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**Rekonstrukcja technik obróbki żelaza na terytorium  
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## Streszczenie w języku angielskim

This dissertation, entitled "Reconstruction of Iron Processing Techniques in the Territory of the Przeworsk Culture in the pre-Roman and Roman Period. Characteristics and Development" aims to present the subject of blacksmithing as faithfully and accurately as possible. The research underlining this study produced a thorough picture of the transformations observed in the historical material of the Przeworsk culture. In the case of specialised crafts such as steel processing, there is no uniform development. The political situation, the introduction of new customs in clothing, armed conflicts and other events may have significantly affected the pace and frequency of the emergence of new patterns in weapons and clothing, and thus in the development of blacksmithing. The work portrays the observed changes in the direction of the development of the craft, its intensity, and slowdowns occurring during the functioning of the Przeworsk culture. Additionally, the investigation of traces on some steel relics made it possible to identify the tools used in the forges of the Central European Barbaricum.

The research sheds light on the development of blacksmithing within various groups of relics in particular periods. The analysis of the craft reveals a variety of factors influencing its progress. Interestingly, similar models of evolution seem to have been triggered by the same transformation stimuli. This concerns all kinds of weapons produced by the Przeworsk culture which are heavily influenced by changing combat methods and tactics.

In the pre-Roman period, they take a significant variety of forms, making it difficult to distinguish any leading trends. This could be down to the fact that this type of arms was frequently made by local blacksmiths. Moreover, the lack of skilled craft centres, combined with very limited influence of trends on pole-arms, also had a significant impact on the situation. The most fundamental division concerns items with and without barbs, as well as unique forms. The former, both in the pre-Roman and Roman periods, were characterised by a well-established method of production consisting in forging a fan-shaped extension at one end of a piece of steel and shaping a blade on the other. This process required the use of simple tools. Even more complex spear-heads were still possible to make with a hammer, a small anvil and blacksmith tongs. Then, in the late Roman period during the migration of peoples, a substantial change took place. A socket embracing a specific section of the lower part of the

blade appeared, which required considerable blacksmith skills and the preparation of an appropriate amount of material.

The production of spear-heads made of a broken sword engaged a broader array of blacksmithing methods. Some of the findings suggest the use of basic techniques of forging and bending to obtain the socket of a spear-head. It was also necessary to use a cutter to make a groove for a broken sword blade.

A much broader issue, also illustrating progress in blacksmithing and the production of pole-arm spearheads, are decoration methods observed on this type of weapon. Early examples of elaborate ornamentation date back to the pre-Roman period and prove the existence of numerous specialised tools in the area of the Przeworsk culture.

Demonstrating the development of blacksmith techniques based on pole-arm spearheads is daunting due to minor changes occurring in this type of weapon. On the other hand, their local nature resulted in the emergence of unique solutions in the field of blacksmithing. A comprehensive analysis of spearheads both with and without barbs shows no significant changes in their production process over the course of the Przeworsk culture. Much more information comes from research on unique forms, but rather than indicating any generally prevailing trends, they reveal individual innovative technical or stylistic solutions.

In some cases, pole arms featured iron shaft end fittings. Most examples from the Przeworsk culture areas were made by forming a fan-shaped sheet, which was then wrapped in the like of a socket in the spearhead, thus creating a pointed cone. In the case of more massive shaft ends equipped with a pin, the treatment consisted in reducing the diameter of one end of the shaft to shape a spikey protrusion.

Central shield fittings make a significant group of relics in terms of analysing the development of blacksmithing techniques in the Przeworsk culture. Relying on craftsmanship experience, one can state that the level of difficulty in making an umbo may be a minor challenge in the case of domed forms, but significant when forging a spiked one. As it is, the latter are sometimes equal to the difficulty of making a sword. This discrepancy, combined with the chronological appearance and disappearance of individual types of umbos, perfectly reflects the evolution of blacksmithing techniques in the Przeworsk culture.

A rapid technological leap may have been related to the intensification of the La Tène influence in the areas inhabited by the Przeworsk culture. Not only is it manifested in the appearance of complex forms of the central shield fittings, but also in the aforementioned examples of polearms. In the early Roman period, these forms tend to be archaised, which is reflected by the increased presence of conical umbos. Moreover, it is then that we observe an

intense development of non-ferrous metals processing at the expense of iron metallurgy. Analysing the central fittings of shields, one can conclude that the quantum leap in blacksmithing in the Przeworsk culture coincided with the appearance of umbs with a sharp and then a blunt spike.

Difficult as they were to make, umbs frequently featured additional intricate decorations. The most common is the polygonal shape of a spike. Some umb spikes were given a decorative rim made of copper alloy sheet. Others were all covered with this metal, while still others had their heads covered with thin metal sheet. This variety of decorations with other metals suggests a wider range of activities undertaken by blacksmith workshops and a greater degree of experimenting with material. All this proves the remarkable progress in craftsmanship in the B2 phase of the Roman period. The subsequent stage down the timeline brought a further increase in the variety of forms, yet the level of their complexity decreased, which was the result of another archaisation of blacksmithing methods. The only individual examples that stand out are some umbs belonging to the Dobrodzień and the Horgos types. They hint on the maintenance of a high level of craftsmanship or even its development. Nevertheless, they are no longer as popular a weapon as spiked umbs in phase B2.

In the Przeworsk culture, single-edged swords were produced locally with local raw materials. The technology of forging the blade, regardless of the period, was the same and corresponded to the production of knives. What differed the most was the design of the hilt. The earliest examples were fitted with a plate with rivet holes, the execution of which was not a major craft challenge. The most complicated types of hilts appeared in the late pre-Roman period, which coincides with the intensification of highly developed forms of other kinds of armament. The subsequent Roman period saw a significant simplification manifested by the return to simple plates for fixing grips. Apart from the obvious issues related to the difficulty of forging pattern welded blades, the argument in favour of the frequency of single-edged weapons production in the workshops of the Przeworsk culture is the lack of the need to correct opposite-placed cutting edges.

In the late Roman period, the people of the Przeworsk culture made their first attempts to produce double-edged weapons. Previously, these were merely imports, first from Celtic and then from Rome. Local double-edged swords were made of steel melted on the spot, which made them similar in quality to single-edged products. Simple techniques of forging steel into a bar of specific dimensions were used to produce them. Contrary to imported weapons, the local double-edged blades were not pattern-welded or inlaid, which confirms the much lower level of blacksmithing in the Przeworsk culture.

The analysis of the technology also embraced metal elements of sword sheaths. As far as fittings of single-edged swords are concerned, there are few stylistic and technological changes over the occurrence of this type of armament in the grave material.

The analysis of suspension loops and chapes says little about the development of blacksmithing in the Przeworsk culture. It only shows the use of various solutions leading to the production of a functional object, at times with an additional aesthetic value in the form of a specific shape or decorations.

Spurs are a group of relics that stands out in the chapter on weapons. However, they were often associated with the equipment of a warrior in the Przeworsk culture. On their basis, it is possible to trace general trends in the production of objects with significant changes in geometry on their various sections. It required the use of numerous specialised blacksmithing techniques, such as welding or upsetting the material. In the pre-Roman and Roman period, the variety of bow forms was limited, which went hand in hand with the slow development of the technology of their production. The situation changed with the advent of a new kind of spurs (stuhlsپoren), the design of which often differed significantly from that of the bow spurs. The most evident difference was the appearance of a riveted spike, which made the work much easier without compromising functionality.

Another remarkable set of relics are the elements of clothing. A considerable diversity and high frequency of occurrence of the Przeworsk culture in the historical material make it a suitable subject for research on the development of crafts. Fibulae make the most extensive group. In the pre-Roman period, they share the same general scheme of execution based on a one-piece structure. The methods of their production focused on shaping the semi-finished products into a wire of appropriate thickness. The biggest changes coincide with the appearance of the models with an openwork frame foot. The archaeological material reveals fibulae being unsuccessful attempts to reproduce a full or openwork catch-plate. They testify to attempts made by local artisans to import new patterns. The analysis showed gradual development up to the end of the pre-Roman period when the La Tène influence, also affecting the appearance of the elements of clothing, faded leading to the emergence of new patterns in the Roman period.

At the beginning of phase B1, completely new types of fibulae appear. Now, they significantly differ from anything known before. The fast development of non-ferrous metals processing, bringing the possibility to cast the elements of clothing, must have incited the desire to reproduce some shapes in iron. As a result, extremely complex fibulae of groups II and IV according to O. Almgren start to appear. Their execution required the use of an appropriately rich set of tools, such as various types of files, cutters, punches and forms enabling the profiling

of the foot with a centrally placed catch-plate. Fibulae included in these groups show a very high level of blacksmithing in the Przeworsk culture, with an emphasis on shaping small complex forms in phases B1 and B2.

The Roman period saw unprecedented diversification of the elements of clothing, the manifestation of which are the fibulae of the V group. The diversity of this group coincides with the pinnacle of the development of craftsmanship in the Przeworsk culture. As it was with other relics, it may have resulted from an increased tendency to experiment with new patterns or from attempts to transplant them from foreign cultures onto the local ground.

In the late Roman period, the technology of forging elements of clothing again undergoes archaisation. The more and more frequent group VI fibulae show a much lower complexity than the earlier types. Technology-wise, this group corresponds with Mid-La Tène fibulae, which by no means indicates any relation, but rather the scale of the decline of the craft of making steel elements of clothing.

Metal elements of belts are another group of relics showing the development of craftsmanship. Their structure changed with the appearance of successive milestones in blacksmithing, also seen in other steel objects from the Przeworsk culture. The sepulchral material from the pre-Roman period features examples of simple, one or two-piece buckles. Their uncomplicated structure was based on shaping a bar or sheet and folding the ends into hooks. At that time, there were also buckles with a round frame and a spike, as well as specimens with an integral ferrule and a spike. The analysis indicates that the development of belt fittings settled in introducing moving elements into the structure of buckles. In the early Roman period, the elements of belts underwent not only stylistic but also structural changes. The old system of a frame and a spike integrated with a ferrule was improved by separating the two elements. Consequently, independent movement of all the parts of the buckle was possible adding to the ease of fastening the belt. The highest level of complexity in the construction of buckles is exemplified by figure eight-shaped pieces.

In phase B2, buckles were frequently subjected to a variety of treatments influencing the visual effect. The simplest ones include making notches on a spike or frame. In most cases, these were filled with non-ferrous metal wire, of which silver was the most frequently used for this purpose. In the historical material of the Przeworsk culture, we also meet motifs cut on the ferrule. In the late Roman period, the axis no longer featured in the construction of buckles. It was the simplification of the structure that made removing this so-far innovative component possible.

Sometimes the belt also had fittings at its end. A vast majority of them were made with

the same method resulting in obtaining mounting plates and a characteristic ending. Filing the material to create rolls and beads was the simplest method of decorating the fittings. In later periods, archaisation of forms set in in the production of steel belt fittings, visible in those made of metal sheet folded in half. Due to their simplicity and little development in the design, belt end fittings are not a good example of developmental changes taking place in the blacksmithing of the Przeworsk culture.

Apart from fibulae and belt elements, miniature representations of tools deserve researchers' attention. Thanks to their multi-part, yet uncomplicated, structure, it is possible to trace how individual components were joined. The analysis showed the use of small rivets, as in the case of miniature shields, or the soldering technique applied for bucket elements. The last analysed group included tools and everyday objects. Their characteristic feature is the frequently registered domination of functionality over aesthetic value. As in the case of armament, some tools required the selection of appropriate steel, ensuring their the proper functioning. This rule applied in particular to spring elements such as box locks, scissors and other objects with cutting edges. High-quality material was also essential in the production of flints.

This group of relics also includes specimen which underwent a mending process. Interestingly, these activities tended to be performed with much less attention to detail than was typical for armament repairs.

The collective analysis of all the described groups of relics of the Przeworsk culture portrays variable dynamics of the development of blacksmithing. The convergence with historical events, shifts in the influences and transformations of archaeological cultures, proves that the craft is susceptible to various factors. The stable development until the end of the pre-Roman period resulted in the gradual emergence of new, increasingly complicated forms of objects and improved knowledge of blacksmithing techniques. The fall of the La Tène domination, combined with the simultaneous cultural pressure of Rome, caused the shift away from steel metallurgy into the processing of non-ferrous metals. It is best seen on the example of individual garments, previously mainly made of steel, and in phase B1 more frequently of copper alloys. This short-lived episode may have indirectly influenced the rapid development of blacksmithing in later years. The appearance of very complex copper alloy fibulae in phase B1 and the desire to transfer the pattern to another material may have contributed to frequent experimentation and the need to use new types of tools. This phenomenon became widespread in the Przeworsk culture in phase B2 when we observe the widest variety of blacksmithing techniques, the variability of steel forms and decoration methods.

The presented analysis proves uneven pace of blacksmithing development in the area inhabited by the Przeworsk culture. It also indicates the gradual introduction of new blacksmithing and decorative techniques. The findings help understand the evolution of some relics, which does not only result from transformations on the battlefield or changes in fashion but also the skills and abilities of local craftsmen. The conducted research also emphasised single finds in the historical material which deviated from the established standards. Their presence confirms experimental activities leading to the development of new forms or the desire to reproduce an element of clothing or armament, previously unknown in a given area. The introduction of innovative technological solutions was also associated with the use of a broader inventory of tools.

Further research on the production techniques of steel objects may give rise to the need to introduce certain changes in typologies, which are now mostly reliant on changes in style.

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