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The hoard of bronze objects from site 8 at Zagórze, Wadowice District

Abstract: During rescue excavations carried out in 2012 in site 8 at Zagórze, Comm. Mucharz, Dist. Wadowice, a hoard of bronze objects was discovered, comprising a binocular brooch of the Strzebielinko type, three spiral bracelets made of thick bronze sheet of triangular cross-section, and three twisted necklaces with flattened and rolled ends. The deposit should be dated to HaD and linked with the Górnśląsko-Małopolska (Upper Silesian-Lesser Polish) group of the Lusatian culture. The spiral bracelets and the decoration featuring on the ends of one of the necklaces find the closest analogies in the hoard from Krásna Hôrka, Dist. Tvrdošín, in Slovakia. All metal objects originating from site 8 at Zagórze were subjected to chemical and technological analysis (XRF spectrometer of the Spectro-MIDEX type).

Keywords: hoard, bronze ornaments, Lusatian culture, Early Iron Age (HaD), Polish Carpathians, chemical analysis, technological analysis

1. Introduction

The water reservoir at Świnna Poręba, Dist. Wadowice (N 49°49'25.9" E 19°31'56.94') is situated on the border of the Middle and Small Beskidy Mts. A water dam has been built on the Skawa River below its gorge, located between the mountain ranges. Due to the execution of the project, a number of archaeological sites were threatened with destruction and it was necessary to carry out the rescue excavations. One of the sites excavated at that time was Zagórze, distr. Wadowice, site 8 (Fig. 1). In this paper, the bronze hoard discovered at this site is presented.

2. History of research

Archaeologists have been interested in the terrain of lately completed reservoir of the Skawa River Valley since the beginnings of its construction in the 70's.

The first archaeological recognition was led in this area by Józef Żurowski in the year 1930. In later years, Paweł Valde-Nowak conducted surface survey on the left bank of the Skawa River between Skawce and Wadowice (1976). The research led to a discovery of a small chip of Mesolithic character, made of Cracow Jurassic flint. This work was continued in the spring of the next year (1977), in cooperation with Jacek Rydlewski (Rydlewski, Valde-Nowak 1979).

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Other Mesolithic materials were discovered on the southwestern slope of Mucharz. The only smallscale excavations prior to reservoir construction were led by Marek Gedl in the year 1960 in Dąbrówka (Genczewska-Rydlewska, Rydlewski 1982).

Surface investigations have been conducted in this microregion within the project AZP (Archaeological Picture of Poland), with the investigated area found in AZP sheets no: 107-52 and 107-53. The 1986 surveys were led by Eugeniusz and Edelgarda M. Foltyn (Foltyn, Foltyn 1986) and by Jacek Rydlewski in 1987 (Rydlewski 1987).

The site at Zagórze was given the AZP number 107-53/5, and was recognized to cover the area between Skawa river and its right-bank tributary, Łękawka stream.

In 1990, the surface research continued, led by Teresa Kosmala (Kosmala 1993; Kosmala *et al.* 1999). The surface surveys continued in this area until the end of June 1993, and were followed by the discovery of 25 another archaeological sites. Also, some more flint artifacts were found. In the course of following archaeological procedures, a portion of these sites was negatively verified, and another part of them was designated to be a subject of excavation works.

Archaeological research in the region continued in 2007 and was led by Arkadiusz Tarasiński (Tarasiński *et al.* 2007, 186–199; Paternoga, Tarasiński 2008, 8–13). Archaeological trenches were prepared in different zones of the site (Fig. 2: 1). This research has led to the recognition of the presence of Lusatian and Przeworsk cultures people. Also, relics of a 15th–18th/19th century residential house were unearthed. Regular excavations at the site 8 were conducted in 2010 and 2012 (Kraszewska *et al.* 2011; Micyk 2014). In the eastern part of the excavation, more than ten Lusatian culture graves were found. The place of hoard discovery is situated some 150 meters from those points. Lusatian culture graves were also discovered at Zagórze 14 site (most likely as the continuation of site 8 towards the east) as well as in Mucharz 24 site, and a settlement of the Lusatian culture was found at Zagórze site 6. The hoard was unearthed in 2012 by the team of Paweł Micyk (archaeological company Galty).

3. Circumstances of discovery, methods of field work

In the year 2012, in north-eastern, peripheral part of the site on the foot of long slope, after removing of the topsoil, at the depth of 10–20 cm some metal artefacts were found in an oval-shaped feature, which dimensions were 0.39×0.34 m (feature no. 401/12, Fig. 2: 2). No pottery pieces or other archaeological materials have been collected here. According to report given by excavators all artefacts were placed close to each other, and three necklaces were put inside of one of the spiral bracelets (Fig. 3). All elements of the hoard are deposited in the City Museum in Sucha Beskidzka (Inv. No. 3157) and are presented there as a part of a permanent exhibition. Due to the presence of virulent patina, some of the artefacts underwent conservation treatment, which was performed by Dolmen company (Marcin Przybyła and Michał Podsiadło).

4. Description of artefacts

1. Spiral bracelet no. 1 (7 coils) made from tightly twisted, broad bronze ribbon resembling a flat triangle in cross-section, with one end wound spirally into small loop. The ribbon width is 16 mm, 3–4 mm towards the ends, with maximum thickness of 2 mm. The total length is 104 mm, and the diameter is 67 mm. Weight: 202 g. Undecorated. The bracelet has a sound bronze core (Fig. 4: 1).

2. Spiral bracelet no. 2 (7 coils) made from tightly twisted, broad bronze ribbon resembling a flat triangle in cross-section, with ends wound spirally into small loops. The ribbon width is 11 mm, 5 mm towards the ends, with maximum thickness of 3 mm. The total length is 104 mm,

Fig. 1. Map of the Lusatian culture sites in the area of the dam in Świnna Poręba (Skawa River Gorge):

1. Zagórze, site 8, 2. Zagórze, site 6, 3. Mucharz, site 24, 4. Zagórze, site 14.

a – range of archaeological sites, b – location of the hoard (layout U. Bąk, acc. to Paternoga, Targaczewski 2010, map 1; Micyk 2014)

and the diameter is 69 mm. Weight: 282 g. Undecorated. The bracelet has a sound bronze core (Fig. 4: 2).

3. Spiral bracelet no. 3 (9 coils) made from tightly twisted, broad bronze ribbon resembling a flat triangle in cross-section, with ends wound spirally into small loops. The ribbon width is 18 mm, 5 mm towards the ends, with maximum thickness of 3 mm. The total length is ca. 150 mm, and the diameter is 71 mm. Weight: 393 g. Undecorated (Fig. 4: 3).

4. Bronze binocular brooch with the bow in the shape of the figure-of-eight between spiral plates. Bipartite and bimetallic: the bow and the plates are made of bronze, while a fragment of iron sheet (for attaching the pin) has survived on the bottom side. The pin itself has not survived, but it was also probably made of iron. The bronze wire from which the brooch was made is square in section. Another distinct element of the brooch is a bronze tutulus consisting of two plates joined by a short shaft. The tutulus' upper plate tapers into a spike terminating in a small, concave disc. The tutulus was placed in the centre of one of the spiral plates, closing the aperture left after the wire was coiled. The iron sheet mentioned above was attached to the

Fig. 2. Zagórze site 8, Dist. Wadowice. 1. General plan of the excavation area, 2. Location of the hoard (in the feature 401/12), 3. Reconstruction of original arrangements of the artefacts (photo by P. Micyk).
a – location of the hoard (acc. to Micyk 2014)

Fig. 3. The hoard from site 8 at Zagórze, Dist. Wadowice (photo by U. Bąk)

tutulus' bottom part. Neither the tutulus nor the brooch were decorated. The total length of the brooch is 182 mm, the spiral plates had dimensions of 83 mm, and the wire is 6–7 mm thick. Weight: 348 g (Fig. 5).

5. Open necklace no. 1 made from a 'twisted' bronze bar, with ends hammered flat and formed into rolls.³ Diameter: 201 mm, bar thickness 9 mm, width at the ends 36 mm, thickness of the flattened parts 2–3 mm. Weight 247 g. A poorly visible pattern of diagonal lines can be seen on one of the flattened ends. The artefact has undergone conservation, its colour is that of pure bronze – surfaces covered with virulent patina have been removed (Fig. 6).

6. Open necklace no. 2 made from a 'twisted' bronze bar, with ends hammered flat and formed into rolls. Diameter: 190 mm, bar thickness 9 mm, width of the ends 37 mm, thickness of the flattened parts 1–2 mm. Weight 224 g. The flattened ends are decorated with three longitudinal incised lines executed in the tremolo technique (German: 'Tremolierstichmuster'). The

³ We suggest using the term 'roll' (Polish: 'rulon') rather than more commonly used 'tube' (Polish: 'rurka'), since in some of the artefacts the ends are formed into more than one coil and they are also rolled without much care and typically do not resemble tubes.

Fig. 4. Spiral bracelets from bronze ribbon (drawing B. Pilarski, photo by U. Bąk)

decoration on one end is damaged by corrosion. The artefact has undergone conservation – see remarks above (Fig. 7).

7. Open necklace no. 3, made from a 'twisted' bronze bar, with ends hammered flat and formed into rolls. Diameter: 194 mm, bar thickness 11 mm, width of the ends 31 mm, thickness of the flattened parts 1–2 mm. Weight 261 g. The flattened ends are decorated with two dotted zigzags separated with a single dotted line (punctum technique). The decoration on one end is damaged by corrosion. The artefact has undergone conservation – see remarks above (Fig. 8).

Fig. 5. The binocular brooch (drawing B. Pilarski, photo by U. Bąk)

5. Remarks on typology and chronology

5.1. Spiral bracelets from bronze ribbon

Spiral bracelets made from ribbon of triangular or plano-convex section occur from the beginning of the Bronze Age until the Early Iron Age. Those from Zagórze, however, represent a specific variant in which the ends are rolled into small loops. This probably had an utilitarian rather than aesthetic meaning, since bracelets which such endings were less likely to lacerate the forearm.

Fig. 6. Open necklace no. 1 (drawing B. Pilarski, photo by U. Bąk)

Bracelets made from ribbon having somewhat similar (more plano-convex) section but decorated and without loops at the ends are known from two hoards discovered in Nowa Słupia, Dist. Kielce, dated to HaD (Kostrzewski 1964, 67, fig. 87:2, 6).

The only good analogies that we could find, although having greater numbers of coils (more than 12 and more than 10 respectively) come from a hoard discovered in Krásna Hôrka (today part of the town of Tvrdosín), Dist. Tvrdosín, Slovakia. The hoard is dated to HaD (Novotná 1984, 54, pl. 80:5, 7).

5.2. The brooch

It belongs in a group of bipartite binocular brooches with figure-of-eight bows occurring in central and southern Europe. Finds from the territory of Poland share certain traits, which allowed Marek Gedl to distinguish them as a separate *Strzebielinko* type. This type is represented by at least 20 specimens, primarily originating from hoards, most of which have been found in Eastern Pomerania and Lesser Poland, with single examples

known from Lower Lusatia and Greater Poland: Biała Wielka, Dist. Częstochowa, hoard; Bychowo, Dist. Wejherowo, hoard; Cielmów, Dist. Żary, hoard; Deszkowice, Dist. Zamość, hoard II, 2 pcs; Dzierżęcin, Dist. Sławno, hoard; Gorzyce, Dist. Tarnów, hoard; Gozd, Dist. Koszalin, hoard or single find; Kartuzy, hoard; Koszalin-Gołogóra, single find in peat; Krasnołęka, Dist. Malbork, hoard; Lubsko, Dist. Żary, hoard, 2 pcs; Strzebielinko, Dist. Wejherowo, hoard; Środa Wielkopolska, hoard, 3 pcs; Świdnik, Dist. Limanowa, hoard; Świdnik, Dist. Nowy Sącz, hoard; Kwaczała, Dist. Chrzanów, from cemetery (Gedl 2004, 65–68, pl. 43:170, 44:172A–173, 45:174–175, 46:176–177, 47:178–181, 48:184–187). They date to the younger stage of the Early Iron Age, i.e. to the times corresponding to HaD (Gedl 2004, 65–69, pl. 83B).

Some of the brooches found in Poland, all of them from the southern or western area (Cielmów, Deszkowice, Lubsko, Środa Wielkopolska), were bimetallic (Gedl 2004, 65). The brooch from Zagórze fits well within this picture.

Fig. 7. Open necklace no. 2 decorated in the tremolo technique (drawing B. Pilarski, photo by U. Bąk)

necklaces add finds from outside Poland, which occur in hoards or graves – from West Podolia and Slovakia to Saxony and Jutland. Next, necklaces of this type were analysed by Sabine Pabst-Dörrer, who added several more finds from Poland, Germany, and Denmark, as well as Bosnia and Herzegovina, and pointed at similar finds from the Caucasus area (Northern Ossetia, Georgia, Azerbaijan), whose connection with central Europe is difficult to determine. A few more necklaces or their fragments have been published in recent decades.

In total, the type in question comprises approx. 90 complete necklaces or fragments originating from more than 40 finds. A significant part of these artefacts have ends decorated with incised or punched geometric motifs.

Greater Poland and Kuyavia: Bojanowo Stare, Dist. Kościan, hoard, undecorated ends; Bydgoszcz (environs), hoard, decorated ends; Kluczewo, Dist. Szamotuły, hoard, decorated ends; Kołuda Mała, Dist. Inowrocław, hoard, 2 pcs, no information about ends, they are shown from

In her master's dissertation published in 2000, Sabine Pabst-Dörrer supplemented the list of the Strzebielinko-type brooches with 2 new sites: Grünz, Dist. Vorpommern-Greifswald, hoard A; Żary, probably a fragment (Pabst-Dörrer 2000, 172). At the same time she attributed some others into a new type which she labelled the Krásna Hôrka type: Biała Wielka; Gorzyce; Krásna Hôrka, Dist. Tvrdošín, hoard; Świdnik, Dist. Nowy Sącz; Świdnik, Dist. Limanowa (Pabst-Dörrer 2000, 15–31, 171–173).

5.3. Necklaces

The Zagórze necklaces represent a very characteristic and widespread type defined 60 years ago by Józef Kostrzewski as typical of HaD and occurring primarily in Kuyavia and eastern Greater Poland (Kostrzewski 1954, 38). Kostrzewski also published the first list of such necklaces (1954, 61–62, map III). The finds from Poland were later included by Dobromir Durczewski (1961, 96–97) and Józef Kostrzewski (1964, 21) in their papers concerned with hoards and stray metal finds. To the picture of distribution of such

Fig. 8. Open necklace no. 3 decorated in the punctum technique (drawing B. Pilarski, photo by U. Bąk)

the side in the photograph, but the description suggests they are not decorated; Orchowo, Dist. Słupca, hoard, 2 pcs (one specimen with decorated ends, other with undecorated ends); Stanomin, Dist. Inowrocław, hoard, 30 pcs and 1 fragment, all have their ends decorated with geometric motifs and 'wavy or zigzag' lines, but it is impossible to determine whether the techniques and motifs similar to those from Zagórze occur there; Kwilno, Dist. Radziejów, single find, decorated ends (Durczewski 1961, 12, 16–17, 33, 35, 45, 61, 72, fig. 4:4, 7:2, 27:1, 30:2, 4, 36:1–2, 55:2–31, 79). Finds from graves: Nadziejewo, Dist. Środa Wielkopolska, 1 fragment, probably decorated (Koehler 1900, pl. XXXIII:6); Sobiejuchy, Dist. Żnin, 1 fragment, no information on decoration available (Kostrzewski 1954, 62); Czekanów, Dist. Ostrów Wielkopolski, fragments of a 'diagonally grooved' specimen from the cemetery, the end is not decorated (Zeylandowa 1972, 79, fig. 4:2; Pabst-Dörrer 2000, 142).

With this cluster link the finds from the Chełmno Land: Papowo

Biskupie, Dist. Chełmno, hoard, decorated ends (von Hirschfeld 1876, pl. X:1–2); Mała Kępa, Dist. Chełmno, 1 pc. from a grave, the ends probably decorated – they are poorly visible on the photograph (Zielonka 1958, 4, fig. 1:b; Pabst-Dörrer 2000, 142).

The finds from Western and Central Pomerania are isolated: Linie, Dist. Pyrzyce, hoard, undecorated ends (Kossinna 1915, 105, fig. 20; Dorka 1939, 156, pl. 32; Kostrzewski 1954, 61); Miszewo, Dist. Bytów, stray find, 1 fragment, decorated end (Rembisz-Lubiejewska 2016, 255–256, 258, fig. 2:A, 3:A).

Mazovia and Podlachia: Kisielsk, Dist. Łuków, hoard, decorated ends; Kluczewo, Dist. Płońsk, hoard, 2 pcs, ends (Kostrzewski 1964, 39–40, 45, pl. XII:2, fig. 34:1–2, pl. XVI:4). One can also add here Brańsk, Dist. Bielsk Podlaski, hoard, 6 pcs – 3 with undecorated and 3 with decorated ends (Jaskanis 1976, 142, 147, figs 9–11); perhaps Ginetówka, Dist. Grójec, hoard, undecorated end (Kostrzewski 1964, 33, pl. VIII:9, Pabst-Dörrer 2000, 142). Finds from graves: Zaborowo, Dist. Płońsk, 1 pc., undecorated ends, irregular notches featuring on one

of the ends shown in the drawing are most likely modern period damage (Dąbrowski 1957, 377–378, fig. 1; Pabst-Dörrer 2000, 143); Wola Kisielska, Dist. Łuków, 1 fragment, undecorated ends (Węgrzynowicz 1968, 326, fig. 1*i*; Pabst-Dörrer 2000, 143).

Lesser Poland: Kielce (environs), context of discovery unknown, ends not decorated (Kostrzewski 1954, 62 – as Podstawie, Dist. Opatów; 1964, 39, pl. XI:1; didactic collection of the Jagiellonian University Institute of Archaeology in Kraków); Lelowice, Dist. Proszowice, context of discovery unknown, 1 fragment, undecorated end; Łącko, Dist. Nowy Sącz, hoard, 3 pcs, no information on the ends available, they are shown from the side in the illustrations; Nowa Słupia, Dist. Kielce, hoard II, no information on the ends available, the specimen is shown from the side in the photograph; Świdnik, Dist. Limanowa, probably from a hoard, 2 pcs, ends partly broken off, see remarks above (Kostrzewski 1964, 45, 67, 73, pl. XVI:6, XVIII:16, 20, fig. 45:5, 87:1); Wakijów, Dist. Tomaszów Lubelski, hoard, undecorated ends (Poklewski 1954, 267–268, pl. 23:1, fig. 4:1; Pabst-Dörrer 2000, 143).

Ukraine: Czechy (today Chishki, raj. Brody), grave; Hłuboczek Wielki (today Velykyi Glybochok, raj. Ternopil'), grave; both specimens have undecorated ends (Sulimirski 1931, 62, 100, pl. XXVI:1, XXVII:1; Kostrzewski 1954, 62).

Slovakia: Krásna Hôrka, Dist. Tvrdošín, hoard, 2 pcs, decorated ends; probably Dobšiná, Dist. Rožňava, cave find, ends straight, decorated (Novotná 1984, 52, pl. 53:342–345); perhaps also Dolný Kubín II, grave 136, specimen damaged by fire, decorated ends (Novotná 1984, 53, pl. 54:345).

Germany: Grossammensleben, Dist. Börde, hoard, no information on the ends available (Kostrzewski 1954, 62); Prenzlau, Dist. Uckermark, grave, undecorated ends (Raddatz 1959, 220, fig. 472:2; Pabst-Dörrer 2000, 143).

Denmark: 3 hoards discovered within a close distance to each other in marshes in Hedensted Municipality, Region Midtjylland, formerly Velje County (Jensen 1970, 163–168, fig. 2): Aarup Mose (Tagkær), formerly Hedensted Parish Municipality, 2 pcs have ends relatively narrow, undecorated (Kostrzewski 1954, 62; Jensen 1970, 168, 184, fig. 6:29–30; Pabst-Dörrer 2000, 142); Råddenkær, formerly Øster-Snede Parish Municipality, decorated ends (Jensen 1970, 182, fig. 3:10; 1997, pl. 98:3; Pabst-Dörrer 2000, 143); Gammelsole, formerly Øster-Snede Parish Municipality, 1 with relatively narrow ends, undecorated, 1 with damaged ends (Jensen 1970, 166, 182–183, fig. 4:17,19; Pabst-Dörrer 2000, 142).

Bosnia and Hercegovina: Donja Dolina, Gradiška Municipality, Republika Srpska, grave IV, undecorated ends (Truhelka 1904, pl. LXVIII:13; Pabst-Dörrer 2000, 142).

Russia: Koban-Vozdvizhenskaya krepost', Dist. Prigorodnyy, Northern Ossetia, cemetery, fragments of at least twisted 1–2 pcs, the end shown in the illustration is decorated but is not formed into a roll (Krupnov 1960, 289–290, pl. III:2–3; Pabst-Dörrer 2000, 142).

Georgia: Melaani, Gurdžaani Municipality, Kakheti, 1 specimen in a temple, no information on decoration available (Pabst-Dörrer 2000, 142).

Azerbaijan: Kalakent-‘Paradiesfestung’, Dist. Gədəbəy, grave 3–2 undecorated pcs, grave 4 – 4 undecorated pcs (Nagel, Strommengel 1985, 54, 56, pl. 5:1–2, 6:1–4; Pabst-Dörrer 2000, 142); Gogdaja, Dist. Gədəbəy, grave 10 – 2 similar pcs, undecorated (1 specimen with damaged ends), grave 18, decorated ends (Nagel, Strommengel 1985, 48, 113, pl. 68:6–7, 71:1; Pabst-Dörrer 2000, 142).

The search for analogies to the decoration adorning the ends of the Zagórze artefacts have produced only one published analogy to the necklace described as the last position here (Fig. 8). It is decorated with two dotted zigzags separated with a single dotted line, and 2 somewhat similar necklaces have been found in the hoard from Krásna Hôrka, Dist. Tvrdošín in Orava

(Novotná 1984, pl. 53:342–343), mentioned in the context of the spiral bracelets. Unfortunately, no analogy has been found for the tremolo zigzags decoration (Fig. 7).

6. Chemical and technological analyses of bronze artefacts

Seven metal objects originating from site 8 at Zagórze, Dist. Wadowice, were subjected to analysis. They included three spiral bracelets, three twisted necklaces, and one binocular brooch. All the artefacts have well preserved metal cores, which allows for reliable analytical measurements.

The primary goal of the analysis was to identify the raw material from which the artefacts were made and to attempt the identification of determine the technology of their manufacture. All the objects were subjected to non-damaging analysis of chemical composition in a small spot energy dispersive X-ray fluorescence spectrometer of the Spectro-MIDEX type (XRF). In addition, to obtain a broader range of elements, the analyses were performed in the helium atmosphere, with the spectrometer's chamber being rinsed with helium during each measurement.

The results were analysed using TURBO QUANT software from the SPECTRO package, and presented in the form of tables showing percentages of particular elements in the analysed samples (Table 1). Prior to the examination, the artefacts' surfaces had to be properly prepared. In places selected for examination the surface was polished using a diamond microblade to remove the patina, so that the results reflect the composition of the metal rather than patina. Next, the artefacts prepared in this manner were set in special holders allowing them to be placed beneath the spectrometer's collimator (see e.g. Biborski 2016; 2017).

The results shown in Table 1 are the mean values from several measurements taken for each artefact.

The analysis demonstrated that the three spiral bracelets were the only homogenous group among the examined artefacts from Zagórze. They have similar contents of copper in the alloy, amounting to 88.2% (bracelet no. 2 – Fig. 4: 2), 89.87% (bracelet no. 1 – Fig. 4: 1), and 89.06% (bracelet no. 3 – Fig. 4:3), which means that the maximum difference in copper content is merely 1.67%. The shares of tin are also similar in all the analysed bracelets, amounting to 9.31%, 8.15%, and 10.18%, respectively. In this case, the maximum difference is only 2.03%. Such alloys, with tin percentages oscillating around 10%, are perfectly suited for casting and cold processing. They are distinguished by a beautiful golden colour and are resistant to corrosion. It should be also emphasised here that alloys of non-ferrous metals have much better strength characteristics as compared with pure metals – a trait appreciated and widely exploited already in the antiquity (cf. Piaskowski 1981, 134–136).

Table 1. Chemical composition of metal in the analysed artefacts from site 8 at Zagórze, Dist. Wadowice

ARTEFACT	Cu	Sn	Pb	Si	Fe	Al	Ni	Ag	Sb	P	Bi	W	As
BRACELET1	89.87	8.15	0.62	0.25	0.16	-	0.29	0.09	0.21	-	0.02	0.03	0.25
BRACELET2	88.20	9.31	0.57	0.11	0.30	-	0.63	0.07	0.14	-	0.02	-	0.13
BRACELET3	89.06	10.18	0.16	0.09	0.11	-	0.05	-	0.05	-	0.01	0.03	0.20
NECKLACE1	86.02	12.27	0.47	0.19	0.19	-	0.08	0.03	0.03	0.02	0.06	0.17	0.40
NECKLACE2	88.46	8.06	1.93	0.16	0.07	-	0.48	0.14	0.30	-	0.05	0.04	0.24
NECKLACE3	92.89	2.96	2.14	0.87	0.36	0.20	0.09	0.06	-	0.02	0.08	0.13	0.12
BROOCH	82.64	13.5	1.32	1.15	0.08	-	0.02	-	0.04	0.06	0.03	0.17	0.42

All the bracelets were probably cold hammered (Table 2) from a cast metal bar, as indicated by traces of minor casting defects in the form of discontinuities noticeable on bracelet no. 3 (Fig. 9: A). This bracelet was made from tin bronze (Cu-Sn), and the other two were probably made from the same raw material. This is suggested by similar proportions of basic alloy components in all three artefacts, and generally similar percentages of trace elements. Observations with optic microscope suggest the technique of manufacture was the same as well. In all three cases the bronze ribbons have similar triangular cross-sections, and were probably shaped using a stencil (Fig. 9: C). Such the shape of the surfaces made the object less flexible, while at the same time the two planes of the outer surface reflected light at two different angles, enhancing the aesthetic value of the bracelet. It should also be noted that the technique of hammering made the material much stronger and more resilient.

At the final stages of their manufacture the ribbons were polished with a very fine-grained abradant, which left traces clearly noticeable in optic microscope, e.g. on bracelet no. 1 (Fig. 9: B)⁴. Next, they were wound around a cylinder of a proper diameter, made of wood or some other material. Taking all the above into account we believe that all three bracelets were manufactured in the same workshop, in similar time, and from the same raw material.

The last group of artefacts, comprising three similar 'twisted' necklaces with the ends hammered flat, presents a different picture. One necklace (Fig. 7 – necklace 2 in the tables) has a minuscule decoration in the form of a zigzag line (Fig. 10: A), executed in the tremolo technique with a graver having narrow, triangular tip, while another features linear decoration in the punctum technique, applied with a small punch (Fig. 8 – necklace 3 in the tables, Fig. 10: B). One cannot rule out that the third necklace (Fig. 6 – necklace 1 in the tables) was also decorated with this technique, but traces of pitting corrosion on its surface blur the original appearance of the artefact (Fig. 10: C).

In terms of chemical composition the necklaces show notable differences, e.g. in the contents of copper which amounts for 92.89% (necklace no. 1), 86.02% (necklace no. 2), and 88.46% (necklace no. 3). Significant differences can be observed in the contents of tin as well, with values of 2.96%, 12.27%, and 8.06%, respectively (Table 1). Furthermore, two of the necklaces have revealed additions of lead, which strongly affects castability of metals and enhances plastic properties of bronzes (Wendorff 1976, 465–468; Wesołowski 1981, 420–423; Dobrzański 1999, 505–508). The proportions of lead were 2.14% (necklace no. 1) and 1.93% (necklace no. 3). This allows us to conclude that both these artefacts have been made from multicomponent, tin-lead bronze (Cu-Sn-Pb), while necklace 2 has been made from tin bronze (Cu-Sn).

Despite differences in terms of alloy composition, examination with optic microscope suggests the same technique of manufacture for all three necklaces. They were lost-wax cast, probably using a wax model prepared in a bivalve mould. This technique is suggested by traces of small casting defects, discernible in the form of material discontinuities and voids left by air bubbles trapped during the casting (Fig. 10: D–F).

Table 2. Technology used in the manufacture of bronze artefacts from site 8 at Zagórze, Dist. Wadowice

ARTEFACT	TECHNOLOGY
BRACELET 1	Cold hammering, surface treatment
BRACELET 2	Cold hammering, surface treatment
BRACELET 3	Cold hammering, surface treatment
NECKLACE 1	Lost-wax casting, surface treatment
NECKLACE 2	Lost-wax casting, surface treatment
NECKLACE 3	Lost-wax casting, surface treatment
BROOCH	A bar drawn through a square die, tempered in fire and coiled

⁴ These traces were observed before conservation treatments.

Fig. 9. Technological analyses of bronze artefacts from site 8 at Zagórze, Dist. Wadowice: A. Spiral bracelet no. 3 with traces of casting defect, B. Traces of cleaning and polishing detectable on the surface of bracelet no. 1, C. Reconstruction of the process of shaping the band used for making the bracelet (drawn by U. Bąk), D. Traces in the brooch of parallel scratches along the wire's edges, which suggest pulling the wire through a drawing (photo by M. R. Biborski)

After casting, the necklaces were probably cleaned and had casting jets removed, and were next polished. However, traces of these treatments have most likely been removed during conservation works.

The last artefact analysed was the binocular brooch. It was made from a thick, square-sectioned wire, wound into two spirals. The fastening, which has not survived in full, was made of iron. It has corroded, leaving only a thick layer of partly hydrated iron oxide ($\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$) on the bottom side of one of the spirals.

The wire was an alloy consisting primarily of copper (82.64%) and tin (13.50% – the highest value of all the artefacts analysed), with an addition of lead (1.32%). Moreover, the analysis

Fig. 10. Technological analyses of bronze artefacts from site 8 at Zagórze, Dist. Wadowice: A. Tremolo decoration featuring on necklace no. 3, B. Linear decoration executed in the punctim technique on necklace no. 1, C. Alleged linear pattern in the punctim technique on the corroded necklace no. 1, D–F. Traces of small casting defects, discernible in the form of material discontinuities and voids left by air bubbles trapped during the casting respectively on the necklaces no. 1 (D) and 2 (E, F) (photo by M. R. Biborski)

has revealed the presence of silicon (1.15%) in the metal, which makes it a multicomponent, tin-lead-silicon bronze (Cu-Sn-Pb-Si). The addition of lead, improving the castability of the metal, was by no means accidental, and silicon was surely intentionally added as well, since even in shares as low as over 1% it increases the elasticity of an alloy, a quality very desirable in this kind of artefact.

The raw material used in the manufacture of the brooch was most likely a bar cast from the bronze described above, which was next pulled through a drawing die (draw-plate) until the desired diameter and shape were obtained. This technique is suggested by traces in the form of parallel scratches along the wire's edges (Fig. 9: D). During the process, the wire was surely heated from time to time, in order to reduce the undesirable surface hardness aroused due to drawing, which could lead to breakages. The two spiral discs of the brooch were probably formed from two ends of the wire, and later the section between them was shaped into the figure-of-eight bow.

7. Concluding remarks

In the hoard from Zagórze we have a very rare case when a deposit of metal objects have been discovered and retrieved in the course of archaeological excavations, a situation known from no more than 30 cases in Poland (out of approx. 1100 hoards known).⁵

All the available analogies confirm the dating of the Zagórze hoard to HaD, which means to the period when deposits of bronze, and less often iron or bronze and iron, artefacts occur in large numbers in the Oder and Vistula basins (Blajer 2001, 293–297, 357–370, map 8). A different view in this respect was expressed by Sabine Pabst-Dörrer who believes that sets of ornaments containing spiral brooches (including those of the Strzebielinko and Krásna Hôrka types), as well as other finds containing objects from these sets, should be dated as early as the 8th–7th centuries BC (2000, 116–117), which is to HaC.

The hoard from Zagórze is somewhat isolated from other finds from the period. The geographically closest hoard is that from Trzebinia-Siersza in Dist. Chrzanów, discovered approx. 40 km to the north, but it has a different composition (Kostrzewski 1964, 66, pl. XXV:3–6). Much greater distance separates Zagórze from a cluster of hoards having similar composition, situated in the eastern part of the Dunajec River basin, with the closest find at Łącko, Dist. Nowy Sącz, being 80 km away. However, the bracelets and the decoration featuring on one of the Zagórze necklaces show clear connection to the Krásna Hôrka hoard in Orava, approx. 50 km to the south, which is linked with the Slovakian group of the Lusatian culture (Novotná 1984, 54–55).

The valleys of the Skawa and Orava Rivers were no doubt a convenient route linking the basin of the Vistula with that of the Vah River and further with the Danube basin, which means between the territories occupied by traditionally distinguished taxonomic units – the Górnośląsko-Małopolska (Upper Silesian-Lesser Polish) and Slovakian groups of the Lusatian culture. A starting point for future research should be the hypothesis positing the existence in this part of the West Carpathians of a local metallurgic centre. This centre may have produced its own variants of ornaments originally created in the Eastern Greater-Poland and Kuyavia, such as twisted necklaces with ends hammered flat and formed into rolls.

⁵ Before 2001, 21 hoards discovered in the course of archaeological excavations in Poland were published (Reguła 1980; Blajer 2001, 314, 324, 330, 333–336, 340, 343, 348, 351–352, 357–358, 361, 363, 368, 371). The research carried out during the last two decades, primarily in connection with large construction projects, have revealed further deposits, such as Aleksandrowice, Dist. Kraków (Blajer, Chochorowski 2015); Kaldus, Dist. Chełmno (personal information from Dr hab. Mirosław Hoffman); Ludwinowo, Dist. Włocławek (personal information from Wiesław Koszkuł, MA); Lutol Mokry, Dist. Międzyrzecz (Kirschke *et al.* 2012, 133, 291–292, fig. 12:1–2); Milejowice, Dist. Wrocław (Bugaj, Gediga 2004); Wrocław-Widawa (Sych 2011).

Acknowledgements

We are indebted to Mrs. Barbara Woźniak, MA, director of City Museum in Sucha Beskidzka for her support of this publication and made available the hoard for the metallographic detection and archaeological analysis.

We would like to thank Karol Dzięgielewski, MA, from the Jagiellonian University Institute of Archaeology in Kraków for his help in completing the list of analogies, for turning our attention to new publications and the views expresses therein, and for his valuable comments. We would also like to express our gratitude to Marcin M. Przybyła for his opinion concerning the state of preservation of the artefacts, and for carrying out conservation of items threatened by corrosion.

We are grateful to Mrs. Urszula Bąk, MA, for graphical layout of figures. The authors are grateful to Piotr Godlewski for linguistic consultation.

Skarb przedmiotów brązowych ze stanowiska 8 w Zagórze, pow. wadowicki

Podczas badań ratowniczych prowadzonych przez Pawła Micyka w 2012 roku na stanowisku numer 8 w Zagórze, pow. wadowicki, został odkryty skarb przedmiotów brązowych. W jego skład wchodziły trzy wielozwojowe bransolety spiralne z daszkowatej taśmy, z końcami zwiniętym w uszka, binoklowata bimetaliczna zapinka typu Strzebielinko oraz trzy pseudotordowane naszyjniki z końcami rozklepanymi i zwiniętymi w ruloniki. Skarb należy datować na okres HaD i łączyć z grupą górnośląsko-małopolską kultury łużyckiej. Spiralne bransolety oraz motyw zdobienia widocznego na rozklepanych końcach jednego z naszyjników (punktowane linie zygzakowate) mają analogie w zabytkach odkrytych w skarbie z miejscowości Krásna Hôrka, okres Tvrdošín na słowackiej Orawie. Wszystkie przedmioty metalowe zostały podane analizom chemicznym i technologicznym z zastosowaniem spektrometru typu Spectro-MIDEX (XRF). Taśma, z której zostały skrócone bransolety, została wykuta na odpowiednim wzorniku, zapinka została wykonana z drutu uzyskanego techniką przeciągania, a naszyjniki odlano metodą na wosk tracony. Ozdoby zostały wykonane z brązu o zawartości ok. 82,6–93% Cu i ok. 8–13,5% Sn, przy czym bardzo zbliżony skład chemiczny bransolet przemawia za odlaniem ich w jednym warsztacie, natomiast skład chemiczny naszyjników wyraźnie się różni.

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