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"Precious swords eaten through by rust". The context of an early medieval sword found in the mountains near Jerzykowice Małe, Lewin Kłodzki commune, Poland

Abstract. The study situates the Jerzykowice Małe sword within the broader historical context. The correlation between high quality and iron-inlaid inscriptions underscores the symbolic and material value of such weapons.

Keywords: medieval, sword, martensite, inscription.

Introduction

One of the authors of this paper was asked by the Provincial Officer of Heritage Protection in Wałbrzych to professionally excavate and record a historically important early medieval sword discovered during a surface survey by a team of metal detectorists. The leader of the latter Konrad Oczkowski reported his discovery as required by the law (decision no. 126/22 of the Lower Silesian Provincial Conservator of Monuments, Wałbrzych Department), but declined to collect the weapon. The sword was found immediately below the summit of Pańska Góra (782 m a.s.l.), approximately 150 m northwest of the peak, at an altitude of 753 m a.s.l. near a steep mountain ridge in the forest topsoil of plot no. 37/2 belonging to the village of Jerzykowice Małe, Lewin Kłodzki commune, by the Polish-Czech border (Figs. 1–3).



Fig. 1. Location of the find on the overall map of Poland (developed by L. Marek)

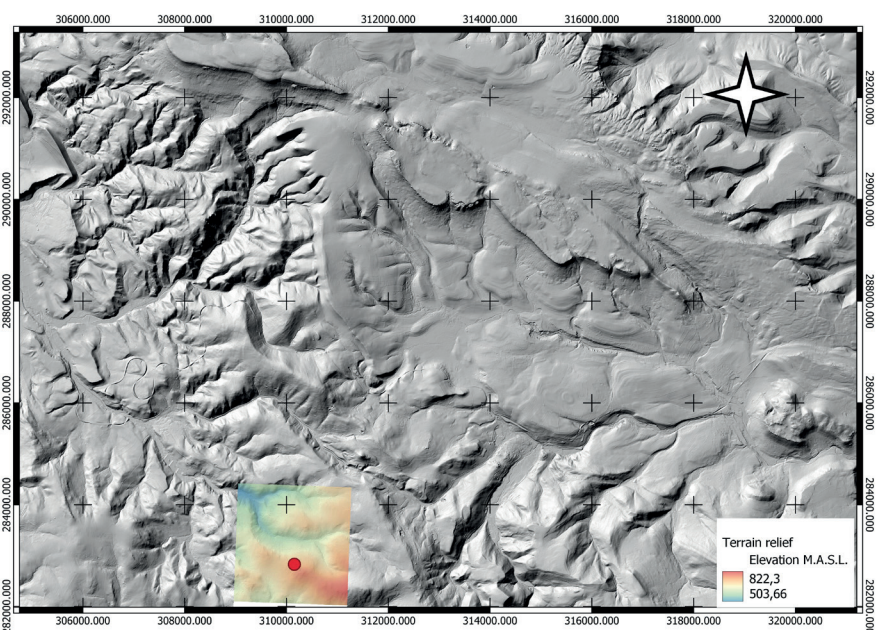


Fig. 2. Digital terrain relief model with elevation values and the marked find location (developed by L. Marek)

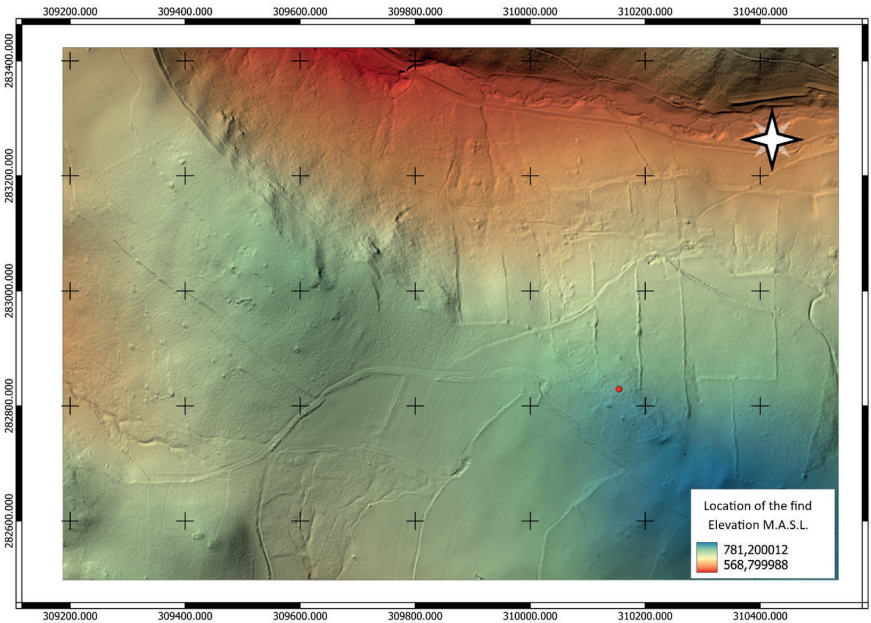


Fig. 3. Magnified digital terrain relief model with elevation values and the marked find location (developed by L. Marek)

On the 19th of July, 2022, a team of nine students from the Institute of Archaeology, University of Wroclaw supervised by Lech Marek and Marek Kowalski documented the object according to archaeological methods. After being discovered using a metal detector, the sword was carefully unearthed and all its spatial data were recorded. The find was mapped, including all the information obtained by means of LIDAR scanning.

The shattered weapon must have been displaced, damaged, and exposed by erosion, as it was found among young trees only ca. 10 cm below the ground surface, in forest-floor humus overgrown with small roots (Fig. 4). At first glance, the weapon's tang gives the impression of being deliberately broken. Upon a more careful examination, however, it can be concluded that most likely, it was damaged by post-depositional processes (Fig. 5a, b). The thin deposit containing the sword coated an underlying regolith layer.



Fig. 4. Photogrammetry of the sword when excavated with marked control points (see coordinate list) (developed by L. Marek)

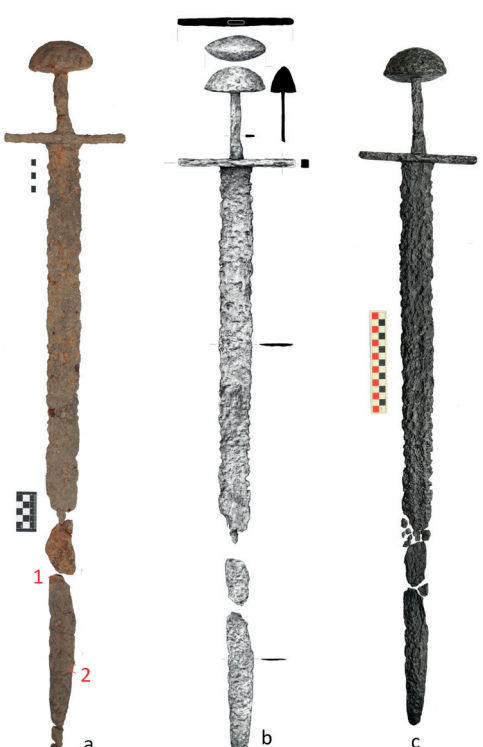


Fig. 5.
Sword from Jerzykowice Małe, 10th–early 11th century, Lewin Kłodzki commune, Poland: a – before conservation, marked with red sample no.1 and sample no. 2 taken from the edges for metallography; b – drawing of the sword after conservation; c – photograph of the sword after conservation (a – photo by B. Miazga and L. Marek; b – drawing by N. Lenkow; c – photo by L. Marek)

Methods

All the spatial data related to the find were collected using a Leica Total Station (Model 407) and a GPS RTK device (Hi-Target V30 GNSS) with a Q-Mini controller and the Hi-Target Hi-RTK Road programme. The data were processed in Agisoft Metashape and QGIS 3.22 software using the PUWG 92 (EPSG 2180) local coordinate system. The outline of the sword fragments was documented using 37 fixed points (Fig. 4) and photogrammetry. The weapon was then secured for transport, and the shallow trench was searched for further contextual data.

Archaeometric methods included metallographic investigations of the object based on sampling, precise micro-hardness testing (using a Zwick Roell ZKV 10 hardness tester), inner microstructure analysis, and microscopic structural observations with the application of a Nikon Eclipse LV100 metallographic microscope (Fig. 6), i.e., everything that allows us to draw proper conclusions concerning the quality of the interpreted artefact. Being aware of the most recent developments in non-destructive methods, such as neutron tomography and neutron diffraction for analysing the microstructure and different steel components in sword blades (Grazzi *et al.* 2018, pp. 834–842), we decided to limit the size of the samples taken from the edges of the investigated weapon near its point (Fig. 5: a). Otherwise, in order to learn as much as possible about the technology of the sword, one needs to cut the blade halfway or all the way through, visibly damaging the object (Moilanen 2015, p. 51).

Non-destructive methods included medical X-ray analyses, which produced two images of the sword blade (Fig. 7). This was done to reveal iron-inlaid marks and letters expected in this area based on matching examples documented in the literature (Leppäaho 1964, pp. 16–17). One digital radiograph (Fig. 7: a, c) was produced with the following radiation values: Exposure Index: 877, Target Exposure Index: 393, Deviation Index: 3.5 (upper part with the crossguard); the other (Fig. 7: b) with: Exposure Index: 1440, Target Exposure Index: 393, Deviation Index: 5.6. The images were analysed using QXLink Portable Viewer software. Radiographs were also commissioned at the Wrocław Technology Park and carried out by Piotr Wilk using an industrial CT scanner. These were particularly useful for examining the internal structure of the pommel (Fig. 8: a) and confirmed the data yielded by medical radiography. Everything mentioned above was done before the careful conservation process to which the artefact was subjected at the Department of Archaeometry and Conservation of Archaeological Artefacts in the Institute of Archaeology, University of Wrocław. Measurements of the weapon were taken both before and after the conservation. Some blade splinters, for example, initially interpreted as coming from the weapon's point, proved to belong to the middle section. Thus, there is a discrepancy in the blade's length recorded before and after the process. Next, we decided to apply a non-destructive method of revealing hidden

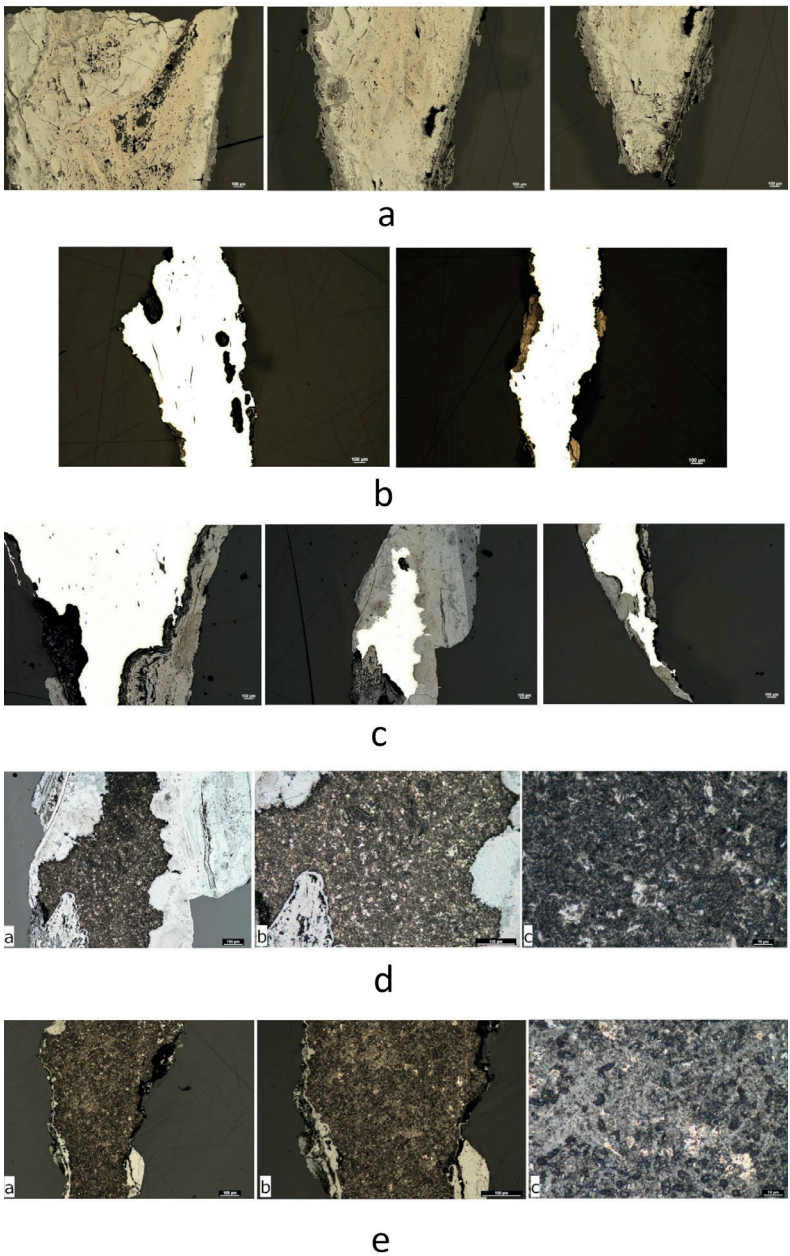


Fig. 6. Photomicrographs: a – corroded metallic phase in sample no. 2, magnification 50x; b – visible metallic phase, corrosion layers, and non-metallic inclusions in sample no. 2, magnification 50x; c – visible metallic phase, corrosion layers, and non-metallic inclusions in sample no. 1, magnification 50x; d – microscopic image of the sword's edge cross-section – sample no. 1; a very fine-grained structure is visible throughout the cross-section, etched with nital, magnification 100x (a), 200x (b) and 1000x (c); e – microscopic image of the sword's edge cross-section – sample no. 2. A very fine-grained structure is visible throughout the cross-section, with a slight amount of ferrite grain formation, etched with nital, magnification 100x (a), 200x (b) and 1000x (c) (photo by B. Miazga)

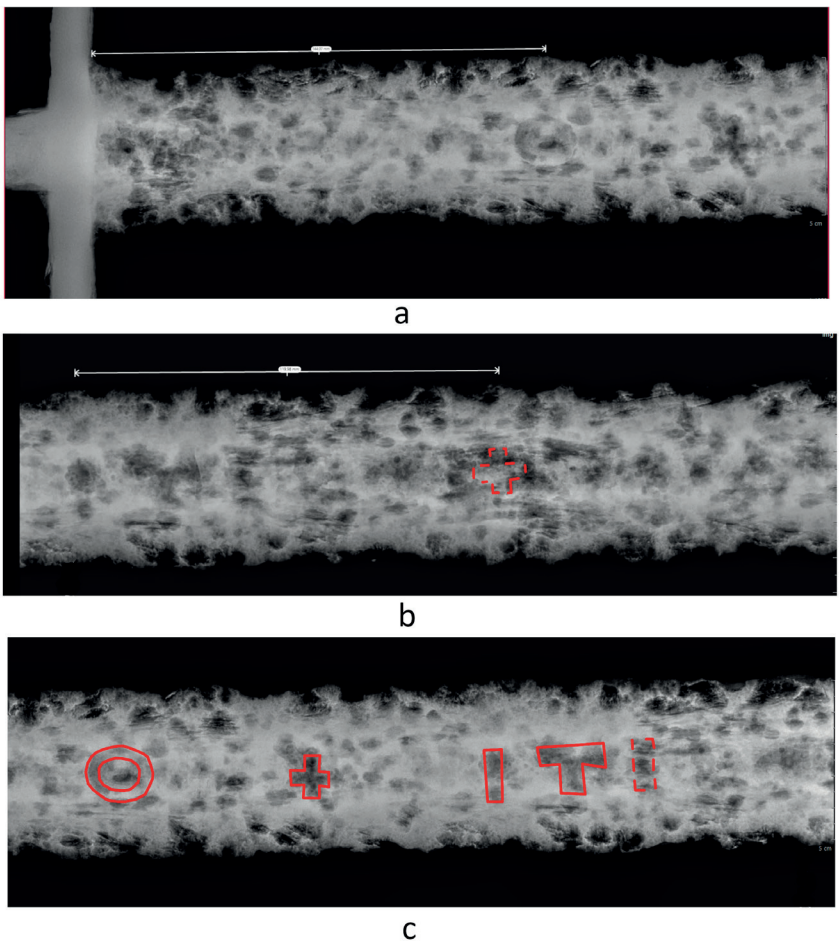


Fig. 7. Medical radiographs of the sword blade from Jerzykowice Małe: a – letter O legible at a distance of 14.4 cm from the cross-guard, followed by a Greek cross (20.2 cm from the guard); b – letter I T and probably another I at a distance of 25.97 cm from the guard; the inscription ends with another Greek cross revealed by thermography (not the X-Ray) at a distance of 38 cm from the guard (marked with red); c – legible symbols and letters marked with red (snapshots by L. Marek)

iron inlays on early medieval sword blades with the use of a thermal camera Testo model 872s (Thermal image technical specifications: Infrared resolution 320 x 240; Noise-Equivalent Temperature Difference <50 mK; Field of View 42° x 30°/< 05 m; Instantaneous Field of View 2.3 mrad; Super Resolution 640 x 480 pixels/1.3 mrad; Image Refresh Rate 9 Hz; Wavelength range: 7.5–14μ)[1]. This method, based on heating the sword to ca. 50°C and recording the object's response at subsequent stages of cooling, was first applied during the investigation of two 10th–early 11th-century swords from Ostrów Lednicki and the Lake of Lednica (Więcek *et al.* 2011, pp. 133–137). It proved successful in obtaining images of the blade's iron inlays, otherwise obscured by corrosion (Fig. 8: b, c). The thermal response is usually different in blade areas characterised by higher or lower density. Thermal maps of the analysed sword blade were processed using Testo IRSoft and GIMP software. Although another method for revealing iron inlays on blades is highly effective, we decided to refrain from using it due to the risk that it poses to the object's integrity, as it is based on mechanical cleansing, polishing, and etching of the blade surface using acids or reagents that react differently with iron and steel alloys (Moilanen 2015, p. 46). In our opinion, the risk of causing additional corrosion to the object in question is too high if the acid is not properly neutralised.

Results of the expert analysis

Technological investigations were conducted on two blade samples taken from the edges, where the metallic phase was still preserved. A microscopic analysis before etching confirmed the presence of not only non-metallic (slag) inclusions in the metallic matrix, but also significant corrosion, visible not solely in the near-surface area, but also throughout the cross-section (Fig. 6: a–c). After etching sample no. 1 with Nital, a very fine-grained microstructure was observed, with larger grains formed in the central part and evenly distributed throughout the cross-section of the sample (Fig. 6: d). Upon magnification, the image was identified as martensite mixed with larger ferrite grains. The second sample tested showed a similar image: the structure was very fine-grained, albeit with significantly fewer ferrite grains (Fig. 6: e). Microhardness testing of the sword found values within a wide range, with 352–503 HV for sample no. 1 and 405–684 HV for sample no. 2. These structural features and microhardness values indicate careful and thoughtful work by the sword maker, taking into account the weapon's function. The edge is hard, but the presence of softer ferrite structures reduces its hardness and therefore brittleness.

[1] The authors would like to thank PE MA Paweł Jędrzejewski for his professional advice and for providing us with all the necessary equipment used for thermography.

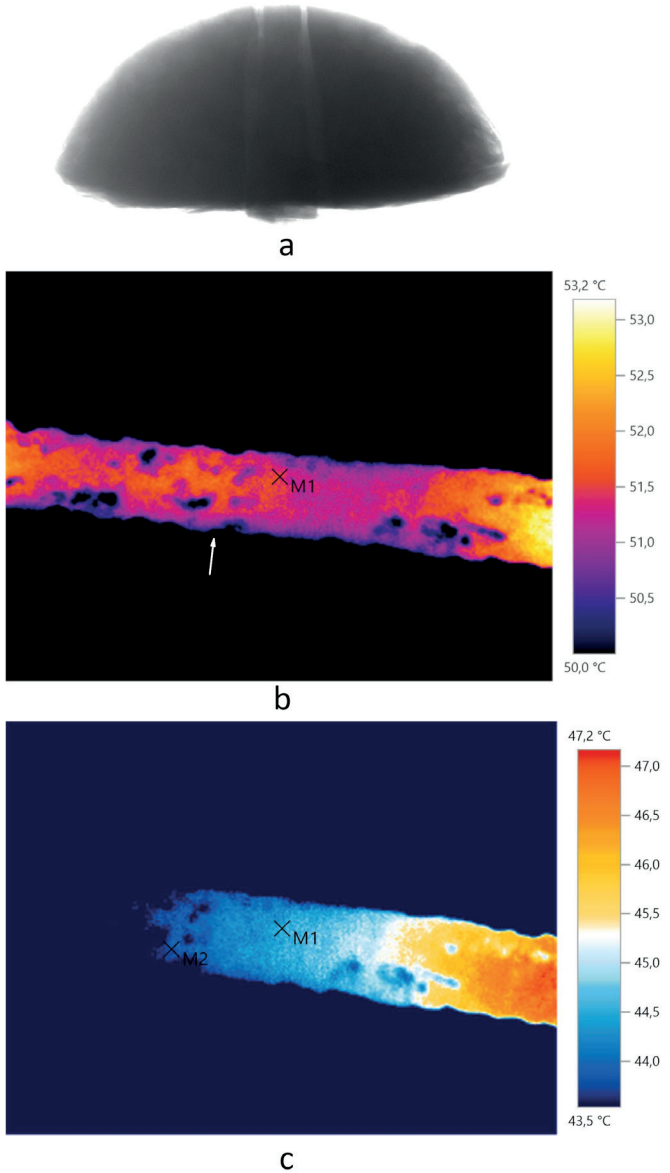


Fig. 8. Sword from Jerzykowice Małe, radiograph with thermal images: a – industrial radiograph of the solid pommel with the visible tang channel; b – thermal image of the blade heated to the temperature of 50–53°C, showing the sign of a cross (marked with a white arrow) at a distance of 38 cm from the guard; c – another thermal image of the blade 43.5–47.2°C showing the same cross at a distance of 38 cm from the guard. Temperature of point M1 – 44.5°C, temperature of point M2 marked on the sign of the cross – 43.8°C (a – photo by P. Wilk; b – c – photo by B. Miazga and L. Marek)

The radiographs revealed clear traces of an iron-inlaid inscription on the blade (Fig. 7: a–c). Some of the inlays probably fell out due to excessive corrosion, leaving only imprints on the blade's surface in the form of letters and symbols.

A symbol resembling a circle or the letter O is legible at a distance of 14.4 cm from the crossguard, followed by a Greek cross (20.2 cm from the guard) (Fig. 7: a). Further, we may see the letter I (25.97 cm from the guard), with T and signs that may be letters (Fig. 7: b, c), ending with another Greek cross revealed by thermography at a distance of 38 cm from the guard (Fig. 7: b, Fig. 8: b, c). A radiograph of the sword pommel confirms its bulky construction and forging from a solid piece of iron (Fig. 8: a). Only a narrow channel was cut from the bottom to the top to accommodate the tang. As revealed by another radiograph, a special cutout for the blade shoulders is made in the crosspiece, and a considerably narrower tang hole is cut in the back of the sword guard.

Historical landscape context

Pańska Góra is the only significant peak of the short side ridge of the Orlickie Mountains, which slopes westward from the main ridge of this range – the keystone is today's Kozia Hala (no German name), or more precisely, the shallow pass between the peaks of Jeleń (German: *Hirsch-Berg*) and Krupy (German: *Graupe-Berg*). The northern slopes of this side ridge descend towards the valley of the Klikava stream, a left-bank tributary of the Metuje, which is already within the North Sea basin and the Elbe river basin. The opposite slopes of this valley lie within another physiographic unit of the Central Sudetes – the Lewińskie Hills. These two mountain ranges – the Orlické Mountains and the Lewińskie Hills – are separated by the Polskie Wrota (Polish Gate) Pass (660 m a.s.l.; German: *Hummelpaß*), located 2.5 km in a straight line from Pańska Góra.

Since the prehistoric times, a trans-Sudeten route has passed through the Polskie Wrota Pass, connecting the region that later became Prague via today's Eastern Bohemia and the Kłodzko Land with the vicinity of Wrocław and the entire Odra River basin. Evidence for this route in the past includes several Neolithic stone axes (Lewin Kłodzki, Witów, Duszniki-Zdrój) and Roman coins, including those from Duszniki-Zdrój and Wolany near Polanica-Zdrój (Konik 1965, p. 156; Lodowski 1972, p. 5 *ff*.; Jaworski 2012, pp. 26, 39 – older literature there). The route through the Polskie Wrota Pass was also the most convenient passage from the eastern Elbe basin to the Odra basin – the areas east of the pass are drained by the Bystrzyca Dusznicka River, a left tributary of the Nysa Kłodzka.

The unique geographical context of the former route, which passed through the Polish Gate, was emphasised early in historical literature, among others, in the works of Joseph Kögler (1799), the father of Kłodzko historiography, who wrote at

the turn of the 19th century. In German historical literature, including that penned after the Second World War, the section of the Prague – Kłodzko – Wrocław route through the Kłodzko region is commonly referred to as the Polish Road (German: *Polenweg*; Albert 1932, p. 30 *ff.*; Weczerka 2003, p. 200). This name was adopted by Polish historians shortly after the war (Dziewulski 1948, pp. 30, 39). It also signifies this communication route in Czech literature (Cetwiński *et al.* 2012, p. 49 *ff.*).

Almost all the historians who addressed the Polish Route emphasise the exceptional importance of Homole Castle that guards the Polish Gate pass and is referred to in medieval sources as Landfrede (1366), Landes-Frede (1387), Landfred (1392), Landfried alias Homole (1403), Landsfridt (1408), Landesfried (1414), castrum dietum Homoly (1427), Homule (1428), and Homel (1477) (Klemenz 1932, p. 27; Jaworski 1988, p. 13; Sobczyński 2020, p. 85). The stronghold was built on the summit of Mount Gomoła (733 m above sea level; German: *Hummel*), directly above the pass on its northwestern side. In older literature, e.g., Georgius Aelurius's *Glaciographia* from 1627, there was even speculation about the age of this structure, dating it back to "before the birth of Christ," but relatively early, at the beginning of the 19th century, this was questioned by J. Kögler, and replaced by the concept that the fortification of Mount Gomoła took place in the 10th century during the reign of the Czech magnate Slawnik, who died in 981 and was mentioned by Cosmas of Prague (*Kosmas* 2012, lib. I, cap. 27, pp. 85–86) as the lord of, among others, the stronghold in Kłodzko (Jaworski 1988, p. 10 *ff.*, where the state of the discussion on the date and origin of Homole Castle is presented).

Although the earliest written mention of Homole Castle dates to 1350 (the document fails to name the castle, though), the archaeological research conducted in 2020–2021 on the ruins indicates early medieval origins. In the course of preliminary surface surveys (2020), several fragments of pottery from the late 9th–early 10th century were found in the summit forest clearing and on the northern mountain slopes. During excavations in several archaeological trenches, fragments of vessels from the early 13th century were found, mixed with the dominant materials from the 14th and 15th centuries (Jaworski *et al.* 2022, p. 92 *ff.*). Therefore, the discoveries at the top of Gomoła indicate that there must have been a settlement in the early Middle Ages in the immediate vicinity of Pańska Góra, where the sword was found.

The discovery of the sword from Pańska Góra can be considered a contribution to the debate among historians that has been ongoing for nearly two centuries concerning the location of the place mentioned by Cosmas as "Dobenina" (Palacký 1836, p. 304), where in 1068 the Czech army of Vratislav II gathered before a military expedition against Poland (*ventum erat ad custodiae portam, qua itur in Poloniam et in loco, qui dicitur Dobenina dux convocat populum et proceres in coentum*; *Kosmas* 2012, lib. II, cap. 23, p. 136).

Historians consider this record to be primary evidence confirming the existence of the Polish Way in the 11th century (Müller 1837, p. 103 *ff.*; Perlbach 1869, p. 271; Hegerhorst 1906, p. 20; Albert 1932, p. 19 *ff.*; Cetwiński 1990, p. 48 *ff.*). This toponym is identified, among others, with the immediate vicinity of Homole Castle (Eysymontt 1964, p. 106), with Vaclavice near Náchod, with the area of the village of Heřmankovice near Broumov, with the village of Dębowina near Bardo, and with the vicinity of Trutnov (Cetwiński 1990, p. 48 *ff.*). Among these proposals, it is worth noting that Dobenina near Vaclavice is about 20 km west of Pańska Góra. The flat plain at the western foot of the Orlické Mountains, at the confluence of the Metuje and Upa rivers, is well suited for the concentration of Czech troops. At the same time, it was a good starting point for a march towards the Kłodzko region and then Silesia – not only through Nachod, the Klikava valley, and the Polskie Wrota pass, but also via another route: immediately eastwards, initially up the Metuje River, then along its tributary Olešenka and through the southern slopes of Pańska Góra to the aforementioned shallow pass on the main ridge of the Orlické Mountains, slightly south (2.5 km) of the Polskie Wrota Pass. From this point, it was possible to quickly descend to the Bystrzyca Dusznicka valley, less than one kilometre to the east. This route was likely a convenient addition to the main Polish road, i.e., through the Polskie Wrota pass, or it could have been used to bypass the stronghold on Mount Gomoła. However, at this stage of research, it is not possible to provide even a preliminary verification of whether this hypothetical route was connected to the discovery of the sword from Pańska Góra.

Discussion

Despite being a chance find, the sword remains an invaluable source of information (Fig. 5). It is mounted with a hilt classified by Alfred Geibig (1991, pp. 70–72) as combination type 16, variant 1. This classification is based on a thorough metrological analysis of archaeological evidence from Europe. The same hilt type is also represented by robust, solid iron pommels reaching up to 11 cm in width (Geibig 1991, p. 70). Likewise, the straight iron quillons of Oakshott's style 1 are consistent with the metrological characteristics of A. Geibig's combination type 16, variant 1, and type ά according to Andrzej Nadolski's classification (Geibig 1991, p. 72). To date, over 35 swords representing A. Nadolski's ά type are known from Poland (Pudło 2012, p. 69). Among them, only a few may be considered precise analogues of the weapon from Jerzykowice Małe. Even fewer have been recorded by professional archaeologists. Hilts of this form may be dated to a period from the end of the 10th century to the fourth quarter of the 12th century. In Poland, massive, heavy iron pommels with a convex base, such as the one examined in this paper, occur mainly in the 11th century (Geibig 1991, pp. 146, 151, Fig. 39). An

early 11th-century weapon similar to the sword from Jerzykowice Małe was found during underwater archaeological investigations of the eastern bridge relics at the bottom of Lake Lednica. It is characterised by a blade forged from several rods of hard steel, with welded- on edges of high- carbon steel (0.6–0.77% C) (Biborski *et al.* 2011, p. 92), an iron- inlaid inscription + VLFBERT + H, and a large iron pommel (Pudło *et al.* 2011, p. 47, cat. no. 5, Plate 4. 1). Unlike its solid counterpart from Jerzykowice Małe, the latter comprises three separate elements welded together to form a hollow interior (Pudło *et al.* 2011, pp. 121–122, Plate 41). Similar bulky iron pommels, also hollow inside (Żabiński *et al.* 2014, pp. 33, 35), are mounted on swords from Charłupia Wielka, Sieradz district (Marek 2005, p. 127, cat. no. 145) and Płock – Winiary/Winnica (now the suburb of Płock) (Marek 2005, p. 134, cat. no. 228; Żabiński *et al.* 2014, pp. 33, 35). Based on the iron-inlaid INGELRII-type inscription, the latter may be more precisely dated to the 10th–11th century (Żabiński *et al.* 2014, pp. 105–106). Professional excavations at the early medieval stronghold in Rzymówka, Legnica district, yielded a crossguard and a massive iron pommel similar to the analysed find. The set of hilt elements found in building no. 36 of this fortress was dated by archaeological methods to the 11th century (Bykowski 1982, p. 67, Fig. XIX: e). Dendrochronological dating of other features excavated on the site (after 990 for feature no. 9; after 995 and 1018 for feature no. 24) is consistent with the preliminary dating based on ceramic contexts (Pankiewicz 2024, p. 384). The Jerzykowice sword's blade may be classified, with caution due to its poor state of preservation, as Geibig's type 5, which is dated in most cases to a period from the latter half of the 10th to the end of the 11th century (Geibig 1991, pp. 86, 153, Fig. 40). Sword blades of this variety can reach up to 91 cm in length, which is roughly consistent with the dimensions of the weapon in question.

Recently, an interesting discussion was presented concerning a group of long-bladed swords from Moymirid Moravia, which considerably predate their Northern and Western European counterparts (Hošek *et al.* 2021, pp. 81–82). They come from Great Moravian contexts dated to a period from the second half of the 9th century to the early 10th century. Scholars argue that the development of long-bladed weapons was strongly related to the transformation of the Frankish army, in which cavalry became the main pillar (Hošek *et al.* 2021, p. 79). Insufficiently interconnected by sea and river networks, the early Carolingian empire favoured cavalry (Hošek *et al.* 2021, p. 82). Fighting or training on horseback placed new demands on the design and quality of blades (Hošek *et al.* 2021, p. 79). The emergence of elite cavalry during the Carolingian period is widely regarded as the foundation of Western European knightly culture, both militarily and ideologically. Interestingly, the earliest sword inscriptions related to weapon-girding rituals, highly characteristic of the knightly accolade, appear also on Carolingian swords (Marek 2014, pp. 9–16). In the Southwestern Slavic milieu, the first under the influence of the Avar Khaganate and, after the late 8th century, under the Frankish

vogue for straight double-edged swords, both Nomadic and Carolingian traditions likely merged (Hošek *et al.* 2021, p. 82). In effect, cutting-edge sword forms could have been preferred in this area. Of course, one should exercise caution to abstain from far-fetched conclusions, since the Moravian long swords are an isolated and relatively scarce group of finds.

The sword from Jerzykowice Małe comes from a later time, as indicated by the typological and technological features of its blade. Although fragmentary, the iron-inlaid blade inscription also confirms the object's chronology. Based on the letters and symbols visible in the X-rays, we propose a hypothesis that it is probably the maker's name. The letters IT would constitute either an abbreviation or the end of the inscription FECIT. The most numerous group of swords, undoubtedly marked with the sword maker's name INGELRII (Kuśnierz 2006, p. 93), and sometimes also with the words ME FECIT (made me), is usually dated to the 10th–11th century (Moilanen 2015, p. 140; Košta *et al.* 2018, p. 7, Table 1). However, some examples might have been used as late as in the early 12th century (Bruhn-Hoffmeyer 1954, pp. 112–113). Sometimes the word FECIT appears in an abbreviated or misspelt form, reading FIT (Moilanen 2015, p. 140). To date, 22 swords from the 10th–12th centuries with the FECIT or ME FECIT formula have been found in Europe (Hošek *et al.* 2021, p. 137, Fig. 55). On the examined sword-blade from Jerzykowice Małe, one can observe a circle before the mentioned Greek cross, followed by letters IT, a space for more letters, and another Greek cross revealed by thermal images (Fig. 8: b, c). Crosses are sometimes seen as an indication of an ecclesiastical hierarchy that the swordsmith might have been associated with (Hošek *et al.* 2021, p. 129). This seems highly unlikely, as Greek crosses are more universal marks, probably indicating the beginning or the end of an inscription, and are not only linked with names but also with invocations on swords (Głosek 1973, p. 19, Table III: 2; Moilanen 2015, p. 142). Had the circle been meant as a symbol rather than a letter, it would have been flanked by two crosses or triple bar patterns (Leppäaho 1964, p. 24–25, Tafel 10). If interpreted as the letter O, it suggests we may be dealing with a smith's name or a word similar to those found on the swords from the same period: +NZOME-FECIT+, +NISOMEFET+, +BENOMEFECIT, +BENNOMEFECI, +INNO MEFECIT, +BA^NOMEFECIT, ABOFECIT (Košta *et al.* 2018, p. 7, Table 1). The inscription starting with the words INNO should not necessarily be regarded as a maker's name but as an abbreviated or misspelt formula often used in sword blessing rituals, starting with the invocation IN NOMINE DOMINI (Marek 2014, pp. 15–16). Such an interpretation of the INNO sword riddle may be confirmed by the 12th-century sword excavated from a lavishly furnished grave from Gródek nad Bugiem. One side of the blade bears the inscription +INNOMEFECT+, while the other is inscribed with the misspelt swordsmith's name +INGELIIRMEFCIT+ (Kuśnierz 2006, p. 93, Pl. X – here a slightly different reading of the former as +INHOMEFECIT+). On the other hand, we know of an early medieval sword with the name INGELFRII on

one side and the inscription ULFBERHTC on the other, kept at Wisbech & Fenland Museum in England (Williams 2012, pp. 147–148). The ULFBERHT inscription, which adorns the above sword, is among the most discussed in the context of early medieval weapons (Moilanen 2015, pp. 83–89). It has been suggested that the word should also be regarded as the name of a swordsmith renowned for the quality of his products. However, of the 224 swords dated between the late 9th and the turn of the 11th century with the inscription known to date (Hošek *et al*. 2021, p. 124), none is accompanied by the ME FECIT formula. ULFBERHT must indeed have been a quality mark, as a group of sword blades with the spelling variant + VLFBERH + T is distinguished by high-quality eutectoid and hypereutectoid steel with very few slag inclusions and high carbon content (around 0.8% or higher) (Williams 2012, pp. 117–140). Crucible (hypereutectoid) steel for such high-quality blades could have been imported into Europe from Persia via the well-established route from the Baltic via the Volga River used by the Varangians in the 9th–10th centuries (Williams 2012, p. 121). Recent research, however, has shown that hypereutectoid steel could also have been produced in medieval Europe (Hošek *et al*. 2021, pp. 85–86). Crucible (high-carbon) steel must be cooled slowly after smelting (Khorasani 2006, p. 108) and forged at a lower temperature than is customary to retain its properties (Williams 2012, p. 121). Although probably also bearing a quality mark in the form of the maker's name, and presenting high quality as testified by the considerable hardness of its edges, the characteristic microstructure with slag inclusions, rather excludes the possibility that the sword blade from Jerzykowice Małe was forged from hypereutectoid steel. Without sampling the interior of the blade, we cannot learn whether the body of the sword was forged of iron with welded-on steel edges or whether it was all steel (Williams 2012, p. 149). The microstructure shows a mixture of ferrite and martensite, suggesting the sword was fully quenched and underwent a process of annealing as well to reduce the brittleness of its edges (Williams 2012, p. 149). Full-scale metallurgical analyses were conducted on the matching swords from Charłupia Wielka and Płock Winiary (Żabiński *et al*. 2014, pp. 185–188, 193–197). In the former case, the blade's technology testifies to an 11th-century date (Żabiński *et al*. 2014, p. 185). The body of the sword was pattern-welded and forged from five pieces of various materials, with possibly quench-hardened, now perished edges. However, in its current state, it is considerably softer (110–130 HV) (Żabiński *et al*. 2014, p. 185) than the discussed weapon found near Jerzykowice Małe. Interestingly, the sword from Płock Winiary is probably even a better match for the latter in terms of blade technology. The body of the Płock sword was forged from three pieces of different materials: a soft steel core (135–140 HV) enveloped in semi-hard steel (425–436 HV) and welded on hard steel edges. The hardness of the cutting edges measures 513 HV and 483 HV, and the blade, in terms of quality, may be regarded as excellent (Żabiński *et al.* 2014, p. 197). On both flats of the sword from Płock, there are relics of an iron-inlaid inscription reading INGEPI and II…LI,

probably a misspelt double inscription INGELRII ME FECIT and the INNO ME FECIT (Żabiński *et al*. 2014, pp. 105–106, Fig. 13) discussed above. In both cases of the Jerzykowice Małe and Płock Winiary swords, we may observe a correlation between the presence of the iron-inlaid inscription, probably related to the maker, and the excellent quality of the blade.

Sword finds of a similar date and well-documented find circumstances are still lacking in the neighbouring region, including the territory of the Czech Republic (Hošek *et al*. 2019, pp. 33, 36, Figs. 2, 3).

Conclusions

The sword from Jerzykowice Małe is a peculiar find regarding its archaeological context. It is difficult to determine whether it was originally intentionally deposited or just lost during a military action. It is less likely that we are dealing with a weapon from a disturbed grave, as the shattered parts of the sword, although disarticulated by post-depositional processes, remained in an anatomical order. Moreover, the find was not accompanied by human remains or grave goods.

All technological features of the sword from Jerzykowice Małe, evaluated through scientific and typochronological analyses, confirm it may be dated to the 10th–early 11th century and was a high-end product of its time. The iron-inlaid inscription on the blade, probably belonging to the discussed ME FECIT type, corresponds well with the excellent quality of its cutting edges. In our opinion, due to its exceedingly long blade and a massive pommel, the discussed object may be regarded mainly as a horseman's weapon. Several historical events could have been related to the loss of such a valuable sword, starting from the short rule of Bolesław I the Brave of Poland in Kłodzko in 1003, to the preparations of Vratislav II's expedition against Poland in 1068. This makes the sword an important source of information, as it was properly mapped and excavated according to archaeological standards and thus contextualized.

The cautious behaviour of the finders and the efforts of all those involved in securing this early medieval artifact for future comprehensive study, which is unique in Poland, deserve special recognition.

Metrical data, before conservation:
Blade length – ca. 91.7 cm (blade broken through several times)
Blade width at the hilt – 5.35 cm
Blade thickness at the hilt – 0.5 cm
Blade thickness – 0.7 cm (at the thickest point)
Hilt length – ca. 15.35 cm (tang broken through)
Crosspiece length – 17.7 cm

Crosspiece height – 1.4 cm
Crosspiece thickness – 1.7 cm
Tang width at the crosspiece – 2.5 cm
Tang width at the pommel – 1.9 cm
Tang thickness – 0.9 cm
Tang length between the crosspiece and the pommel – ca. 9.7 cm (tang broken through)
Pommel height – 4.8 cm
Pommel width – 9.5 cm
Pommel thickness – 4.35 cm
Weight 1,648 g
Metrical data, after conservation:
Blade length – ca. 85.5 cm (blade broken through several times)
Blade width at the hilt – 4.8 cm
Blade thickness at the hilt – 0.5 cm
Blade thickness at the point – 0.3 cm
Hilt length – ca. 15.35 cm (tang broken through)
Crosspiece length – 17.6 cm
Crosspiece height – 1.3 cm
Crosspiece thickness – 1.6 cm (in the middle); 1.2 cm (at the terminals)
Tang width at the crosspiece – 2.3 cm
Tang width at the pommel – 1.55 cm
Tang thickness – 0.6 cm
Tang length between the crosspiece and the pommel – ca. 9.7-10 cm (tang broken through)
Pommel height – 4.2 cm
Pommel width – 9.1 cm
Pommel thickness – 3.9 cm
Weight 1,348.02 g

Spatial data related to the sword-find: X, Y coordinates according to PUWG 1992 (EPSG 2180) coordinate system for Poland, Z – M.A.S.L.
Coordinates of the control points visible in Figure 4:

M	X	Y	Z
M1	310154.5875	282829.1741	753.873398
M4	310154.6127	282829.2738	753.922591
M5	310154.5949	282829.2481	753.890565
M6	310154.5381	282829.2569	753.87781
M7	310154.5367	282829.2303	753.86989
M8	310154.5851	282829.2151	753.87911
M9	310154.5274	282829.211	753.876467

M10	310154.507	282829.23	753.869268
M11	310154.5025	282829.2656	753.867749
M12	310154.4898	282829.3031	753.875014
M13	310154.4758	282829.2454	753.859775
M14	310154.3616	282829.2411	753.852863
M15	310154.2588	282829.2464	753.849206
M16	310154.1434	282829.2464	753.846304
M17	310154.028	282829.2483	753.85672
M18	310153.9496	282829.2437	753.865553
M19	310153.9086	282829.2159	753.85835
M20	310153.9443	282829.1886	753.858919
M21	310154.0371	282829.1862	753.865137
M22	310154.1438	282829.1845	753.859759
M23	310154.2472	282829.1755	753.84887
M24	310154.3628	282829.1758	753.860491
M25	310154.4677	282829.1773	753.866677
M26	310154.488	282829.1105	753.885975
M27	310154.5123	282829.1878	753.863872
M28	310153.9597	282829.2644	753.869411
M29	310153.9697	282829.306	753.85005
M30	310153.8887	282829.2922	753.84069
M31	310153.7997	282829.277	753.857457
M32	310153.742	282829.2408	753.879025
M33	310153.8066	282829.2247	753.874935
M34	310153.8925	282829.2393	753.849324
M35	310153.9561	282829.2597	753.869271
M36	310153.7239	282829.2451	753.875478
M37	310153.6972	282829.2566	753.872458
M38	310153.6752	282829.2403	753.877304
M39	310153.7038	282829.2299	753.87543

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