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*A History of Combat Armour*

(The History of the Development of Body Protection Systems Deployed in Western European Warfare, from the 10th to the Mid-16th Century)

I.

CHOICE OF SUBJECT AND OBJECTIVES

There are many misapprehensions, delusions and myths concerning the effectiveness, characteristics and use of mediaeval weapons not only in common knowledge, but in historical works, too, and it particularly concerns armour. Therefore, this dissertation treats the evolution of this leading product of the European military trade, to give a clear picture of the forces behind its development, and to provide an answer to the most important question of how effective this combat gear fulfilled its task. A definition of armour, in the sense of body protection system, has also been given. **All complete or incomplete body protection equipment that people (or animals) wear on their bodies as clothing to give them protection during conflicts against dangerous wounds and fatal battlefield traumas, or to minimise the possibility of their occurrence are called armour.** Its importance is well reflected by the fact that the armour had become a symbol of the mediaeval knight, and its existence exercised essential influence on the course of military history. During his research, the author learned that mediaeval blacksmiths had created a very difficult “system,” taking into consideration human anatomy, weight-carrying capacity, the expectable battlefield traumas, and, somewhat surprisingly, even the actual fashion. Blacksmiths and their art were always highly and mystically respected for a simple reason that distinguished them completely from the masters of any other arts. The knowledge reflected in the works of the armour makers did not serve artistic pleasure, but was one of the factors influencing the fates of the fighting men. Combat armour was not valued by art experts, but was tested in brutal and merciless battles, where the qualities of armour makers often decided over the lives or deaths of the warriors wearing them.

The armour did not only increase its owner’s chances to survive a battle, but also showed his wealth and rank clearly, as it was an item of everyday use and a status symbol at the same time. Distinguished armourers were all-round craftsmen. They were knowledgeable about the complicated methods of producing iron, and about all the characteristics of the required ores, coal types and additives. They knew the secrets and tricks of manufacturing

and moulding various kinds of tempered steel, both when cold and when glowing. The knowledge of kinetics was essential, and the masters had to have direct experience regarding the types, usage and power of weapons that posed threat on the armour and the body to be protected. As opposed to public belief, a vital factor of combat armour design was to provide movement as free as possible, so that the armour could be worn even for a whole day. Therefore, armour is just as significant from the point of view of the history of technology, as is from a military historical aspect.

It is important to emphasize that such a comprehensive study on the history of armour has not been published even internationally, except for a work by Claude Blair in 1958, and that hardly any scientific studies analysing armour have been published in Hungary. Although there have been popular articles published on the topic, those are not scientifically satisfactory and often include several mistakes. To sum it up, no monograph has been published in this field of research so far, and thus, the dissertation fills in a gap.

The work is also necessitated by the fact that both museum curators and military history re-enactors require comprehensive and scientific literature on armour. On the other hand, (military) historians and those working in education may also find the scientific results of the dissertation useful in the course of their activity. The author hopes that the research results will help clear up existing misapprehensions concerning mediaeval armour, and will contribute to a better understanding of medieval military history and the history of trades, and to a correct evaluation of their phenomena.

## II.

### SOURCES AND METHODOLOGY

In the dissertation, the author, somewhat arbitrarily, discusses the topic from the early 10th century to the first third of the 16th century, when muskets came into use. The time limits were chosen for the following reasons. From the former date, the armoured heavy cavalry controlled the European battlefields. From a technical aspect, their superiority in close combat was a result of body armour primarily, as it provided significant protection. The end of the period was brought about by the musket, the first weapon with a perforating effect that armourers could not entirely compensate for. It caused considerable difficulty during the research process that none of the public collections in Hungary holds a complete set of armour manufactured in the above described period, and even armour elements or parts are hard to find. Therefore, as the first stage of the work, the available sources were collected and

systematised, including Hungarian and international special literature, images, and catalogues of Hungarian and international public collections. The author's aim was to get hold of the catalogues of the great weapon collections of the world, as most of those even offered technical data of the items. Where any of the items raised doubts, the author attempted to obtain information from the curator of the given collection. Efforts were also made to find various studies and articles, with special regard to metallographic analyses. The dissertation is primarily based on those sources, but information provided by military history re-enactors wearing armour, as well as by present-day armourers was also extremely useful. The experiences that the author gained as a curator show that it is impossible to analyse the effectiveness of mediaeval armour on the strength of written and pictorial sources only. Therefore, the efficiency tests conducted on weapons under laboratory conditions form a most significant part of the dissertation. The tests necessitated an examination of the metals of the available museum items, which was followed by the manufacturing of armour and weapon replicas appropriate for testing. The testing of materials was carried out in the laboratories of the Department of Materials Science and Engineering of the Budapest University of Technology and Economics, and at the testing station of the Civilian Small Arms and Ammunitions Examination Ltd. Metallurgic tests were conducted by György Torma, student of mechanical engineering, with the guidance of Mechanical Engineer and Metallurgist János Dobránszky PhD. Shooting tests were planned and carried out by Engineer Emil Hamza, Deputy Director of the Civilian Small Arms and Ammunitions Examination Ltd. Samples were taken from the arms and armour collections of the MoD Military History Institute and Museum and the Hungarian National Museum. Replicas were produced by Máté Bánsághi, György Torma and Enikő Vályi-Nagy. The dissertation can be divided into two main units: a *study* that discusses all aspects of the topic, and a *supplement* that contains an introduction to metallurgy, written in a manner anyone can understand, and the research results. A great number of illustrations were inserted in the text of the study, where they are easier to follow. All captions include the sources and inventory numbers of the items and images. A third part of the *supplement* contains a multilingual glossary of words related to armour and its parts, which was compiled by the author and may prove useful for those interested in the history of arms and armour.

The study contains a general introduction, which discusses the special aspects of dealing with armour, and offers a survey of the international and Hungarian scientific works treating the topic. A separate chapter introduces the relations between experimental archaeology and arms and armour history, and presents its results.

The main part of the dissertation examines the technical development of armour, which is being dealt with in a strict chronological order, starting with the mail, then introducing the combined, and finally the full plate armour. All types of armour are being dealt with in detail, discussing the main components (helmets, trunk protection, pauldrons, etc.) in separate subchapters, so that they are easy to study.

Separate chapters deal with the tactical characteristics of what the author calls “the weapons that upset the balance,” such as the crossbow, the longbow and the gunpowder small arms. This is essential, as a key factor in the development of armour was to avert the threat posed by those weapons. At the end of each main chapter, there are summaries stressing the significance of the various types of armour in arms and armour history. The special metallurgic features of German and Italian armour, which demonstrate the high-level working skills of the armourers of the period, are also being dealt with separately. The several hundreds of illustrations comprise a vital part of the dissertation. The captions contain detailed information about the shown items. Where possible, the technical data of the portrayed armour or components are provided, so that their size and weight become perceptible. The study also deals with the guilds of armourers, mediaeval arms trade and the quality assurance of the period. In the course of his work of analysis, the author consulted several works of art, and he points out all the doubtful details that one encounters when examining such sources.

At the end of the dissertation, a list of the consulted sources and a bibliography of works published in the field of research can be found.

With the help of illustrations, the dissertation is supposed to analyse the topic in a new aspect and in its entirety, to show that armour is more than just a means of protecting the vulnerable human body. Combat armour was a masterwork of technology and a work of art at the same time: a product of the most excellent armourers uniquely combining the harmony of aesthetics, combat function and the almost perfect protection of the body.

Therefore, combat armour was not only a functional item. It also represented enormous financial value and also served as a symbol. Even for the contemporaries, full combat armour represented the unlimited control of the battlefields, power and wealth.

### III.

#### THE SCIENTIFIC RESULTS OF THE DISSERTATION

Body armour gives enormous advantages in close combat, as it significantly reduces the risks of physical impact during battles. In European warfare, the properly commanded armoured heavy cavalry was vastly superior to any other arm of service in the open battlefield from the 10th century to the first third of the 16th century. The author made the following statements during the analysis of the history of development. The main means of body protection was the mail until the mid-13th century, and performed its task effectively. Induced by the appearance and the increasingly growing power of the crossbow primarily, the protective qualities of the mail were improved from the late 12th century to the second third of the 14th century. There were two possible methods of strengthening the mail. One was to thicken the chain links, and the other was to provide the mail, the period's most common equipment, with additional protection. The simplest and most effective way of strengthening the mail was to cover it with some kind of energy absorbing material and/or to line its most endangered parts. Its most advanced form was the so-called coat-of-plates, which had developed from the surcoat, worn over the mail coat. The surcoat, a garment in the form of a poncho, was altered to comply with defence requirements. The coat was lined with plates at the front and the back, which were riveted to the fabric. Broad, belt-like pieces were added to the two sides of the breast of the "poncho" to surround the trunk of the wearer. That reinforcement obviously offered protection against many kinds of battlefield trauma. In the author's opinion, however, its development most likely was induced by the threat of the crossbow bolts, which had to be eliminated. That argument is supported by the fact that no other weapon appeared from the 10th to the first third of the 14th century (the gaining ground of the longbow) in the European battlefields that would have been superior to the mail. The greatest difference between the threat imposed by bolts and that by the infantry's close combat weapons suitable for defeating the mail (axes, long-stick tipped maces, war flails and lances) was that the only means of protection against bolts was the passive way, i.e. the usage of bolt-proof plates and shields, whereas the dangerous long-stick infantry weapons could be overcome actively.

The longbow, which appeared on the Continent in the early 14th century, necessitated another step forward. As opposed to public belief, it was not the strength of the weapon that represented real threat, but the intensity of the English storm of arrows. Masses of attacking armoured warriors always proved to be excellent targets and, concerning the number and

intensity of the arrows fired, the coats-of-plates were almost certain to be penetrated or some of the poorly protected parts of the body to be hit. The armour was hit at many points in a short interval of time and so the chances of arrows to cause injury were great. Soldiers' odds against the arrows were determined by luck and not by their talents. From the point of view of weapons, there was only one way of reducing that incalculableness: by manufacturing an armour that provided high-level protection against arrows shot in great numbers. In the author's opinion, the main impulse for manufacturing plate armour consisting of interlinking large metal plates was the need to eliminate that battlefield threat. It seems that the moment when iron metallurgy, blacksmiths' skills and practical experience reached a level where armourers did not only react to battlefield threats, but envisaged and created forms that were supposed to compensate traumas successfully came in the mid-14th century. The author considers the appearance of the "bascinet" helmets equipped with conical visors as the first manifestation of that. That shape is nearly perfect, inasmuch as it shows convex or angular surfaces to the opponent from all sides. That must have been the last step before armourers were able to offer similarly designed forms to protect other body parts as well, and so their craft was not merely limited to reinforcing already existing components anymore. It seems that this type of armour was first materialised by North Italian masters and that it was also typically manufactured in that region. The two most important places of mediaeval armour-making were Lombardy and Southern Germany, i.e. north and south of the Alps, obviously due to the availability of water power, raw materials and the vicinity of big cities. There were no remarkable differences in quality between German and Italian armourers, but their workshops differed in style and their guilds in their structure, so the author, sticking to the traditions of arms and armour history, treated them separately. The Italian craftsmen seem to have been driven by the main aim of covering the bodies of their clients by plates as large as possible. The manufacturing of a full armour demanded extraordinary skills from the armourers. Any armour made in Lombardy covered the entire body, except for the soles, the palms and the inner parts of the thighs. In the author's opinion, such a complicated and practical structure must have been the result of methodical design. A Lombard breastplate, for instance, functioned as an integral body construction, with double thickness in several places due to the laminating of material, and thus providing a high level of energy absorption without limiting the wearer's freedom of movement drastically.

A general characteristic of Italian armour was a plate thickness varying between 1 and 2 millimetres, which produced surprisingly light armour. Full trunk plates only weighed around 10 kilograms. There are many misapprehensions regarding these suits of armour in

public belief. It is not true that it was impossible to move in them: craftsmen made armour parts fit human anatomy perfectly, and therefore Italian armour manufactured to size offered its wearer almost unlimited freedom of movement. A full set of Italian armour did not weigh more than 22-26 kilograms, and did not exceed 30-36 kilograms even when worn together with a short-sleeve mail. The complete combat equipment of a soldier today may weigh twice that load, and he has to carry it on his shoulders and partly on his waist. As opposed to that, the entire weight of the armour was evenly spread on the body. The armour also had a rarely mentioned advantage: knowing that his body was protected, the knight went to fight with greater self-confidence and self control than simple soldiers.

The majority of the armour-making workshops in Europe, the most excellent ones of which were located in Southern Germany, were established by masters who had emigrated from Lombardy. German armour differed from Italian products in style, taste and from the point of view of certain protective mechanisms, as German armourers worked their armour differently from Lombard blacksmiths. The magnificent Gothic shapes that they created were not induced by the strict requirements of the battlefield. When comparing their works of art with the portrayals of the period it may be established that German Gothic armour imitated the noble costumes of Burgundy, namely the tight-fitting stockings worn with broad-shouldered jackets particularly tight in the waist. The fluted German Gothic armour mimed the organ pipe-like folds of garment of the period. It should be mentioned that even the greatest experts cannot specify the first appearance of the typical German Gothic armour. It is also strange that that type of armour does not seem to have had an archetype; it “suddenly” appeared instead, with the above described general characteristics, and the sets only differed in their finish – either when portrayals or existing pieces are concerned.

The most probable explanation for that is that those graceful works of art were first manufactured by the court armourers of the workshop of Mühlau, established by Archduke Sigismund of Tirol (1427-1496), and the archduke donated the items to other potentates. Those sets of armour most likely served the purpose of parade and imitated the then fashionable Burgundy garment. When comparing the two great schools of armour-making, it may be stated that the main motivation for Lombard masters was to protect the wearers of the armour, whereas German armourers were stimulated by the elegant appearance of their costumers. In general, the author thinks that Italian Gothic armour represented the peak of mediaeval combat armour, regarding both construction and aesthetics. Lombard craftsmen created almost perfect balance between protection and the freedom of movement; the perfection of their work was reflected by the clear, powerful and harmonic forms of their

products. A survey of the history of the development of armour has made it clear that armour-making was a great business from the mid-14th century, with certain Lombard workshops fulfilling orders by the thousands. In connection with that, a Europe wide net of traders and depots was maintained and operated in a way noticeably resembling the production and marketing methods of today's multinational car factories. The same differences between suits of armour and their makers appeared regarding quality and prestige, as are present today in the world of cars and their manufacturers. Anonymous blacksmiths produced simple armour for simple warriors in the masses, and works of unique design and artistic finish were also manufactured to size for aristocratic customers, using the finest steel.

Tests have verified the indispensability of armour in the battlefield. According to the results, combat armour with a general thickness of 2-3 millimetres provided the wearer with sufficient protection against crossbow and longbow shots, as well as against weapons moved by muscular strength. Unquestionably, the plates were damaged or penetrated above a certain level of energy. For instance, a piercing head with 170 Joules of energy entered a 2.5-millimetre thick plate 25 millimetres deep. In that case, it is not the fact but the extent of penetration that matters. The main aspect is the invulnerability of the wearer and not of the armour, as the warrior could continue fighting if he remained unhurt, even if the plate got damaged. The energy of firearms, however, proved to be so great that in most cases they perforated the armour. That could only be compensated by plates thicker than 4 millimetres, but plates thicker than 6 millimetres were needed to block bullets fired from muskets, the most powerful weapon in this aspect. Examining the technical development of mediaeval armour in general it becomes clear that the armourers of the period had the skill of planning in advance. The practical and rational structure of Italian plate armour proves that.

It can be rather surprising that the changes in the form of armour were strongly influenced by fashion, too. In certain cases, outward appearance was given preference to battlefield aspects, to the detriment of effectiveness. The history of the development of armour and the characteristics of the industry specialised in its production clearly show that human thinking in the field of industrial products has hardly changed at all. Even mediaeval blacksmiths endeavoured to keep pace with battlefield requirements and to satisfy all strata of the society with the range of their products, and their basic business guidelines correspond to those of today's big companies. They were able to create new forms remarkably quickly: certain components were replaced by updated ones within two or three decades from their introduction. It is most interesting that even the motives of the development of mediaeval combat armour and today's field uniforms coincide. Although they are commonly thought to

lie in practicality, fashion is almost as similarly important. The only real difference between the old and the new combat wear is the lack of official patterns in the case of the former, but it must be added that all the famous armour-making workshops applied their own system of quality assurance, which was certified by their trademarks. The author holds that the above vindicate his opinion according to which armour-making was a branch of mediaeval economy that emerged from the guild system very early, due to the great number of orders and the high level of raw material consumption, and established large companies that may be considered as the direct antecedents of munitions factories in the modern sense of the word.

#### IV.

#### PUBLICATIONS BY THE AUTHOR ON THE DISSERTATION SUBJECT

„A Déri Múzeum számszeríjai.” [Crossbows in the Déri Museum.] *A Déri Múzeum évkönyve 1992-1993*. Ed. György Módy. Debrecen, 1994. 111-161.

„Az összetett íj.” [The Composite Bow.] *Kaliber*, 2000. February 47-49.

„A számszeríj.” [The Crossbow.] *Kaliber*, 2000. March 43-46.

„Fa acél ellen – az angol hosszúj.” [Wood against Steel – The English Longbow.] *Kaliber*, April 2000. 22-25.

„Az acél csodája.” [The Miracle of Steel.] *Kaliber*, July 2000. 38-41.

„Élet és halál urai a csatatereken – elődeink fegyverei.” [The Masters of Life and Death – The Arms of Our Ancestors.] *Az Árpád- és Anjou-kor csatái, hadjáratai*. Ed. László Veszprémy. Zrínyi, Budapest, 2008. 17-56.

„Az acél építészete. Páncélok a Hunyadiak korában.” [The Sculpture of Steel. Armour in the Age of the Hunyadi's.] *Rex Invictissimus. Hadsereg és hadszervezet a Mátyás-kori Magyarországon*. Ed. László Veszprémy. Zrínyi, Budapest, 2008. 96-120.