MICHAŁ STĄPÓR

# EARLY MEDIEVAL ARROWHEADS WITH TWISTED SOCKETS DISCOVERED IN POLAND – THE CONCEPTS OF PURPOSE

The problem of early medieval arrowheads seems interesting because of a very small number of published works dealing with this issue. The only publication dealing exclusively with arrowheads with twisted sockets found in the Polish territory appeared in 2005.

The authors indicate that arrowheads with twisted sockets appeared in the Polish territory at the end of the 8th century and continued to be used uninterruptedly until the 12th century (Dudak, Kurasiński 2005, pp. 362–364). According to these authors, the spread of arrowheads with twisted sockets can be mainly associated with areas occupied by the Slavs from the west and south, and rarely from the eastern part of Europe. In addition to Poland, they occurred in central and southern Germany, Bohemia, Moravia, Slovakia, Slovenia and Croatia (Dudak, Kurasiński 2005, p. 360). In their work they suggest many questions and issues that relate to arrowheads with twisted sockets. The most important one is the function of these arrowheads. Heretofore there have been many theories, but none has been unequivocally proven. In my work I will try to answer this question, supporting the answer with some experiments. To best explain this problem, I will start with analysing the origins and spread of arrowheads with twisted sockets in Poland once again.

## THE GENESIS AND SPREAD OF ARROWHEADS WITH TWISTED SOCKETS IN POLAND

Distribution of archaeological sites in the Polish territory where arrowheads with twisted sockets were found clearly indicates their southern origin. In this respect particularly distinguished is the southeast region of Poland where there is a high density of theses arrowheads (Fig. 1, Nos. 7, 9, 17–20). The tradition of producing arrowheads with a twisted socket in the area of south-eastern Poland can be dated back to the end of the 8th century and continued at least until the 13th century (May, Zoll-Adamikowa 1992; Tyniec- Krępińska 1996; Zoll-Adamikowa 2000). The culture of the Slavic-Avar population, where arrowheads of this type were known at least since the end of the 8th century, is assumed to be responsible for dissemination of the idea of twisting the arrowhead sockets in this area (Kraskovská 1962, p. 428, fig. 4; Zábojnik 1978, p. 196; Jaworski 2005, p. 57). From this region, they spread northward into Greater Poland, Central Poland and Pomerania. As shown on the map below (Fig. 1) it went along two routes, which are associated with major rivers in Poland: the Wisła River and the Warta River. The emergence of this type of arrowheads in Lower Silesia (Fig. 1, Nos. 8 and 4) in the 9th or 10th century (Jaworski 1995; Busko, Dymek, Piekalski 1994, pp. 436–440) is still unclear, although it may be associated with impacts from Bohemia (Jaworski 2005). Also noteworthy is an almost total absence of arrowheads with twisted sockets east of the Wisła River.

So far twenty-five arrowheads with twisted socked have been found in the territory of Poland. In contrast to the authors of the previous paper on arrowheads with twisted sockets, into this collection I have added two specimens which were found on

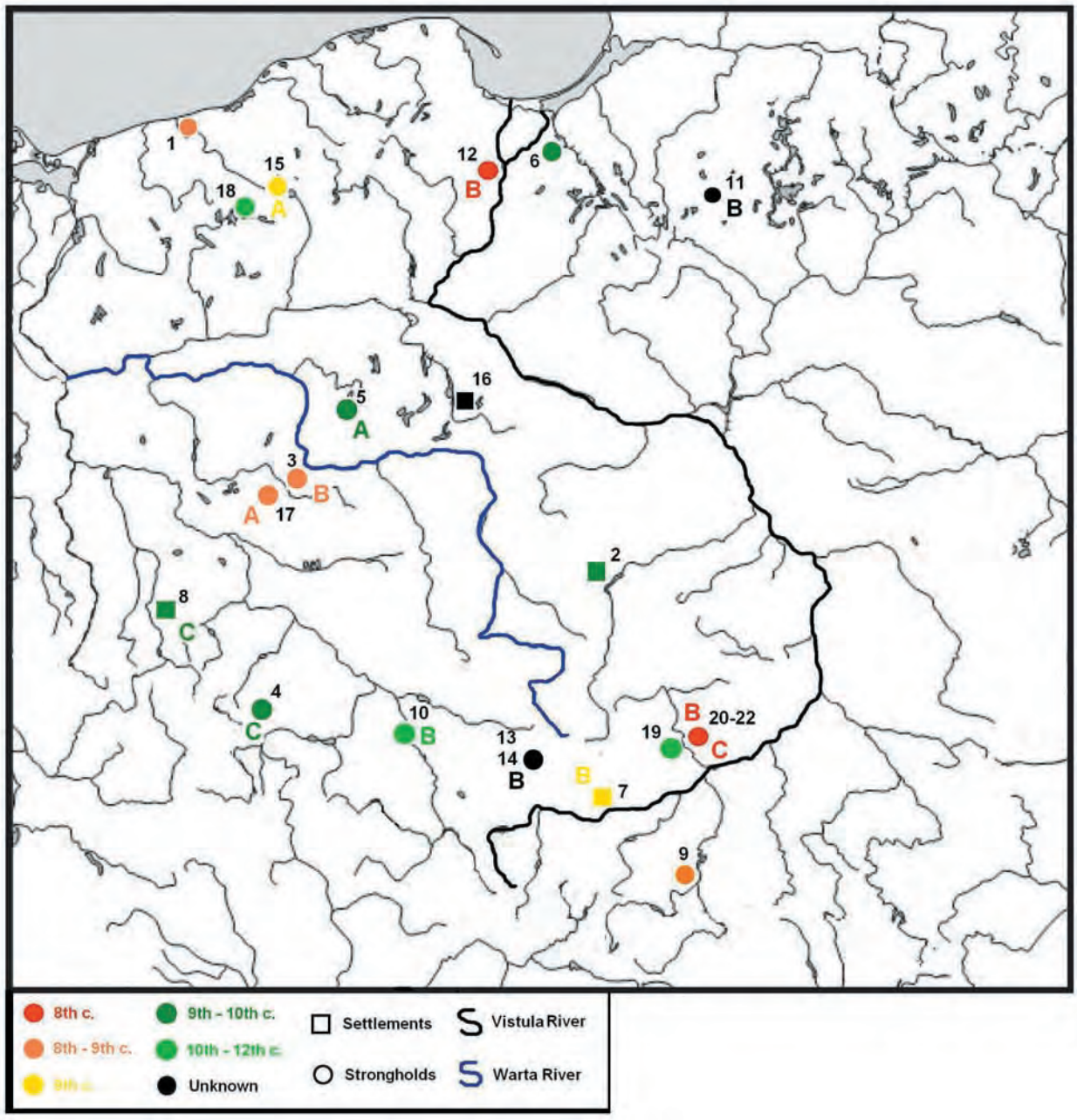


Fig. 1. Distribution and dating of barbed arrowheads with twisted sockets: 1 – Bardy, Zachodniopomorskie Voivodeship; 2 – Barkowice Mokre, Łódzkie Voivodeship; 3 – Bonikowo, Wielkopolskie Voivodeship; 4 – Gilów, Dolnośląskie Voivodeship; 5 – Gniezno, Wielkopolskie Voivodeship; 6 – Janów Pomorski, Warmińsko – Mazurskie Voivodeship; 7 – Kraków Mogiła, Małopolskie Voivodeship; 8 – Łupki, Dolnośląskie Voivodeship; 9 – Naszacowice, Małopolskie Voivodeship; 10 – Opole, Opolskie Voivodeship; 11 – Pasym, Warmińsko–Mazurskie Voivodeship; 12 – Pelplin – Maciejewo, Pomorskie Voivodeship; 13 – 14 – Podzamcze, Śląskie Voivodeship; 15 – Radacz, Zachodniopomorskie Voivodeship; 16 – Radziejów Kujawski, Kujawsko – Pomorskie Voivodeship; 17 – Siemowo, Wielkopolskie Voivodeship; 18 – Stare Drawsko, Zachodniopomorskie Voivodeship; 19 – Stradów, Świętokrzyskie Voivodeship; 20 – 22 – Szczaworyż, Świętokrzyskie Voivodeship

Mount Birów in Podzamcze (Muzolf 1994a, fig. 3: 2; 1994b, fig. 7: 2; 1997, p. 120, fig. 2: 6). In my opinion, they are an important proof of the origin of these arrowheads in the south-eastern region of Poland. In the analysis of this phenomenon I did not take into consideration three finds, whose parameters differ considerably from other specimens. These are three arrowheads found on the Cathedral Island in Wrocław (Kaźmierczyk, Kramarek, Lasota 1979 p. 131, fig. 13; Dudak, Kurasiński 2005, p. 355). Their length is 151 mm and over 139 mm respectively, and they weigh more more than 25 g. The use of these two artefacts as arrowheads required a bow with much more than 100 pounds power. Finds of bows from

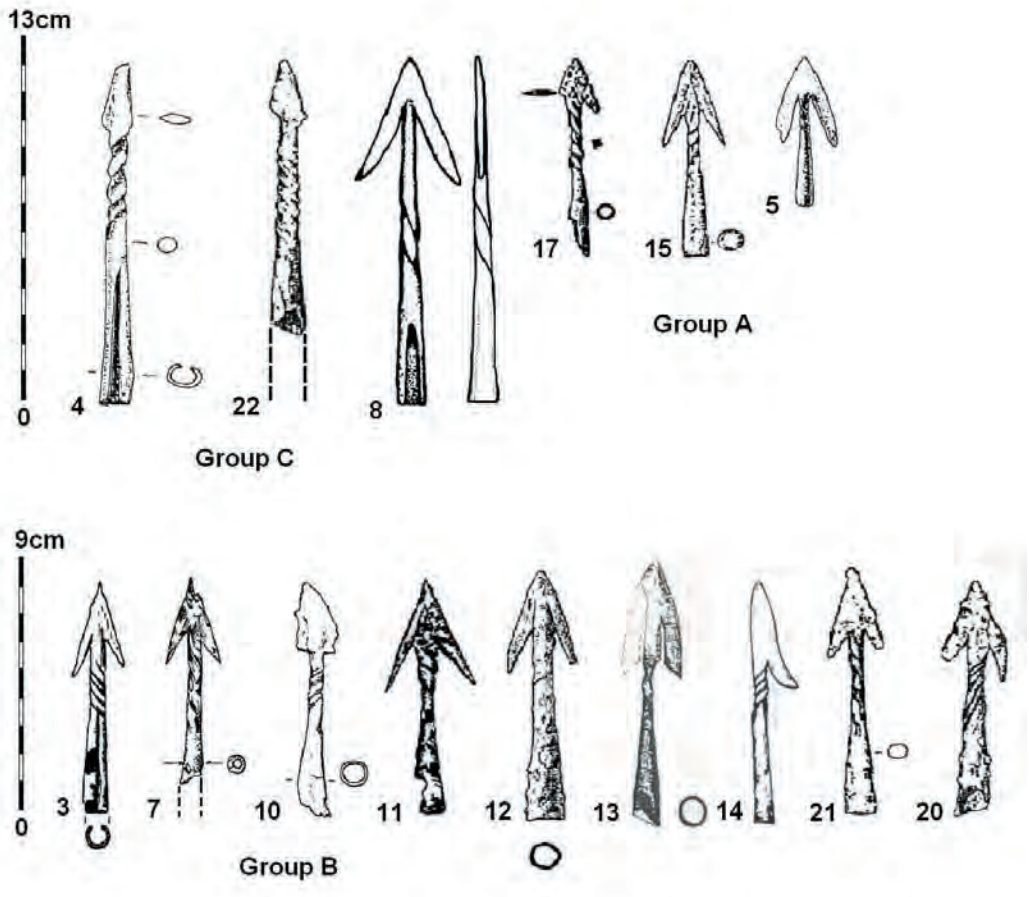


Fig. 2. Classification of barbed arrowheads with twisted sockets in terms of size (after Dudak, Kurasiński 2005, Muzolf 1994a.)

Poland did not confirm the existence of weapons with such a high tension power. However, this specific group of large arrowheads, which appeared in the Lower Silesia region probably in the 10th century, is very interesting and requires an individual study.

All the other twenty-two arrowheads with twisted sockets from the Polish territory were made with iron forging techniques. They have sockets for mounting on the arrow shaft, and the upper part of the socket is usually twisted to the right. Their total length ranges from 51 to 125 mm and the leaf width from 20 to 39 mm (Dudak, Kurasiński 2005, p. 356). The internal diameter of the sockets is averagely 8 mm.

## ANALYSIS OF INDIVIDUAL FINDS

Such a large variation in size and thus the weight of individual items does not seem to be accidental. Also in the works of K. Wachowski (1982; 1984), dealing with the arrowheads collected from Ostrówek in Opole, a similar conclusion can be found. When he measured the arrowheads with the sleeve and barbed ones, he noted that the weight of individual units was closely related to their length (Wachowski 1982, p. 180). Using this analogy, I split seventeen best-preserved specimens into three groups.

Group A includes three items (Fig. 2: 17, 15, 5), whose size is between 51 and 73 mm. These are the lightest arrowheads whose weight should not exceed 6 g (Wachowski 1982, p. 180). The oldest of them (from Siemowo) is dated to between the 8th and the 9th century (Hilczerówna 1967b, p. 150, 158; Hensel, Hilczer-Kurnatowska 1987, p. 82) and the youngest one (from Stare Drawsko) is dated to the turn of the 11th and the 12th century (Janocha 1965, p. 490; 1998, p. 84; Świątkiewicz 2002, fig. VIIA, Item 37).

Into Group B I assigned arrowheads with the length of 74 to 90 mm (Fig.2: 3, 7, 10, 11, 12, 13, 14, 21 and 20), whose presumable weight is between 7 and 9 g (Wachowski 1982, p. 180). The chronology of individual arrowheads is quite broad, ranging from the oldest one from (the 7th–8th century) to the young-

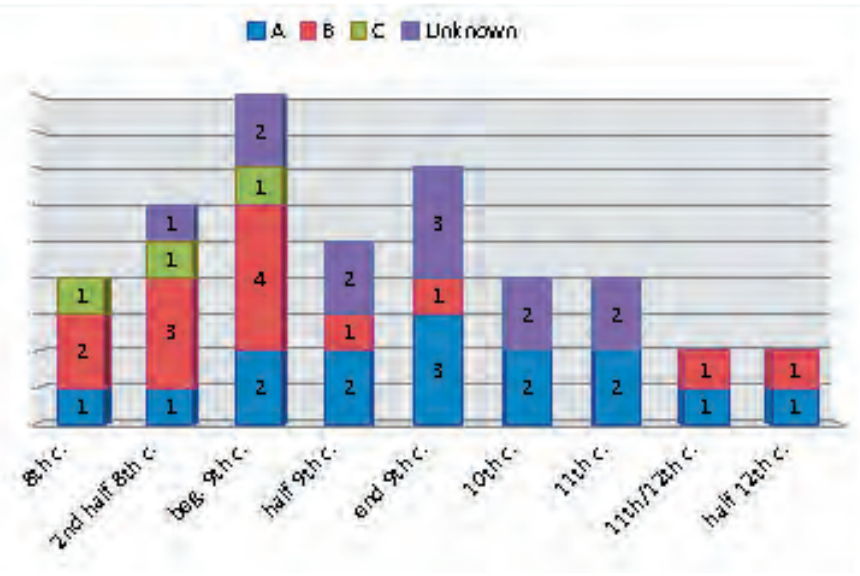


Fig. 3. Attempt to place different types of arrowheads with twisted sockets in time

est one from Ostrówek in Opole (the mid–9th century) (Bukowska- Gedigowa, Gediga 1986, p. 258).

The same issue of dating appears in Group C with three arrowheads found in Gilów, Łupki, and Szczaworyż. The oldest find from Szczaworyż is dated to the 8th or to the beginning of the 9th century (Dąbrowska 1969, p. 286) and the youngest one from Łupki, to the 10th century (Busko, Dymek, Piekalski 1994, pp. 436 – 440). The size of these finds is more than 100 mm and their weight is likely to significantly exceed 20 g (Wachowski 1982, p. 180). In order to effectively launch the arrowheads of this weight a war bow with significant strength was needed (Wachowski 1982). In his work dealing with the arrowheads from Opole K. Wachowski assumed a possibility of using such missiles for a "primal crossbow" (Wachowski, 1982, p. 190). In my opinion the emergence of these most massive arrowheads in Lower Silesia (Fig. 2: 4, 8) should not be related to the process of the spread of barbed arrowheads in the rest of the Polish territory. Unfortunately, at present it is difficult to associate the fact of the appearance of only the largest arrowheads in this area with any adjacent area, even Bohemia or Germany.

In conclusion of this analysis I paid attention to a clear division of the Polish territory into two parts. In the first (Southern) one, i.e., Lower Silesia and Lesser Poland, no arrowheads from Group A (the lightest ones) were found. However, in the Northern part no Group C arrowheads (the heaviest ones) were found.

## ANALYSIS OF VARIOUS TYPES OVER TIME

Unfortunately, arrowheads belong to the group of artefacts whose precise dating poses many problems. In most cases this is related to difficulties in establishing the find context, which is often a reason to classify them as stray finds (Dudak, Kurasiński 2005, p. 356). In this case, the dating of many arrowheads with twisted sockets is within the range of over a hundred years in some instances. Despite these difficulties I tried to place these arrowheads on the timeline.

The periods presented in the table below (Fig. 3) are closely linked to individual finds and represent the most likely time of appearance and duration of various types. The arrowheads from Pasym and Podzamcze as well as the arrowheads from the Lower Silesia region are the exceptions, because the dating of these specimens is too uncertain and troublesome, and could affect the resulting image. Apart from these exceptions, an illustrated diagram shows clearly that in the initial period, which lasts at least since the second half of the 8th or the end of the 8th to the early 9th century, items with intermediate parameters dominate. The greatest number of arrowheads falls to the beginning of this century. A clear change occurs in the mid- and late 9th century, when heavy arrowheads disappear and their place is partially taken by the lightest arrowheads.

This status quo could be caused, for example, by changing military or hunting tactics, which led to a decrease in the number of possible situations in

Fig. 4. The bows and arrowheads used in the experiment

which barbed arrowheads with twisted sockets were used. This is confirmed by data from the 10th and 11th centuries, at the end of which the need to use this weapon almost completely disappeared.

As a consequence, two periods are the most important for the explanation of the problem of appearance and destination of arrowheads with twisted sockets. The first one involves the emergence and spread of these arrowheads in the Polish territory, reaching a peak at the beginning of the 9th century. The second one, in my opinion the most important, is a quite rapid disappearance of the arrowheads with the weight between 8 and 9 g at the end of this century.

If these arrowheads were mainly used in combat, their complete disappearance in the 2nd half of the 12th century may be associated with the appearance of arrowheads which served mainly to pierce armour in that period. Such a process can be observed at Opole (Wachowski 1982 p. 169, fig. 1).

## FINDS OF MEDIEVAL BOWS IN POLAND

Analysing the amount of information appearing in publications describing the early medieval Slavic military, it seems that the bow was very often used as a weapon. However, in order to be effectively used in war, the bow must have some basic characteristics. The first of these and also the most crucial one is the draw weight. It is the weight that we must overcome with the force of our muscles to draw the string to launch an arrow at a great distance. This weight is measured in kilograms. For bows generally regarded as battle bows it is 70 pounds or 35 kg. It is another apparent feature, because in order to achieve such a strength the bow cannot be less than 158 cm in length, otherwise it will break (Jones, Renn, 1982, p. 446).

So far five examples of bows were found in the Polish territory during the excavations. The first two of them are children's bows, as indicated by their length being about 70 cm and a section which suggests a small draw weight (Werner 1974). The next two with a length of 120 cm found in Brzeg (Opolskie Voivodeship) have been classified as hunting bows. The last find obtained during excavations in Opole was lost during the Second World War. It was classified as a battle bow (Wachowski 1982, s. 187).

When analysing the largest series of early medieval arrowheads from Ostrówek in Opole, the arrowheads of a weight not exceeding 10 g were

described as missiles used mostly for hunting bows (Wachowski 1982, pp. 186–187). Studying early medieval arrowheads with twisted sockets, we can say that most likely the vast majority of them did not exceed that limit. Therefore the question about the function of bows in Slavic societies arises. Was it merely the only hunting weapon or did it have a real value in combat?

## THE BOW AND THE SLAVIC TACTICS OF WAR

Much information about the Slavic habits and tactics is provided by Byzantine texts. The oldest one dates from the first quarter of the 6th century, and describes Slavs and Antes, who arrived in the Lower Danube region shortly before that date: "*To fight, most of them move against the enemies on foot, holding in their hands small shields and spears. They never wear armour…*" (Grotowski 2005, p. 10). These scantily equipped warriors could not be of a high-value in combat, especially in the open terrain. However, as it later turned out, they were able to catch up all shortcomings in the equipment with the war stratagems and subterfuge, for example, capturing Toperos over Mestos west of Ksanti in Thrace in the 6th century (Grotowski 2005, p. 10). The Byzantine Emperor Maurice (582–602) was the author who best described Slavic tactics in the 6th century. According to him, the Slavs were able make use of the shape of the terrain in fighting; they were excellent swimmers and they hid very well in the field (Grotowski 2005, p.11). Their settlements were in hardly accessible places, often in the marshland, and had a few escape routes (Grotowski 2005, p.11). During the fight against the Slavs, Maurice recommended to use such troops as javelin throwers, archers, and cavalry (Grotowski 2005, p.11). These are units capable of fighting and gaining an advantage at a distance. The cavalry charged, flanked and hunted down the fleeing Slavs before they reached the area which was more difficult to access for the Byzantine troops. Not without significance is the fact that the Romans sent light troops against the Slavs. The only information about the use of bows by the Slavs is also associated with the "guerrilla" tactics. In the 6th c. Emperor Maurice writes: "*The Slavs use the bows with short poisoned arrows. If the injured did not drink the antidote before... should immediately cut the wound around, preventing the spread of the poison…*" (Grotowski 2005, p.11). J. Tyszkiewicz, who in his works deals with the issue of preparation and use of poisons by the Slavs, believes that these were obtained as a plant decoction, and weapons poisoned with them were very dangerous (Tyszkiewicz 1970, p. 166).

In the text quoted above the phrase "*short arrows"* is also interesting. Probably it could indicate the technique and the stance of the archer during shooting.

Such an example might be seen in the Bayeux Tapestry (Odar 2006, p. 261, fig. 16) where we can see archers holding bows bent at the elbow and pulling the string to the chest, and not as it is now in the "*English style*," pulling the string to the chin. In this case, the arrow could be shorter. Perhaps this problem requires more attention.

The oldest written mention on the methods of fighting of the Slavs living in Poland in the early Middle Ages comes from the 11th century chronicle of the German Bishop Thietmar. He described the Polish archers who ambushed the German army as "*sagittis ... maxime defendentur*" (Nadolski, 1954, p. 98). However, it is not known whether this information concerns specially trained archers or just warriors who used bows in a particular situation, which is definitely the ambush.

Tactics used by Slavic warriors which dominated the entire early Middle Ages can be described as "guerrilla." Quick unarmoured troops drew the enemy into difficult terrain in which it was impossible to arrange any formation. And the body protection such as armour only restrains and slows down movements. The use of bows in such situations was also limited. Probably the most suitable were the hunting bows. Although short, their strength could be enough to pierce armour at close range. Shortening the distance could also be easier to hit in the exposed part of the body.

## THE CONCEPTS OF PURPOSE OF EARLY MEDIEVAL BARBED ARROWHEADS WITH TWISTED SOCKETS

It is well known that barbed arrows were used to cut the skin and veins of victims. They were so universal because they could be used both in the hunt for big game and during the war in the fight against cavalry or unarmoured opponent or as incendiary arrows. The question is why the Slavs twisted the

sockets of some barbed arrowheads? What additional functionality, apart from causing strong bleeding of the opponent, did these arrowheads have in their arsenal?

Authors of papers on the arrowheads with twisted sockets assign to them a number of functions, *inter alia*: decorative function (Hilczerówna 1967, p. 158); twisting prevented the socket from penetrating too deeply (Ruttkay 1976, p. 328); application during the siege as heavier projectiles with a steep flight trajectory, that made it easier to shoot inside the fortifications (Lutovský, Michálek 2001, p. 136).

The last two theories seem to be the most relevant. The first one says that these arrowheads were used to carry incendiary materials (Sikorski 1997, p. 243; 2000, p. 136), or they served as a poison-coated missiles (Tyszkiewicz 1961, pp. 14–15). The first one seems less likely because of the weight of the largest and heaviest arrowheads which could reach even 30 g. After wrapping in material soaked with incendiary liquid the weight of the arrowhead will probably increase to a level that prevents it from being launched at a long distance. We also need to take into account that the Slavic bows were probably short and too weak to launch arrows weighing more than 10 g at long distances.

However, the theory of covering arrowheads with twisted sockets with poison in my opinion is quite likely. The poison contained in cavities of this arrowhead does not slide off and would not be stopped on the skin or fur of the victims but it will get into the body with the whole point. J. Tyszkiewicz believes that arrowheads with twisted sockets served precisely this purpose (Tyszkiewicz 1961; 1970; Tyszkiewicz, Wida – Tyszkiewicz 1996).

## THE EXPERIMENT – GOALS AND METHODS

The first experiment will seek to verify the mass of arrowheads for fighting and hunting. The result will have a decisive role in determining what types of bows were used by the Slavs. Is it significant whether the development of bows in the Polish territory can be dated only to the first half of the 12$^{th}$ century or perhaps earlier? I will also check whether the proposed division into groups is correct.

The test will consist of shooting at a distance from the traditional bow with the draw weight of 50 pounds and the modern hunting bow with the draw weight of 41 pounds. Thanks to its advanced construction, arrows launched from it can reach speeds similar to that achieved in traditional battle bows.

For this purpose, twelve arrow shafts have been made of beech wood and their fletching from goose feathers. Instead of real arrowheads, I will use the steel rings whose weight corresponds to the weight of medieval arrowheads and are in range of 5 to 15 g. Also, I will use the ring whose weight is 23 g, as in the case of the heaviest arrowheads.

For every of twelve arrows, I will make ten attempts. Then, the average distance will be presented in a graphic form, which I hope will review the theory of impact of the weight of arrowhead on its use.

Another test will focus on the reason of twisting the sockets, where attention will be paid to the ability of carrying poison by these arrowheads, as the most

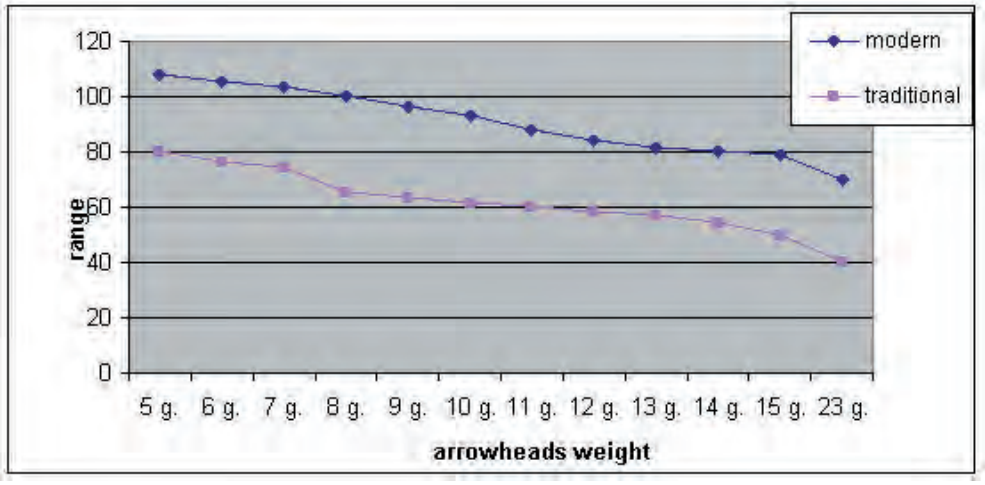


Fig. 5. Review of the possibility of using arrowheads with different weight

probable function. Therefore I forged two barbed arrowheads, one of them with a socket twisted to the right.

To give the best conditions for the behaviour of the arrowheads in the living body I used a block of 10% gelatine at about 4˚C as a target. This best describes the ballistic properties of a living body. The role of poison will be played by a special "marker," a solution used in medicine. The quantity of submerged arrowheads in the gelatine with be displayed on X-ray photos. A wool blanket on the gelatine block which aims at stopping the excess of poison will be an obstacle for arrowheads. The amount of poison that gets into the target should be visible on X – ray photos.

## RESULTS AND CONCLUSIONS

The diagram (Fig. 5) shows a greater decrease in efficiency of a traditional 50 lbs bow for the arrowheads with the weight of 8 g. However, a modern bow can be effectively used with arrowheads of all weights.

The results confirm the previously adopted classification of the arrowheads. If among the largest number of barbed arrowheads with twisted sockets there were items with the weight between 7 and 9 g, it can be certainly said that the Slavs had bows which were more powerful than 50 lbs already at the end of the 8$^{th}$ century. Probably they knew even then the strongest battle bows.

The diagram also shows that the arrowheads with twisted sockets, known from the Polish territory, were mostly used for military purposes.

On the X-ray photo it can be clearly seen that most of the poison that got into the gelatine was from the arrowhead with the twisted socket (Fig. 6). A lot of poison found its way into gelatine in the cavities of the socket. Unfortunately, we cannot see this on the picture. This confirms that the arrowheads were twisted to be effectively used as poisoned arrows. A considerable amount of poison which remains in cavities of the socket will not be washed away by the flowing blood.

The disappearance of arrowheads with twisted sockets in the 13$^{th}$ century probably has two causes. The first is the spread of armour, which they could not penetrate. This is further shown in Opole where from the first half of the 12$^{th}$ century there is a large number of arrowheads designed primarily for piercing armour (Wachowski 1982 p. 169, fig 1). Another reason is the spread of Christianity in the Polish territory at this time, which destroyed all forms of paganism, including production of poisons as an expression of paganism. Perhaps the people who were involved in the production of poisons have

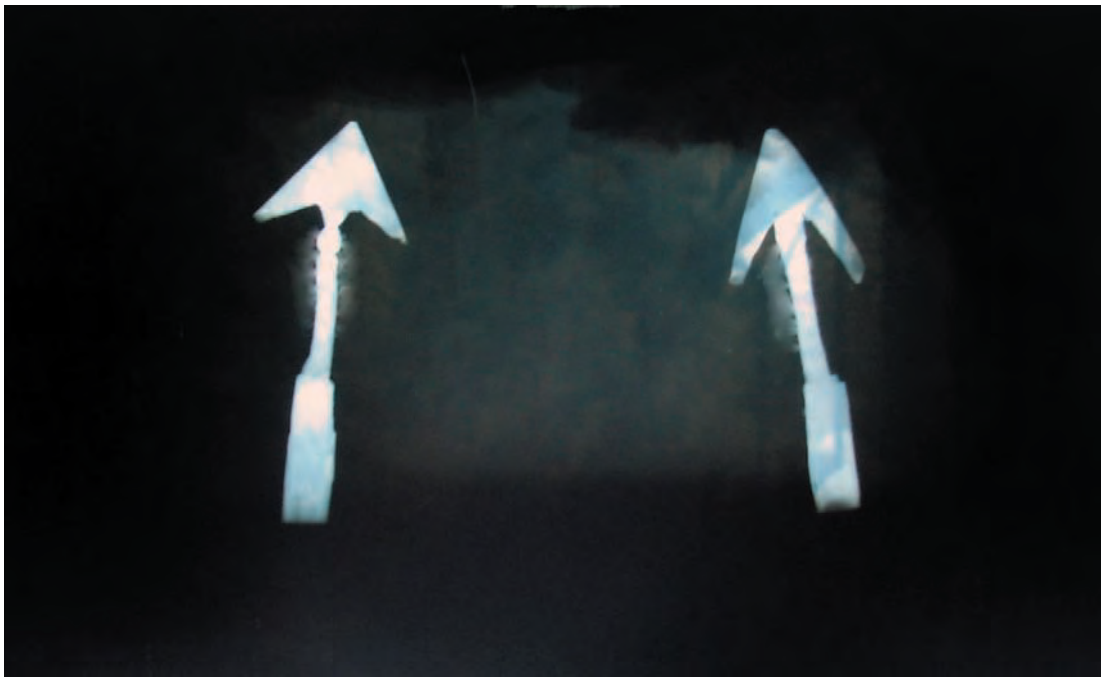

Fig. 6. X – ray photo of arrowheads in gelatine

Tab. 1. Chronology of the arrow heads

| | 7th c. | mid 8th c. | 8th c. | 8th c. 2nd h | beg. 9th c. | 9th c. | end 9th c. | 10th c. | 11th c. | mid 12th c. | 12th c. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pelpin Maciejewo | B | B | B | | | | | | | | |
| Pasym | | | | | | | | | | | |
| Szczaworyż | | | B | B | B | | | | | | |
| Szczaworyż | | | B | B | B | | | | | | |
| Szczaworyż | | | C | C | C | | | | | | |
| Bonikowo | | | | B | B | | | | | | |
| Naszacowice | | | | | | | | | | | |
| Szczaworyż | | | | | | | | | | | |
| Bardy | | | | | | | | | | | |
| Siemowo | | | A | A | A | A | | | | | |
| Radacz | | | | | A | A | | | | | |
| Kraków - Mogiła | | | | | B | B | | | | | |
| Barkowice Mokre | | | | | | | | | | | |
| Gilów | | | | | C | C | C | C | | | |
| Janów Pomorski | | | | | | | | | | | |
| Łupki | | | | | | | | C | | | |
| Stradów | | | | | | | | | | | |
| Gniezno | | | | | | | | | | | |
| Opole | | | | | | | A | A | A | B | B |
| Stare Drawsko | | | | | | | | | A | A | A |
| | | 8th c. | 2nd half 8th c. | beg. 9th c. | half 9th c. | end 9th c. | 10th c. | 11th c. | 11th/12th c. | half 12th c. | |
| | A | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | |
| | B | 2 | 3 | 4 | 1 | 1 | | | 1 | 1 | |
| | C | 1 | 1 | 1 | | | | | | | |
| | Unknown | | 1 | 2 | 2 | 3 | 2 | 2 | | | |

other functions associated with Old Slavic beliefs. In the culture of Christian Europe, where Poland also belonged, people were very scared of "*sudden death*," which also included death by poisoning. They could not fulfil their most important duty, which was the ante-mortem confession and conciliation with God (Mróz 2009, pp. 197 – 198). Only in this way they could find themselves in Paradise.

## BIBLIOGRAPHY


Bukowska-Gedigowa J., Gediga B.
1986 *Wczesnośredniowieczny gród na Ostrówku w Opolu*, Wrocław–Warszawa.

Buśko C., Dymek K., Piekalski J.
1994 *Zamek we Wleniu, woj. jeleniogórskie, w świetle ostatnich badań*, Śląskie Sprawozdania Archeologiczne, Vol. 35, pp. 427–441.

Dąbrowska E.
1969 *Sprawozdanie z badań wykopaliskowych na wczesnośredniowiecznym grodzisku w Szczaworyżu, pow. Busko w latach 1965–1966 (rejon: gród właściwy),* Sprawozdania Archeologiczne, Vol. 20, pp. 277–286.

Dudak W., Kurasiński T.
2005 *Wczesnośredniowieczne tordowane groty strzał znalezione na terenie Polski. Rekonesans badawczy*, Archaeologia Historica Polona, Vol. 15/1, pp. 355–371.

Grotowski P. Ł.
2005 *Sztuka wojenna Słowian w świetle bizantyjskich traktatów wojskowych,* Acta Militaria Mediaevalia, Vol. I, pp. 9 – 25.

Hensel W., Hilczer-Kurnatowska Z.
1987 *Studia i materiały do osadnictwa Wielkopolski wczesnohistorycznej*, Vol. 7, Wrocław.

Hilczerówna Z.
1967 *Wyniki badań archeologicznych na wczesnośredniowiecznym grodzisku w Siemowie pow. Gostyń*, Slavia Antiqua , Vol. 14, pp. 131–175.

Janocha H.
1965 *Badania archeologiczno–architektoniczne na grodzisku wczesnośredniowiecznym i zamku średniowiecznym w Starym Drawsku, pow. Szczecinek (stanowisko 1) w latach 1964–1965*, Materiały Zachodniopomorskie, Vol. 11, pp. 461–501.
1998 *Gród i zamek w Starym Drawsku gmina Czaplinek – walory obronne i uzbrojenie załogi w oparciu o wyniki badań archeologicznych*, Koszalińskie Zeszyty Muzealne, Vol. 22, pp. 69–132.

Jaworski K.
1995 *Grodzisko z IX – X wieku w Gilowie koło Niemczy. Badania w 1993 roku,* Śląskie Sprawozdania Archeologiczne, Vol. 36, pp. 171 – 177.
2005 *Grody w Sudetach (VIII – X w.)*, Wrocław.

Jonem P. N., Renn D.
1982 *The military effectiveness of Arrow Loops . Some experiments at White Castle,* (in:) *Chateau Gaillard*, Etudes de Castellologie Medievale, Vol. IX-X, pp. 444–456.

Kaźmierczyk J., Kramarek J., Lasota C.
1979 *Badania na Ostrowie Tumskim we Wrocławiu w 1977 roku*, Silesia Antiqua , Vol. 21, pp. 119–18

Kraskovská L.
1962 *Pohrebisko v Bernolákove*, Slovenská archeológia , Vol. 10, No. 2, pp. 425–476.

Lutovský M., Michálek J.
2001 *Archeologie násilného zamku: pád Hradce u Němětic,* (in:) Z. Měřínský (ed.), Achaeologia medievalis Moravica et Silesiana, 1, Konference Prohansko 1999, Brno, pp. 133–142.

Maj U., Zoll–Adamikowa H.
1992 *W kwestii chronologii wczesnośredniowiecznego grodziska w Stradowie*, Sprawozdania Archeologiczne, Vol. 44, pp. 271–296.

Mróz P.
2009 *Zła śmierć w polskim społeczeństwie średniowiecznym*, Forum Medycyny Rodzinnej , Vol. 3, No. 3, pp. 186–198.

Muzolf B.
1994a *Badania na wielokulturowym stanowisku na Górze Birów w Podzamczu, województwo katowickie, w 1991 roku,* (in:) E. Tomczak (ed.), Badania archeologiczne na Górnym Śląsku i w Zagłębiu Dąbrowskim w latach 1991–1992, Katowice , pp. 86–91.
1994b *Wielokulturowy zespół archeologiczny na górze Birów w Podzamczu, gm. Ogrodzieniec, woj. katowickie*, Łódzkie Sprawozdania Archeologiczne, Vol. 1, pp. 131–147.
1997 *Badania wielokulturowego stanowiska na górze Birów w Podzamczu, województwo katowickie,* (in:) E. Tomczak (ed.), Badania archeologiczne na Górnym Śląsku i ziemiach pogranicznych w 1994 roku, Katowice, pp. 119–131.

Nadolski A.
1954 *Studia nad uzbrojeniem polskim w X, XI i XII wieku*, Łódź.

Odar B.
2006 *The archer from Carnium*, Archeološki vestnik, Vol. 57, pp. 243–275.

Rutkay A.
1976 *Waffen und Reiterausrüstung des 9. bis zur ersten Hälfte des 14. Jahrhunderts in der Slowakei (II)*, Slovenska archeologia, Vol. 24, No. 2, pp. 254–395.

Sikorski C.
1997 *Wood Pitch as Chemical in the light of Jan Długosz Annales and Some of the Old Polish Military Treatises,* (in:) W. Brzesiński, W. Piotrowski (eds.), Proceedings of the First International Symposium on Wood tar and Pitch, Warszawa, pp. 235–247.
2000 *Smoła drzewna jako bojowy środek chemiczny w świetle „Roczników" Jana Długosza i niektórych staropolskich traktatów wojskowych*, Rocznik Kasprowiczowski, Vol. 9, pp. 115–123.

Świątkiewicz P.
2002 *Uzbrojenie wczesnośredniowieczne z Pomorza Zachodniego*, Acta Archaeologica Lodziensia, Vol. 48, Łódź.

Tyniec-Krępińska A.
1996 *Nowe spojrzenie na fortyfikację grodu właściwego w Stradowie, woj. Kielce*, Sprawozdania Archeologiczne, Vol. 48, pp. 33–47.

Tyszkiewicz J.
1961 *Jady bojowe Słowian Zachodnich we wczesnym średniowieczu*, Kwartalnik Historii Kultury Materialnej, Vol. 9, No. 1, pp. 3–22.
1970 *O łuku i zatruwaniu strzał*, Z Otchłani Wieków, Vol. 36, No. 2, pp. 160–167.
Tyszkiewicz J., Widy – Tyszkiewicz E.
1996 *Euro-azjatyckie trucizny roślinne stosowane w walce,* (in:) Z. Kwiecień *et al.* (eds.), Pochwała historii powszechnej, Warszawa, pp. 77–88.
Wachowski K.
1982 *Średniowieczna broń miotająca na Śląsku w świetle znalezisk z Ostrówka w Opolu*, Archeologia Polski , Vol. 27, No. 1, pp. 167–202.
1984 *Militaria z grodu na Ostrówku w Opolu,* (in:) B. Gediga (ed.), Studia nad kulturą wczesnopolskiego Opola. Militaria – Wyroby bursztynowe, Wrocław, pp. 11–112.
Werner J.
1974 *Polska broń. Łuk i kusza*, Wrocław.
Zábojnik J.
1978 *K výsytu predmetow západněho povodu na pohrebiskách z obdobia awarskiej riše v Dunajskiej kotlinie*, Slovenská archeológia , Vol. 56, No. 2, pp. 205–391.
Zoll-Adamikowa H.
2000 *Problem datowania grodziska w Smardzowie w świetle najnowszych badań,* (in:) A. Buko, Z. Świechowski (eds.), Osadnictwo i architektura w dobie Zjazdu Gnieźnieńskiego, Warszawa, pp. 245–248.

Michał Stąpór, MA
Wroclaw University of Technology
Institute of History of Architecture, Art and Technology
53/55 Bolesława Prusa St.
50-317 Wrocław, Poland
arch.michal.stapor@wp.pl