

In Roman-era archaeological contexts, the only elements preserved from the structure of bows are those made of bone or antler, labeled under the generic term of bow reinforcements[53](Pl. 3/2). They have been grouped, according to where they were attached to the wooden core, in two categories: central and terminal reinforcements[54]. The size and shape of bow reinforcements depends on the size of the bow to which they were attached[55]. Thus, long, wide, and less curved reinforcements were employed on large bows, used by pedestrian archers[56], while the smaller and more curved ones were used on smaller bows, employed by horse archers[57]. The fact is also confirmed by the discoveries made inside the bow making workshop in *Micia*[58], where the two types of reinforcements were used by the same military unit, the *cohors II FlaviaCommagenorumSagittariaEquitata* that included both foot soldiers and cavalrymen[59]. It is also possible that reinforcements of different size were used in the composition of the same bow[60].

Arrows are the most abundant archaeological finds connected to archers[61], dueto the large number of arrows used and therefore lost. The iron head is the part usually preserved, but in the eastern provinces, where the climate allowed for better preservation conditions, entire arrows were also found.

An arrow consists of head, shaft, and fletching[62].

An arrow head is usually made of metal. It seems that the Huns used arrows with bone heads that shattered on impact and could be extremely dangerous against enemies not wearing armor[63].

For the Roman period, the most often encountered arrow heads are those three-lobe-shaped in section[64], a type spread by oriental archers in the entire Empire besides the composite bow[65], One sometimes finds also arrows with four-lobed-section-heads, flat heads, pyramidal heads, and heads for fire arrows(Pl. 1/2).

The production of three-lobed arrow heads was extremely complex and required highly specialized masters. The process included twelve steps[66] and thus required an average of 105 minutes for each item[67].

Two methods were employed for attaching the arrow head to the shaft: with the aid of a cap(Pl. 1/2 a, c) or a socket tang(Pl. 1/2 b, d, e).

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49 Coulston 1985, 222, fig. 2.
50 Yadin 1963, 63–64, *apud* Miller *et al.* 1986, 181.
51 Feugère 1993, 212.
52 Bârcă 2009, 275.
53 Coulston 1985, 223.
54 Petculescu 2002, 765.
55 Țentea 2007, 155.
56 Coulston 1985, 245–246.
57 Dixon, Southern 1992, 53.
58 Petculescu 2002, 765.
59 Petculescu 2002, 789.
60 Bârcă 2009, 276.
61 Miller *et al.* 1986, 189.
62 McAllister 1993, 20.
63 Ammianus Marcellinus 31.2.8–31.2.10; Coulston 1985, 268.
64 Țentea 2012, 108; Pauli Jensen 2009, 370.
65 Coulston 1985, 264; Țentea 2007, 154.
66 Zanier, Guggenmos 1995, 21, Abb. 2, 3.
67 Zanier, Guggenmos 1995, 22.

The best materials for making the shaft are rush[68], reed[69], corneal or pine tree wood[70], and bulrush. These materials combine the essential characteristics of an arrow; they are light, rigid, elastic[71] and aerodynamic. About rushand reed, a Persian manual states that they must be mature, dried, modeled, and strengthened[72]. Elasticity is extremely important since an arrow's shaft must be able to curve beside the bow when it is released, but then to return to the shooting line in order to reach the target accurately[73](Pl. 2/4).

Because when it is made of rush or reed the shaft can be very light and there is a danger it might get carried away by the wind[74], the tip must be provided with a weight[75]. In the case of arrows discovered in Egyptian tombs, this was ensured by ebony tips[76], while stone or bone arrowheads were used in the Orient, ca. 6000 B.C., inserted into a wooden cane and attached to the tip of the arrow. In the case of arrows employed during the Roman period, the necessary weight was usually accomplished with the aid of the metal head, and in cases this was insufficiently heavy, the tip was inserted into a wooden cane that was attached to the shaft[77]. This type of arrow was also used in order toprevent the shaft from shattering on impact with a target wearing armor[78] or in order to make it more difficult to extract from a wound.

An arrow's fletchings were attached to the back of the shaft, near the notch where the string was fixed and had the role of providing the arrow with speed and stability during flight, making the hit more precise and stronger[79]. In all preserved antique examples that are known so far, the fletchings are made of feathers[80].

Arrows can be of different size and weight and can have different shafts and heads, according to the archer's strength, the manner in which the bow is employed, the target's vulnerability[81], the shooting range, and the archer's purpose[82]. Archers carried several types of arrows which they used according to circumstances. Thus, they employed heavier arrows in order to penetrate armor and lighter ones for harassment from a distance[83]. Since archers and bows are of different size, the arrows as well must be adapted for each archer. For this reason, one can presume that each archer had a stock of arrows made especially for him, and when they ran out he tried to use standard-size arrows or to use/reuse those shot by the enemy[84].

Since a large number of arrows was shot even during short battles[85], very large quantities of reed or rush were needed; one can presume that such plants were cultivated in areas with archers[86].

From a purely mechanical perspective, the maximum efficiency of a bow is reached when used with a very heavy arrow, capable of taking over the entire propelling force of the string. This arrow did not cover a large distance, but its impact when hitting the target was significant; if the head was well chosen, it could penetrate armor. A light arrow, even if reaching higher speed, cannot take over the entire energy transmitted by the string[87]. Thus, depending on the archer's goal, he could be armed with a smaller bow and a light arrow when required to hit a target located farther away and when he needs fast arrows, or a larger bow and a heavy arrow when fighting against an enemy wearing armor and thus needing an arrow with increased force of penetration[88].

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68 Ascham 1869, 116; Mason 1893, Moseley 1792, 115–119, *apud* Miller *et al.* 1986, 188.
69 Plinius, 16.65.
70 Pausanias, *Description of Greece*, 1.21.5–1.21.6.
71 Elmer 1952, 264, *apud* Miller *et al.* 1986, 188.
72 McEwen 1974, 84 *apud* Miller *et al.*1986, 185.
73 Paterson 1984, 44, *apud* Miller *et al.*1986, 188.
74 Plinius, 16.65.
75 Mason 1893, 660–661, Heath, Chiara 1977, 47 – 50, *apud* Miller *et al.*1986, 188.
76 McLeod 1982, 55, Rouault 1977, 63, *apud* Miller *et al.*1986, 188.
77 Miller *et al.*1986, 188.
78 Coulston 1985, 268.
79 Plinius, 16.65.
80 McAllister 1993, 22.
81 Coulston 1985, 264.
82 Miller *et al.*1986, 187.
83 Paterson 1984, 44; Heath 1980; McEwen 1974 *apud* Miller*et al.*1986, 188.
84 Xenophon, *Anabasis*, 3.4.17; Coulston 1985, 270.
85 Miller *et al.*1986, 188.
86 Moens 1984, 24; Roth 1970, 156 *apud* Miller *et al.* 1986, 188.
87 Paterson 1966, 80.
88 Paterson 1966, 80–81.

The strongest arrows were short, with narrow heads, meant to penetrate armor according to the same principle as the *pilum*[89].

In order for the arrow to reach its target, the archer had to pay attention that its trajectory was unobstructed and that the string would not catch at his equipment[90].

The bow sheath, quiver, (Pl. 2/4) and arrows are extremely important elements of an archer's equipment.

The bow sheath is an essential item in an archer's equipment since both the string and the attached and glued wooden, bone, and antler parts can be destroyed by dampness. There is no direct proof of such sheaths having been used in the Roman army, but they are depicted on Sassanid and Parthian reliefs[91]. Among the Sassanid, the bow sheath was called *kamandan*[92].

The quiver, usually made of leather, was also very important, since it protected the arrow from becoming damp. In visual sources it is depicted as being cylindrical in shape among the Romans, carried on one's back[93], connected to the *balteus,* as seen on sculptural monuments (one funerary stone from Walbersdorf)[94], in the case of soldiers on foot, while horse archers carried it by the right side of the saddle, behind the rider[95], or at the waist[96]. Scythians and Parthians used a single sheath for both bow and arrows, called *gorytos* by the Greek[97]. Traces of quivers were found in Sarmatian tombs, as traces of leather, wood, or birch tree bark. They were cylindrical in shape and painted or even decorated with bronze appliqués[98]. Quivers were also used by the Sassanid archers, who called it *tirdan*[99].

Another element of the archery equipment consisted of arm guards[100]. They were used to protect the left arm from injuries that may result from releasing the cord. No material evidence of such elements being used by the Romans has been found, but they are depicted worn by archers on Trajan's Column. The lack of archaeological remains might be explained by the fact they were made of organic materials[101] or might be the result of certain materials having been wrongly identified and erroneously attributed to other categories. Archery arm guards are mentions in the fourteenth line of the Rig-Veda as *gasatagna*[102].

Vegetius mentions the fact that those archers for whom the armor was not a specific element were forced to wear it since they were unable to carry shields[103].

It is possible that the archers were also equipped with lances, in order to reduce their vulnerability when facing the danger of being captured by the enemy, but due to the lengthy periods they spent training in archery, the time available for practicing with other weapons was rather limited[104].

The archery units recruited in the Roman army initially preserved their traditional equipment, dress, fighting style, and field instructions in their native tongue[105]. After a while though, Oriental archers underwent a strong process of Romanization that is also reflected militarily. Thus, they gradually gave up the traditional, cone-shaped helmets, since they werenot produced in Roman workshops. Also, the Roman sword, plus sometimes several spears, gradually replaced the traditional battle axe, the *bipennis*[106].

The shooting distance and efficiency depend both on the archer's physical characteristics (physical force, length of the arms, wideness of the chest) and on those of the bow (weight, characteristics of component materials)[107].

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89 Goldsworthy 1996, p. 185.
90 McAllister 1993, 15.
91 Coulston 1985, 271.
92 Farrokh 2005, 15.
93 Zanier 1988, 7.
94 Coulston 1985, 271.
95 Schleiermacher 1984, no. 23, *apud* Dixon, Southern 1992, 57.
96 Coulston 1985, fig. 29, 30, 33; Dixon, Southern 1992, 57, Fig. 23
97 Anglim 2007, 97.
98 Bârcă 2009, 286, Fig. 116.
99 Farrokh 2005, 15.
100 Vegetius, 1.20.
101 Coulston 1985, 277; Dixon, Southern 1992, 55.
102 Bârcă 2009, 287.
103 Vegetius 1.20; 2.15
104 McAllister 1993, 38.
105 Țentea 2012, 102.
106 Țentea 2007, 154; Țentea 2012, 106.
107 Paterson 1966, 78.

Specialists disagree on the shooting range of composite bows[108]. Thus, ancient authors claim that an archer on foot could hit a target 600 feet away (180 meters)[109], while a mounted archer, employing a weaker bow[110] and thus having a smaller shooting range, was able to hit a target measuring 90 cm in diameter from a distance of 70 meters, according to Saracen manuals[111]. Modern researchers have different opinions on the topic. After an experiment performed during the reign of Napoleon III it has been concluded that a Roman archer could shoot an arrow as far as 165–175 meters[112]; Bivar suggests a maximum distance of up to 230 meters, but with maximum efficiency only at 90 meters[113]; Collingwood and Richmond agree with Bivar on the effective range of the composite bow, but believe it could be deadly up to a distance of 137 meters[114]; McLeod believes that the archer could hit his target accurately from a distance of 50–60 meters[115]. The most optimistic view on the shooting range of an arrow is that a war arrow, weighing 30 gr., shot from a composite bow, could easily reach 330 – 370 meters, while the accomplishments of light arrows are almost unbelievable, reaching up to 700 meters[116]. One of the main reasons behind such diverging opinions on the shooting range of a Roman bow is the fact that an archer's talent was much more important than the manufacturing technology of the bow[117]. I believe that the shooting range was rather large, and that suggested by McLeod is much closer to the distance at which a strong spearman could throw his weapon. I also think that the 700 meter shooting range is exaggerated. As for the wooden bow, some researchers believe it had a shooting range of 210–230 meters[118], while others mention that it was three times less effective than the composite bow (i.e. ca. 60 m)[119].

No exact details on the distance from which an arrow could pierce armor are available, but since Parthian archers were capable to penetrate the armor of Roman soldiers at *Carrhae* without entering the shooting range of their weapons, the *pila*, one can presume that armor penetration could be achieved from a distance of 30 – 50 m[120].

The large number of *sagittarii* troops recruited between the first and the third century A.D.[121] proves the special and extremely significant role that such troops played due to certain characteristics: mobility[122], wide shooting range[123], penetration power, volume of arrows shot, and the accuracy of their shooting[124]. Thus, despite the fact that the bow and arrow were not traditional Roman weapons, the Romans managed, dueto the flexibility of their military thought, to employ them at maximum capacity by recruiting populations with experience in this field.

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[108] See also Ureche 2008, 253 – 254.
[109] Vegetius 2. 23.
[110] Paterson 1966, 85.
[111] Goldsworthy 1996, 184; Ureche 2009, 334.
[112] Anglim 2007, 82; Goldsworthy 1996, 184.
[113] Goldsworthy 1996, 184.
[114] Bârcă 2009, 276–277.
[115] Goldsworthy 1996, 184.
[116] Peddie 1996, 90.
[117] Goldsworthy 1996, 184.
[118] Peddie 1996, 92, table 4.
[119] Anglim 2007, 82.
[120] McAllister 1993, 16.
[121] Davies 1977, 269–270; McAlister, Appendix 1, 95–101.
[122] McAllister 1993, 38.
[123] Bradbury 1985, 5.
[124] Farrokh 2005, 14.

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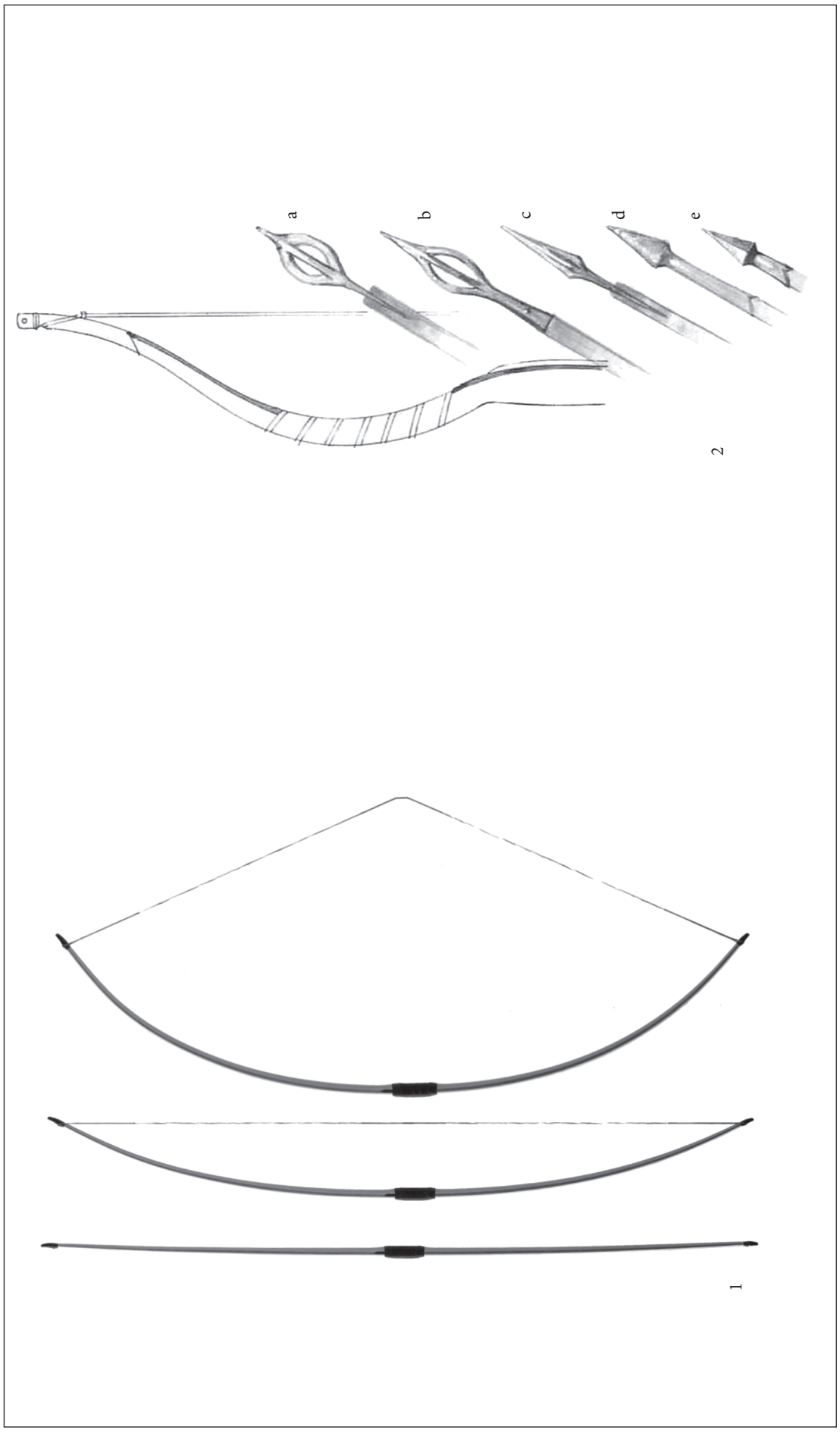

Plate 1. 1. Simple bow (taken from http://rangersapprentice.wikia.com/wiki/Longbow?file=English_longbow.jpg); 2. Types of arrow heads and shafting methods (taken from Cowan, McBride 2003, Fig. D).

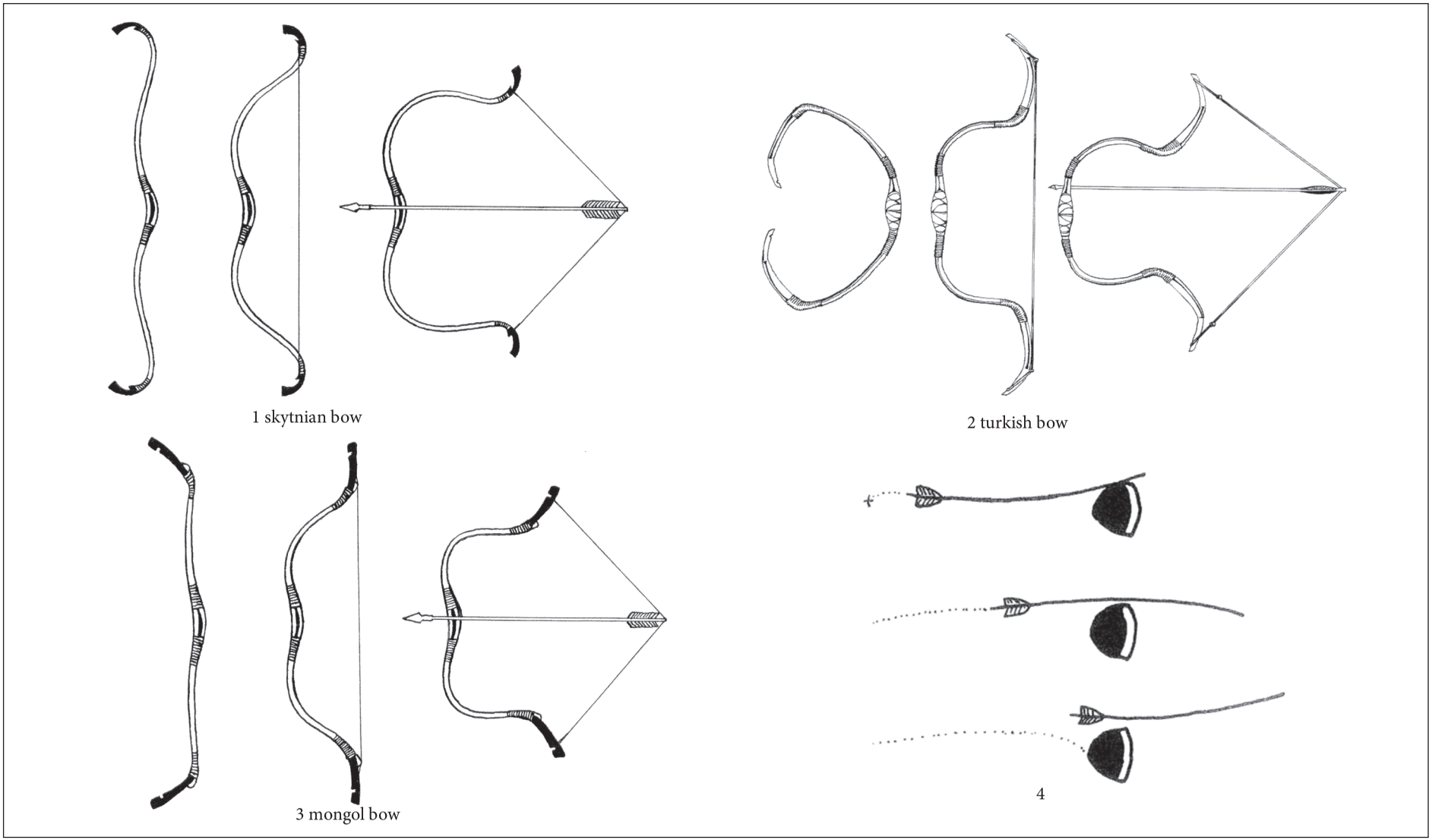

Plate 2. 1-3. Types of bows (taken from Karasulas, McBride 2004, 8, 20, 23); 4. Arrow bending by the bow in flight (taken from Miller, McEwen, Bergman 1986).

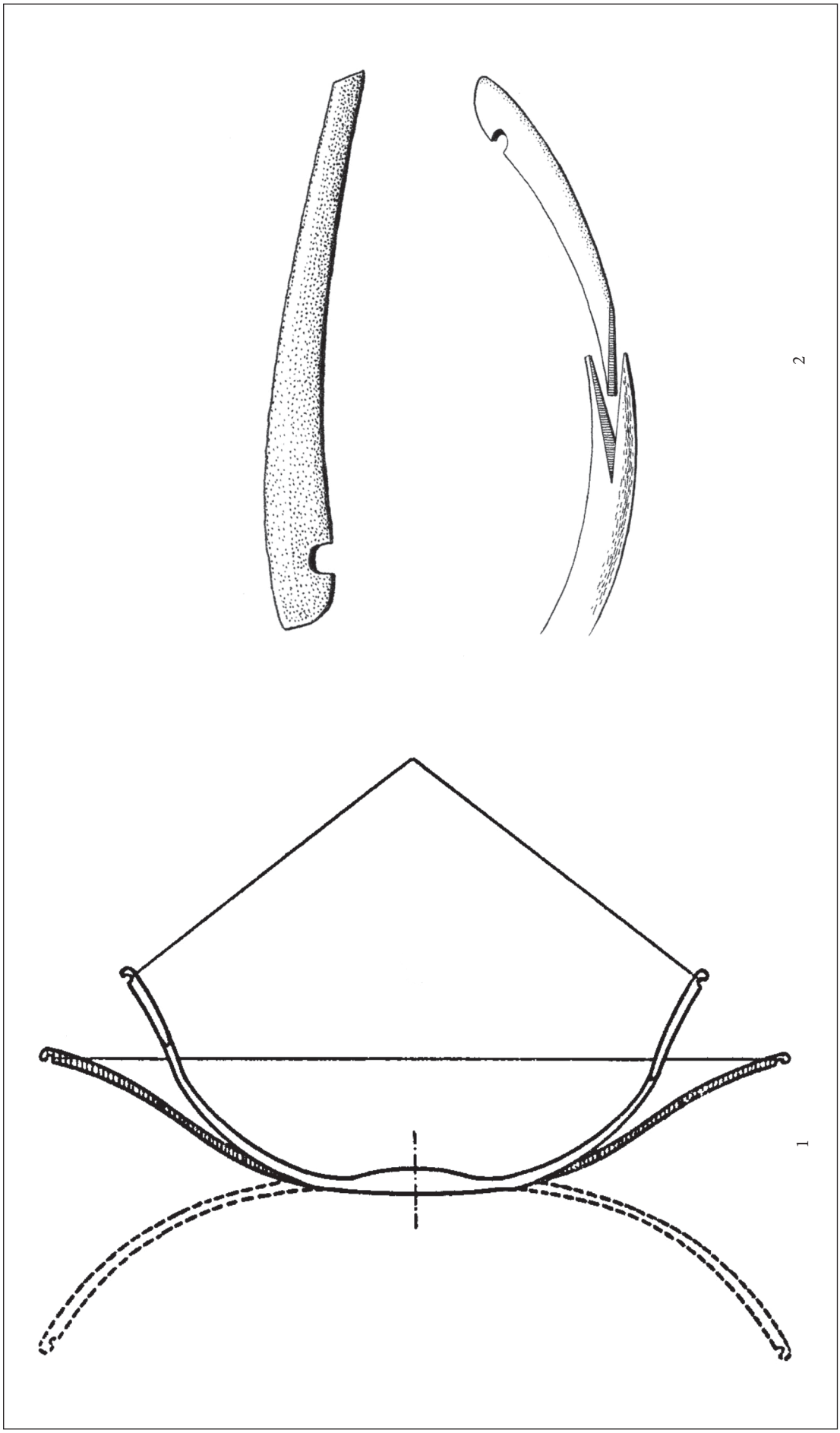

Plate 3. 1. The bow from Yzri (taken from Brown 1937, 4); 2. Bow reinforcements (taken from Karasulas, Mcbride 2004, 22).

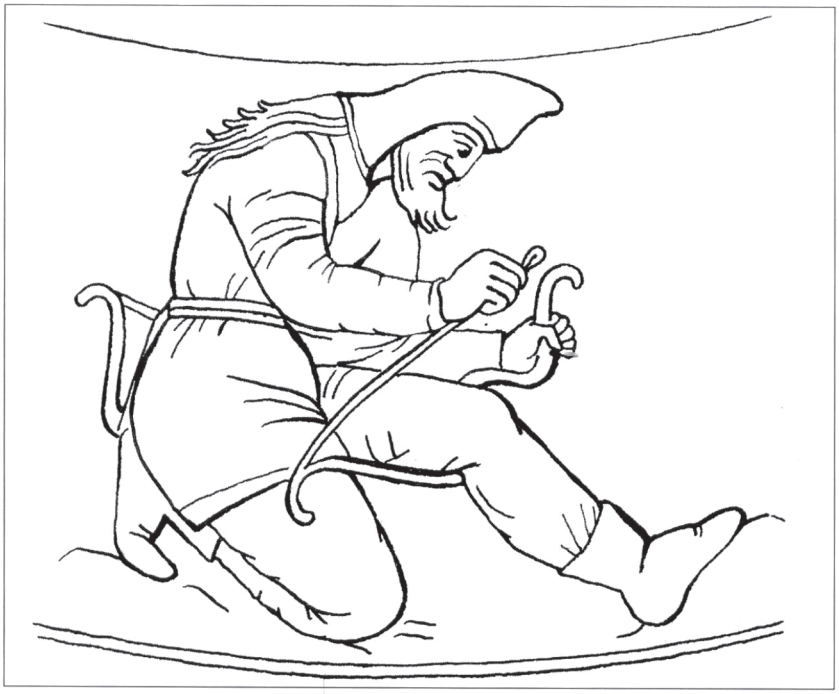

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Plate 4. 1. Bowing an arrow, drawing on the pot from Kul Oba (taken from Karasulas, McBride 2004, 60); 2. Antoninianus. Obverse - Postumus, Reverse – Bow and quiver/quiver (RIC 5.2, Postumus 291).

Abbreviations

AAC	Acta Archaeologica Carpathica. Cracovia.
AARMSI	Analele Academiei Române. Memoriile Secțiunii Istorice. București.
ACSSTU	Annals. Computer Science Series Tibiscus University. Timișoara.
ActaArchHung	Acta Archaeologica Academiae Scientiarum Hungaricae. Budapest.
AÉ	Archaeologiai Értesitõ. Budapest.
AGGH	Acta Geodaetica et Geophysica Hungarica. Budapest.
AIINC	Anuarul Institutului de Istorie Națională Cluj. Cluj-Napoca.
AISC	Anuarul Institutului de Studii Clasice. Sibiu.
AJPA	American Journal of Physical Anthropology. New York.
Alba Regia	Alba Regia. Annales Musei Stephani Regis. Az István Király Múzeum Közleményei. Székesfehérvár.
AMN	Acta Musei Napocensis. Cluj-Napoca.
AMP	Acta Musei Porolissensis. Muzeul Județean de Istorie şi Artă Zalău. Zalău.
AnB S.N.	Analele Banatului, Serie nouă. Timișoara.
Analele ANTIM	Analele Asociației Naţionale ale Tinerilor Istorici din Moldova. Chișinău.
Apulum	Apulum. Alba-Iulia.
ArchKorrbl	Archäologisches Korrespondenzblatt. Urgeschichte, Römerzeit, Frühmittelalter. Mainz.
ArhMed	Arheologia Medievală. Brăila, Reşiţa, Cluj-Napoca.
AS	Acta Siculica. Sepsiszentgyörgy/Sfântu Gheorghe.
ATS	Acta Terrae Septencastrensis. Sibiu.
AUVT	Annales d'Université Valahia Targoviste, Section d'Archéologie et d'Histoire. Târgoviște.
BAM	Brvkenthal Acta Mvsei. Sibiu.
BAR International Series	British Archaeological Reports, International Series. Oxford.
Banatica	Banatica. Muzeul Banatului Montan. Reșița.
BÁMÉ	A Béri Balogh Ádám Múzeum Évkönyve. Szekszárd.
BCȘS	Buletinul Cercurilor Științifice Studențești. Istorie-Arheologie-Muzeologie. Alba Iulia.
BerRGK	Bericht der Römisch-Germanischen Komission des Deutschen Archäologischen Instituts, Frankfurt a. M .- Berlin.
BHAB	Bibliotheca Historica et Archaeologica Banatica. Timișoara.
BSNR	Buletinul Societății Numismatice Române. Societatea Numismatică Română. București.
Caietele CIVA	Caietele CIVA. Cercul de Istorie Veche și Arheologie. Alba Iulia.
CCA	Cronica cercetărilor arheologice. București.
CCDJ	Cultură şi civilizaţie la Dunărea de Jos. Muzeul Dunării de Jos. Călăraşi.
CN	Cercetări Numismatice. Muzeul Național de Istorie a României. București.
CNA	Cronica Numismatică și Arheologică, Societatea Numismatică Română. București.
Corviniana	Corviniana. Acta Musei Corvinensis. Hunedoara.
Crisia	Crisia, Muzeul Ţării Crişurilor, Oradea.
Cumania	Cumania. A Bács-Kiskun Megyei *Önkormányzat* Múzeumi Szervezetének *Évkönyve*. Kecskemét.
Dacia N.S.	Dacia. Recherches et Découvertes Archéologiques en Roumanie, Bucureşti; seria nouă (N.S.): Dacia. Revue d'Archéologie et d'Histoire Ancienne. Bucureşti.
DMÉ	A Debreceni Déri Múzeum Évkönyve. Debrecen.
DolgKolozsvár	Dolgozatok az Erdély Nemzeti Múzeum Érem- és Régiségtárából (Travaux de la section numismatique et archéologique du Musée National de Transylvanie). Kolozsvár/Cluj-Napoca.

DolgSzeged	Dolgozatok a Szegedi Tudományegyetem Régiségtudományi Intézetéből. Szeged.
Drobeta	Drobeta. Muzeul Regiunii Porților de Fier. Drobeta Turnu-Severin.
EME	Erdélyi Múzeum Egyesület. Cluj-Napoca.
EphNap	Ephemeris Napocensis. Cluj-Napoca.
ETF	Erdélyi Tudományos Füzetek – Erdélyi Múzeum Egyesület. Kolozsvár/Cluj-Napoca.
FdI	File de istorie, Muzeul de Istorie. Bistrița.
FolArch	Folia Archaeologica. A Magyar Nemzeti Múzeum Évkönyve. Annales Musei Nationalis Hungarici. Budapest.
Germania	Germania. Anzeiger der Römisch-Germanischen Komission des Deutschen Archäologischen Instituts. Berlin.
História	História – történelmi folyóirat. Budapest.
HK	Hadtörténelmi Közlemények. Budapest.
HOMÉ	A Herman Ottó Múzeum Évkönyve. Miskolc.
Istros	Istros. Muzeul Brăilei. Brăila.
JAHC	Journal for the Association of History and Computing. Michigan University.
JahrbRGZM	Jahrbuch des Römisch-Germanischen Zentralmuseums zu Mainz, Mainz.
JAMÉ	Janus Pannonius Múzeum Évkönyve. Pécs.
KL	Kartografické listy. Bratislava.
Korall	*Korall Társadalomtörténeti Folyóirat*. Budapest.
Közl	Közlemények az Erdélyi Nemzeti Múzeum Érem- és Régiségtárából. Kolozsvár/Cluj-Napoca.
Lucrări	Lucrări Ştiinţifice. Istorie-Ştiinţe-Pedagogie, Institutul Pedagogic. Oradea.
GT	Geographia Technica. International Journal of Technical Geography. Cluj-Napoca.
Marisia	Marisia. Marisia. Studii și materiale. Arheologie – Istorie – Etnografie. Târgu-Mureș.
MCA	Materiale și Cercetări Arheologice. București.
MEKSB	A Miskolci Egyetem Közleménye. A sorozat, Bányászat. Miskolc.
MFMÉ StudArch	A Móra Ferenc Múzeum Évkönyve. Studia Archaeologica. Szeged.
MFMÉ MonArch	A Móra Ferenc Múzeum Évkönyve. Monumenta Archeologica. Szeged.
MHB	Monumenta Historica Budapestinensia. Budapest.
MIM	Materiale de Istorie și Muzeografie, Muzeul de Istorie a Municipiului București. București.
MSW	Materialy Starozytne Wczesnosredniowieczne. Kraków.
MW	Materialy Wczesnośredniowieczne. Kraków-*Wrocław*-Warsawa.
NK	Numizmatikai Közlöny, Magyar Numizmatikai Társulat. Budapest.
NNT	Norsk Numismatisk Tidsskrift.
NZ	Numismatische Zeitschrift, herausgegeben von der numismatischen Gesellschaft in Wien. Wien.
OJA	Oxford Journal of Archaeology, Oxford.
OpHung	Opuscula Hungarica. Budapest.
PBF	Praehistorische Bronzefunde.
Potaissa	Potaissa. Studii și comunicări. Turda.
PZ	Prähistorische Zeitschrift. Berlin.
Régészeti Füzetek	Régészeti Füzetek. Magyar Nemzeti Múzeum. Budapest.
RÉSÉE	Revue des Études Sud-Est Européenes. l'Institut d'Études Sud-Est Européennes de l'Académie Roumaine. București.
RI	Revista de Istorie, Institutul de Istorie „Nicolae Iorga". București.
RM	Revista Muzeelor. Centrul pentru Formare, Educație Permanentă și Management în Domeniul Culturii. București.
RRH	Revue Roumaine d'Histoire, Academia Română. București.
Sargetia	Sargetia, Muzeul Civilizației Dacice și Romane Deva.

Savaria	Savaria – a Vas megyei múzeumok értesítője. Pars historico-naturalis. Szombathely.
SCIVA	Studii și Cercetări de Istorie Veche (și Arheologie). București.
SCN	Studii și Cercetări Numismatice. Institutul de Arheologie „Vasile Pârvan". București.
SCȘI	Studii și Cercetări Științifice. Istorie.
SIB	Studii de Istorie a Banatului. Universitatea de Vest Timișoara.
SlovArch	Slovenská Archeológia. Bratislava.
SMIM	Studii și Materiale de Istorie Medie. Institutul de Istorie „Nicolae Iorga". București.
SMK	Somogyi Múzeumok Közleményei. Kaposvár.
SSCR	*Social Science Computer Review. North Carolina State University.*
Speculum	Speculum. Cambridge Journals Online. Cambridge.
StComCaransebeș	Studii și Comunicări. Etnografie. Istorie. Caransebeș.
StComSatuMare	Studii și Comunicări. Satu Mare.
Stratum plus	Stratum plus Journal. High Anthropological School University. Cultural Anthropology & Archaeology.
Studia Caroliensia	Studia Caroliensia. A Károli Gáspár Református Egyetem szakfolyóirata. Budapesta.
Studia Comitatensia	Studia Comitatensia. Tanulmányok Pest Megye Múzeumaiból. Szentendre.
Századok	Századok. A Magyar Történelmi Társulat Folyóirata. Budapest.
Terra Sebus	Terra Sebus. Acta Musei Sabesiensis. Sebeș.
Thraco-Dacica	Thraco-Dacica. București.
Transilvanian Review	Transilvanian Review/Revue de Transylvanie. Cluj-Napoca.
TS	Történelmi Szemle. A Magyar Tudományos Akadémia Történettudományi Intézetének Értesitöje. Budapest.
UPA	Universitätsforschungen zur Prähistorische Archäologie. Bonn.
VAH	Varia Archaeologica Hungarica. Budapest.
VMMK	Veszprémi Megyei Múzeumok Közleményei. Veszprém.
World Archaeology	World Archaeology. London.
ZfA	Zeistchrift für Archäologie. Berlin.
Ziridava	Ziridava, Complexul Muzeal Arad. Arad.
ZMSW	Zeitscrift für Münz-, Siegel- und Wappenkunde. Berlin.