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LETTER TO THE EDITORS
RESPONSE TO CHVÁTAL A (2017): DISCOVERING THE STRUCTURE OF NERVE TISSUE: PART 3: FROM JAN EVANGELISTA PURKYNĚ TO LUDWIG MAUTHNER. *JOURNAL OF THE HISTORY OF THE NEUROSCIENCES* 26: 15–49.

Robert Bentley Todd's contributions to the structure and function of nerve tissue

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Alexandr Chvátal's review (2017) of histological and morphological discoveries of the structure of nerve tissue between 1838 and 1865 overlooks the significant contributions of Robert Bentley Todd (1809–1860). As we have reviewed in this journal (Binder et al., 2011) and elsewhere (Hubbard & Binder, 2016, pp. 1–38), Todd added important original histological observations of the structure of neural tissue to those of Schwann, Valentin, and Purkyně. He was also the very first to understand the function of these cellular structures.

Todd was an Irishman who trained in medicine in Dublin where his father was Professor of Anatomy and Surgery. In 1836 he was appointed to the Chair of Physiology and Morbid Anatomy at King's College in London, where he also became the leading physician at King's College Hospital, which he founded in 1842 and where his statue was erected in 1861. He is best remembered for Todd's paralysis but this was a minor aspect of his contributions to neurology and neuroscience. Influenced by his contemporary in London, Michael Faraday (1791–1867), he was the first to apply the new polar forces of electricity and magnetism to the brain and to develop the concept of electrical discharges in epilepsy (Reynolds, 2004).

Writing in the mid-1840s (Todd, 1845; Todd & Bowman, 1845) before Schwann's 1839 book had been translated into English in 1847, Todd was clearly aware of Schwann's cell theory. He noted that the essential elements of the grey nervous matter were "vesicles" or cells, also called "globules" or "kugeln" by Valentin. Valentin and Purkyně did not consider the "fibers" they observed were connected to the "globules." Todd recognized two kinds of "fibers," "tubular" and "gelatinous," the former including the "white substance of Schwann" surrounding the fine "axis cylinder." Independently of Remak, Todd recognized the continuity of at least one axis cylinder with each "vesicle" (Binder et al., 2011, figure 5). He also described continuous nerve cell branching processes, later called dendrites.

Influenced by Faraday, Todd first suggested that each nerve "vesicle" (cell) and its related fibers was a distinct apparatus for the development and transmission of "nervous polarity." He also anticipated that the white substance of Schwann (myelin) was a

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mechanism for insulating the central axis cylinder to facilitate conduction in the latter, just as insulating with silk can facilitate galvanic conduction in a wire. Although "the law of dynamic polarization" is sometimes attributed to Cajal, it really belongs to Todd half a century earlier.

Todd also recognized the limits of histological studies with the techniques available in the 1840s and anticipated that a complete understanding of the connections between the many different cells, their intimate processes, and the many different "fibers" would require new techniques, as indeed emerged with Golgi and Cajal at the end of the century, leading to the "neuron doctrine."

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