



ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 3, Issue 8 , August 2016

The Birth of Biomechanics

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ABSTRACT: Many texts of Biomechanics begin with a brief historical introduction. In it, a lot of people who influenced its development are mentioned. According what Humphrey and Delange expressed in a very good book on Biomechanics, "it is not possible to identify a true father of biomechanics" [1]. Contrary to this position, we consider that it is possible to give this distinction to the Austrian physician Moriz Benedikt (1835-1920). In this short paper, we show why.

KEYWORDS: Biomechanics, origin, basis, first textbooks, principles, laws

I. INTRODUCTION

Moriz Benedikt (1835-1920) was an Austrian neurologist. His main interests were Anthropology and Criminology, though his scientific investigations cover a great variety of subjects [2]. In one of his most famous and controversial works, he postulated that there were specific differences between "normal" and "criminal" brains. During the 1870s, after macroscopic morphological examination of criminal brains [3], he proposed a remarkable neurological localization of morality in the human brain. More precisely, he thought of the ultimate parts of the occipital lobes as the seat of the moral sense [4]. Among the many areas of knowledge in which he served, it is little known his influence in the birth, development and spread of Biomechanics. Taking as a starting point that the first mention of the concept was made at a conference in Wiesbaden (1887) [5], our purpose is to highlight their role in this new science.

II. RELATED WORKS

History of Biomechanics is generally recognized to begin with two works belonging to the Corpus Aristotelicum, known as *De motu animalium* and *De incessu animalium* [6]. According to Y. C. Fung [7] and S. L. Woo (2004) [8], Biomechanics is a field that has a very long history. They mentioned that it was described in ancient Chinese and Greek literature. The foundation of Biomechanics, however, was laid during a period between the 1500's to 1700's by renowned personalities, Da Vinci, Galileo, Harvey, Descartes, Borelli, Hooke, Newton and so. Giovanni Alfonso Borelli (1608–1679), author of "*De Motu Animalium*" [On the Movement of Animals], is referred to as the Father of Biomechanics by M. H. Pope (2005) [9] although he never mentioned the term biomechanics. Professor Paul Allard (1996) was the one who in his historical inquiry discovered that Moriz Benedikt coined the word biomechanics and, as far as we know, no one had ever used this term before 1887 [10]. A few months later, Dr. Ing. Volker Schlegel (1997) found that Benedikt himself stated that his main purpose was to promote the (new) idea of biomechanical (neo-vitalistic) way of thinking in Medicine and Biology [11]. Since then, this word has been accepted and used daily. Finally, in a recent work (2016) we concluded that "*Kraniometrie und Kephalometrie*" could be the first book on Biomechanics [12]. At present, after an article by G. S. Kassab (2004), Fung is known as the father of Modern Biomechanics [13].

III. MATERIALS AND METHODS

To carry out the work, we have traced and identified books and articles written by Moriz Benedikt, in which the term Biomechanics appears. By this procedure were identified six original texts, between 1888 and 1912.

> *Kraniometrie und Kephalometrie* (1888) [14]

> Benedikt, Moriz; Keraval, P. (trad.) (1889) [15]



ISSN: 2350-0328

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- > Das biomechanische (neo-vitalistische) Denken in der Medizin und in der Biologie (1903) [16]
- > Krystallisation und morphogenesis: Biomechanische Studie (1904) [17]
- > Biomechanische Grundfragen (1910) [5]
- > Biomechanik und biogenesis (1912) [18]

IV. RESULTS

What we have found in our research it is expressed in the following historical quotations:

1. "To avoid speculation, I created the concept of Biomechanics" [17]
2. "I coined the concept and the word 'Biomechanics' for the first time in the Wiesbaden Naturalists Congress (1887) in a conference entitled On the Mathematical Morphology and Biomechanics" [5]
3. *Kraniometrie und Kephalmetrie* (1888), would be the first textbook in which the term "Biomechanik", [Biomechanics] is used [14]
4. Benedikt proposed Two Principles of Biomechanics [15]:
 - a. First Principle of Biomechanics: "... the cell is limited in its growth"
 - b. Second Principle of Biomechanics: "The struggle of the cell for the conservation of its own existence and its specific characters"
5. He introduced various applications in *Das biomechanische* (1903) [16]:
 - a. "Cell Biomechanics"
 - b. "Biomechanics of growth"
 - c. "Biomechanics of bloodstream"
 - d. "Biomechanics of reproduction"
 - e. "Biomechanics of the nervous-muscular system" [18]
6. He proposed a "biomechanical thinking in medicine and biology" [16].
7. He replaced the term Neo-vitalism by Biomechanics: "I substitute the term Neo-neovitalism by "Biomechanics" [16]
8. He postulated and described Three General Laws of Biomechanics [16]:
 - a. The Fundamental Law of Life Manifestations: "Every manifestation (M) or expression of vital activity is a function of the inherited nature or heritage (N), of the second nature or external nurture of appropriate environment, psychical as well as physical (N'), of less essential developmental or environmental influences (E), and of incidental or occasional



ISSN: 2350-0328

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interruptions (O)” [19]. These elements can be favorable (positive) or inhibitory (negative). These elements can be favorable (positive) or inhibitory (negative). Thus we reach the vital equation:

$$M = f(\pm N, \pm N', \pm E, \pm O).$$

b. The Biomechanical Minimum Law: “Nature achieves its purpose with the least expenditure (Minimum) of energy, time and space, and with the lowest consumption of the most suitable material in the most appropriate spatial conditions”.

c. The Biomechanical Luxury Law: Living beings are structured with an excess of matter and force, ie on the principle of a luxury arrangement.

V. DISCUSSION

Moriz Benedikt developed, throughout his life, a real program of Biomechanics. He coined the name of this discipline, instituted its first Principles and its first General Laws, established the first fields of application, proposed a new way of thinking in medicine and biology and gave empirical support for their ideas. Therefore, we consider appropriate to grant to Dr. Moriz Benedikt the title of father of Biomechanics.

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