

Ildar Kayumov - Alexander Minchev

THE *KAMBEΣTPION* AND OTHER ROMAN MILITARY EQUIPMENT FROM THRACIA

Ildar Kayumov
Tsyurupa Str. 80-36
450077 Ufa
RUSSIA
ildar@xlegio.ru

Alexander Minchev
Varna Museum of Archaeology
Maria Lousia Blvd. 41
9000 Varna
BULGARIA
al_minchev@abv.bg

INTRODUCTION

A rare metal object, kept for a long time in the Historical Museum of Nova Zagora, Bulgaria, until recently remained virtually unnoticed. This object, a part of a hoard of various metal items, was found by an accident in 1962 while ploughing a field in the vicinity of the Elenovo village in the Southern Bulgaria. The hoard was discovered 40-50 cm below the current ground surface level¹. Unfortunately, the discoverer did not consider the find to be of any significance, but still picked up the items of the hoard out of curiosity. Considerably later he reported the find to a local town museum. It is not certain whether *all* of the items of the hoard were collected. In 1964, then-curator of the Historical Museum of Nova Zagora registered all the submitted items and entered them into the museum collection under nos. 3288-3306².

The hoard consisted of 20 various objects, one bronze and 18 iron. It included both items of military equipment — a *pilum* iron, a shield *umbo*, and a significant number of digging tools, such as five pickaxes, three spades, and three mattocks. Additionally, the hoard

contained a ploughshare with a ring, a linchpin, and a tent peg. Finally, it included three items, which, apparently belonged to an arrow-shooting *ballista* with an all-metal spring-frame: a so-called *καμβέστριον*, a massive object of a cranked shape, and a round-sectioned rod with a loop on its end.

The museum inventory book included no additional information about the circumstances of the find, and no archaeological research has been conducted in the site of the discovery, probably because the precise location of the find could no longer be established. The find has not been properly published yet³. Certainly, due to its significance for the Roman military history in general and for the history of the Roman Thrace in particular, the discovery deserves a thorough publication⁴.

³ Apart from a preliminary article dedicated to the *kambestriion* (MINCHEV 2002, 7-13). Unfortunately, for various reasons, the technical data given in that article was found to be incorrect.

⁴ The authors express their most sincere gratitude to Dr. Veselin Ignatov, the curator of the Nova Zagora Historical Museum, for his kind permission and provision of all the accompanying data and photographs of the items. Without his friendly support this publication would not be possible. The authors thank Alexander Kyrychenko (Emory University, Atlanta) for his help in preparation of this article, and also Alexander Spiridonov and Ruslan Suleimanov for their assistance with 3D-modelling.

¹ According to the record in the inventory book.

² The date is known from the record in the inventory book.



Fig. 1: The location of the Elenovo village.

The village of Elenovo is situated in the District of Nova Zagora, which belongs to the Sliven Region located on the fertile Thracian plain of Bulgaria. Renowned Western travellers and scholars mentioned and recorded some of the rich archaeological sites in the region already in the late 19th century⁵.

The vicinity of Nova Zagora is known for a significant number of the Prehistoric, Ancient and Mediaeval settlements, Thracian burial *tumuli* of the Early Bronze Age, Pre-Roman, and Roman times, and other archaeological monuments. Archaeological excavations, conducted in the region by both local and international scholars, accompanied more than a hundred years of the research. Most of the finds gathered during these excavations, including some unique occasional artefacts now in the collection of the Nova Zagora Museum, were either mentioned or published in detail.

⁵BOUE 1871, 175; KANITZ 1880, 16.

The list of the publications includes numerous articles and books⁶. Some of the archaeological monuments were destroyed in unfortunate circumstances, whereas some others that did enter the museum collection still await their proper examination.

The excavations of several *tumuli* containing a large number of very rich burials mostly of second — early third centuries AD testify to the stability of the region during the Roman period⁷.

As of today, none of the several archaeological sites located in the area of the Elenovo village has been archaeologically examined. One of them — a settlement of the Roman period of the first — third centuries AD located at the site named Kyoshka about three kilome-

⁶ The most important publications include: SHKORPIL - SHKORPIL 1898, 11, 39 and 69; DETEV 1950, 77-78; KOICHEV 1952, 366-68; KOICHEV 1955, 55-59, KOICHEV 1958, 469-74; BATSOVA - KANCHEV 1974, 50-56; KANCHEV 1973, 42-51; KANCHEV 1984, 134-59; IGNATOV - KANCHEVA-RUSEVA - VELKOV 1996, 9-16 (with extended bibliography and maps, etc.).

⁷ IGNATOV, KANCHEVA-RUSEVA - VELKOV 1996 and bibl.

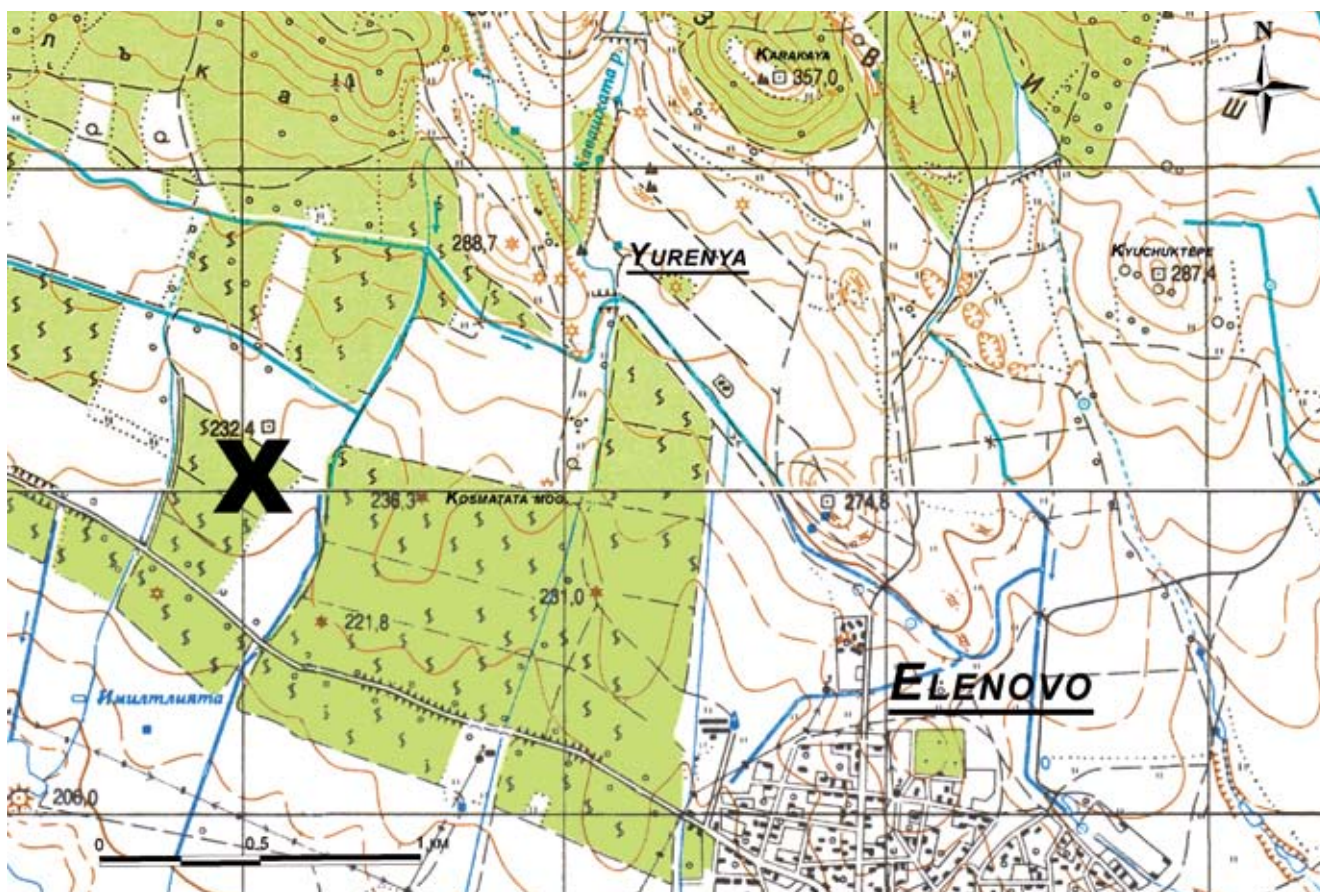


Fig. 2: A map of the Elenovo village area. X - the approximate location of the find.

tres north-west of the village — yielded a find of coarse and red-slip pottery of the Roman period. Four burial *tumuli*, a part of its necropolis, are located nearby. Another ancient settlement, which, along with the neighbouring five *tumuli*, likely dates to the Roman period, is situated about one kilometre south-east of Elenovo at the place known as Trite Penevi Mogili⁸. Regrettably, some of the *tumuli* around the village were destroyed by construction works in the 1960-70s or by the looters in the 1990s⁹.

Several settlements of various historical periods are located in the rural area of Maslaka, which also has a significant water source, and currently also a water reservoir. One of them most likely was an important Thracian settlement, possibly of the Late Classical and Hellenistic period of the fourth — first centuries BC, which is suggested by the finds of the imported black-glazed Greek pottery shards. Additionally, the site yielded

numerous fragments of the red-slip Roman pottery of about first — third centuries BC, as well as some fragments of green-glazed pottery¹⁰. The latter fragments could have either belonged to the pottery of the Late Antiquity that is to the period of the late fourth — fifth centuries AD¹¹ or, more likely, to the Early Mediaeval Bulgarian pottery of the late ninth — tenth centuries. This is suggested by the accompanying finds of a body of a clay horse and other animals with quite characteristic decorative finishing, similar to that of the glazed vessels¹². All these ceramic artefacts witness to the lengthy, stable, and continuous community life at this site, only rarely interrupted by chronological gaps.

The hoard was excavated about three kilometres north-west of the Elenovo village, at the site called Yurenya. This site is an elongated open-ended hollow sloping to the south-east through the Yurenya River valley toward the Thracian plain. Three moderate-height

⁸ DETEV 1950, 78.

⁹ IGNATOV - KANCHEVA-RUSEVA - VELKOV 1996, 13.

¹⁰ DETEV 1950, 78 and fig. 30.

¹¹ Examples of similar pottery produced at Marcianopolis in Moesia Secunda, Bulgaria see in MINCHEV - GEORGIEV 1991, 225-26.

¹² BAKALOVA 1988, 26-27, cat. nos. 29, 31 and bibl.



Fig. 3: An aerial view of the Elenovo village area. X - the approximate location of the find (42°23'54", 26°07'21").

ridges named Karakaya (the Black Rock), Ostar Kamak (the Sharp Stone) and Yurenja embrace the hollow and present a sort of a natural shelter and defence to those settled within. The published archaeological finds from this site are scarce but important and speak in favour of existence of at least one large settlement of the Roman period there. According to the research conducted in the area during the early 1950s, the site produced numerous finds of fine Roman red-slip and coarse pottery of the first — third centuries AD, several milestones of various shapes, a small bronze statuette of the *Venus Pudica* type of second — third centuries AD, and other items. A Roman paved road about four meters wide stretching out from the settlement southward was still visible at that time. A large necropolis of the same period is connected to the settlement. Additionally, ten large Thracian burial mounds (*tumuli*) of an earlier period stretch along the Yurenja ridge¹³.

¹³ DETEV 1950, 77-78 and figs. 28-29.

VARIOUS EQUIPMENT AND TOOLS

The item no. 3301 described in the inventory record as “an iron rod of unknown purpose” is a *pilum* shank with a square-sectioned socket. The shank itself is also square-sectioned. The total preserved length of the iron is 56.2 cm, the width of the socket is 3.5 cm. The shape and the length of the *pilum* head cannot be determined due to its extensive corrosion. Similar *pila* shanks with the characteristic square-sectioned sockets are known from the Antonine era through the third century AD¹⁴.

Unfortunately, the bronze shield *umbo* was stolen from the exhibit in the town of Tvarditsa in 2000. All what was left was a rough drawing and the following inventory book record no. 3288: “A bronze *umbo* with a flange, the width is 4.8 cm, and a dome, the height is 5 cm. The *umbo* diameter is 21.5 cm, the thickness is 1 mm. The *umbo* was secured by four nails with prominent raised semispherical heads.”



Fig. 4: Pilum shank. No. 3301. 56.2×3.5 cm.

The hoard contains five pickaxes or *dolabrae* — the typical Roman military tools — of different sizes and shapes¹⁵. Three of them have wide axe blades, and two — narrow ones¹⁶. All of them have chisel-bladed tines on the other end. Their lengths vary from 39.5 to 53.1 cm.

Three mattocks, 31.6, 33, and 39.5 cm in length, also have chisel-bladed tines, but, unlike those found in Künzing¹⁷, they have trapezoid, not rectangular, blades. Several mattocks with similar trapezoid blades were found in 1984 within a Late Roman hoard of metal objects buried in a barrack of the *Castra ad Montanensium* (modern town of Montana, Bulgaria)¹⁸. A similar in shape mattock, for instance, was recently found among other items on the early third century battlefield at the Harzhorn, Germany¹⁹.

¹⁴ BISHOP - COULSTON 2006, 130, 151, figs. 74,1; 92,6.

¹⁵ BISHOP - COULSTON 2006, 117.

¹⁶ Examples of the third century pickaxes see in BISHOP - COULSTON 2006, 185; HERMANN 1969, 135-36 and abb. 5.

¹⁷ HERMANN 1969, 136-37 and abb. 6.

¹⁸ ALEKSANDROV 1988, 30 and fig. 3.

¹⁹ GRÜNEWALD 2010, 89.



Fig. 5: Pickaxes. 1 - No. 3296. 39.5×32.1 cm; 2 - No. 3297. 42.5×9.6 cm; 3 - No. 3298. 53.1×14.2 cm; 4 - No. 3299. 42.5×6.5 cm; 5 - No. 3300. 48.8×17.7 cm.



Fig. 6: Mattocks. 1 - No. 3292. 31.6×19.2 cm; 2 - No. 3293. 33.0×20.5 cm; 3 - No. 3294. 39.5×38.8 cm.

The length of all three trapezoid spade blades is about the same — 39, 39.5 and 42.3 cm. The thickness of iron in different areas varies from 2 to 6 mm. Two of the spades had their shafts attached between two rectangular extensions, the third had it inserted into a round socket. The latter is analogous to a spade from the hoard found earlier in the destruction layer of the south-western tower of the Montana fortress²⁰. One of the spades still had two nails used to secure its shaft attachment.

The working part of the ploughshare has a shape of an isosceles triangle with a convex surface. A long rectangular-sectioned handle was forged together with the working part out of one piece of iron. The ploughshare was attached to the plough by means of a ring and a bent-down end of the handle, which was hammered into the wood. The total length of the ploughshare is 43.7 cm, about half of which is the handle. Ploughshares of this type, apparently, were of the Thracian origin and were common to the Balkans up until the Early Medieval period²¹. For instance, eight such ploughshares, some complete with rings, were found within the Montana hoard in 1984²².

The linchpin that was found within the hoard was purposed to prevent the wheel from slipping from the axle of the cart. Its top end is flattened and forms a loop for the rope, which secured the linchpin in place. Numer-

ous linchpins of this kind²³ were found within the Roman Empire²⁴, but this one presents one of the largest examples. Its length is 19 cm.

The hoard contains a tent peg²⁵, which implies its military provenance. The peg is 20 cm in length and is forged in one piece with the loop for securing a rope. Its closest analogy comes from the Künzing hoard²⁶.

THE *KAMBEΣTPION*

The function of this find could not be determined until the publication of Eric Marsden's seminal work in 1971²⁷ and the archaeological analogies that followed²⁸. Thus, the inventory book record no. 3305 states: "Iron part of a mechanism (chariot?), of complex design, consists of two parts, length — 26 cm, width — 13 cm."

²³ Type 2b after MANNING 1985, 73-74 and fig. 20.

²⁴ Blackburn Mill: PIGOTT 1952, 41, 43 and fig. 11,B4. Carlingwark: PIGOTT 1952, 32-33 and fig. 8,C8. Carpow: DORE - WILKES 1999, 555-56 and fig. 48,19. Great Wakering: MANNING 1985, 74 and pl. 31,H41; H42. Mumrills: MACDONALD - CURLE 1928, 561, 563-64 and fig. 124,5. Neupotz: VISY 1993, 275-77 (Band 1); 82-83 (Band 2) and tafn. 425, 426,F115; F116 (Band 4). Newstead: CURLE 1911, 294-95 and fig. 70,1; 3; 6.

²⁵ The interpretation of these objects as tent pegs is the most popular, although some scholars believe that these iron pegs were used for tethering animals; so BISHOP - COULSTON 2006, 69, 187 and fig. 121.

²⁶ HERMANN 1969, 138-39 and abb. 8,10-17.

²⁷ MARS DEN 1971, 206-33.

²⁸ Gornea, 1968: BAATZ - GUDEA 1974, 54-57 and abb. 3-5; Orșova/Dierna, 1969: BAATZ - GUDEA 1974, 57-58 and abb. 6-8; Lyon, before 1857: BAATZ - FEUGÈRE 1981: 201-3 and figs. 1-2; Sala, 1960:BOUBE-PICCOT 1988: 213-15 and pl. 3-4, 8-10.

²⁰ ALEKSANDROV 1988, 31 and fig. 3.

²¹ VAZHAROVA 1956, 11-12, 50-53 and fig. 6.

²² ALEKSANDROV 1988, 28-29 and fig. 2.



Fig. 7: Spade blades. 1 - No. 3289. 39.0x36.3 cm; 2 - No. 3290. 42.3x26.5 cm; 3 - No. 3291. 39.5x20.9 cm.



Fig. 9: *Kambestrion*. No. 3305a.



Fig. 8: 1 - Ploughshare. No. 3295. 43.7x13.3 cm; 2 - Ring. No. 3306. 8.4x3.0 cm; 3 - Linchpin. No. 3304. 19.0x4.5 cm; 4 - Tent peg. No. 3303. 20.0x2.0x0.4 cm.



Fig. 10: *Kambestrian*. 1 - Top view; 2 - Bottom view.



Fig. 11: *Kambestrian*. 1 - Right view; 2 - Left view.



Fig. 12: *Kambestrian*. 1 - Front view; 2 - Rear view.

About 25 years ago, one of the authors of this article saw this object in one of the showcases of the Nova-Zagora Museum. However, despite all the efforts undertaken, due to various circumstances and the scarcity of the available data, a complete publication of this rare find could not yet be accomplished.

The object is a part of an all-metal spring-frame called *καμβέστριον* in Greek (Heron, *Cheir*. W128), which housed one of the two torsion-springs of the Roman arrow-shooting *ballista*. This *kambestrian* is the third in terms of its finding date among the seven presently known. It is made of iron, as is the case with almost all of the others found so far. Unlike the others, however, the parts of this *kambestrian* were put together by forge welding instead of riveting. Due to the rigidity of the construction caused by forge welding, it preserved its original shape, just as the only known cast bronze *kambestrian* from Sala. Our *kambestrian* is the smallest of those that, apparently, were designed for the stationary engines and not for the hand ones, as was the case with three tiny *kambestria* from Gornea. Its height is only 26.5 cm, the diameter of the spring-hole for the washer — 6.7 cm, weight — 5.33 kg. For comparison, the *kambestrian* from Sala is 37.4 cm in height, its spring-hole diameter is 8 cm, its weight is 15 kg²⁹; the *kambestrian* from Orșova/Dierna has the measurements of 36 cm, 7.9 cm, and about 8 kg accordingly³⁰. The *kambestrian* from Lyon has superior height and diameter, but inferior weight of 4.85 kg³¹. In appearance, the Sala *kambestrian* is the closest to the Elenovo find. The *kambestrian* consists of two hole-carriers, two stanchions, and four brackets riveted to the stanchions and used for connection with the upper arched (*καμάριον*) and lower composite (*κλιμάκιον*) struts.

The hole-carriers are nearly square in shape with two rounded opposing angles. In addition to the central hole for the washer installation, the hole-carriers also have four drilled small holes for the retaining pins, 6-8 mm in diameter. Nearly all of the remaining known *kambestria* have the same number of the retaining pin-holes. The only exception is the *kambestrian* from Sala, which, however, likely had the same number of the holes originally.

The rear-stanchion is straight, whereas the front-stanchion has a convex bulge on its outer side, and a semicircular recess on its inner side, used as an arm rest after firing. The stanchion widens considerably in

²⁹ BOUBE-PICCOT 1994, 188.

³⁰ BAATZ - GUDEA 1974, 57-58.

³¹ BAATZ - FEUGÈRE 1981, 202.

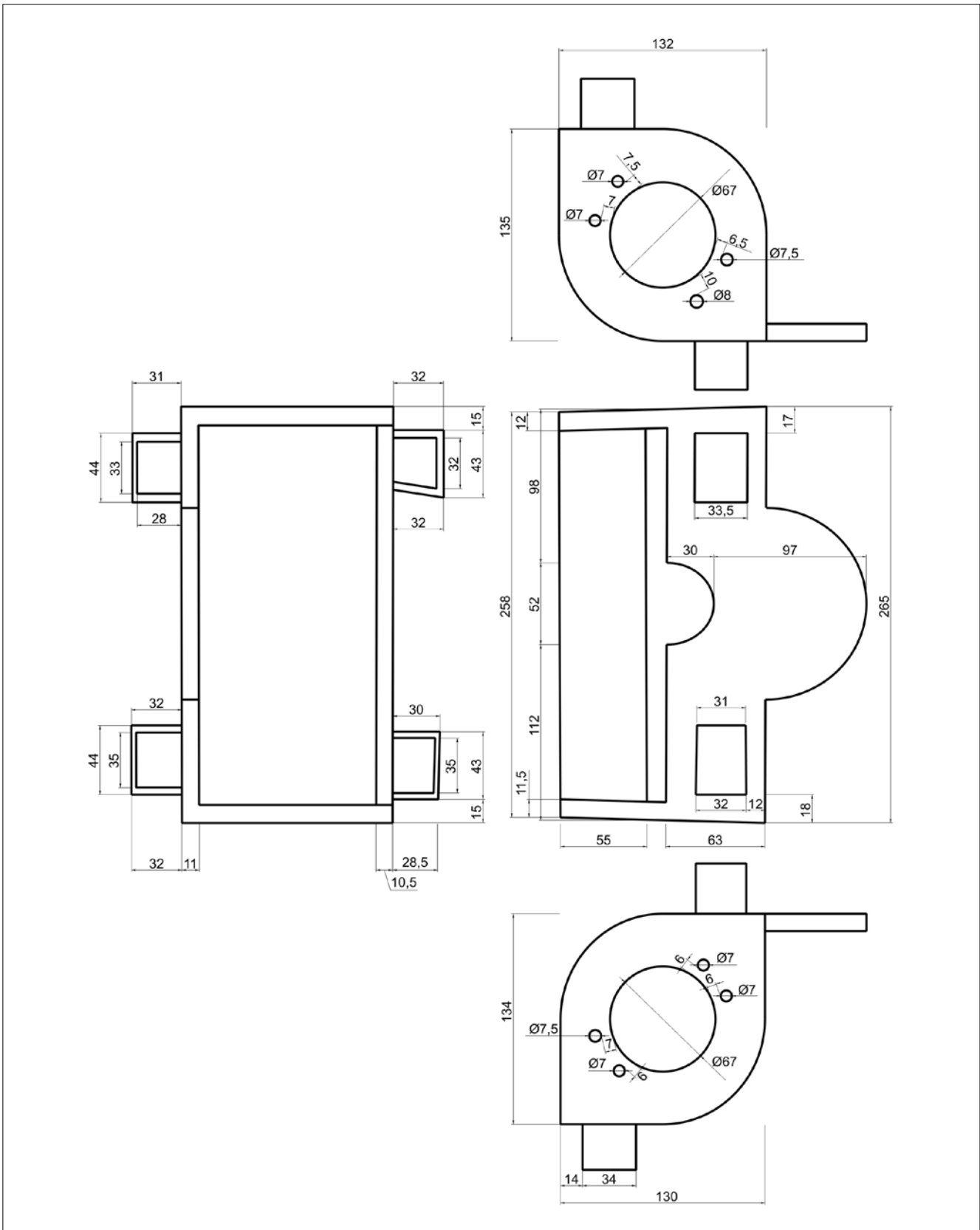


Fig. 13: Kambestriion. Dimensions.

the place of the convex bulge. This type of the cross-section increase in width or thickness is known for the front-stanchions of all found *kambestria* with the exception of the one from Lyon. This construction feature prevented bending of the stanchions at this weak point. As an example, the only two horsehair torsion-springs 7.9 cm in diameter used in the Ampurias catapult reconstructed by Erwin Schramm, compressed the wooden spring-frame with the force of 11 tons³².

The stanchions are welded to the corners of the hole-carriers parallel to their edges and with significant offset in relation to each other. Such positioning of the stanchions and the shape of the hole-carriers, as is also the case with the Sala *kambestrion*³³, clearly suggests a palintone construction³⁴ of this spring-frame. Moreover, the diamond shape of the hole-carriers (Heron, *Bel.* W103-4; Philon, *Bel.* W52; Vitruvius, *De arch.*, X, 11, 4) of the *kambestria* from Orșova and Lyon suggests that apparently they were also originally made according to the same palintone scheme with the offset of the stanchions and were not positioned radially across from each other. Subsequently, due to the weakness of the riveted joints, their stanchions could have shifted to their current positioning. It is also possible that a similar shift had occurred with the stanchions of the three *kambestria* from Gornea, which have nearly round hole-carriers.

The thickness of the hole-carriers and stanchions varies from 11 to 12 mm.

The upper and lower mounting brackets or *πικάρια* (Heron, *Cheir.* W129) are made out of iron which is thinner than it is for the rest of the *kambestrion* and varies from 2 to 5 mm in thickness. The brackets are approximately similar in their dimensions. This makes this *kambestrion*, just as the *kambestrion* from Sala, different from all the other *kambestria*, which all have the lower brackets larger in size than the upper ones. The brackets are attached to the stanchions through riveting, not welding.

The surface of the *kambestrion* parts not affected by corrosion show clear signs of thorough treatment.

³² SCHRAMM 1918, 40, 77.

³³ BOUBE-PICCOT 1994, 188-195 and pl. Z¹, 1; 49; 96-98.

³⁴ MARSDEN 1969, 22-23, 189; MARSDEN 1971, 231; WILKINS 1995, 31, 48; IRIARTE 2000, 54-55; WILKINS 2003, 42.

CRANK-HANDLE

An unusual iron object found within the Elenovo hoard was a rod 45 cm in length with two opposing shanks forge-welded to it. Its weight is 3.27 kg. The shape of the object suggests that most likely it presents a crank-handle used to turn a windlass, which possibly belonged to the same *ballista* as did the *kambestrion* from the same hoard.

Until recently, virtually all the researchers denied the very existence and application of cranks in Antiquity³⁵. Without doubt that was a consequence of the complete absence of any supporting evidence to the contrary in surviving treatises of ancient mechanics and architects, as well as of inconclusiveness of the scarce archaeological data, such as the hypothetical reconstruction of the bilge chain-pump with a wooden wheeled crank-handle of Caligula's second ship from Lake Nemi (Italy)³⁶ and the obscure reference to an iron crank-handle of the Archimedes screw from the mine in Alcaracejos³⁷. However, recent finds prompt for revising this view. They include, first of all, the iron crank-handle of a hand-mill from Aschheim³⁸ and those of unknown purpose from Augusta Raurica³⁹, as well as the established usage of the crank-and-rod system in the stone saw-mills in Hierapolis⁴⁰, Gerasa⁴¹,

³⁵ The discussion of the crank see in RITTI - GREWE - KESSENER 2007, 154-56. See also MARSDEN 1971, vii: "It is most unlikely that ancient engineers knew anything about the crank in any shape or form", 178 and n. 109: "evidence for cranks in Hellenistic times is virtually non-existent"; OLESON 1984, 286: "It seems highly probable that [the combination of water-wheel, crank and connecting rod] is a late medieval invention", 402: "the nearly total ignorance of the crank and the connecting rod in the classical world" ... "The absence of the crank on machines is all the more remarkable in that its principle appears at least partially formed on the rotary quern in the second century BC"; HUMPHREY, OLESON - SHERWOOD 1998, 34: "an oscillating saw would require use of a crank, for which there is a little evidence in antiquity"; LANDELS 2000, 10: "It is generally agreed that the Greek and Romans did not, apparently, discover or use a crank in place of the handspikes on a windlass", 25: "In the absence of any evidence for [crank and connecting rod] we can only guess, regret all the more that no technical writings have survived from that area or from that period"; LUCAS 2005, 5 and n. 9: "it remains unclear how long before the eight century the crank handle was commonly used in the West" ... "The more sophisticated mechanisms of the crank and connected rod appear to be early medieval developments"; SCHIØLER 2005, 34: "all historians of technology agree that the one armed-crank was unknown in Roman times".

³⁶ UCELLI 1950, 184, 428 and fig. 199; OLESON 1984, 230-31; IRIARTE 2000, 68-70.

³⁷ TREPTOW 1918, 180-81; DAVIES 1935, 27.

³⁸ VOLPERT 1997, 193-199.

³⁹ LAUR-BELART 1978, 59 and abb. 46.

⁴⁰ RITTI - GREWE - KESSENER 2007, 138-63; GREWE - KESSENER 2007, 227-34; GREWE 2009, 429-54; GREWE 2010, 381-401.

⁴¹ SEIGNE 2002a, 14-16; SEIGNE 2002b, 205-13.

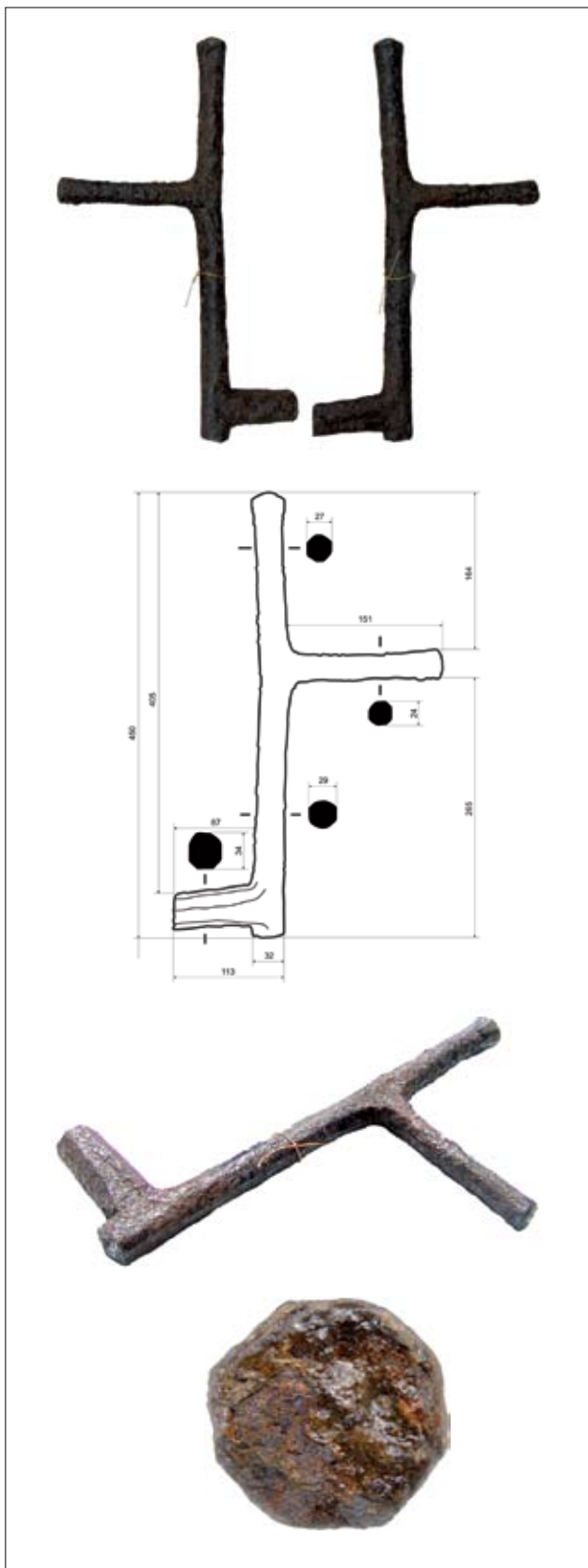


Fig. 14: Crank-handle. No. 3305b.

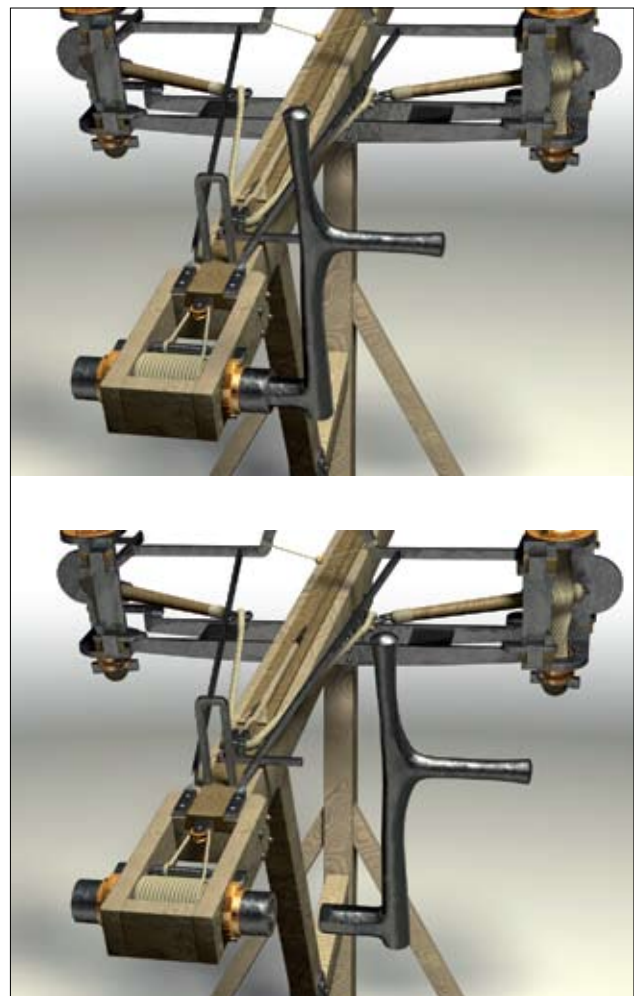


Fig. 15: Crank-handle (reconstruction). 1 - Inserted into the axis of the windlass, 2 - Separated from the axis of the windlass.

and Ephesus⁴². The absence of any references to cranks in the technical treatises, the latest of which belongs to Heron of Alexandria, can be explained by the fact that all of the finds date to the period from the end of the second century to the middle of the sixth.

The short and thick shank is octagonal-sectioned and, apparently, could be a kind of a key that could have been inserted into the octagonal counter-hole in the butt-end of the all-metal or metal-bound axle of the windlass. Its octagonal cross-section would allow repositioning of the crank-handle every 45°, which would

⁴² RITTI - GREWE - KESSENER 2007, 151-53 and figs. 15-16; GREWE 2009, 435, 440-43 and abb. 3, 11-12; GREWE 2010, 384-85, 388-90 and figs. 3, 11-12.

be convenient in the particularly exerting last stage of *ballista's* pullback. In that case, a side grip, used for fast rotation of the windlass, would be positioned on the other end of the crank. The length of the side grip would allow the application of both hands. The vertical grip, in that case, could be used for exerting additional force by increasing the gear ratio on more difficult stages of the pullback.

ARM (?)

Although the exact purpose of the round-sectioned iron rod registered under no. 3302 is unknown, it is possible that it belonged to the same *ballista*. This supposition has some support. Its length, 37.1 cm, fits well within the theoretical length of the arm equal to six diameters of the spring-holes, especially taking into account that the actual diameter of the torsion-spring hole would be less than that of the hole-carrier. The thinner end of the rod is bent into a loop, undoubtedly for passing a rope or, possibly, a bowstring. The other end of the rod has a local thickening, similar to that of the arm depicted in some of the copies of Heron's treatise about a *cheiromballistra*⁴³, as well as of the arms shown in some of the medieval illustrations depicting an one-armed stone-thrower⁴⁴. Such thickening would prevent losing of the arm from the torsion bundle.

RECONSTRUCTION

Without doubt, the *kambestrion* belonged to a stationary garrison arrow-shooter or to a *ballista* carried on a battle-cart — *carroballista* (Veg., *Mil.*, II, 25; III, 14; 24) — to which the found linchpin could have also belonged. *Ballistae* on battle-carts were first seen on the Trajan's column — they have only two wheels and are pulled by mules⁴⁵. A similar two-wheeled artillery cart pulled by mules and carrying a *ballista* base on it is apparently depicted on the Marcus Aurelius column⁴⁶. The first literary evidence relating to the use of the *ballistae* on battle-carts in the field battle belongs to the end of the third — beginning of the fourth century. The *ballistarii* of the Chersonesos used them in battles at the city walls of the Cimmerian Bosphorus and on the Danube (Const. Porph., *De adm. Imp.*, 53, 29; 34; 132).

⁴³ See PROU 1877, 148 and fig. 27 (ms. de Paris 2438); Oxford, Magdalen College, Magd. MS. Gr. 14, fol. 15r.

⁴⁴ See SCHMIDTCHEN 1987, XXIX (Cod. Pal. Lat. 1888 Rom; CPV 3069 Wien).

⁴⁵ TC, XL, 104-5; LXVI, 163-64.



Fig. 16: Arm (?). No. 3302. 37.1×1.5 cm.

In the time of Vegetius (Veg., *Mil.*, III, 14; 24), along with the mules horses were used to drive the artillery carts placed in the rear ranks of the battle order. The so-called Roman Reformer and Inventor of the fourth century recommends using of armour for protection of the horses of such a cart, now with four wheels instead of two (Anon., *De reb. bel.*, VII, 2). According to Mauricius (*Strat.*, XII, B, 18), the *ballistae* on carts were most probably driven by oxen and followed the infantry in battle formation as a part of a *karagon*, which protected the wagon train on the march. In the rear, the draft animals and the crews of the battle carts were protected from projectiles by felt screens. (Mauric., *Strat.*, XII, B, 6; 18). The heads of the catapult bolts, found in abundance in Harzhorn, confirm the regular use of the throwing engines by the Roman army in the battlefield⁴⁷.

⁴⁶ WILKINS 1995, 43 and fig. 22

A short treatise entitled “Heron’s Construction and Dimensions of the *Cheiroballistra*” is the main source of our knowledge about the construction of the *ballista* with the all-metal spring-frame. The archaeological finds of the last 40 years that occurred in two small Late Roman bridgehead forts in the Danube limes in Romania, as well as in France and Morocco, also played a significant role in our understanding of the constructions of these engines.

The last decade witnessed a heated debate about the construction of these *ballistae*⁴⁸. The classic construction of the torsion arrow-shooters of the Hellenistic and the Roman Republican periods undoubtedly originated from the earlier engines, which used a composite bow as the source of the spring force. In such construction, the wooden frame for the torsion springs was narrow, and the arms for the bowstring attachment faced outwards. The frame itself was positioned in the front of the stock in order to ensure the maximum bowstring travel. However, we have all reasons to believe that the *ballistae* with the all-metal spring-frame had principally different construction: their arms were directed inwards of the spring-frame. What are the grounds for such a supposition?

First, the supposition is grounded in the width of the frame itself. A significant increase of the dimensions of the all-metal spring-frame in comparison with the classic wooden one and the increase of the aperture between the torsion springs would be too high a price to pay for such an insignificant achievement as an increase of the shooter’s field of vision⁴⁹. Nobody would change the construction of the arrow-shooter so radically for such a reason.

⁴⁷ GRÜNEWALD 2010, 85, 89.

⁴⁸ ANSTEE 1998, 131-39; IRIARTE 2000, 47-75; WILKINS - MORGAN 2000, 94-100; MIKS 2001, 153-233; WILKINS 2003, 38-50, 69-70; IRIARTE 2003, 111-40; CAMPBELL 2003, 37-42; LEWIS - FAULKNER 2004, 45-46; RIHLL 2007, 209-18; LEWIS - HART 2010, 261-73.

⁴⁹ MARSDEN 1971, 227: “The widely spaced field-frames, together with the arch and the ladder, form a relatively large window through which the artilleryman can observe an extensive area of enemy territory. When a target presents itself, he can align his machine on it instantly without leaving his position beside the rear of the stock.”; BAATZ 1978, 13: “In combination with the wide spacing of the field-frames this provided a useful opening in the framework of the catapult, through which the ancient artilleryman could observe the field and spot his target.”; WILKINS 1995, 50-51: “In contrast the open framework of the *cheiroballistra* allows the approaching enemy to be followed at all times however much he swerves, and the final shot can safely be delayed until a hit is certain and the bolt will penetrate with maximum force. The missile can be followed throughout its trajectory and corrections easily judged; accurate medium and close range aiming are assisted by relating both the missile and target to the arch in the upper strut.”

Second, the supposition is supported by a small number of the surviving pictorial evidences, both of the Hellenistic and of the Roman periods. The arms of the throwing engines, just as the arms of the bows, are prominent features and would be certainly depicted by an ancient artist. Indeed, two of the surviving reliefs presenting frontal views of the Hellenistic and the Roman *scorpiones* clearly show their arms⁵⁰, whereas the Trajan’s column reliefs⁵¹, depicting arrow-shooting *ballistae* with the all-metal spring-frame, do not show their arms. Is not that so because the arms were positioned inside of the spring-frame and did not protrude to the sides⁵²? Furthermore, the Trajan’s column provides additional indirect evidences in favour of this hypothesis. The spring-frame of such an arrow-shooter should have been positioned not in the front of the stock, as was the case with the earlier Hellenistic engines, but shifted rearward closer to the middle, because at firing the arms had to continue their movement beyond its frontal plane. Therefore, a significant portion of the stock had to protrude forward beyond the spring-frame, which indeed was clearly the case for the five of the seven *ballistae* depicted on the reliefs⁵³. Out of the remaining two, one is shown from the front⁵⁴, and the other is partially covered by the back of a mule⁵⁵. A supposition that the reliefs portray protruding sliders⁵⁶ is ungrounded. Due to its small cross-section, a slider was a quite fragile element which was moved forward immediately prior to loading. A Roman artilleryman would hardly leave his engine in such a vulnerable state out of fear of accidental damage. This constructional feature can also be seen in the illustrations from the treatise of the Roman Reformer and Inventor⁵⁷. Parts of both of the *ballistae*, which undoubtedly present arched struts of the spring-frames, are significantly shifted rearwards. It is also possible to notice some details, which apparently are depictions

⁵⁰ According to a relief carving from the frieze of the Sanctuary of Athena at Pergamon (c. 170 BC) and the tombstone of C. Vedennius Moderatus (c. AD 100), who served as an *architectus* in the imperial arsenal at Rome (CIL, VI, 2725). See SCHRAMM 1918, 35-36 and abb. 9-10; MARSDEN 1971, pl. 1, 3; WILKINS 2003, 28-29 and figs. 13-14; CAMPBELL 2003, 22, 24; RIHLL 2007, 129, 214 and figs. 6.3, 9.9.

⁵¹ TC, XL, 104-5; LXVI, 163-66; 169.

⁵² IRIARTE 2003, 119; RIHLL 2007, 214-15.

⁵³ TC, XL, 104; LXVI, 165-66; 169. A. Iriarte erroneously speaks of four; see IRIARTE 2003, 119.

⁵⁴ TC, LXVI, 163-64.

⁵⁵ TC, XL, 105.

⁵⁶ WILKINS 1995, 48.

⁵⁷ See, for instance, Oxford, Bodleian Library, MS. Canon. Misc. 378, fol. 71v, 76r; München, Bayerischen Staatsbibliothek, Cod. lat. Mon. 10291, fol. 71v, 76r.

of the arms and the bowstring situated inside of the frame. Some of the engines from the Trajan's column⁵⁸ display semicircular bulges in the middle parts of their *kambestria* on both sides of their spring-frames. If we interpret the bulges as specific recesses for arm rests⁵⁹, it becomes apparent that their positioning as depicted on the column is only possible when the arms rotate inside of the frame, not outside of it. Besides, one of the Trajan's column reliefs depicts the *ballistae* situated so close to each other on the top of the fortress wall that it would not be possible to achieve with the outer positioning of the arms⁶⁰.

Third, the supposition is supported by the archaeological finds. An excavation conducted in the southwestern tower of the Roman fort in Orșova yielded a *kambestri- on* and an arched strut, which were found next to each other in the same destruction layer⁶¹ and apparently belonged to the same garrison *ballista*. Had the arms been faced outward, a direct connection of the tenons of the strut through the brackets of the *kambestri- on* would position the semicircular recess for the arm rest in a wrong place where it would be unable to perform its function. The stanchions of the *kambestri- on* would inhibit the movement of the arm, which stops at the maximum tension of the bowstring, and that would be unacceptable. Complex adapters between the *kambes- tria* and both of the struts would be required in order to turn the *kambestria* to their proper position⁶². Such an adapter hardly existed in the case of the Orșova *ballista*, and the *cheiromballistra* treatise does not mention it either. A bronze plating of the buried wooden spring-frame of a stone-thrower found along with washers next to the northern gate of Hatra in Iraq can, apparently, shed some light on this issue⁶³. Unlike the narrow Hellenistic spring-frames, the spring-frame from Hatra has its torsions significantly further apart from each other, and its proportions clearly resemble the frames of the Heron's *cheiromballistra* and Orșova *ballista*. The construction of this frame does not allow outward facing of the arms, whereas the semicircular recesses in the front stanchions are on the inside as is the case with the iron *kambestria* when they are directly connected to the struts.

⁵⁸ TC, XL, 104-5; LXVI, 163-64.

⁵⁹ IRIARTE 2000, 61-62; IRIARTE 2003, 119; MIKS 2001, 206-7.

⁶⁰ TC, LXVI, 165.

⁶¹ GUDEA - BAATZ 1974, 58; BAATZ 1978, 9.

⁶² GUDEA - BAATZ 1974, 64; A. Wilkins suggested to use so called "locking rings" consisting of 12 bronze parts of very complicated design to connect the struts and the *kambestria* in the "correct" position (WILKINS 1995, 34-38, WILKINS 2003, 49-50). In his reconstruction of the *cheiromballistra*, C. Mijs used eight "befestigungs klammern" to connect them (MIKS 2001, 191-193).

⁶³ BAATZ 1978, 3-9.

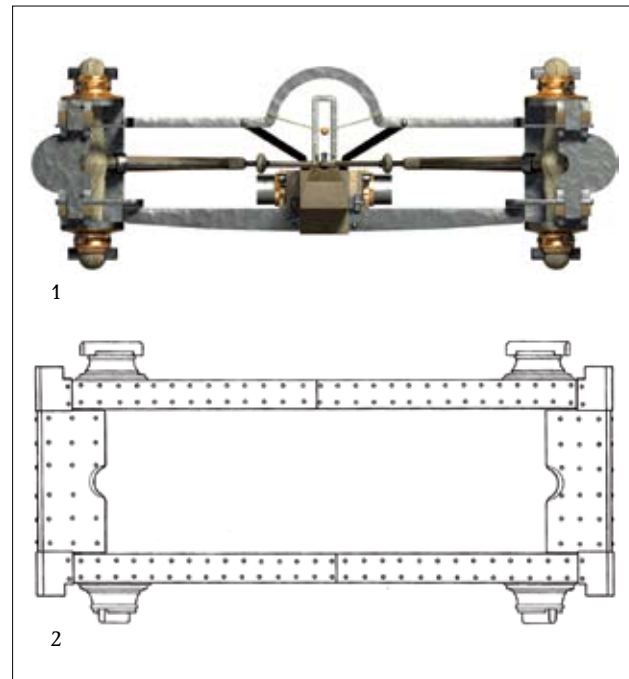


Fig. 17: 1 - The Elenovo spring-frame; 2 - The Hatra spring-frame.

Finally, there is one more consideration. The arched strut from Orșova has two openings on both sides of the central arch. It is believed that the openings secured a cord stretched through the arch, which had a bead attached to it and served as the sight as was the case for the Late Medieval bullet-shooting crossbow⁶⁴. The existence of such sight not only possible, but is required by the central arch itself. However, these holes are too large — their diameters are nine and ten mm with the overall height of the cross-section of the strut is 36 mm⁶⁵. Decreasing the area of the cross-section in more than a quarter, they significantly weaken the strength of the construction that needs to carry a significant load. Besides, there is no need to drill the holes, especially at a considerable distance from the central arch, to attach a cord. What then was the likely purpose of these holes? The Hellenistic wooden palintones used two diagonal stays for supporting the spring-frame (*anteridon*: Vitruvius, *De arch.*, X, 11, 9; *αντηρέϊδας*: Heron, *Bel.*, W101). Apparently, these holes served for securing similar stays of the most power-

⁶⁴ WILKINS 1995, 26.

⁶⁵ GUDEA - BAATZ 1974, 58.

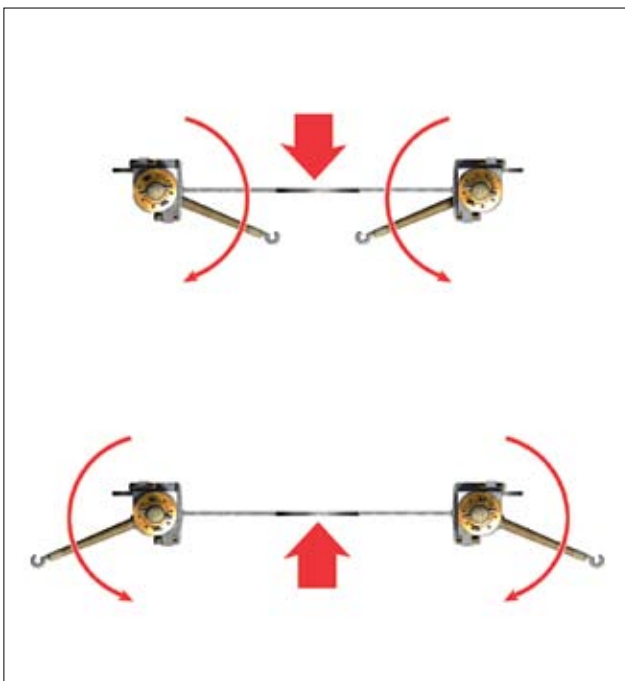
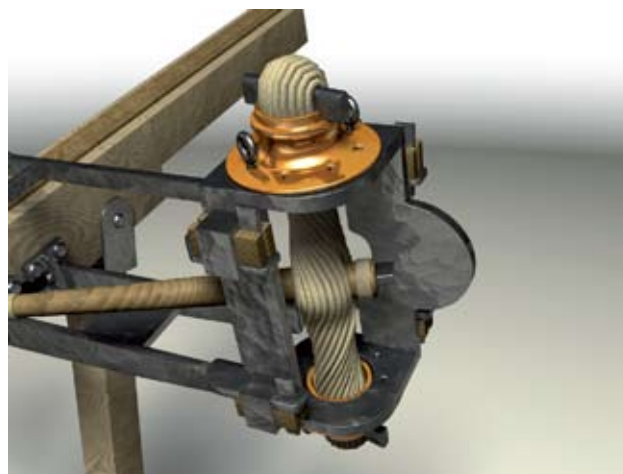
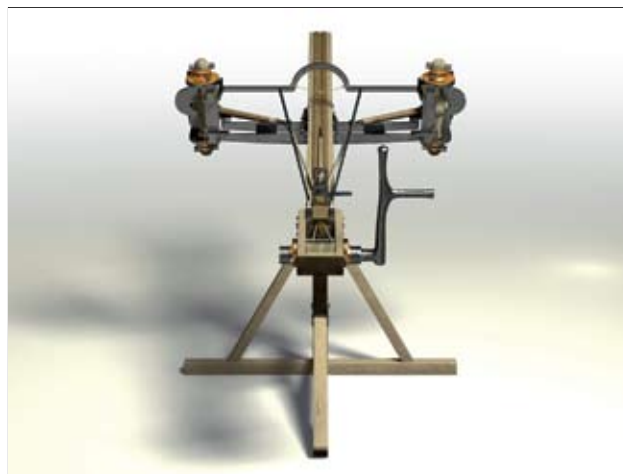


Fig. 18: The direction of the force applied to the arched strut during the rotation of the arms. 1 - Inside of the spring-frame; 2 - Outside of the spring-frame.

Fig. 19: 3D-reconstruction of the Elenovo *ballista*.



ful arrow-shooting *ballistae* with the purpose of preventing the bending of the arched strut. Such considerable bending is displayed by the model *ballista* of Nick Watts, which *kambestria* and *kamarion* are made by the dimensions of the Orşova finds⁶⁶. However, the diagonal stays would perform effectively only if the compressive force is directed toward the rear part of the engine, that is, when the arms turn inside of the spring-frame. Otherwise, the tension would likely lead to detachment of the rivets and failing of the construction.

Thus, only the inner positioning of the arms allows a satisfactory resolution of the majority of the issues regarding the construction of the all-metal spring-frame *ballistae*.

It has to be noted that the positioning of the arms inside of the spring-frame is not something unusual. According to the drawings from the treatises of Roberto Valturio⁶⁷ and Johannes Formschneider from Nuremberg⁶⁸, it had been applied for the torsion springalds in the Late Medieval period.

⁶⁶ The *ballista* had nylon torsion bundles; the muzzle velocity of the 465 g bolt — 100 m/s with the draw weight of 2.2 tons. A 454 g bolt with the muzzle velocity of 95 m/s pierced 6.5mm iron plate. See <http://wattsunique.com/blog/>

⁶⁷ London, British Library, Add. 24945, fol. 185r.

⁶⁸ München, Bayerischen Staatsbibliothek, Cod. germ. Mon. 734, fol. 103v.

CONCLUSION

Unfortunately, the exact location of the Elenovo hoard containing military and agricultural equipment can no longer be established. Therefore, it is hard to determine whether the find can be directly connected to some of the aforementioned archaeological sites and, respectively, to their local population. For the same reason the dating of the find is difficult, although the second half of the second century — third century AD is the most probable time frame.

Did all these objects belong to a local garrison permanently or temporarily based at one of the Roman settlements mentioned above, or were they buried by some Roman military unit due to an accident, for instance, during its hurried retreat because of the Gothic invasion of the 250-51 AD? That is a question which will have to remain unsolved. Nevertheless, this rare find provides additional information about Roman military presence in Thracia and gives some answers to some questions regarding construction of the Late Roman arrow-shooting *ballistae*.

BIBLIOGRAPHY

- ALEKSANDROV 1988: Георги Александров, Оръдия на труда и предмети на бита от Монтана, Археология 4, 1988, 28-38.
- ANSTEE 1998: J. Anstee, "Tours de Force". An experimental Catapult/Ballista. In: Zahariade, M. (ed.). *Studia Danubiana I. The Roman Frontier at the Lower Danube 4th-6th centuries*. Bucharest 1998, 131-139.
- BAATZ 1978: D. Baatz, Recent Finds of Ancient Artillery, *Britannia* 9, 1978, 1-17.
- BAATZ - FEUGÈRE 1981: D. Baatz and M. Feugère, Éléments d'une catapulte romaine trouvée à Lyon, *Gallia* 39, 1981, 201-209.
- BAKALOVA 1988: E. Bakalova et al., Trésors d'art médiéval de Bulgare, VIIe-XVIe siècles, Geneve, 1988.
- BATSOVA - KANCHEV 1974: E. Батцова и М. Кънчев, Новооткрити тракийски погребения в Новозагорско, Археология 15/1, 1974, 50-56.
- BISHOP - COULSTON 2006: M.C. Bishop and J.C.N. Coulston, *Roman Military Equipment from the Punic Wars to the Fall of Rome*, Oxford, 2006.
- BOUBE-PICCOT 1988: C. Boubé-Piccot, Éléments de catapultes en bronze découverts en Maurétanie Tingitane, *Bulletin d'archéologie marocaine XVII*, 1988, 209-30.
- BOUBE-PICCOT 1994: C. Boubé-Piccot, *Les bronzes antiques du Maroc. IV. L'équipement militaire et l'armement*, Paris, 1994.
- BOUE 1871: A. Boue, Aufzählung von Tumuli oder alten Grabhügeln in der europäischen Türkei, *Mitteilungen der anthropologischen Gesellschaft in Wien* 1, 1871, 156-58.
- CAMPBELL 2003: D.B. Campbell, *Greek and Roman Artillery 399 BC - AD 363*, Oxford, 2003.
- CURLE 1911: J. Curle, *A Roman Frontier Post and its People: The Fort of Newstead in the Parish of Melrose*, Glasgow, 1911.
- DAVIES 1935: O. Davies, *Roman Mines in Europe*, Oxford, 1935.
- DETEV 1950: П. Детеv, Старините по рида Св. Илия, *Известия на Народния Музей Бургас* 1, 1950, 67-100.
- DORE - WILKES 1999: J.N. Dore and J.J. Wilkes, Excavations Directed by J.D. Leach and J.J. Wilkes on the Site of a Roman Fortress at Carpow, Perthshire, 1964-79, *Proceedings of the Society of Antiquaries of Scotland* 129, 1999, 481-575.
- GREWE 2009: K. Grewe, Die Reliefdarstellung einer antiken Steinsägemaschine aus Hierapolis in Phrygien und ihre Bedeutung für die Technikgeschichte. In: M. Bachmann (ed.), *Bautechnik im antiken und vorantiken Kleinasien*, *BYZAS* 9, Istanbul, 2009, 429-54.
- GREWE 2010: K. Grewe, La máquina romana de serrar piedras. La representación en bajorrelieve de una sierra de piedras de la antigüedad, en Hierápolis de Frigia y su relevancia para la historia técnica. In: *Las técnicas y las construcciones de la Ingeniería Romana*, V Congreso de las Obras Públicas Romanas, Madrid, 2010, 381-401.
- GREWE - KESSENER 2007: K. Grewe, P. Kessener, A Stone Relief of a Water-Powered Stone Saw at Hierapolis, Phrygia. A First Consideration and Reconstruction Attempt. In: *Énergie hydraulique et machines élévatrices d'eau dans l'Antiquité. Actes du colloque international organisé par l'Établissement public de coopération culturelle Pont du Gard*, Naples, 2007, 227-34.
- GRÜNEWALD 2010: S. Grünwald, *Antikes Echo*, *Regio Südniedersachsen* 3, 2010, 78-87.
- GUDEA - BAATZ 1974: N. Gudea - D. Baatz, Teile spätromischen Ballistenaus Gornea und Orşova (Rumänien), *Saalburg-Jahrbuch* 31, 1974, 50-72.
- HERMANN 1969: F.-R. Herrmann, Der Eisenhortfund aus dem Kastell Künzing, *Saalburg-Jahrbuch* 26, 1969, 129-141.

- HUMPHREY - OLESON - SHERWOOD 1998: J.W. Humphrey - J.P. Oleson - A.N. Sherwood, *Greek and Roman Technology: A Sourcebook. Annotated Translations of Greek and Latin Texts and Documents*, London, 1998.
- IGNATOV - KANCHEVA-RUSEVA - VELKOV 1996: В. Игнатов, Т. Кънчева-Русева и К. Велков, *Проучвания на надгробни могили в Новозагорско, София, 1996.*
- IRIARTE 2000: A. Iriarte, *Pseudo-Herons cheiromballistra, a(nother) reconstruction: I. Theoretics*, *Journal of Roman Military Equipment Studies* 11, 2000, 47-75.
- IRIARTE 2003: A. Iriarte, *The Inswinging Theory*, *Gladius* 23, 2003, 111-40.
- KANCHEV 1973: М. Кънчев, *Културната група Караново IV в Новозагорско*, *Археология* 15/3, 1973, 42-51.
- KANCHEV 1984: М. Кънчев, *Селища и находки от късната бронзова и ранножелязната епоха в Новозагорско*, *Thracia* 6, 1984, 134-59.
- KANITZ 1880: F. Kanitz, *Donau Bulgarien und der Balkan. Historisch-Geographisch-Ethnographische Reisestudien aus den Jahren 1860-1880* 3, Wien, 1880.
- KOICHEV 1952: Н. Койчев, *Нови находки в Новозагорско*, *Известия на Археологическия институт* 18, 1952, 366-68.
- KOICHEV 1955: Н. Койчев, *Материали от гробни находки в Новозагорско*, *Известия на Археологическия институт* 19, 1955, 55-59.
- KOICHEV 1958: Н. Койчев, *Могилни находки от Новозагорския музей*, *Изследвания в чест на акад. Димитър Дечев по случай 80-годишнината му*, София, 1958, 469-74.
- LAUR-BELART 1978: R. Laur-Belart. *Führer durch Augusta Raurica*, Basel, 1978.
- LEWIS - FAULKNER 2004: M.J.T. Lewis - N. Faulkner, *Trajan's Artillery: the Technology of a Roman Technological Revolution*, *Current World Archaeology* 3, 2004, 41-48.
- LEWIS - HART 2010: M.J.T. Lewis - V.G. Hart, *'The Hatra ballista: a secret weapon of the past?'*, *Journal of Engineering Mathematics* 67/3, 2010, 261-73.
- LUCAS 2005: A.R. Lucas, *Industrial Milling in the Ancient and Medieval Worlds. A Survey of the Evidence for an Industrial Revolution in Medieval Europe*, *Technology and Culture* 46, 2005, 1-30.
- MACDONALD - CURLE 1928: G. Macdonald - A.O. Curle, *The Roman Fort at Mumrills, near Falkirk*, *Proceedings of the Society of Antiquaries of Scotland* 63, 1928-29, 396-575.
- MANNING 1985: W.H. Manning, *Catalogue of the Romano-British Iron Tools, Fittings and Weapons in the British Museum*, London, 1985.
- MARSDEN 1969: E.W. Marsden, *Greek and Roman Artillery: Historical Development*, Oxford, 1969.
- MARSDEN 1971: E.W. Marsden, *Greek and Roman Artillery: Technical Treatises*, Oxford, 1971.
- MIKS 2001: C. Miks, *Die Χειροβαλλιστρα des Heron: Überlegungen zu einer Geschützentwicklung der Kaiserzeit*, *Saalburg Jahrbuch* 51, 2001, 153-233.
- MINCHEV 2002: А. Минчев, *Камбестрион - детайл от римска катапулта в Тракия*, в В. Йотов (ред.), *Оръжие и снаряжение през късната античност и средновековието IV-XV в.*, Варна, 2002, 7-14.
- MINCHEV - GEORGIEV 1991: A. Minčev - P. Georgiev, *'Marcianopolis – ein neues Zentrum der Keramikproduktion im 2.–6. Jahrhundert'*, *Rei Cretariae Romanae Fautores acta* 29-30, Abingdon, 1991, 223-44.
- OLESON 1984: J.P. Oleson, *Greek and Roman Mechanical Water-Lifting Devices: The History of a Technology*, Toronto, 1984.
- PIGOTT 1952: S. Piggott, *Three Metal-Work Hoards of the Roman Period from Southern Scotland*, *Proceedings of the Society of Antiquaries of Scotland* 87, 1952-53, 1-50.

- PROU 1877: V. Prou, La Chirobaliste d'Héron d'Alexandrie, Notices et Extraits des manuscrits de la Bibliothèque nationale et autres bibliothèques 26, 1877, 1-319.
- RIHLL 2007: T. Rihll, The Catapult: A History, Yardley, 2007.
- RITTI - GREWE - KESSENER 2007: T. Ritti - K. Grewe - P. Kessener, A Relief of a Water-Powered Stone Saw Mill on a Sarcophagus at Hierapolis and its Implications, Journal of Roman Archaeology 20, 2007, 138-63.
- SCHIØLER 2005: T. Schiøler, How to Saw Marble, International Molinology 70, 2005, 34-35.
- SCHMIDTCHEN 1987: V. Schmidtchen, Büchsen, Bliden und Ballisten. Bernhard Rathgen und das mittelalterliche Geschützwesen. In: B. Rathgen, Das Geschütz im Mittelalter, Berlin, 1928, Reprint, Düsseldorf, 1987, V-XXXIX.
- SCHRAMM 1918: E. Schramm, Die antiken Geschütze der Saalburg, Berlin, 1918.
- SEIGNE 2002a: J. Seigne, Sixth-Century Waterpowered Sawmill, International Molinology 64, 14-16.
- SEIGNE 2002b: J. Seigne, A Sixth Century Water-Powered Sawmill at Jarash, Annual of the Department of Antiquities of Jordan 46: 205-13.
- SHKORPIL - SHKORPIL 1898: К. и X. Шкорпил, Могили, Пловдив, 1898.
- TC: C. Cichorius, Die Reliefs der Traianssäule, Tafelband I, Berlin, 1896.
- TREPTOW 1918: E. Treptow, Der älteste Bergbau und seine Hilfsmittel, Beiträge zur Geschichte der Technik und Industrie 8, 1918, 155-191.
- UCELLI 1950: G. Uccelli, Le navi di Nemi, Roma, 1950.
- VAZHAROVA 1956: Ж.Н. Выжарова, О происхождении болгарских пахотных орудий, Москва, 1956.
- VISY 1993: Z. Visy. Wagen und Wagenteile. In: E. Künzl (ed.), Die Alamannenbeute aus dem Rhein bei Neupotz. Plünderungsgut aus dem römischen Gallien, Mainz, 1993, Band 1: 257-327, Band 2: 67-106.
- VOLPERT 1997: H.-P. Volpert, Eine römische Kurbelmühle aus Aschheim, Lkr. München, Bericht der bayerischen Bodendenkmalpflege 38, 1997, 193-199.
- WESCHER 1867: W: C. Wescher, Poliorcétique des Grecs. Traités Théoretiques. Récits Historiques, Paris, 1867.
- WILKINS 1995: A. Wilkins, Reconstructing the Cheiromballistra, Journal of Roman Military Equipment Studies 6, 1995, 5-59.
- WILKINS 2003: A. Wilkins, Roman Artillery, Princes Risborough, 2003.
- WILKINS - MORGAN 2000: A. Wilkins - L. Morgan, Scorpio and Cheiromballistra, Journal of Roman Military Equipment Studies 11, 2000, 77-101.