ANALECTA

ARCHAEOLOGICA RESSOVIENSIA

VOLUME 17 RZESZÓW 2022

ISSN 2084-4409 | DOI: 10.15584/ANARRES

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FUNDACJA RZESZOWSKIEGO OŚRODKA ARCHEOLOGICZNEGO

Uniwersytet Rzeszowski
Kolegium Nauk Humanistycznych
Instytut Archeologii

WYDAWNICTWO UNIWERSYTETU RZESZOWSKIEGO

ISSN 2084-4409 DOI:10.15584/anarres

1987

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Home page: https://wydawnictwo.ur.edu.pl

RZESZÓW ARCHEOLOGICAL
CENTRE FUND
ul. Moniuszki 10, 35-015 Rzeszów, Poland
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Home page: www.froa.pl/

First edition, A4 format, 12,40 publishing sheets, 14,50 printing sheets, order no. 109/2022
Printed and binded: The University of Rzeszów Printing House

ANALECTA
ARCHAEOLOGICA RESSOVIENSIA
Volume 17 / Rzeszów 2022
ISSN 2084-4409
DOI: 10.15584/anarres

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ANALECTA
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ISSN 2084-4409
DOI: 10.15584/anarres

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DOI: 10.15584/anarres.2022.17.2

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New Finds of Bronze Axes from the Carpathian Foothills

Abstract

Pasterkiewicz W., Skała P. 2022. New Finds of Bronze Axes from the Carpathian Foothills. *Analecta Archaeologica Ressoviensia* 17, 25–36

This article presents the results of archaeological and metallurgical research on two axes made of bronze, discovered in 2020 in two locations: Izdebki, Brzozów district and Gogołów, Strzyżów district. It was possible to determine the cultural context and chronological affiliation of the artefacts. The axe from Izdebki was classified as a type with elevated edges, dated to the BrB phase and associated with the Otomani-Füzesabony culture, whereas the item from Gogołów was classified as a socketed axe with ornamented sides, dated to the period corresponding to HaB1–HaB3. An analysis of the metallurgical composition of objects was carried out, examining the cores and their surfaces (corrosion layers). It was established that both axes represent so-called tin bronzes. The discovered artefacts should probably be considered loose finds.

Keywords: Carpathian Foothills, bronze axes, Otomani-Füzesabony culture, Gáva culture

Received: 19.10.2022; **Revised:** 10.11.2022; **Accepted:** 21.11.2022

In 2020, two bronze axes were donated to the Institute of Archaeology of the University of Rzeszów by anonymous finders. Along with the items, information about the detailed location of the finds (geographic coordinates) was provided with a description of the circumstances of the discovery and the context (depth, presence or absence of other objects in the vicinity of the finds).

The first of the axes comes from the village Izdebki, located in Brzozów district. The artefact was found on a vast elevation at an altitude of 456.7 m above sea level and 100 m above the valley floor (Fig. 1). This prominence is part of a hump divided by the valleys of two streams which are tributaries of the San river – the Magierka and the Wydrna. The item was supposed to be located in a small clearing, at a depth of about 30 cm, under a layer of modern turf.

The aforementioned axe is in fairly good condition (Fig. 2). It is covered with a patina of light and dark green colour, sometimes slightly brown. The artefact is damaged in several places, probably in the process of being excavated from the ground. It has defects on some parts of the outer surface, including the faces and the blade. The item has the shape of a slightly elongated rectangle with arched edges, approaching each other in the central part of the object. The blade is semi-circular in shape and slightly defined. The butt is slightly asymmetrical with a distinct narrowing in the middle part. In the side view, the axe has an axis of symmetry with a slightly convex shape, narrowing towards the blade and the butt. The faces are slightly faceted and have an "T"-shaped cross-section. The axe bevel is flat, quite neatly formed. Casting defects are visible on the tool in the form of mesh-like cracks covering the body (Fig. 3: A, B). They are quite extensive and have the character of unevenly spaced lines, longitudinal, diagonal and transverse, which intersect each other, dividing the surface of the axe into polygons. These defects were most likely caused by the rapid shrinkage of the liquid metal alloy while cooling down in the casting mould. There are no remnants of the casting flash mark on the surface of the object, which allows us to state that the artefact underwent careful treatment after casting. The axe has traces that suggest its use in

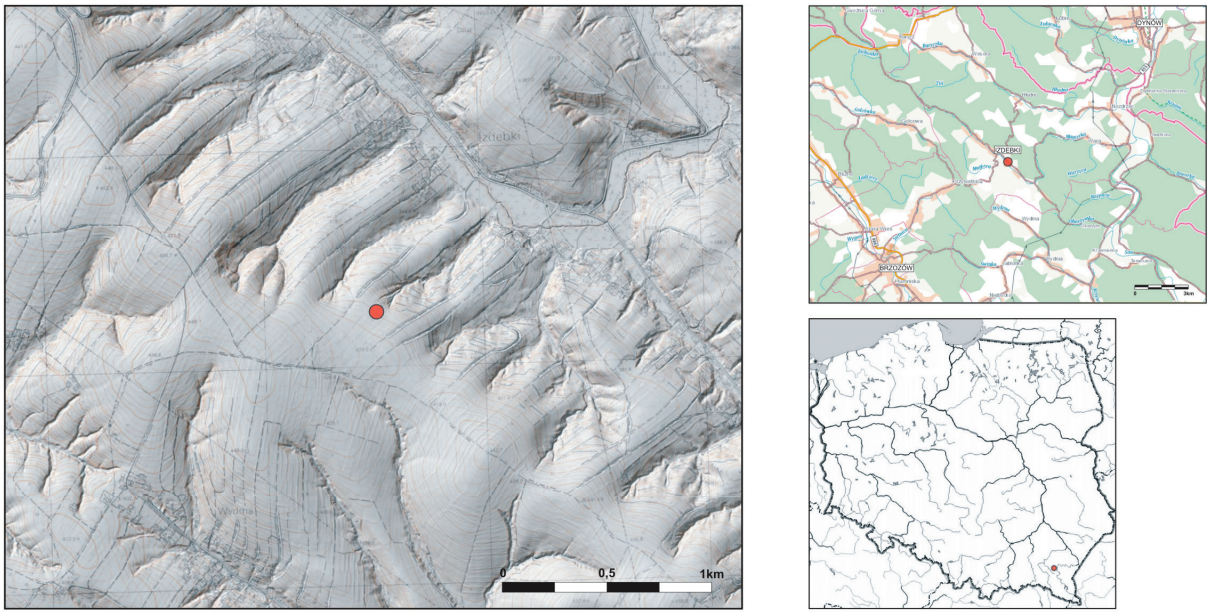

Fig. 1. The location of the place where the bronze axe was found in Izdebki, Brzozów district (prepared by W. Pasterkiewicz).

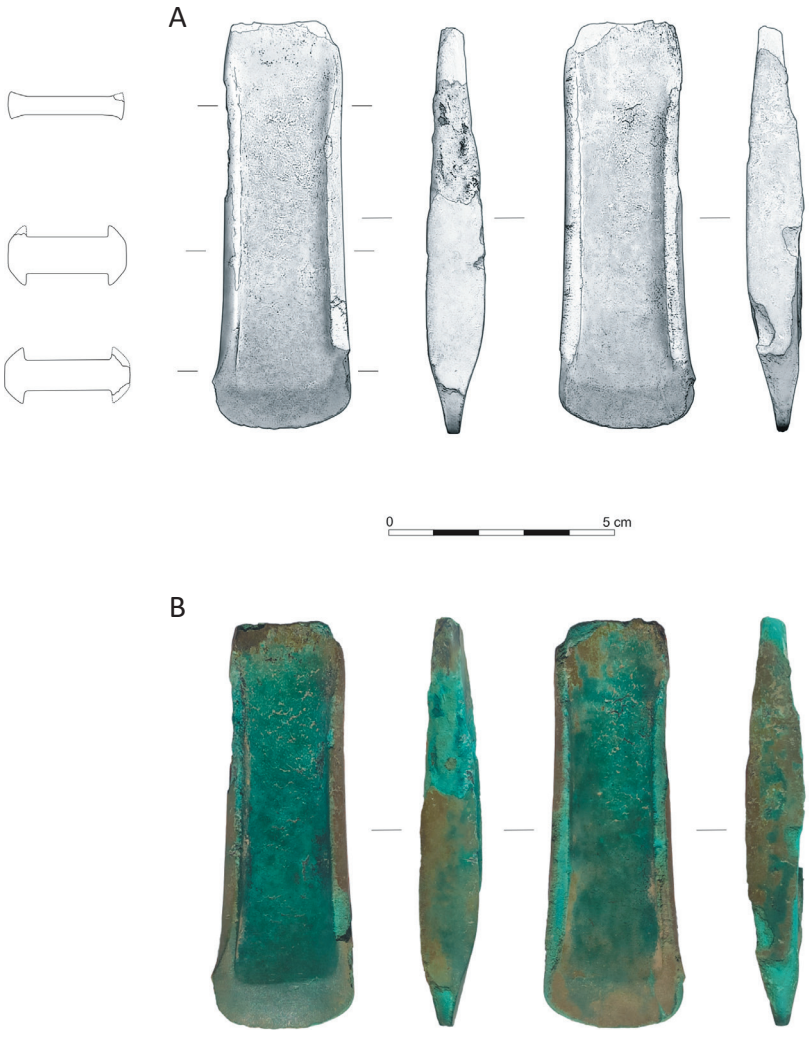

Fig. 2. The axe with elevated edges made of bronze from Izdebki, Brzozów district (drawn by A. Bardetsky, photo by W. Pasterkiewicz).

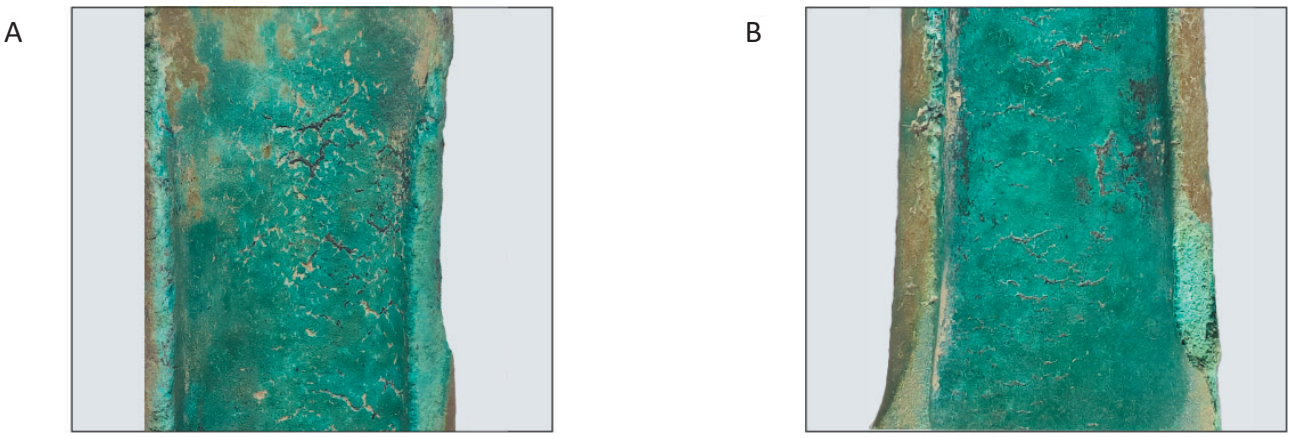

Fig. 3. Izdebki, Brzozów district. Casting defects in the form of mesh-like cracks on the surfaces of a bronze axe (photo by W. Pasterkiewicz).

prehistory. This is indicated by the slight deformation of one of the edges caused by forging or hammering with a hard object. Moreover, the cutting edge of the axe was frequently repaired (grinding), which led to a narrowing of the object and deformation of the shape of its faces. This might have changed the original shape and metric parameters of the tool, which is important in determining the type of the artefact (Szpunar 1987, 7, fig. 6). The metric features of the artefact are as follows: length – 9 cm; width at the blade – 3 cm, width at the middle part – 2.6 cm, width at the butt – 2.5 cm; thickness at the blade 1.2 cm, thickness at the middle part 1.4 cm, thickness at the butt 0.6 cm; the height of the edges – 0.35 cm; weight 114 g.

The typological features of the axe from Izdebki affiliate it to axes with elevated edges. This group of axes is quite plentiful in Poland among the cultures of the Early and Older Bronze Age (Sarnowska 1969, 63–66; Gedl 1975, 53–55; Szpunar 1987). They are numerous in north-western Poland, and their large concentration coincides with the territorial range of the Unietyce culture. In the case of south-eastern Poland, the extent of these axes coincides with the settlement zone of the Otomani-Füzesabony culture (Fig. 4). Currently, there are 7 known cases of such axes, which represent mainly single finds, discovered by accident in: Kobylany, Krosno district, site 37 (Gancarski *et al*. 2021a, 569–571, fig. 3, 4), Miejsce Piastowe, Krosno district (Pasterkiewicz and Dziedzic 2019, 280, fig. 2), Nowy Żmigród, Jasło district, site 38 (Gancarski *et al.* 2021a, 580–583, fig. 18, 19), an unknown village near Sanok (Blajer *et al.* 2021, 513–517, fig. 2), Trzcianiec, Bieszczadzki district (Blajer *et al.* 2021, 517–519, fig. 4), Krościenko Wyżne, Krosno district, site 14 (Gancarski *et al.* 2021a, 573–576, fig. 9, 10). Moreover, there is an item that is part of the deposit uncovered within the defensive settlement in Trzcinica, Jasło district, site 1 ("Wały Królewskie") on the Ropa river (Gancarski 2011, 25, photo 206). Single axes referring to such types are also known from the settlement in Jasło, site 29 (Gancarski 1988, 75, 78, fig. 10: 1) and Trepcza, Sanok district, site 2 (Gancarski and Ginalski 2001, 311, fig. 7: A).

The described axes with elevated edges can be classified into two groups differentiated by slight morphological features. The first one covers the Grodnica type according to A. Szpunar, i.e. axes with the influence of the Unietyce culture with the time frames BrA2/BrB1–BrB1 (Szpunar 1987, 51–52; Blajer 2001, 319). These artefacts occurred, among others. in the villages Kobylany, Jasło, Nowy Żmigród, Trepcza, Trzcinica, site 1, an unknown village near Sanok, Miejsce Piastowe. An item from Trzcianiec, belonging to the Brusy type, corresponding to I–II OEB, may have a slightly older chronological determination (Szpunar 1987, 18). In addition, there is one more artefact, from Krościenko, which can be linked with the culture of our interests. It represents flat axes with poorly marked edges, referring to the Eneolithic copper axes. It was included in a horizon corresponding to the BrA phase and the beginning of BrB1 according to Reinecke. The state of preservation of the artefact from Izdebki and morphological features classify it as an object in the group of axes with elevated edges, the Łuszczewo type or the Grodnica type, dated to the BrB period (Szpunar 1987, 47–49, 51–54). Due to its slender form, it has also several features in common with the item from Nowy Żmigród. These include the narrowing of the faces and the small height of the edges, a similar form of a side view, a notch in the butt and a narrow blade. It is also possible to notice the similarity in terms of the sizes.

Most of the axes discovered thus far in south-eastern Poland can be associated with the metallurgical

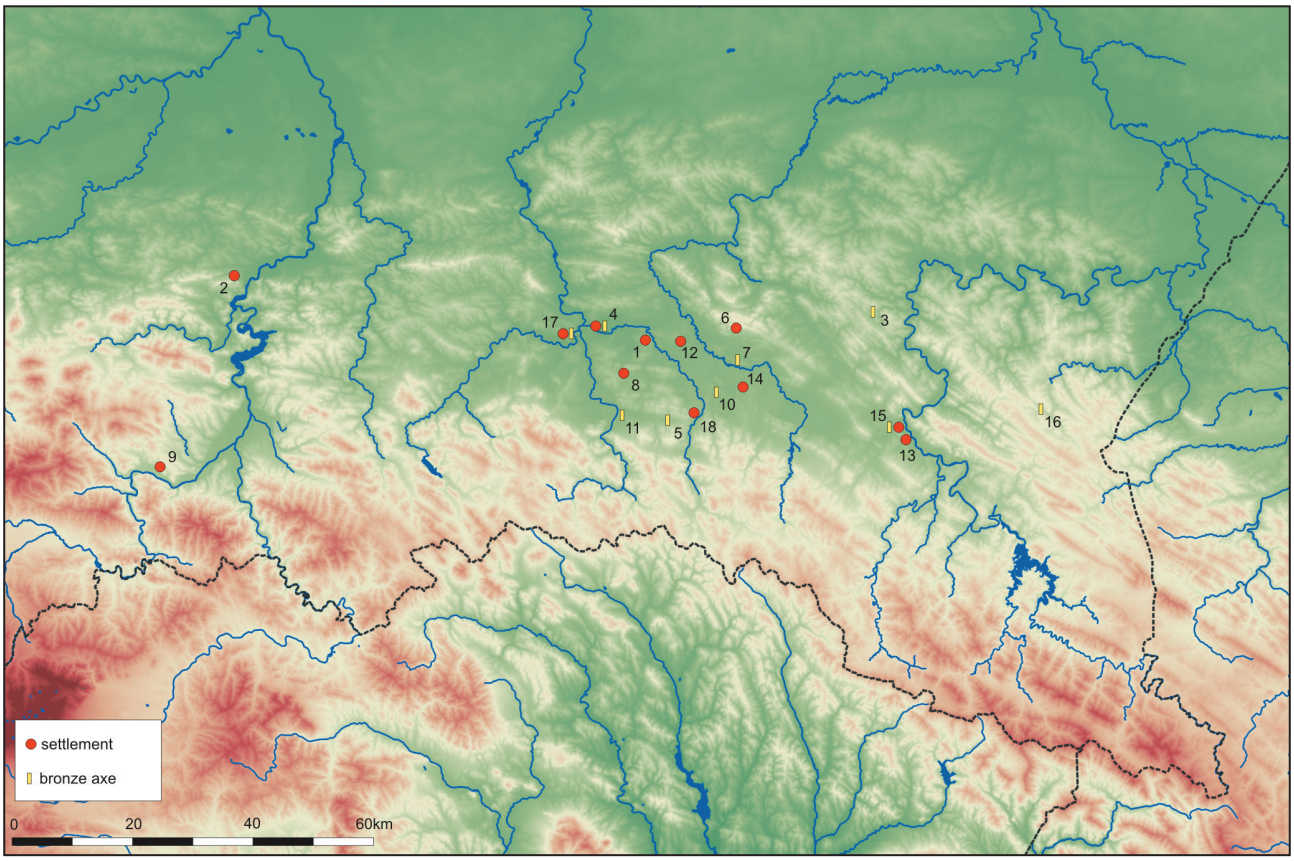

Fig. 4. Arrangement of axes with elevated edges on the background of the settlement of the Otomani-Füzesabony culture (prepared by W. Pasterkiewicz).

1. Brzezówka, Jasło district, site 10 (Gancarski et al. 2021b); 2. Czchów, Brzesko district, site 10 (Madej and Valde-Nowak 1999); 3. Izdebki, Brzozów district; 4. Jasło, site 29 (Gancarski 1988); 5. Kobylany, Krosno district, site 37 (Gancarski et al. 2021a); 6. Korczyna, Krosno district (Gancarski 2002); 7. Krościenko Wyżne, Krosno district, site 14 (Gancarski et al. 2021a); 8. Łajsce, Jasło district, site 9 (Gancarski 2002); 9. Maszkowice, Nowy Sącz district, the "Góra Zyndrama" site (Jędrysik and Przybyła 2019); 10. Miejsce Piastowe, Krosno district (Pasterkiewicz and Dziedzic 2019); 11. Nowy Żmigród, Jasło district, site 38 (Gancarski et al. 2021a); 12. Potok, Krosno district, site 6 (Gancarski 2002); 13. Sanok, site 56 (Gancarski 1994); 14. Targowiska, Krosno district, site 14 (Muzyczuk 2007); 15. Trepcza, Sanok district, site 2 (Gancarski and Ginalski 2001); 16. Trzcianiec, Bieszczadzki district (Blajer et al. 2021); 17. Trzcinica, Jasło district, the "Wały Królewskie" site (Gancarski 2011); 18. Wietrzno-Bóbrka, Krosno district, site 11 (Gancarski 1994).

production of the Otomani-Füzesabony culture. Similar axes with elevated edges are known from Slovakia as loose finds and artefacts from settlements that can be dated to the corresponding chronological frames of the developed and late phases of the Otomani-Füzesabony culture (e.g. Hájek 1961). It is also possible that some of these axes are local products, coming from workshops located outside the Carpathian Basin. It may be indicated by the repeatability of the shapes of some items and their concentration in a small area of south-eastern Poland. Some of the moulds could have been produced there, in a local metallurgical workshop in Trzcinica (Gancarski 2011). In the light of the existing data of the Otomani-Füzesabony culture, it appeared at the earliest in the A2/B1 phase within the Jasło Basin (the settlement in Trzcinica), when there were late-Mierzanowice complexes in this area, whereas the disappearance of the discussed unit took place in the BrC phase (Gancarski 1999; 2002). The axes published to date range within the entire chronological framework of the development of the Otomani-Füzesabony culture in south-eastern Poland.

The discovery site is in the area no. 109–77 of the Polish Archaeological Record. No traces of the Bronze Age were found in the vicinity of the mentioned area. There are only Neolithic settlement points (a settlement and a flint workshop) in the area more than 1 km to the south-east marked as site no. 10 and 11 in Izdebki. As for the place where the axe was discovered, there were no other movable artefacts that could have indicated the presence of the hoard. It is also worth mentioning that the discovery of an axe with elevated edges took place in the middle San basin, i.e. beyond the compact range of the settlements of the Otomani-Füzesabony culture.

Considering the axe from Izdebki, a metallographic analysis was performed using a FEI Quanta 3D 200i scanning electron microscope (SEM) performing chemical microanalysis Energy Dispersive Spectroscopy (EDS), located in the Laboratory of Electron Microscopy and Preparation Centre for Innovation and Transfer of Technical and Natural Knowledge of the University of Rzeszow. As a result, information was obtained on the chemical composition of this item and the processes taking place under post-deposition conditions. As shown in Tab. 1, the object is made of bronze with a high tin content (over 29%). Apart from copper, the following elements have been identified: arsenic, silicon, phosphorus, lead and an increased content of oxygen and carbon (Fig. 5–7). On the other hand, a low share of copper in the samples taken was found, amounting to 21%, which is caused by the oxidation of the top layer up to a depth of 2 mm.

The second axe comes from Gogołów in Strzyżów district, in the part of the village known as Równie. The artefact was found within the flattened, lower part of the hill slope, 337.4 m above sea level, which descends in the tongue like form to the south-east (Fig. 8). From the north it is surrounded by a deep gorge and tributaries of the Gogołówka River. Currently, it is the area of a vast forest complex with a beech and hornbeam stands.

The axe has a rectangular shape with arched long sides bent towards the inside (Fig. 9). The socket mouth has the shape of a flattened oval, smooth inside and rounded at the bottom. The blade is fan-shaped and runs smoothly to the middle part. The cutting edge is semi-circular, sharpened on both sides. In the side view, the axe is symmetrical, wedge-shaped, and in its cross-section it has a hexagonal shape. On the sides there are wide (about 3 mm) casting flash marks. The sides of the axe at the socket mouth are quite significantly displaced from each other, which indicates that the two parts of the mould did not fit well together during the casting process. On the narrower side, at the point of contact of both side planes, there is also a small hollow caused by the lack of alloy. It can also be a trace of the wedge-shaped plug being removed too quickly after the casting process. The tool also has a decoration in the form of convex ribs with a semicircular profile on each face. They are in groups of three, parallel to the outer edges. Towards the axis of the tools, they are gradually shortened diverging into an arc. Below the outer edge of the axe, there are also three horizontal rings, quite thick and not very regular in profile. They run around the tool, descending on the sides in the place of the casting flash. The entire surface of the artefact is covered with a green to dark green patina. Looking at the body, the sides, between the ribs and the loop, there are light brown coatings caused by corrosion processes taking place in the soil in which it was deposited. Similar traces are visible inside the socket mouth, additionally with a thin layer of hard and compact fine mineral grains of a light green colour. In several places (mainly on the faces) there are small scratches – damages caused during the excavation of the object by the finder. Moreover, there are also traces on the surface of the axe that may indicate its use in prehistoric times for work, such as

Table 1. Izdebki, Brzozów district. List of the results of the quantitative analysis of the EDS chemical composition of a sample taken from a bronze axe (analysis by P. Skała).

	First measurement		Second measurement		Third measurement		Mean and standard deviation	
	Wt%	At%	**Wt%**	At%	**Wt%**	At%	**Wt%**	At%
C	**14,3**	30,0	**14,3**	31,6	**17,9**	40,64	**15,5±1,7**	34,1±4,7
O	**34,2**	53,7	**28,6**	47,4	**24,3**	41,4	**29,0±4,0**	47,5±5,0
Cu	**20,8**	8,2	**30,1**	12,6	**14,0**	6,0	**21,7±6,6**	8,9±2,7
As	**1,6**	0,5	**1,8**	0,6	**1,3**	0,6	**1,6±0,2**	0,6±0,1
Si	**2,0**	1,8	**2,9**	2,7	**2,1**	2,0	**2,3±0,4**	2,2±0,4
P	**0,3**	0,2	**0,1**	0,1	**0,3**	0,3	**0,2±0,0**	0,2±0,0
Pb	**0,6**	0,1	**0,3**	0,1	**0,9**	0,1	**0,6±0,2**	0,1±0,1
Sn	**26,2**	5,5	**21,9**	4,9	**39,2**	9,0	**29,1±7,4**	6,5±1,8

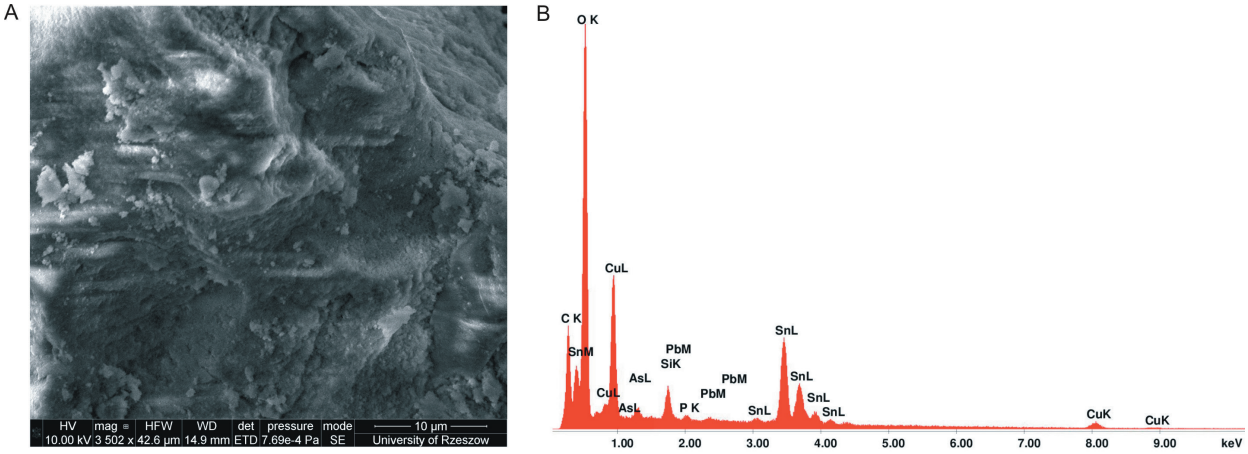

Fig. 5. Izdebki, Brzozów district. Research results of the EDS chemical composition of the bronze axe; the microstructure image, EDS spectrum; the first measurement (analysis by P. Skała).

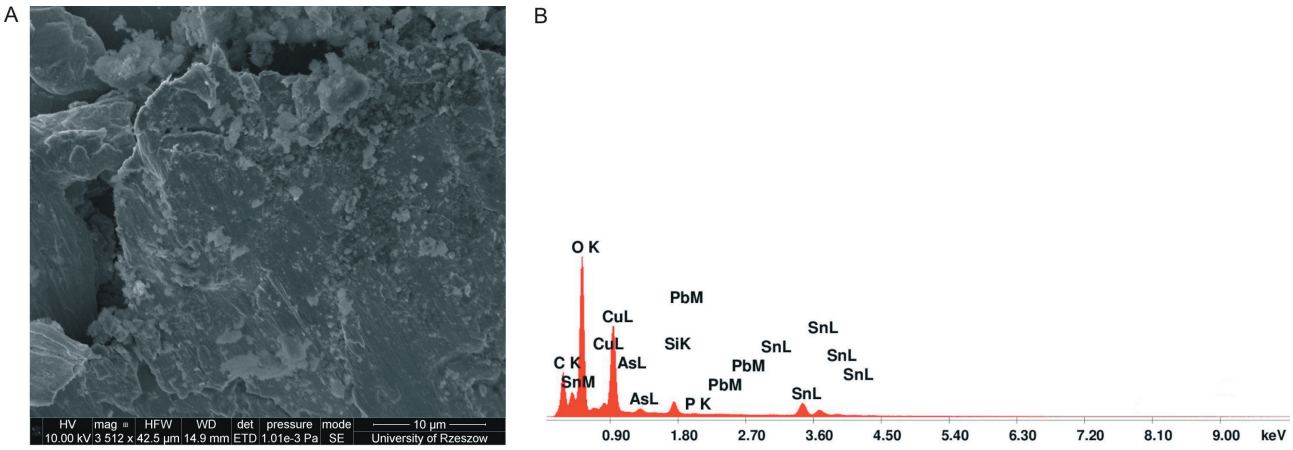

Fig. 6. Izdebki, Brzozów district. Research results of the EDS chemical composition of the bronze axe; the microstructure image, EDS spectrum; the second measurement (analysis by P. Skała).

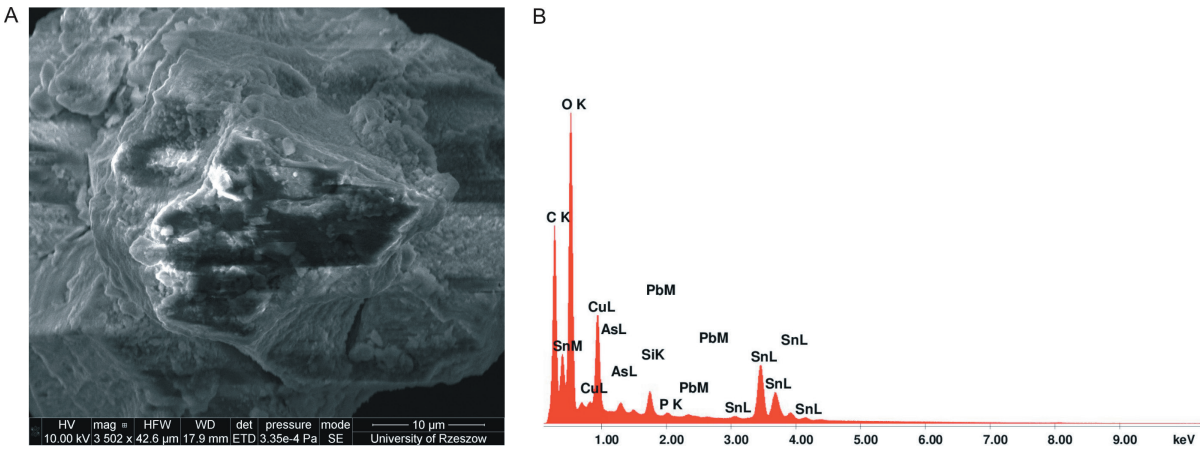

Fig. 7. Izdebki, Brzozów district. Research results of the EDS chemical composition of the bronze axe; the microstructure image, EDS spectrum; the third measurement (analysis by P. Skała).

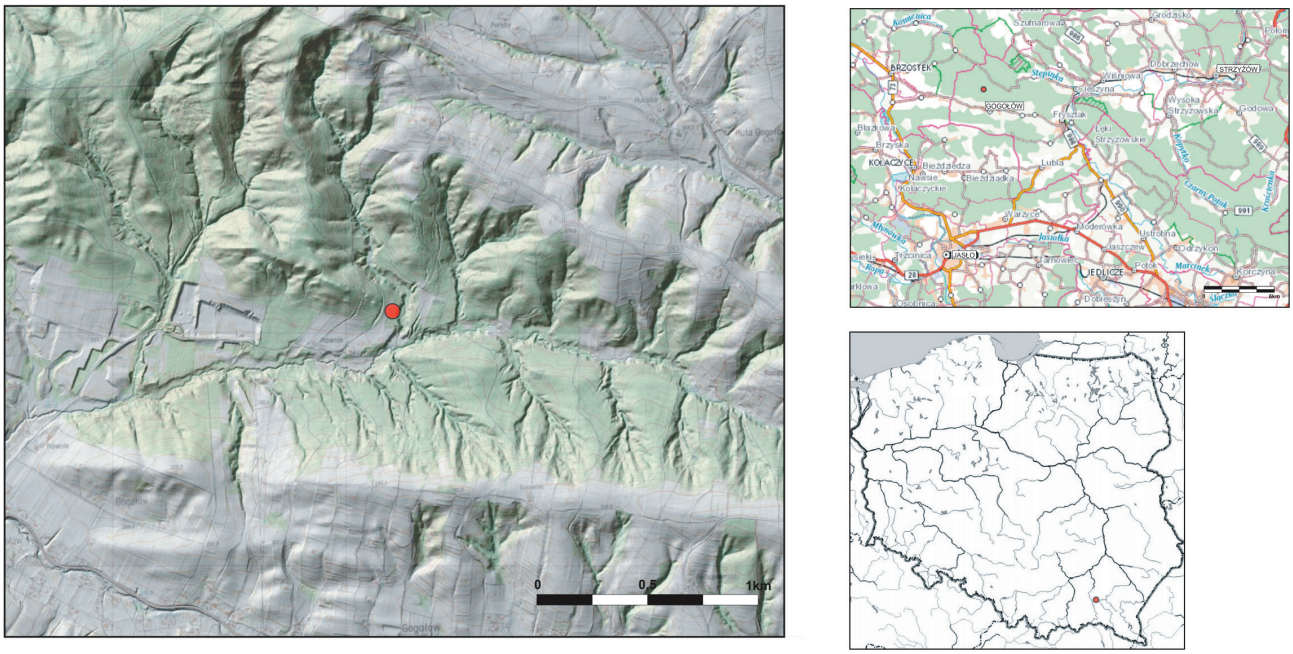

Fig. 8. The location of the place where the bronze axe was found in Gogołów, Strzyżów district (prepared by W. Pasterkiewicz).

the dulling on the edge along almost its entire length and scratches running parallel to the axis of the tool (Fig. 10: A). The blade has traces of multi-stage repair by hammering with a hard object. As a result of mechanical process, the casting flash was removed above the cutting edge and almost the entire blade was narrowed, changing its shape from trapezoidal to rectangular (Fig. 10: B, C). At the edge of the socket mouth, abrasions from the wooden shaft are also visible (Fig. 10: D). At the height of the middle part of the body there is a small, transverse crack, probably caused by the stress in the structure of the object when the blade was hammered (Fig. 10: E). Currently, the artefact has the following parameters: length – 10.4 cm; width at the blade – 4.4 cm, width at the middle part – 3.4 cm, the socket mouth – 5.1 cm; thickness at the middle part – 1.8 cm; the socket dimensions – 2.4 x 2.9 cm; the socket depth – 7 cm; weight 220 g.

Socketed axes were a very common form in Polish area in the Bronze Age, from III OEB to HaD (Kuśnierz 1998; Blajer 1999, 27–29; 2013, 30–38; Gedl 1975, 59–60). Their number is now, according to conservative estimates, almost a thousand and, as a result of numerous accidental discoveries, is constantly increasing (Blajer 2015, 162). General features of the item from Gogołów indicate a similarity to the axes classified by J. Kuśnierz to the Middle Danube type, a variant with richly decorated faces ("mit reich verzierten breitseiten"; Kuśnierz 1998, 21–24). Due to its ornamentation, the axe does not have faithful analogies among similar socketed axes from the Polish territory. The only good counterpart is an artefact discovered and published recently from the area of Wola Wyżna, Krosno district, near the border with Slovakia (Fig. 11: 1; Gancarski *et al.* 2021a, 590–594, fig. 28–29). However, the item is a bit shorter and has a poorly defined blade. On the wider sides there is a decorative motif with groups of quadruple, vertical ribs, and only two rings at the socket mouth. The find from Wola Wyżna was dated to the period corresponding to HaB2 and affiliated to the Gáva culture. Among the axes known from Poland, a slightly similar copy is known from Suchoręcz near Bydgoszcz (Kuśnierz 1998, fig. 5: 66). However, it has two rings at the socket mouth and slightly shorter ribs on the body. The collective deposit from Suchoręcz can be determined to the HaB1 period or to the half of IV OEB (Kuśnierz 1998, 22). Much more equivalents, formally close to the artefact from Gogołów, can be found in the areas south of the Carpathians. As for the bronze axes from Slovakia, collected and published by M. Novotná, the finds from Blatnica, Martin district (Fig. 11: 2; Novotná 1970, 94, fig. 41: 746), Medovarce, Zvolen district (Novotná 1970, 94, fig. 41: 747) and Slopná, Považská Bystrica district (Novotná 1970, 94, fig. 41: 750) have similar features. Moreover, the ornaments similar to those found on the axe from Gogołów are also found in large numbers on axes with a "beaked" widening of the socket mouth. These are the items known from Bošáca, Trenčín district (Novotná 1970, fig. 32: 570).

Fig. 9. The socketed axe made of bronze from Gogołów, Strzyżów district (drawn by A. Bardetsky, photo by W. Pasterkiewicz).

Individual, similar items are known from the area of today's Hungary. These are i.a. finds from Prügy, Szerencs district (Fig. 11: 3; Mezsolics 2000, 66–67, fig. 76: 8–10; 77: 1, 2, 4, 5), coming from a great hoard with a total of 44 axes and 18 bracelets. Hungarian artefacts are stockier, have more circular ribs, and the longitudinal ribs are slightly shorter. The hoard from Prügy is dated to the period corresponding to the horizon of Bükkszentlászló, i.e. to HaB3. Similar axes with longitudinal ribs (although not identical) can be identified in today's Romania, i.a. in the hoard from Uioara de Sus, Alba district (two double ribs on the sides; Petrescu-Dîmboviţa 1978, fig. 161: 17), Fizeşu Gherli II, Cluj district (two or three rings under the socket mouth, double or triple ribs on the sides; Petrescu-Dîmboviţa 1978, fig. 257: 21, 22), Hida, Sălaj district (Fig. 11: 4; three rings under the socket mouth, triple ribs on the sides; Petrescu-Dîmboviţa 1978, fig. 259: 4), Sângeorgiu de Pădure I, Mureş district (Fig. 11: 5; three rings under the socket mouth, double ribs on the sides; Petrescu-Dîmboviţa 1978, fig. 263: 30, 31), Mintiu Gherli II, Cluj district (two rings under the socket mouth, double ribs on the sides; Petrescu-Dîmboviţa 1978, fig. 266B: 2). The Uioara hoard is

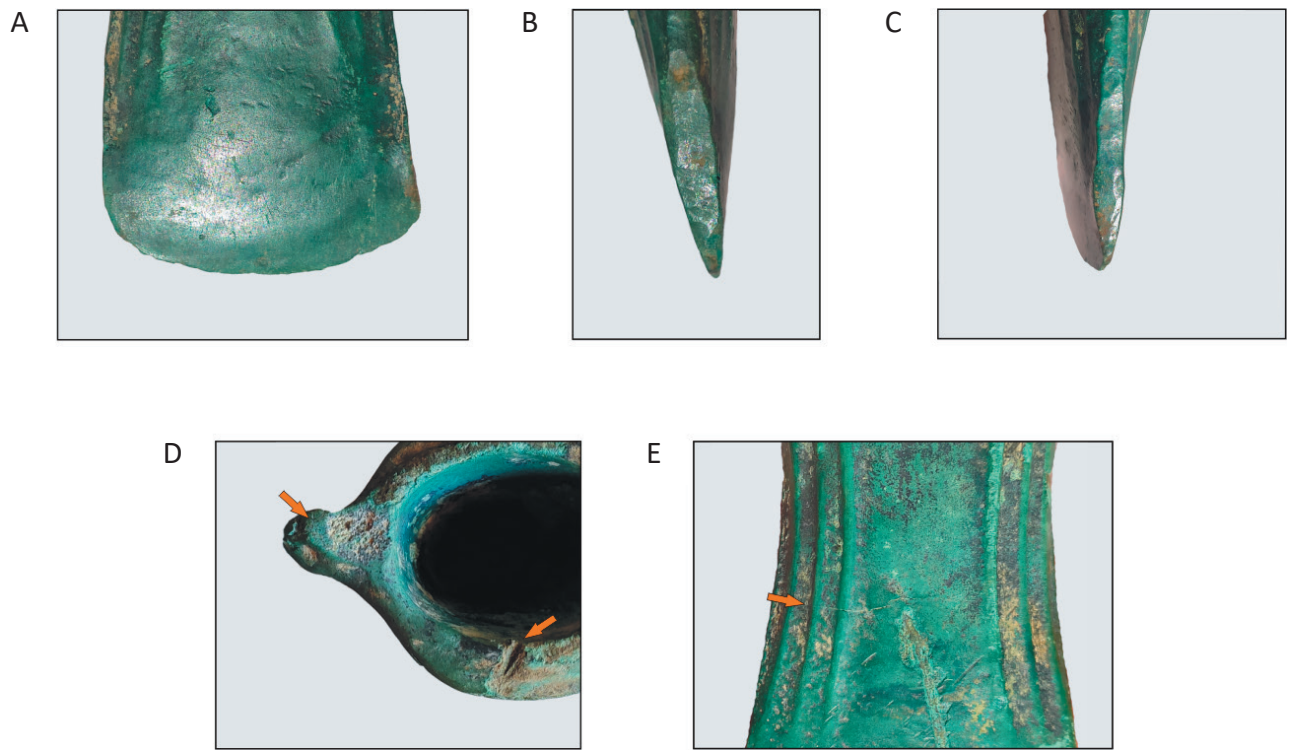

Fig. 10. Gogołów, Strzyżów district. Use-wear traces on the surface of the bronze axe (photo by W. Pasterkiewicz).

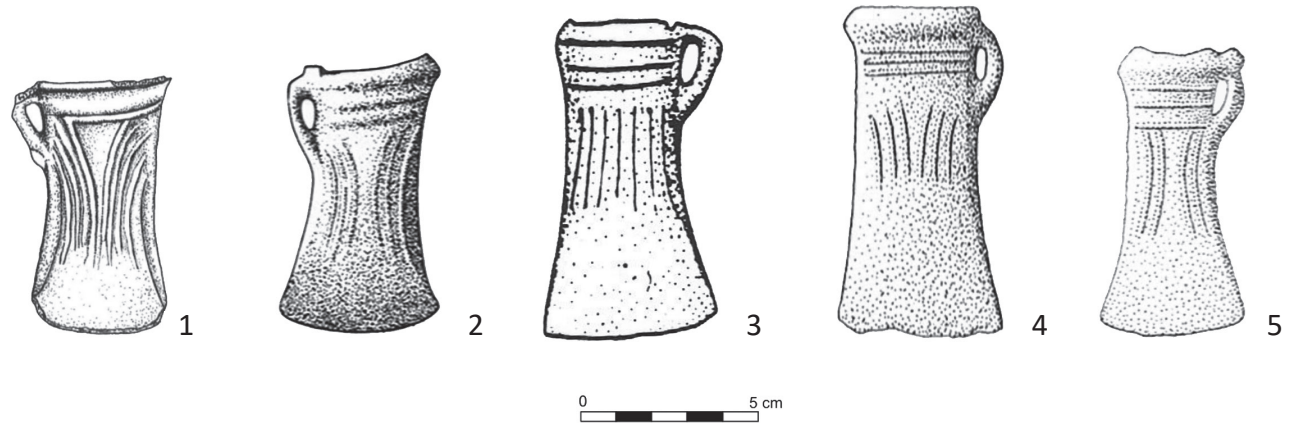

Fig. 11. Selected analogies to the bronze axe from Gogołów, Strzyżów district (prepared by W. Pasterkiewicz).

1. Wola Wyżna, Krosno district, Poland (after Gancarski *et al.* 2021a, 593, fig. 29); 2. Blatnica, okr. Martin, Slovakia (after Novotná 1970, 94, fig. 41: 746); 3. Prügy, kom. Borsod-Abaúj-Zemplén, Hungary (after Mezsolics 2000, fig. 76: 14); 4. Hida, jud. Sălaj, Romania (after Petrescu-Dîmboviţa 1978; fig. 259: 4); 5. Sângeorgiu de Pădure I, jud. Mureş, Romania (after Petrescu-Dîmboviţa 1978, fig. 263: 30).

dated to HaA1, Fizeşu Gherli, Hida and Sângeorgiu de Pădure I to HaB2 (Petrescu-Dîmboviţa 1977; 1978). It is worth noting that there are no formally similar items from Transcarpathia Ukraine in the collection of hoards published by J. Kobal (2000). All aforementioned closer or further analogies – if they can be dated – indicate the HaB1–HaB3 phases (i.e. the second half of the IV period and the V period of the Bronze Age), to which the Gogołów axe can be included.

Near the place of the axe discovery, within the Gogołówka and Stępinka river basins, there are many sites from the Bronze Age and the Early Iron Age, known from surface collection surveys (i.a. Gogołów, Strzyżów district, sites 1 and 2; Januszkowice, Dębica district, sites 3 and 4; Sowina, Jasło district, sites 2, 4, 5). Most of them indicate the existence of an intensively developing settlement in this area. Numerous remains of settlement from the Bronze Age are also

concentrated in the neighbouring areas, including the Warzyce Ridge (Gedl 1998; Czopek and Poradyło 2008). Excavation research carried out in one of the settlements – Warzyce, Jasło district, site 17 uncovered the traces of settlement in the Bronze Age and the Hallstatt period. There are numerous references to materials from the southern part of the Carpathians regarding the ceramic assemblage, which can be associated with the influences of the Kyjatice and Gáva cultures (Czopek and Poradyło 2008, 180). Based on ^{14}C dating as well as analyses of ceramic materials, the functioning of the older phase of the settlement can be related to the HaA period or slightly younger (Czopek and Poradyło 2008, 185, fig. 130). The axe from Gogołów seems to be contemporary to the "Warzyce" type sites coming from the Warzyce Ridge. It is most likely a trace of economic exploitation of the area. This suggestion is confirmed by numerous use-wear traces on the item.

As part of the metallurgical analyses for the axe from Gogołów, quantitative measurements of the chemical composition of the artefact were made (Tab. 2; Fig. 12–14). They have indicated that the material of the axe is almost pure tin bronze. Apart from copper (78.6%), the second, significant element is tin (over 10%). The chemical composition also includes carbon and oxygen in small amounts, less than a few percent, which should be interpreted as contemporary contamination.

Taking everything into account, the discovered artefacts are highly valuable, increasing the collection of sources necessary in the research on the Bronze Age period in the Carpathian Foothills. The axe from Izdebki completes the collection of bronze products related to the metallurgy of the Otomani-Füzesabony culture. It could have been a trade item or a trace left by the population of the Otomani-Füzesabony culture migrating to the north. It may indicate the existence of a trade route at that time, with the axis running along the San basin.

Table 2. Gogołów, Strzyżów district. List of the results of the quantitative analysis of the EDS chemical composition of a sample taken from a bronze axe (analysis by P. Skała).

	First measurement		Second measurement		Third measurement		Mean and standard deviation	
	Wt%	At%	**Wt%**	At%	**Wt%**	At%	**Wt%**	At%
C	**6,3**	22,6	**3,5**	16,2	**7,1**	25,1	**5,6±1,5**	21,3±3,6
O	**7,6**	20,8	**1,6**	5,5	**7,7**	20,9	**5,7±2,9**	15,7±7,2
Cu	**79,1**	54,1	**84,4**	73,4	**72,3**	49,2	**78,6±4,9**	58,9±10,4
Sn	**7,0**	2,5	**10,5**	4,9	**12,9**	4,8	**10,1±2,4**	4,1±1,1

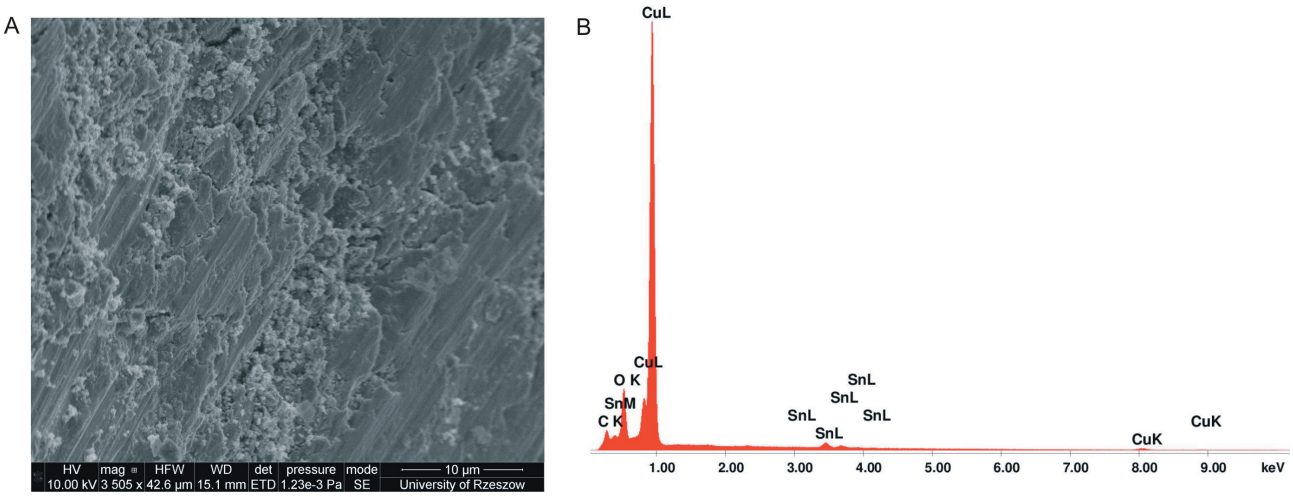

Fig. 12. Gogołów, Strzyżów district. Research results of the EDS chemical composition of the bronze axe; the microstructure image, EDS spectrum; the first measurement (analysis by P. Skała).

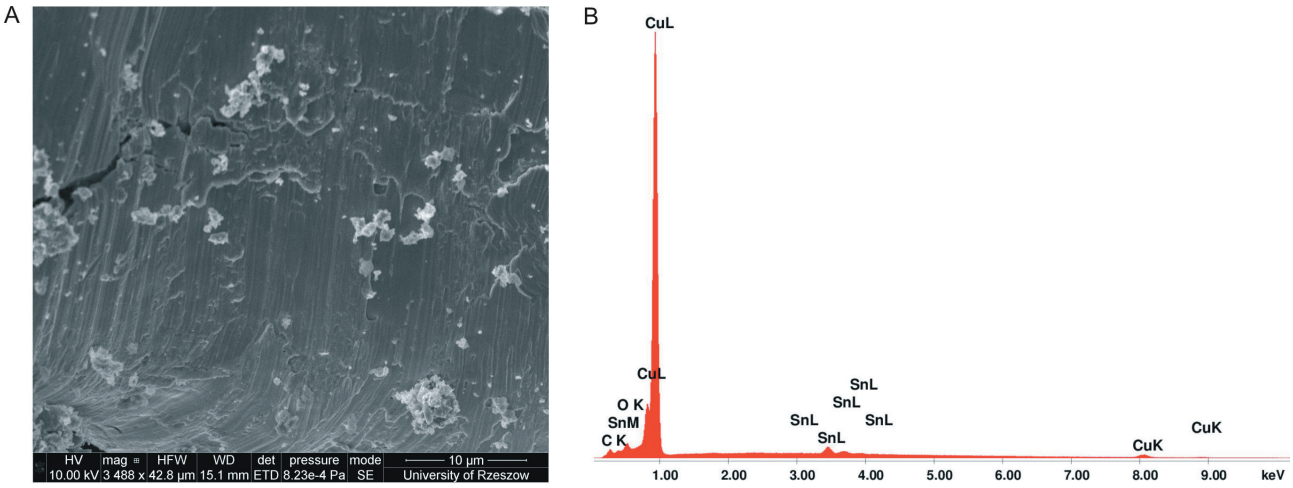

Fig. 13. Gogołów, Strzyżów district. Research results of the EDS chemical composition of the bronze axe; the microstructure image, EDS spectrum; the second measurement (analysis by P. Skała).

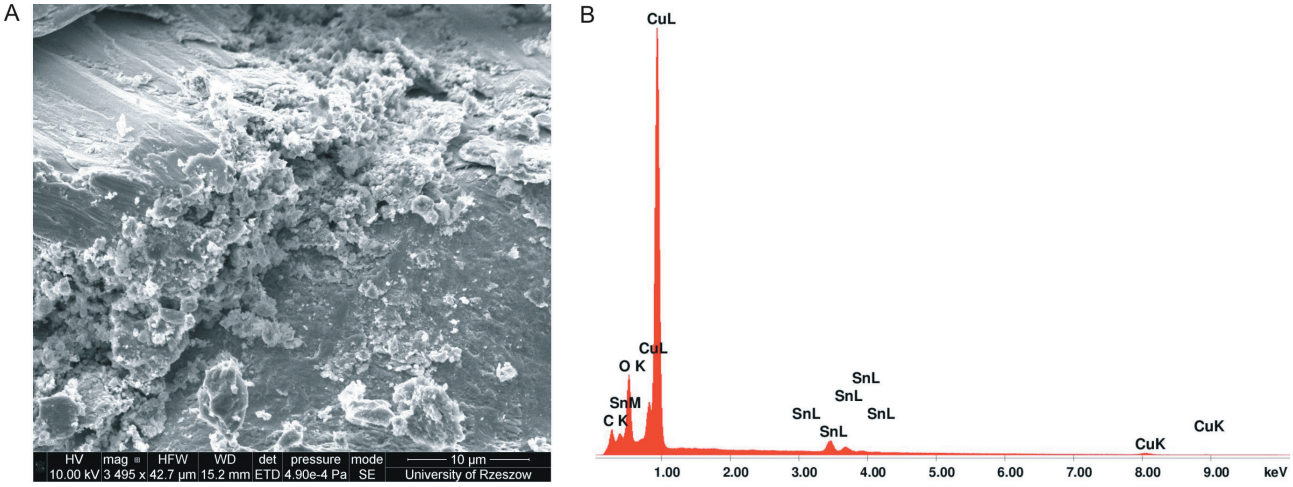

Fig. 14. Gogołów, Strzyżów district. Research results of the EDS chemical composition of the bronze axe; the microstructure image, EDS spectrum; the third measurement (analysis by P. Skała).

An indirect confirmation of this thesis may be the find of a dagger in Sieniawa near Przeworsk, about 60 km north-east of Izdebki (unpublished find). The axe from Gogołów has many features that indicate its distinctiveness from the products of local metallurgical production. It is clear evidence of lively contacts of the people living in the area of the Strzyżów and Jasło Foothills with the Carpathian Basin, which has been visible so far mainly in ceramic collections.

Acknowledgments

The authors would like to thank Prof. dr hab. Wojciech Blajer for his help and valuable comments in the typological determination of the artefacts, determining their provenance, as well as for helping to seek out some difficult-to-reach publications.

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