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Origins of the Bloodstain Pattern Analysis (BPA) with special attention paid to the work of Edward Piotrowski

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Abstract: Bloodstain Pattern Analysis (BPA) is now an obvious part of forensic medicine, a discipline with its own methodology, scientific aims and practical goals. Roots of it are in experimental work of Polish physician Eduard Piotrowski, with results published in 1895. Significance of it was not immediately recognized. In this paper we aim to show why and how Piotrowski's model for BPA was finally incorporated into the realm of medical tradition.

Key words: Forensic medicine, BPA, Eduard Piotrowski, history of medicine.

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Bloodstains — introduction to the problem

Bloodstains, however obvious element for a properly conducted forensic examination, were for many centuries only a margin of interest during criminal investigations, without any theoretical frames which could guide prosecutor in proper understanding of their meaning.

In 1893 Hans Gustav Gross (1847–1914), Austrian criminologist and criminal jurist, in his famous then *Handbuch für Untersuchungsrichter* [Textbook for criminal investigators] wrote about the importance of blood stains during forensic investigation, paying attention not only to the largest and most striking traces, but also to the smallest ones, which can often turn to be the most important ones [1]. *Handbuch für Untersuchungsrichter* went through many editions and was translated to many languages becoming classical textbook in the field of criminology. Gross underlines the practical benefit for the investigator when analyzing directionality of blood droplets and explains how it can be determined. However, he does not provide any methodological pattern, nor provides a general classification of blood stains. This was done two years later by Polish researcher.

In 1895 Edward Piotrowski (1864–1916) from the Jagiellonian University of Kraków published a study entitled *Über Entstehung, Form, Richtung und Ausbreitung der Blutspuren nach Hiebwunden des Kopfes* [On the formation, form, direction and spreading of blood stains resulting from blunt trauma at the head], in fact the first systematic study of bloodstains [2]. The work itself was published at the University of Vienna, where Piotrowski was then working in the Forensic Medicine Institute under the guidance of Professor Edward Hofmann (1837–1897).

Hofman was one of the leading researchers in his field, specializing in the subjects of forensic entomology and pathology, recognized for his modern attitude towards microscopy, spectroscopy, and laboratory animal experimentation for the needs of forensic medicine. His *Lehrbuch für gerichtliche Medizin* [Textbook of Forensic Medicine] and *Atlas der gerichtlichen Medizin* [Atlas of Forensic Medicine] went through translations, gaining their author international fame [3].

Piotrowski when in Vienna, was working on the mechanisms of sudden death. The results of investigation, conducted together with Hofman, were published in 1895 in Polish [4]. This paper was just preceding the major work, mention above, namely *Über Entstehung, Form, Richtung und Ausbreitung der Blutspuren nach Hiebwunden des Kopfes* [5].

The direct impulse to undertake research in that field was the death of one of the Viennese lawyers. Hofman was convinced, that the victim was attacked and murdered, pointing at the upholstery hammer, as a weapon of crime [5]. It was that moment when Hofman observed the importence of blood stains in the place of criminal investigation and recommended Piotrowski to deal with the problem. Now the crime scene should be examined as carefully as the body during forensic examination [5]. The aim of future research was not the blood stains themselves, topic already present in the papers of other scientists, but the mechanism of the distribution and intensity, which was never so closely and precisely investigated before [5].

The best way to achieve that was to construct the animal experimental model, which will serve the close and direct observations and measurements of the effects when using different tools, and when the blow is coming from different angles and directions. Experiments carried out on animals involved tools strictly defined in terms of size, weight, and material, both sharp and blunt.

In general method which was chosen by Piotrowski was as brutal as effective to achieve the goal, which was clearly given in the title of publication. First, he made an imitation of room walls and floor, using sheets of white cardboard, then beating rabbits to death. He observed and documented the characteristics of bloodstains that resulted from carefully planned procedures.

Summarizing his findings, Piotrowski pointed out that repeated blows with a hammer or a tool similar in shape to a hammer always result in bloodstains around the animal's body. He confirmed that in most cases the bloodstains appear with the second blow, which was dependent on the existence of a blood source [1]. This type of bloodstains (In Piotrowski's classification — Type I)

are different from bloodstains created by "scraping" blood from the tool because of the lifting and falling motion, which allows to determine the direction of the blow itself (Type II). According to Piotrowski, only a small number of bloodstains is a direct result of bleeding from a damaged vascular structure (Type III).

Piotrowski's classification of spatter bloodstains (Type I), swinging blood stains (Type II) and blood spurts (Type III), was the first and still valid when it comes to the basics of blood stain research.

He also made a description of different shapes, arguing that all bloodstains can be grouped into the three major groups; round or irregular, retort-shaped (*retortenähnlich*) and elongated or retort-shaped with a wide base facing upwards [6].

Disscusion

Most of modern researchers agree that Piotorowski's work should be regarded as earliest significant study in bloodstain interpretation [5, 7]. Nevertheless, in times when it was published and, in the decades, to come recognition of Piotrowski and his *Über Entstehung, Form, Richtung und Ausbreitung der Blutspuren nach Hiebwunden des Kopfes* was neither immediate nor widespread.

For example, Austrian Albin Haberda (1868–1933) in his short report entitled *Eine besondere Form von Blutspritzern* [A Special Form of Bloodstain] published in 1914 focused his attention on a special kind of bloodstains caused by foamy blood coming out of the lungs. He argued that the distance of the fall and the angle with which the blood hits the ground, influences the shape of bloodstains, which can be described sometimes as round or elliptic, reassembling the club, bottle, and the bear paw like shape. Regardless actual picture of bloodstain, Haberda confirms, that always very small air bubbles are present in their structure [8]. Although he mentions value of Gross observations given in *Handbuch für Untersuchungsrichter*, is not referring to Piotrowski's work. This was acknowledged by German Ernst Ziemke (1867–1935) in his *Die Untersuchung von Blutspuren* which became a part of massive textbook *Gerichtsärztliche und polizeiärztliche Technik* edited by T. Lochte in 1914 [9]. Also, Hugo Marx is aware of Piotrowski's achievements, when publishing in 1919 book about practical side of forensic medicine [10].

Work of Piotrowski had probably influence on the other investigators, including Paul Jeserich (1854–1927) [11] and Victor Balthazard (1872–1950) [12]. Jeserich, talented forensic researcher, was known for his pioneering work on micro-photography to estimate exact match of a gun and bullet, was also investigating the bloodstain patterns as the important source of information when analyzing direct reconstruction of the crime scene [13]. Jeserich was working intensively in the first decades of 20th century on the subject. In 1930s French Victor Balthazard and his associates conducted original research regarding bloodstain trajectories and patterns. A paper on this topic was presented in 1939 at the 22nd Congress of Forensic Medicine entitled *Étude Des Gouttes De Sang Projeté* (Research on Blood Spatter) [14]. However, again we don't find any clear reference to Piotrowski's achievements. Such reference is clearly found in published by Kurt Walcher (1891–1973) in the same year textbook *Gerichtlich-medizinische und kriminalistische Blutuntersuchung. Ein Leitfaden für Studierende, Ärzte und Kriminalisten* [Forensic, medical and criminal blood tests. A guide for students, doctors and criminologists]. Wachler not only goes through text of Piotrowski's book but also uses illustrations coming from it [15].

From what has been said above, it can be concluded that although Piotrowski's work was not completely forgotten, it was not widely known among forensic doctors and investigating judges.

Roots of modern BPA

On American soil it was modern era of the bloodstain pattern analysis dates to 1950s, when it was recognized as important forensic subdiscipline in by Paul Kirk, author of the well-known *Crime Investigation: Physical Evidence and the Police Laboratory Interscience* (1953). We can see in it an important moment when BPA became subject of deeper interest in USA. But it was three decades later, 1983 in Corning, New York State when the International Association of Bloodstain Pattern Analysts (IABPA) was formed as a visible sign of wider and more collective work under the general guidance of Herbert MacDonell. Neither Kirk nor McDonell were aware of Piotrowski's work at that time.

However, it was in early 1980's when notes about *Über Entstehung, Form, Richtung und Ausbreitung der Blutspuren nach Hiebwunden des Kopfes* was rediscovered in the archives of the CUNY John Jay College of Criminal Justice library. The copy of it was found by Herbert MacDonell at the Jagiellonian Library after many years of research in 1992 [5, 16]. Immediately it became subject of interest which finally led Piotrowski's work to be reprinted in German and translated to English — *Concerning Origin, Shape, Direction and Distribution of the Bloodstains following Head Wounds Caused by Blows.*

According to MacDonell, "No one preceded Piotrowski in designing meaningful scientific experiments to show blood dynamics with such imagination, methodology and thoroughness. He had an excellent knowledge of the scientific method and a good understanding of its practical application to bloodstain pattern interpretation." [16] It is worth noting, that MacDonell is credited as an author of most important books on BPA with *Flight Characteristics and Stain Patterns of Human Blood*, first published in 1971 at the top of interest [17].

Results

As it seems Eduard Piotrowski's *Über Entstehung, Form, Richtung und Ausbreitung der Blutspuren nach Hiebwunden des Kopfes* should be credited as the founding text for modern Bloodstain Pattern Analysis (BPA). Its content was recognized quite early on the grounds of forensic medicine, although it did not have immediate impact on practice. Real value of Piotrowski's experimental work became apparent when BPA projects were established in the 1980s. From that moment on his name became important part of BPA tradition.

Conclusion

In 1895, when *Über Entstehung, Form, Richtung und Ausbreitung der Blutspuren nach Hiebwunden des Kopfes* was published it could not have immediate impact on forensic sciences and practice. First the importance of bloodstain pattern analyses was still not properly recognized. Secondly Piotrowski was not venturing more in that problem, devoting himself to scientific research for only few years, and from 1897 until his premature death from typhus infection in 1916 he was working as a physician [5]. The *Über Entstehung, Form, Richtung und Ausbreitung der Blutspuren nach Hiebwunden des Kopfes* was issued in only about 100 copies, so from the very beginning it was rather rare publication [5].

It must be then concluded that importance of Piotrowski's experimental research leading to description and explanation of mechanisms of bloodstain pattern was fully recognized and used in the field of criminalistics and forensic medicine not earlier then last decade of 20th century.

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