

Taxi J. Contribution à l'étude des connexions des neurones moteurs du système nerveux autonome (Contribution to the study of the connections of motor neurons in the autonomic nervous system). *Ann Sci. Natur Zool* 7 413-674, 1965. [Laboratoire de Biologie Animale, Faculté des Sciences, Université Pierre et Marie Curie, Paris, France]

This is a light and electron microscopic study of 1) the ganglionic synapses in vertebrates, which emphasized their particular features in amphibians, 2) the significance of the "interstitial cells" of Cajal in the neurovegetative effector pathway, rejecting their neuronal or glial nature, 3) the neuromuscular junctions in various mammalian muscles, leading to the existence of two main types of innervation [The *SCI*® indicates that this paper has been cited in over 205 publications, making it the most-cited paper published in this journal]

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This work was initiated at Couteaux's suggestion when I first went to his laboratory in the 1950s. His original aim was to clarify the very confused situation prevailing at the time concerning the cellular relationships in the autonomic nervous system, since several leading morphologists like J. Boeke¹ and P. Stöhr² were defending reticularist conceptions of the organization of the autonomic circuits. The role of the primitive "interstitial neurons," which Cajal³ confined to the peripheral autonomic nervous system, was extended by Boeke to the entire nervous system

Our paper, which appeared in 1965 as a DSc thesis, condensed about 15 years of histological and cytological observations. They started in light microscopy, but a veritable mutation occurred in the prospects for this

work when electron microscopy became routinely feasible for us around 1956. The three main conclusions reached were: 1) the synapses of the autonomic ganglia studied in various vertebrates are very similar to those described in the central nervous system, with only a few particularities, especially in amphibians; 2) Cajal's interstitial cells (ex-neurons) should be clearly distinguished from both nerve and Schwann cells. We suggested that they were homologous to the connective cells of Henle's sheath enveloping the motor nerve endings; and 3) the relationships between autonomic nerve fibers and smooth muscle cells can be classified as "fascicular" and "individual" innervation, which fits well with the physiological distinction of Bozler⁴ between "unitary" and "multiunit" muscles. This last part of our work was especially hard and time-consuming because, among other things, it required 400 grids of semiserial sections for electron microscopy of the intestinal muscle innervation.

Conceptually, these conclusions were not really new, as they had already been formulated with varying degrees of clarity. However, objective evidence was lacking, due to the limitations of light microscopy methods. The new situation created by electron microscopy was indicated by a letter I received in 1966 from Stöhr, who had then just retired. He wrote, in reply to my article, that the continuity of nerve fibers and effectors could no longer be supported in view of the evidence provided by electron microscopy.

If our contribution is still of some interest, it is perhaps because it was one of the first synthetic approaches to the ultrastructure of the autonomic nervous system and was abundantly illustrated. Since 1965, many important new observations have been made in this field, but it nevertheless seems to us that our paper has been completed rather than challenged. Those interested will find that the topics discussed have been brought up to date in the recent reports by Gabella,⁵ Thuneberg,⁶ and Elfvin.⁷

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- 2 Stöhr P, Jr. *Mikroskopische Anatomie des vegetativen Nervensystems*. Berlin Springer-Verlag, 1957 678 p
- 3 Cajal S R. *Histologie du système nerveux de l'homme et des vertébrés*. Paris Maloine, 1911 Vol II p 923
- 4 Bozler E. Conduction, automaticity and tonus of visceral muscles. *Experientia* 4 213-18, 1948 (Cited 200 times since 1955)
- 5 Gabella G. *Structure of the autonomic nervous system*. London Chapman and Hall, 1976 214 p
- 6 Thuneberg L. Interstitial cells of Cajal: intestinal pacemaker cells? (Whole issue) *Advan Anat Embryol Cell Biol* 71, 1982 130 p
- 7 Elfvin L G, ed. *Autonomic ganglia*. New York Wiley, 1983 527 p