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SWORD CHAPE FOUND AT SANTOK: TECHNOLOGICAL, TECHNICAL, FORMAL AND TYPOLOGICAL ASPECTS

ABSTRACT

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This paper presents the results of studies and technological analyses of a fragment of the fittings from the lower part of a sword scabbard discovered in 2016 at the stronghold in Santok, Wielkopolska, Poland. The chape represents the type in widespread use across the Baltic lands in the second half of the tenth century and the early eleventh century AD, yet its embellishments are the subject of debate. According to some researchers, the scene shows Odin with his attributes or birds. Others believe that it depicts the sacrifice of Odin, similar to that of the crucified Christ, or the fight between the hero and the monsters. The chape was made of copper alloy, but its chemical composition is unusual, with very high levels of lead. This indicates the conscious and purposeful use of alloys with specific properties. Until now, only about 1% of such artefacts have been subjected to technological analyses, and further research is necessary to confirm standardization regularities in their production process.

Keywords: Santok, Middle Ages, scabbard chapes, ancient metallurgy, metalographic analysis
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In July 2016, the Centre for Prehistoric and Medieval Studies at the Institute of Archaeology and Ethnology, Polish Academy of Sciences (henceforth IAE PAN), Poznań, conducted a surface survey at the stronghold in Santok (site 1). This survey, which included the use of a metal detector, produced a fragment of a so-called chape – the fittings of the lower part of a sword scabbard (inv. no. 127/16 – Fig. 1). The chape, of which only the lower part was preserved, was deposited in humus in the area of the so-called southern suburbium. The 3.66 g fragment is 25.24 mm high and 23.4 mm wide, and the thickness of its walls ranges from 0.9 to 1.3 mm.

Located at a very distinctive place, the Santok site sits at the nexus of three geographical regions – Pomerania, Central Polabia and Wielkopolska (Great Poland) – and at the confluence of the Warta and Noteć rivers. The site is believed to have been first settled in the second half of the eighth century. Initially an open settlement, it was later fortified, and in the second half of the tenth century, expanded to form a multi-part stronghold (Zamelska-Monczak 2017). For about 300 years, Santok was among the central locales in the territorial structures of the Piast state.

TECHNICAL AND TECHNOLOGICAL ASPECTS

Recent years have seen a major increase in the number of archaeological studies making use of the results of physicochemical analyses, as well as papers publishing pure results of such analyses. While this clearly illustrates progress in archaeology, it may also lead to interpretative simplifications resulting from the limitations of the chemical methods themselves or poorly formulated research questions. The analyses of the Santok

Fig. 1. Sword chape from Santok. Photo by A. Janowski

chape conducted at the Bio- and Archaeometry Laboratory at IAE PAN, Warsaw, provide a perfect example to illustrate some of the analytical and methodological problems of archaeometry.

The analyses (no. CL 19558) revealed that the artefact was cast from an alloy of copper (Cu – 74.62%), lead (Pb – 17.87%) and zinc (Zn – 5.85%). The content of other alloying elements did not exceed a total of 2% (Sn – 0.87%, Fe – 0.40%, Al – 0.20%, As – 0.18%, Ni – 0.01%). Analysed as one in a series of a dozen or so artefacts, the chape initially did not arouse much interest, although its chemical composition, i.e. a high amount of lead (about 18%) in the alloy, did not line up with other results. Why should an increased lead content raise doubts and questions about the nature of the artefact? Lead is an alloying additive that improves metal properties. At a level of about 2%, the lead content in the alloy significantly lowers the melting point and increases castability, thus allowing the production of better copies of the mould pattern. It should be nevertheless noted that further increase in the lead content does not improve any metal properties. On the other hand, lead shows an almost complete lack of solubility in copper. Coupled with a low melting point (327°C) relative to the melting point of copper (1083°C), lead is moved to the grain boundaries and into the interdendritic space during the crystallization of the solution. When it solidifies, lead fills the pores, creating zones of increased brittleness, which makes hot copper brittle above the melting point, thus hindering heat treatment. The lead phase shows a tendency for gravity segregation, especially in slow-cooling casts. In the technical sense, the final alloy is a mixture of solid solutions of copper and lead. If additional components, for example tin or zinc, are present in the original metal composition, an alloy is formed after solidification: a multi-component mixture consisting of tin solids in copper and tin solids in lead for the Cu-Sn-Pb alloy. Depending on the tin content and the associated large temperature range of its crystallization, tin can form two phases in copper – a solid α solution and a more brittle eutectoid ($\alpha+\delta$), the secretions of which also accumulate in inter-crystalline spaces. Each of the alloy additives specifically affects the final metal, strengthening or lowering the mechanical properties and affecting the final chemical composition. Some of the most important interactions for early medieval metallurgy include the presence of tin and lead reducing the level of zinc absorption (Craddock 1978, 12), nickel affecting the fragmentation of lead precipitation (Wesołowski 1957, 96) and arsenic increasing the cold and hot brittleness (Hensel 1996, 151).

When the chemical composition of the alloy has been identified, there are a number of questions that can possibly be answered. First, the character of metal – whether it is a single-phase alloy in which the individual elements have been dissolved in the base metal, or an alloy with a two- or more- phase structure. Such mixtures usually have better technological properties: a lower melting point, solidification and overheating (a temperature above the melting point, necessary to pour into the prepared form), as well as a lower production cost.

Secondly, identifying types of alloys helps us to recognise products with similar composition or purpose. Considering the high heterogeneity of alloys produced in the past, the

Table 1. Results of the analysis of the sword chape found at Santok (by P. Gan)

Analysis	Area	Cu	Al	Si	Ti	Cr	Mn	Fe	Ni	Zn	As	Ag	Sn	Sb	Pb	Au	S	Comments
SEM	2	74.62	0.20	0.00	0.00	0.00	0.00	0.40	0.01	5.85	0.18	0.00	0.87	0.00	17.87	0.00	0.00	x200 magnification, measurement from the inside of the artefact, cleaned surface, 20keV
SEM	3 A	69.78	0.04	0.00	0.00	0.00	0.00	0.14	0.06	7.75	0.13	0.00	0.51	0.00	20.85	0.72	0.00	x200 magnification, measurement from the inside of the artefact, cleaned surface, 20keV
SEM	3 B	29.13	0.07	1.12	0.06	0.00	0.00	0.53	0.00	1.34	0.00	0.00	1.91	0.00	56.29	1.60	0.00	x200 magnification, measurement from the inside of the artefact, slightly cleaned surface, 20keV
XRF	3_1	81.96						0.08		8.04	0.25	0.02	0.91	0.17	8.06		0.51	cleaned surface, beam width 200µm, 50keV
XRF	3_2	82.38						0.10		8.19	0.28	0.03	0.83	0.24	7.57		0.37	cleaned surface, beam width 200µm, 50keV
XRF	3_3	78.92						0.16		7.92	0.27	0.03	0.63	0.16	11.30		0.60	cleaned surface, beam width 200µm, 50keV
XRF	3_4	80.98						0.22		8.06	0.29	0.02	0.84	0.22	9.34		0.22	cleaned surface, beam width 200µm, 50keV
XRF	3_5	83.72						0.10		7.38	0.31	0.03	0.75	0.22	6.95		0.67	cleaned surface, beam width 200µm, 50keV

uncritical use of modern technical terminology for this purpose is highly inadvisable, because currently composed alloys are characterised by extreme high mechanical properties, high durability and resistance to atmospheric and chemical corrosion, and steelworkers move within the limits of specific standards, controlling manufactured metal. Commonly used at present are two-phase copper-zinc alloys, or brass, containing amounts of zinc unattainable for historical brass (39%). Brass is a copper alloy with metallic zinc. This technology was invented in Europe as late as the eighteenth century. In the Middle Ages, alloys with brass properties were obtained by combining copper with calamine or zinc ore, and this alloy was known as *aurichalcum* (c.f. Tomaszewska-Szewczyk 2016). Furthermore, the chemical composition of modern copper-tin alloys, or bronze, depends on the purpose: bronzes for plastic forming should contain between 6 and 8% tin, and bronze for casting may have more components (Sn – 2-11%, Pb – 2-26%, Ni – 0.5-1.5%, P – 0.8-1.2%); in addition, special alloys are obtained by adding silicon, nickel, manganese, beryllium, lead or aluminium. However, analyses of archaeological materials do not suggest that similar strict divisions or control of the raw material took place in the past. By observing the physical phenomena occurring during the metallurgical process (e.g., the degree of evaporation, the colour of metal, the degree of its liquidity and viscosity), or by carefully sorting and checking the mechanical properties of the batch of metal prepared for melting, an efficient metallurgist was able to identify materials having better plasticity. Nevertheless, many artefacts were produced and then processed from raw materials that were simply at a manufacturer's disposal at a given time. Several objects treated as multi-component alloys were used both in casting techniques and in plastic processing, requiring more work and inter-operative processes. The main argument against employing historical names of alloys, such as those given for example by Pliny, is their ambiguity: the same metal name denoted a whole range of chemical compositions; the same type of alloy could have had a variety of names depending on the place of production or purpose; in addition, the names of alloys changed over time. Archaeometallurgy has yet to create a single naming system. Based on the content of zinc, tin and lead, the model proposed by British researchers seems to be the most universal (Fig. 2); it allows the maintenance of a uniform nomenclature. Yet, in order to determine detailed boundaries/ranges, at present typically established by each researcher individually based on the analysed material, further research is needed (Dungworth 1997, 906; Ponting 1999, 1312; Bourgarit and Thomas 2012, 3054).

Returning to the Santok chape, after unnaturally high values of lead had been identified, several additional tests were performed. The results of the analyses are summarised in Table 1, including analyses made at various magnifications, and analyses performed on a cleaned and an uncleaned surface to illustrate the wide dispersion of alloy additives. In order for the data to be completely understood, we need to look at the applied research method. Commonly used on archaeological artefacts, the X-ray fluorescence method (XRF – see Miazga 2017, 59-62) allows for the almost non-invasive and quick determination of a number of elements with relatively high accuracy. The characteristic X-ray spectrum is

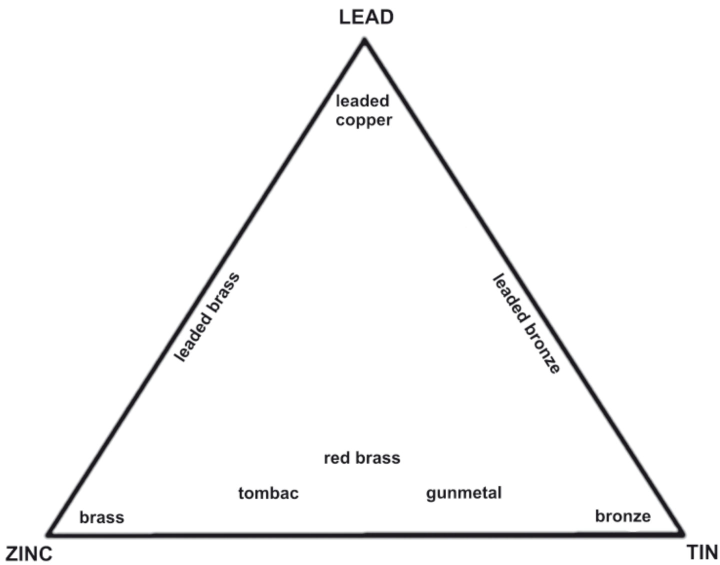


Fig. 2. Alloy nomenclature and relations between alloys.
Elaborated by P. Gan, according to Bayley 1991, fig. 6

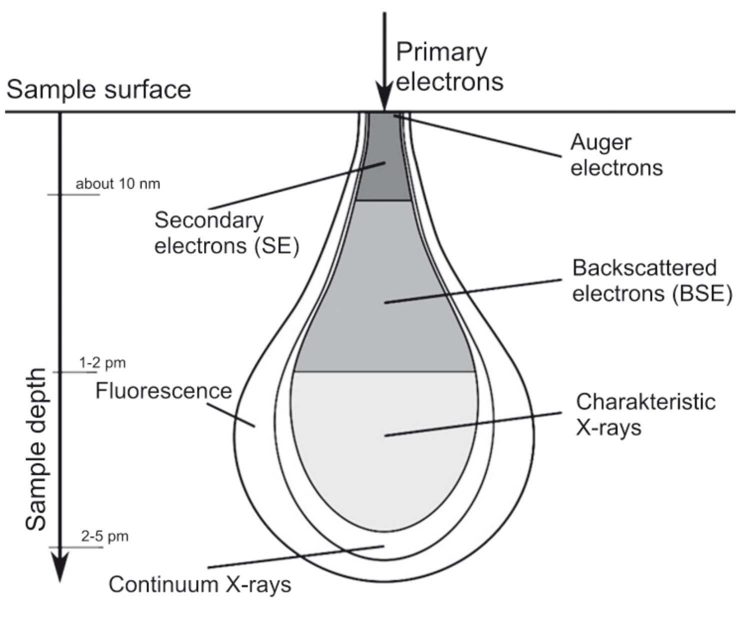
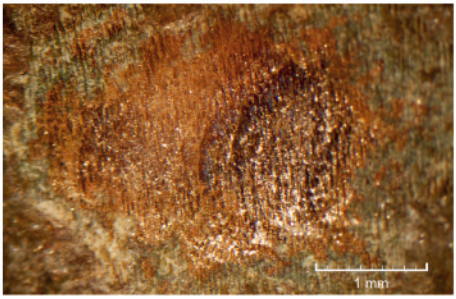


Fig. 3. Scheme showing the range and spatial distribution of emission of various electrons in a sample.
Elaborated by P. Gan

generated by the bombardment of the sample surface with a radiation beam. The supplied energy stimulates electrons, which jump between shells – strictly determined, the energy of such transitions is diagnostic for each element. Changes are registered by the detector in the form of spectra and peaks, and their intensity illustrates the relative content of a given element in a sample. Quantitative reference standards are necessary to quantify the results. The actual chemical composition can be calculated using four methods: k-ratio approximation, a calibration curve based on standards, ZAF matrix correction and fundamental parameters analysis, the so-called non-model analysis. Modern commercial research equipment typically performs an analysis based on theoretical spectrum models from a database, selecting the ones with the highest degree of matching (see Żelechower 2007, 113). The range and spatial resolution of the electron beam and characteristic X-ray are shown in Fig. 3. Characteristic X-ray radiation is collected from a larger area than the falling beam, and also registers the signal located under the surface of the sample. The depth of penetration depends on the applied acceleration voltage, which also affects the degree of excitation of characteristic lines. A voltage of 25 keV is assumed to be a safe energy value of a primary beam. Lower values do not allow the analysis and sufficient separation of all spectral peaks, which is particularly important in identifying, e.g., the Sn, Sb or Pb and As contents.

Figure 4.2 shows the locations and areas of measurements performed on the Santok artefact using the Artax spectrometer (μXRF) and the SEM-EDS microscope (see Miazga 2017, 76-78). Scanning microscope observations both revealed the metal structure, and enabled the precise selection of measurement locations, thereby avoiding inadequately cleaned sample surfaces and allowing for the elimination of interference (Table 1, analysis 3 B, 3_2, 3_3, Fig. 4: 1, 3-4). Based on the above, it is important to choose relevant analytical techniques and conditions for measurements when performing archaeometallurgical analyses. Both analytical techniques confirmed unusually high lead content accompanying the alloy matrix in the Santok chape, which can be identified as red brass. The high content of alloy additives indicates that the artefact was cast, presumably in heated moulds, which favoured the placement of lead phases closer to the surface of the artefact. It is difficult to tell whether the damage and corrosion on the metal surface is a result of casting and metal composition or perhaps subsequent reparations and additions, or whether these are traces of tin plating or protecting the object against corrosion with a metal layer, which also shows a high decorative value. The early medieval collection of *Mappae Clavicula* recipes mentions the *caldarium* alloy. In Pliny's *Natural History*, the name *caldarium* denoted a fragile alloy used for casting, and was the opposite of a *regulare* alloy suitable for plastic working. Believed to be suitable for casting and white in colour, it consisted of one part of lead (about 20%) and four parts of copper, bronze or brass (Craddock 1979, 75). Since the twelfth century, such alloys were the basis for the production of large kitchen utensils, but their use, also in the production of small items such as buckles, spoons or weights, has also been confirmed for earlier periods (Ponting 1999, 1317). Antimony and



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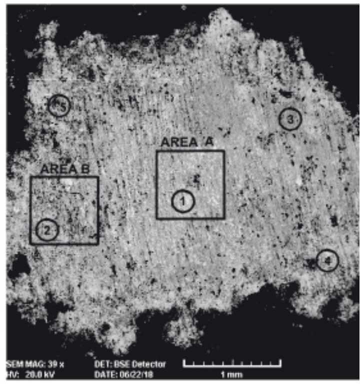

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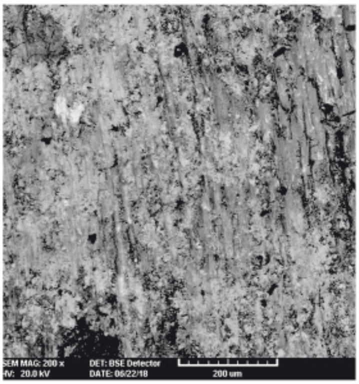

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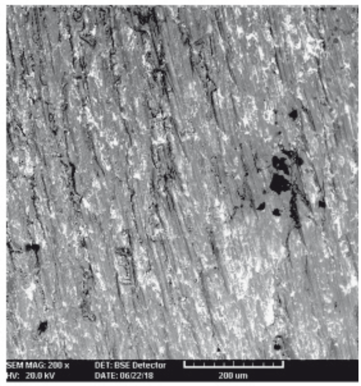

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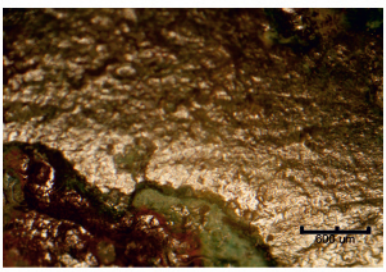

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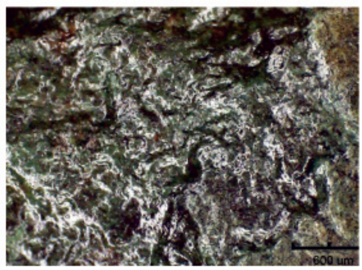

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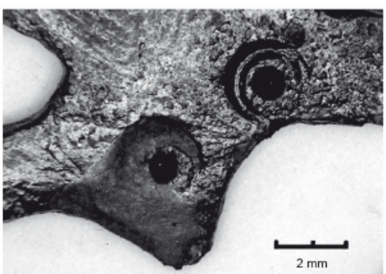

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Fig. 4. 1-4 – Santok chape: 1 – OM micrograph of cleaned, analysed area surface 3; 2 – SEM picture of analysed area 3 with marked SEM and XRF analyses; 3 – SEM picture of insufficiently cleaned 3B surface; 4 – SEM picture of area 3A, visible concentration of white lead precipitations; 5-7 – OM micrographs of Nurzec chape: 5 – external surface, visible areas variously affected by corrosion; 6 – internal surface of the artefact; 7 – leaded tab solidified in the ornament. Photo by P. Gan

arsenic were alloy additives. Of notable similarity to the word *caldarium* – for good reason – is the English term *cauldron*. Analyses of fragments of cauldrons (or pipkins, German *Grapen*) from Poland and Germany also show a significant lead content (Gan 2016, 357). However, it should be added that standards prohibiting the use of lead in this type of product were introduced in the second half of the fourteenth century, at the latest (see Janowski 2016, 303).

Lead seems to have been an auxiliary element in historical alloys. Neolithic and Bronze Age artefacts contained very small amounts of lead, usually no more than 2%. Starting from the Hallstatt period, we witness an increased lead content in alloys, sometimes exceeding 5%, especially in alloys produced in the Roman Period. The Middle Ages saw a continued tendency to increase the addition of lead in copper alloys; Scandinavian metallurgy used alloys with a lead content exceeding 10%. In an important early twentieth century publication, Ture Johnsson Arne identified three types of raw material in early medieval Sweden, Rus and the then Prussia (Baltic areas), linking them to the region of origin (Arne 1914, 217-219), the main criterion being the presence of tin. Scandinavian artefacts, purportedly related to Arab metallurgy, showed trace tin content (less than 1%). The term 'Permian-Siberian alloy', affiliated with the Chinese zone, was coined to describe alloys with a large (over 20%) tin content. The south-eastern-Rus' alloy possessed intermediate values. Contemporary research has perfected T. J. Arne's classification. Noteworthy here is the presence of lead, which is barely present in Permian alloys, but accompanies zinc in Scandinavian alloys. It is difficult to capture definite relations in the Rus' alloys: levels of tin, zinc and lead are frequently very diverse. It seems that alloy heterogeneity could have been typical of peripheral settlement, which had limited access to good raw material. Its production was thus based on the use of scrap metal, and a negative impact on the casting craftsmanship seems only natural in this context.

Archaeometallurgical analyses and their comparisons must be based on an understanding, among cooperating archaeologists and researchers, of the nature of the provided answers and the limitations of research methods. The character and complexity of historical alloys still require an individualized approach to the planning of analyses according to, despite the wide access to research equipment. Non-invasive analyses of chemical composition can be the first step in archaeometallurgical analyses, thus allowing the detection of compound and problematic artefacts. For a comprehensive description of the applied technology, it may be necessary to remove a small sample of metal from the artefact to perform invasive metallographic analyses.

It is unfortunate that the chemical composition analysis has been performed for only a small number of sword chapes (see Table 2), and some of the results have not yet been published. A brief look at the results presented in Table 2 reveals the diversity of the formulas used by manufacturers, but also the differences in the method of sampling that could have impacted the results. In most cases, one measurement was made on the surface of the object. The measurement showed that the chapes from Mielnik, Siemiatycze district,

Table 2. Results of analyses of sword chapes found across Europe (by A. Janowski)

Site	Place of sampling	Cu	Al	Ti	Cr	Fe	Ni	Zn	As	Ag	Sn	Pb	Sb	Au	P	Ca	Si	Cd	Mn	Mg	S	Type wg V.K.*	Source of information
		%																					
Kercz (Russia/Ukraine)	no data	rest						20-25				about 1										Ia	Frenkel' 2002, 134
Uświat (Russia)	warp	81.36						4.02				18.58										Ia	Kainov 2015, 626
	surface	31.40						4.01			11.36	52.96											
Kostrzyn (Poland)	surface	17.91				4.42	0.01	2.56		0.03	2.85	70.61			1.16			0.40				Ia	Michalak and Socha 2017, table 1
	surface	23.57				5.23	0.29	2.78		0.04	5.47	61.07			1.52			0.24	0.05				
Nurzec-Szeszyły (Poland)	warp	81.67	0.05		0.04	0.28		11.33	0.05		2.20	3.79	0.33	0.11			0.09		0.08			Ia Vb	Janowski in preparation
	surface	69.61	0.08			0.23		9.20	0.26		2.39	18.04					0.18		0.02				
Mielnik (Poland)	surface	73.80	0.11	0.09	0.06	0.28	0.15	6.61	0.10	0.30	9.53	8.78		0.18								Ib4	Kotowicz and Śnieżko 2018, table 1
Łekno (Poland)	surface	67.43				0.10		14.54			1.01	9.72			0.70	3.36	3.14					IIc	Wyrwa and Janowski 2014
Nimschütz (Germany)	surface	about 90	trace			trace		about 0.5		0.001	about 5	about 5				trace	trace			trace		IIc	Coblenz 1985, 300
Gardzień (Poland)	surface	84.97	0.09		0.07	0.28		6.24	0.04	0.03	6.02	1.59	0.26				0.32				0.08	Va	Janowski and Szczepański 2018, 417
Czermno (Poland)	warp	78.45				0.41		3.72			11.99	3.66	0.37									Va	Wołoszyn *et al.* 2018, table 1
	surface	70.18				0.64		1.88			19.38	6.85	0.34										
	surface	75.63				0.43		1.41			17.21	3.81	0.31										
Talkowszczyzna (Poland)	surface	85.50	0.06	0.05	0.02	0.20		3.19	0.04	0.22	6.94	3.47	0.27				0.03					Vb	Janowski in preparation
Radzim (Poland)	surface	89						5				about 5										-	Sankiewicz 2012, 247, fig. 3

*V.K. – Vytautas Kazakevičius

Talkowszczyzna, Sokółka district, and Nimschütz, Kr. Bautzen were made of bronzes. In the first case, in addition to copper (Cu – 73.80%), the alloy contained tin (Sn – 9.53%), lead (Pb – 8.78%) and zinc (Zn – 6.61%) (see Kotowicz and Śnieżko 2018, 222-223, table 1). In the chape from Mielnik, the copper content was significantly higher (Cu – 85.5%), but the mutual proportions of other components were similar (Sn – 6.94%, Pb – 3.47%, and Zn – 3.19%) (see Janowski in preparation). The chape discovered at the Nimschütz stronghold contained about 89% copper and an equal amount (about 5%) of tin and lead (Coblenz 1985, 300).

Several analyses were performed on the artefact from Czermno, Tomaszów district: one for the groundmass and two for the surface. In our opinion, the results obtained were significantly different: groundmass composition: Cu – 78.45%, Sn – 11.99%, Zn – 3.72%, Pb – 3.66%; surface composition: Cu – 70.18-75.63%, Sn – 17.21-19.38%, Zn – 1.41-1.88%, Pb – 3.81-6.85% (Wołoszyn *et al.* 2018, table 1). It is clear that the amounts of metals with a low freezing point, such as tin and lead, increase in surface layers. A similar pattern was also observed in the case of a chape found in Usvyaty, Pskov Oblast, Russia. The differences in composition were so significant that the groundmass had the properties of brass (Cu – 81.36%, Pb – 18.58%, Zn – 4.02%), while a lead alloy with copper and tin (Pb – 52.96%, Cu – 31.4%, Sn – 11.36%, Zn – 4.01%) was identified on the metal (!) (See Kainov 2015, 626). Particularly puzzling is the unusually high content of lead, which in this case may be the result of deliberately covering surface to give it a silvery colour. In addition to aesthetic value, this coating could also be a protective layer against bad environmental conditions. Similar treatments were also observed on several other chapes discovered in Russia and Belarus, which were covered with a layer of alloy containing from 33 to 59% lead (unpublished research by S.Ű. Kainov – see Michalak and Socha 2017, 165). According to Sergei Űr'eviča Kainova (2015), such a composition is characteristic of early medieval bronzes from the area of Rus. An even higher lead content was found in the chape from Kostrzyn, Gorzów Wielkopolski district. Two analyses made for both external surfaces of the object show 70.61% and 61.07% lead content, respectively, with only about 20% copper (17.91% and 23.57%, respectively) (see Michalak and Socha 2017, 165, table 1).

The chemical compositions of other analysed sword chapes bear a resemblance to brass. The chape from Gadzień, Iława district has a composition similar to tombac (Cu – 84.97%, Zn – 6.24%, Sn – 6.02%, Pb – 1.59%) (see Janowski and Szczepański 2018, 417), much like the specimen found in Radzim (Cu – 89%, Zn – 5%, Pb – 5%) (compare Sankiewicz 2012, 247, fig. 3). The analysis of the surface of the chape from Łekno, Wągrowiec district, showed that in addition to copper (at the sampling location, at least), it was composed of an alloy containing 14.54% zinc and 9.72% lead (Wyrwa and Janowski 2014, 329). In the case of the artefact found between the villages of Nurzec and Szeszyły, Bielsk Podlaski province, the analysis of the groundmass showed that it consisted of copper (81.67%), zinc (11.33%), lead (3.79%) and tin (2.20%), while 69.61% copper, 18.04% lead, 9.20% zinc and 2.39% tin were detected at its surface (see Fig. 4.5-7; Janowski in preparation). The results are significantly different and, as in bronze artefacts, an increased lead content was observed in the surface layers, while the amounts of tin and zinc are just slightly varied. A chape found in Kerch on the Crimean Peninsula was found to have the highest zinc content. It was made of a copper alloy, with approx. 20-25% zinc and a small addition (less than 1%) of lead (Frenkel' 2002, 134).

Some general conclusions can be drawn despite a low number of available analyses. It is clear that the producers demonstrated a working knowledge of the properties of alloys, and attempted to make them with specific parameters in order to manufacture items displaying desired features. On the other hand, they simply used available raw material, even if it did not exactly match the model. Some additional activities may have been performed on finished forms, such as covering them with metal solutions. For example, grey-coloured lead might have been used to give an item a silvery look (?).

FORMAL AND TYPOLOGICAL ASPECTS

Despite the fragmentary state of preservation, the Santok chape can be precisely positioned within the currently applicable typological and chronological systems. The external surface is decorated with a characteristic deep ornament, which in combination with the openwork construction suggests that the chape represents type Ib3, based on the classification proposed by Vytautas Kazakevičius (1998) (see Fig. 5). According to Kazakevičius, this type groups chapes decorated with a strongly stylised silhouette of a bird, which, unlike the images on the Ia and Ib1-2 type fittings, was not clearly divided into three sections, but rather sketched by a system of swirls and symmetrically spaced openings (Kazakevičius 1992, 94, fig. 3: 3-4; 1998, 293, fig. 2, fig. 8:9). This group was first distinguished by V. Kazakevičius himself, since the first chapes of this type were found as late as the 1970s, which means they were unknown to Peter Paulsen, the author of the first serious monograph (1953) on sword chapes. Laima Vaitkunskienë (1983, 10) was unable to find an analogy to the chapes she recovered from graves 62 and 94 in the village of Žąsinas, near Đilalë, Lithuania (Fig. 8: 3-4). Based on the observed similarity between both items, Vaitkunskienë assumed that they probably came from the hands of the same craftsman. In her opinion, these were *works of local* (Baltic – authors' remark) *masters in which Scandinavian motifs took on a new form of expression*. This view was appreciated by V. Kazakevičius (1998, 293), who also described this type of chape as a Baltic variation of Scandinavian patterns.

In the same vein, Natalia Valentina Eniosova (1994, 106-107) interpreted images on specimens from Žąsinas and Irzekapinis, in the Kaliningrad region of Russia, (Fig. 8: 2) (type A-I-2b in her typology) as representations of a bird, and the items themselves as a product of Lithuanian craftsmen from the late tenth/early eleventh century.

Likewise, in his doctoral dissertation, Artűrs Tomsons (2012, 193-194, fig. 102: 12-13) held the view that such chapes were a stage in the development of forms decorated with

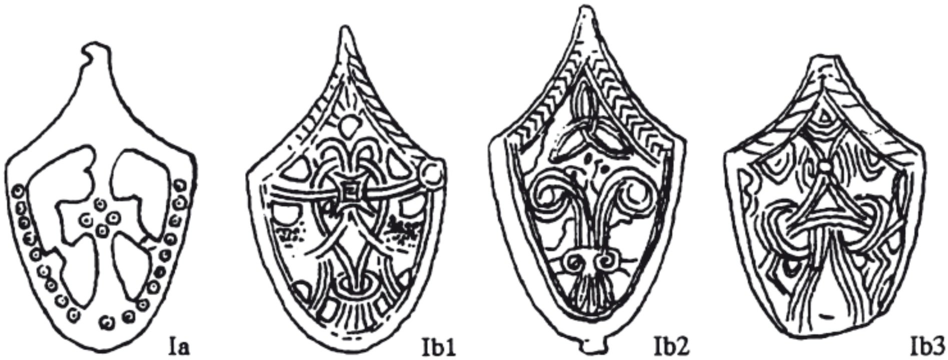

Fig. 5. Type I chapes according to V. Kazakevičius: sub-types. According to Kazakevičius 1998, fig. 2)

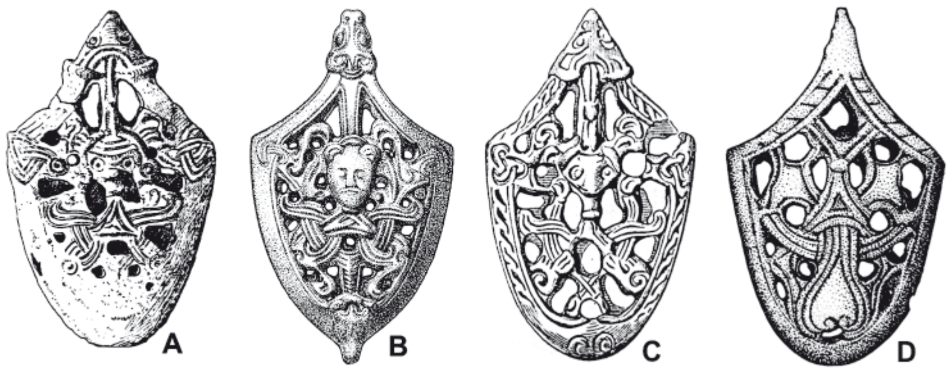

Fig. 6. Classification of chapes with an anthropomorphic figure.
According to Hedenstierna-Jonson 2002, by A. Janowski

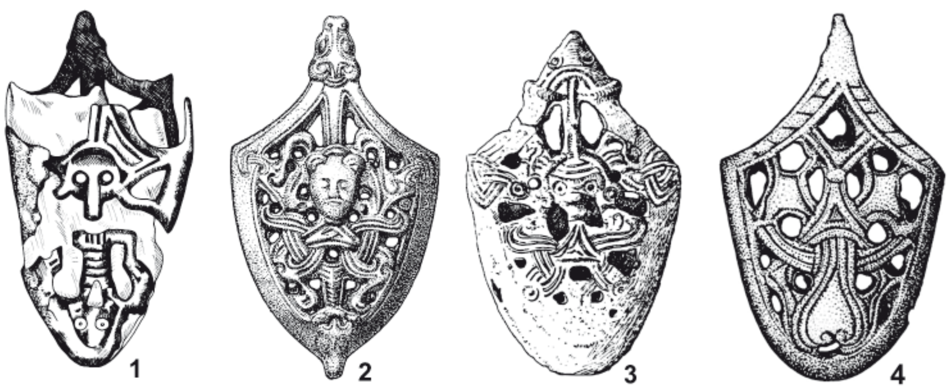

Fig. 7. Classification of chapes with an anthropomorphic figure.
According to Kainov 2009, 97-98, by A. Janowski

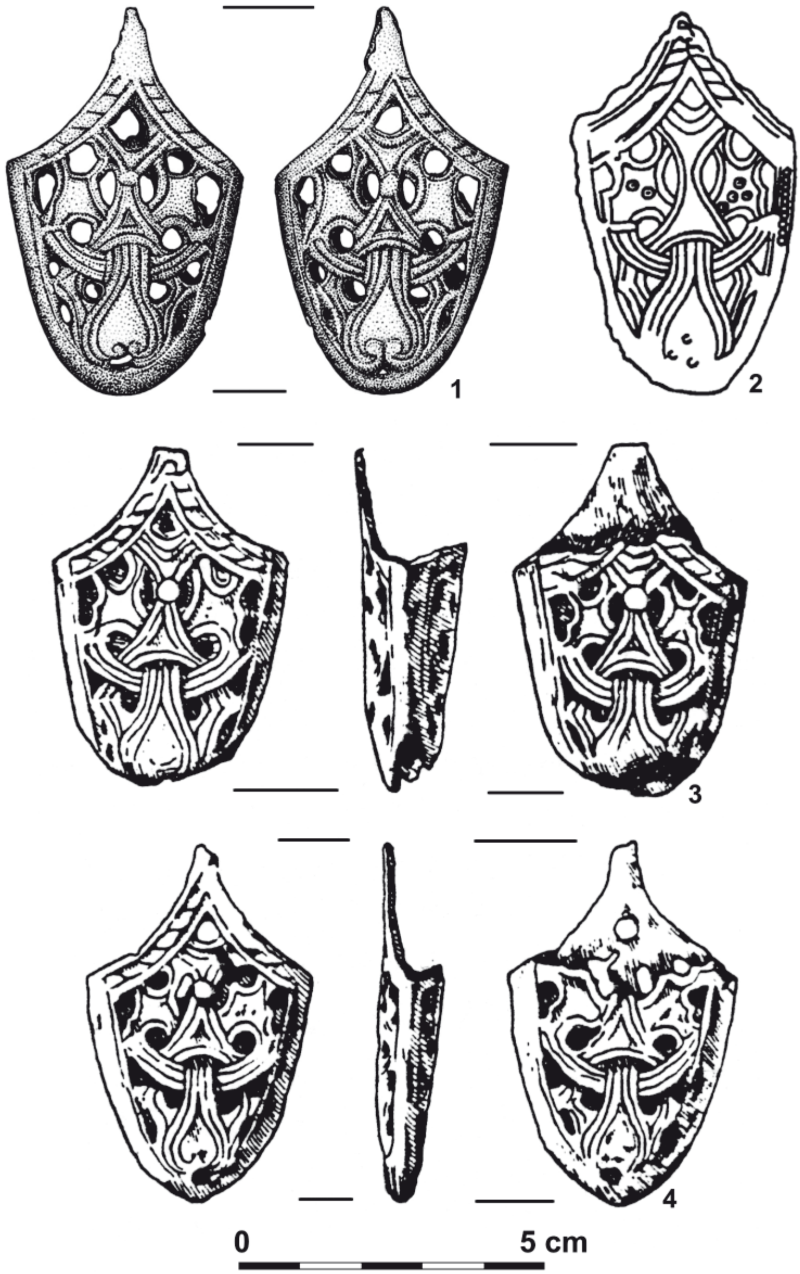

Fig. 8. Type Ib3 chapes: 1 – Novgorod, Russia (according to Kainov and Avdeenko 2012, fig. 1: 2), 2 – Irzekapinis, grave 117 (according to Kulakov 2003, fig. 1: 2), 3 – Žąsinas, grave 62 (according to Kazakevičius 1992, fig. 3: 3), 4 – Žąsinas, grave 94 (according to Kazakevičius 1992, fig. 3: 4). Elaborated by A. Janowski

the silhouette of a bird seen from above. Drawing attention to a certain incoherence and internal stratification within the Ib3 sub-group defined by V. Kazakevičius, Tomsons identified an additional variant. In his view, the Ib3 sub-group included chapes such as those found in Žąsinas and Irzekapinis, while all other items decorated with a motif that can be described as 'two volutes forming a sheaf' were moved to sub-group Ib4 (for more on this subject see Kotowicz and Śnieżko 2018).

The iconography and ornamentation of the discussed group of chapes are perceived differently by Vladimir Ivanovič Kulakov. Starting from the early 1990s, in several papers based on the discoveries of L. Vaitkunskienë in graves 62 and 94 at the cemetery in Ţŕsinas and his own find in grave 117 at the cemetery in Irzekapinis, he argued that the chapes were decorated with a heavily schematised human figure (see, among others, Kulakov 1990, 112; 1995; 2003, 64; Kulakov and Kovalenko 1996, 152, fig. 2: 5-6; Kulakov and Iov 2001).

It is difficult to say whether it is the findings of V.I. Kulakov that inspired Charlotta Hedenstierna-Jonson (2002, 104, fig. 5: 1-3), a Swedish researcher, when she included those artefacts in the classification of chapes with anthropomorphic representations (see Fig. 6). There is no doubt, however, that she knew at least one of his works (Kulakov 1990), although in her article she referred to it only in the list of finds. Chapes similar to those from Santok were placed by Ch. Hedenstierna-Jonson in sub-group D in her classification. In her opinion, the anthropomorphic central motif, clearly visible on artefacts from sub-groups A-C, is drawn so schematically that it is completely unrecognisable (Hedenstierna-Jonson 2002, 104).

The above classification was seriously modified by S.Ű. Kainov (2009, 97-98). In his classification, chapes with anthropomorphic motifs are still divided into four sub-groups; however, Kainov merged sub-groups A and C into one sub-group, and added a sub-group for chapes with a complete human figure (see Fig. 7). After these changes, Kainov's proposition is as follows: sub-group 1 – chapes with a full human figure; sub-group 2 – chapes with a human head in the centre; sub-group 3 – chapes with an animal head in the centre; sub-group 4 – chapes with a barbarised head motif.

The validity of typological sequences proposed by Ch. Hedenstierna-Jonson and S.Ű. Kainov has recently been questioned (see Wyrwa and Janowski 2014). Although the influence of Scandinavian art on the ornaments of the analysed chape group cannot be ruled out (sub-group 4 in the typology of Hedenstierna-Jonson and sub-group 4 according to S. Kainov), the iconography is far enough from that of the alleged prototype so as to be unrecognizable as such. While the chapes in the sequence share some elements, such as elaborate ornamentation with a clear triangle in the field centre and symmetrical entwined ribbon motifs, some major differences, such as the absence of anthropo- or zoomorphic elements, cannot be ignored. The analyzed chapes do not terminate in the heads of animals, which are found mainly on chapes with a bird motif (type I.1 according to P. Paulsen) and a quadruped animal (type II.1 and II.3 according to P. Paulsen), which are characteristic for Scandinavian artefacts. Their borders are decorated with slanting hatches, which

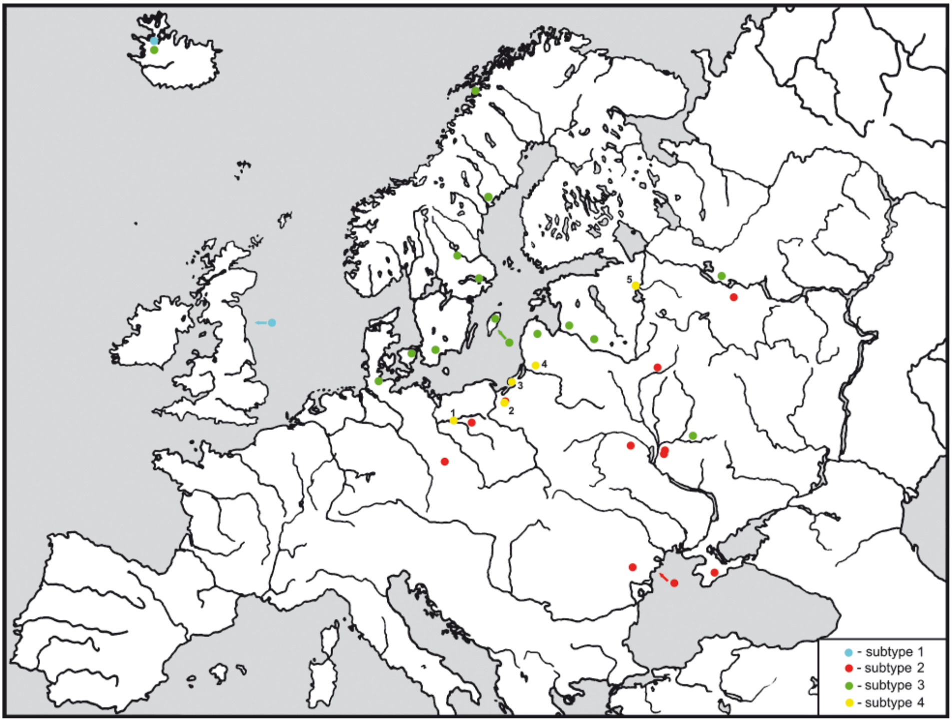

Fig. 9. Map showing the distribution of sword chapes decorated with anthropomorphic motifs: 1 – Santok; 2 – Jerzwałd; 3 – Irzekapinis; 4 – Žąsinas; 5 – Novgorod. According to Wyrwa and Janowski 2014, with supplement, by A. Janowski

makes the chapes closer to the fittings with the representation of the bird, and can be an indirect indication that they originated somewhere in the local Baltic area, far from their Scandinavian prototypes. Nevertheless, the issue remains unresolved. At present, in addition to the Santok find and the aforementioned specimens from graves in Žąsinas (2 specimens) and Irzekapinis, at least two more artefacts of this type are known. One was discovered in Veliky Novgorod, Novgorod oblast, Russia (Kainov and Avdeenko 2012, 146-147, fig. 1: 2) (Fig. 8: 1), and the second in Jerzwałd, Iława district, Poland (unpublished specimen in the collection of the Museum of Warmia and Mazury in Olsztyn). All the finds are spread in a fairly narrow belt from Veliky Novgorod in the northeast to Santok in the southwest. The strip is located in the contact zone of areas which yielded chapes classified as sub-groups 2 and 3 (see Fig. 9), as well as a number of other types of fittings (at Jerzwałd chapes were found belonging to subgroup 3 and 4). This region was inhabited by various communities of Slavs and Baltic peoples; the development of a new chape form in this border area is entirely plausible.

It is interesting to take a look at the – controversial for some – interpretation of anthropomorphs discernible on chapes. According to V.I. Kulakov, the scene depicts Odin, who wraps his arms around the neck of two crows named Huginn ('thought') and Muninn ('memory') (Kulakov 1995, 73; Kulakov and Kovalenko 1996, 150). Although Volodimir Mikolajovič Zocenko (2004, 88; 2007, 96) approves of the 'divine' interpretation, he believes that the depiction on the fittings is Thor, rather than Odin, and that the scene shows the thunder-god in his fight with Jörmungandr, the World Serpent, at Ragnarök.

According to Ch. Hedenstierna-Jonson (2002, 108-110), the scene on the chapes shows Odin's self-sacrifice, similar to that of the crucified Christ. In her opinion, the iconography exemplifies how the new religion, i.e., Christianity, sought to legitimise its existence with the aid of ancient symbols. The Jellinge runestone in Denmark is purported to be evidence confirming this interpretation. Raised by Harald Bluetooth around 965, the stone shows an entwined crucified figure accompanied by a runic inscription trumpeting that Harald made Danes Christians. Even though indisputable, the resemblance between the ornament on the monument and the chapes might simply have been the result of similar chronology and the style prevalent at the time.

Przemysław Sikora (2001, 109) is alone in his interpretation of the anthropomorphic scene as a fight between a hero and two monsters or a monster with several heads.

The chronology of the artefacts excites less controversy or doubt. The chapes from Santok and Jerzwałd are stray finds, but it is possible to establish a fairly exact chronology for other artefacts. It is believed that the graves with chapes from Žąsinas were dug sometime in the tenth or eleventh centuries (Vaitkunskienë 1983, 10). Similarly, V.I. Kulakov dates the chape from grave 117 in Irzekapinis to the tenth century. While the chronology provided in subsequent publications shows some variation (in fact, the dating goes systematically back along with the evolution of the author's views: from the second half of the tenth century – Kulakov 1990, 113, through the second quarter of the tenth century – Kulakov and Kovalenko 1996, 160, to the early tenth century – Kulakov 1999, 255), it generally falls within the tenth century. The most precise dating is that of the chape from Veliky Novgorod, found in the area of Troitski Excavation XI: it was deposited in layers dated to the years 970-990 based on the results of dendrochronological analyses (Kainov and Avdeenko 2012, 146). It is not unreasonable, therefore, to assume that the Santok chape also comes from the tenth or, at the latest, from the early eleventh century.

CONCLUSIONS

Its chemical composition, unusual for early medieval metallurgy, and a rare type of decoration make the Santok chape a remarkable find. The artefact eludes the usual interpretation schemes in both aspects. We believe that the conclusions presented in this paper, based on wide-ranging technological and formal-typological analyses, will provide a basis for even more comprehensive studies in the future. Until now, only about 1% of all protective fittings at the bottom of a sword scabbard have been subjected to technological analyses, and further research is essential if any regularities in the technological processes of their production are to be identified. New finds bring more and more information on the distribution of particular chape types and their iconographic programme, and it is hoped that it will soon be possible to determine the provenance of the chapes and explain the reasons behind the choice of iconography.

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References

Arne T. J. 1914. *La Suède et l'orient*. Uppsala: K.W. Appelbergs Boktryckeri.

Bayley J. 1991. Alloy nomenclature. In G. Egan and F. Pritchard (eds), *Dress Accessories c.1150-c.1450* (= *Medieval Finds from Excavations in London* 3). London: The Boydell Press, 13-17.

Bourgarit D. and Thomas N. 2012. Late medieval copper alloying practices: a view from a Parisian workshop of the 14th century AD. *Journal of Archaeological Science* 39, 3052-3070.

Coblenz W. 1985. Slawische Siedlungsreste in Nimschütz, Kr. Bautzen (mit einem Exkurs über vergleichbare Befunde von Pannewitz). *Arbeits- und Forschungsberichte zur Sächsischen Bodendenkmalpflege* 29, 227-312.

Craddock P.T. 1978. The Composition of the copper alloys used by the Greek, Etruscan and Roman Civilizations. *Journal of Archaeological Science* 5, 1-16.

Craddock P.T. 1979. The copper alloys of the Medieval Islamic world – inheritors of the classical tradition. *World Archaeology* 11, 69-79.

Dungworth D. 1997. Roman Copper Alloys: analysis of artefacts from Northern Britain. *Journal of Archaeological Science* 24, 901-910.

Eniosova N.V. 1994. Ažurnye nakonečniki nožen mečej X-XI vv. na territorii Vostočnoj Evropy. In Ű.L. Ŝapova (ed.), *Istoriâ i evolűciâ drevnih veščej. Sbornik statej*. Moskva: Moskovskij gosudarstvennyj universitat, 100-121.

Frenkel' Â.V. 2002. O nahodke ažuroj buteroli severnoevropejskogo kruga. In D.A. Mačinskij (ed.), *Ladoga i Severnaâ Evraziâ ot Bajkala do La-Manša. Svâzűŝie puti i organizűŝie centry*. Sankt Peterburg: Staroladožskij istoriko-arhitekturnyj i arheologičeskij muzej-zapovednik, 134-137.

Gan P. 2016. Charakterystyka materiałoznawcza wybranych zabytków metalowych. In M. Majewski (ed.), *Archeologia Stargardu* II/2. *Badania na obszarze dawnego kościoła augustiańskiego*. Stargard: Muzeum Archeologiczno-Historyczne, 357-363.

Hedenstierna-Jonson Ch. 2002. A group of Viking Age sword chapes reflecting the political geography of the time. *Journal of Nordic Archaeological Science* 13, 103-112.

Hensel Z. 1996. Produkcja wyrobów ze stopów miedzi w świetle badań chemicznych. In A. Cofta-Broniewska (ed.), *Metalurgia brązu pradziejowych społeczeństw Kujaw*. Poznań: Uniwersytet im. Adama Mickiewicza, 131-193.

Janowski A. 2016. Zabytki metalowe. In M. Majewski (ed.), *Archeologia Stargardu* II/2. *Badania na obszarze dawnego kościoła augustiańskiego*. Stargard: Muzeum Archeologiczno-Historyczne, 293-355.

Janowski A. in preparation. *Dwa nowe trzewiki pochew mieczy w zbiorach Muzeum Podlaskiego w Białymstoku*.

Janowski A. and Szczepański Ł. 2018. Okucie pochwy miecza z Gardzienia koło Iławy. Przyczynek do studiów nad uzbrojeniem na pograniczu bałtyjsko-słowiańskim. *Komunikaty Mazursko-Warmińskie* 3 (301), 416-439.

Kainov S. Ű. 2009. Nakonečniki nožen mečej iz Gnezdova. *Acta Militaria Mediaevalia* 5, 79-110.

Kainov S. Ű. 2015. Nakonečnik nožen meča i fragment kol'cevidnoj bulavki iż Usvâta. In: I.I. Eremeev (ed.), *Drevnosti polockoj zemli v istoričeskom izučenii vostočno-baltijskogo regiona (očerki sredevekovoj archeologii i istorii pskovsko-belorusskogo Podvin'â)*. Sankt Peterburg: Izdatel'stvo Dmitrij Bulanin, 626-630.

Kainov S. Ű. and Avdeenko E.E. 2012. Litye nakonečniki nožen mečej (po materialam Troickogo raskopa Novgoroda Velikogo). *Arheologičeskie Vesti* 18, 145-151.

Kazakevičius V. 1992. Sword chapes from Lithuania. In A. Loit, E. Magurçvičs and A. Caune (eds), *Die Kontakte zwischen Ostbaltikum und Skandinavien im frühen Mittelal*ter. Stockholm: Almqvist and Wiksell International, 91-107.

Kazakevičius V. 1998. Iđ vëlyvojo geleţies amţiaus Baltř ginklř istorijos (kalavijř makđtř galř apkalai). *Lietuvos Archeo*logija 15, 287-332.

Kotowicz P. N. and Śnieżko G. 2018. Unikatowy, brązowy trzewik pochwy miecza z Mielnika nad Bugiem na Podlasiu. *Acta Militaria Mediaevalia* 14, 221-228.

Kulakov V. I. 1990. Irzekapinis i Šestovicy. In P.P. Toločko (ed.), *Problemy arheologii Űžnoj Rus*i. Kiev: Izdatel'stvo Naukova dumka, 111-116.

Kulakov V. I. 1995. Varianty ikonografii Odina i Tora V-XI vv. In I.V. Dubov (ed.), *Drevniaâ Rus': novyje issledovaniâ*. Sankt-Peterburg: Sankt-Peterburskij gosudarstvennyj universitet, 66-80.

Kulakov V. I. 1999. Irzekapinis. *Stratum Plus* 1999 (5), 211-273.

Kulakov V. I. 2003. Varianty ikonografii Odina i Peruna/Perkuno. *Rossijskaâ Arheologiâ* 2003 (1), 60-71.

Kulakov V. I. and Iov O. V. 2001. Nakonečniki nožen meča iz kurgana 174 mogil'nika Kaup i s gorodišča Franopol'. *Kratkie Soobščeniâ Instituta Arheologii* 211, 77-84.

Kulakov V. I. and Kovalenko V. P. 1996. Simbolika odnogo iż tipov knâžeskih mečej. (Ikonografičeskaâ shema „Odin i vorony"). *Gistaryčna-Arhealagičny Zbornik* 8, 148-162.

Miazga B. 2017. *Zabytek archeologiczny jako źródło informacji o przeszłości. Badania specjalistyczne śladów produkcji, użytkowania i depozycji artefaktów*. Wrocław: Uniwersytet Wrocławski.

Michalak A. and Socha K. 2017. A sword scabbard chape with a depiction of a bird of prey from the surroundings of Kostrzyn. *Slavia Antiqua* 58, 159-174.

Paulsen P. 1953. *Schwertortbänder der Wikingerzeit. Ein Beitrag zur Frühgeschichte Osteuropas*. Stuttgart: W. Kohlhammer Verlag.

Ponting M. 1999. East meets West in Post-classical Bet She'an: The archaeometallurgy of culture change. *Journal of Archaeological Science* 26, 1311-1321.

Sankiewicz P. 2012. Późnośredniowieczny trzewik pochwy miecza z Ostrowa Radzimskiego. *Acta Militaria Mediaevalia* 8, 243-251.

Sikora P. 2001. Dolne okucia pochew mieczy (tzw. trzewiki) z terenu północnej Słowiańszczyzny we wczesnym średniowieczu – katalog źródeł. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 22, 107-132.

Tomaszewska-Szewczyk A. 2016. Mosiądz w starożytności i średniowieczu. Przyczynek do dziejów kultury materialnej. *Acta Universitatis Nicolai Copernici. Zabytkoznawstwo i Konserwatorstwo* 47, 7-41.

Tomsons A. 2012. *Divasmeňu zobeni Latvijas arheoloëiskajâ materiâlâ 9.-13. gs*. Rîga (doctoral dissertation stored at Latvijas Universitâte, Rîga).

Vaitkunskienë L. 1983. Skandinavški elementai ţemaičiř kultűroje X-XI a. *Lietuvos istorijos metraštis* 1982, 5-17.

Wesołowski K. 1957. *Metaloznawstwo* III. Warszawa: Państwowe Wydawnictwo Techniczne.

Wołoszyn M., Florkiewicz I., Nosek E.M. and Stępiński J. 2018. Wczesnośredniowieczny trzewik pochwy miecza z Czermna w świetle analiz archeologicznych i metaloznawczych. In T. Nowakiewicz, M. Trzeciecki and D. Błaszczyk (eds), *Animos labor nutrit. Studia ofiarowane Profesorowi Andrzejowi Buko w siedemdziesiątą rocznicę urodzin*. Warszawa: Instytut Archeologii i Etnologii PAN, Instytut Archeologii Uniwersytetu Warszawskiego, 207-216.

Wyrwa A. and Janowski A. 2014. Dolne okucie pochwy miecza z przedstawieniem ludzkiej twarzy z Łekna (stan. Ł5). *Fontes Archaeologici Posnanienses* 50 (2), 323-346.

Zamelska-Monczak K. 2017. Umocnienia wczesnośredniowiecznego grodu w Santoku w świetle nowszych badań archeologicznych. In A. Różański (ed.), *Gemma Gemmarum. Studia dedykowane Profesor Hannie Kóčce-Krenz*. Poznań: Poznańskie Towarzystwo Przyjaciół Nauk, Uniwersytet im. Adama Mickiewicza w Poznaniu, 209-238.

Zocenko V.M. 2004. Skandinavs'ki artefakti Pivdenno-Zahidnoj Rusi. In O.P. Mocâ (ed.), *Starodavnij Iskorosten' i slov'jans'ki gradi VIII-X st., Zbirka naukovih prac'*. Kijv: Korvin Press, 87-105.

Zocenko V. 2007. Pivdennorus'ki znahidki nakonečnikiv pihov mečiv tipu II: 1, 3 – Paulsen. In O.B. Kovalenko (ed.). *Černigiv u seredn'ovičnij ta rann'omodernij istorii Central'no-Shidnoj Evropi*. Černigiv: Desnâns'ka pravda, 90-99.

Żelechower M. 2007. *Wprowadzenie do mikroanalizy rentgenowskiej*. Gliwice: Politechnika Śląska.