

HISTORICAL CORNER

THE WORK OF SANTIAGO RAMÓN Y CAJAL IN BARCELONA

Without any doubt, the work of the Nobel Prize Santiago Ramón y Cajal has had a greater impact on the scientific world than that of any other Spanish researcher. His contribution to the field that is today known as «neuroscience» was fundamental to its development, and even a hundred years later, at the very end of the twentieth century, his studies are still cited.

Cajal was born on 1 May 1852 in the tiny village of Petilla de Aragón, which, although its name suggests otherwise, is in the province of Navarra. He studied medicine in Zaragoza, and thus did, however, spend most of his early life in Aragón. At the age of forty, he was granted a university chair in Madrid, and lived some forty years more in the capital. He spent less than five years in Catalonia, between 1887 and 1892 – in addition to other short stays which need not concern us – but during this time he was engaged in scientific activities of fundamental importance.



It is well known that Cajal lived in Barcelona, but surprisingly little has been written about this period of his life. An examination of his activity in this city will draw on two sources: his publications, that is, an objective analysis of his scientific output, of the areas with which it dealt, and of its repercussions, and his own declarations.

Cajal was appointed to the chair of anatomy at the University of Valencia in 1883. His main interest was microscopic anatomy - histology – which was not yet as taught as an independent science. But in 1887 three chairs of histology were founded, and Cajal applied for the one in Barcelona, even though the other two offered were in Valencia (where he was then working) and Zaragoza (where he had studied, and which was nearer to his home). He was elected to the chair of histology in Barcelona on 2 November 1887 and took up his post in December. The chairs in Valencia and Zaragoza remained vacant.

He came to Barcelona at the age of 35. He was relatively unknown, although he had made something of a name for himself during the cholera epidemic of 1885 in Valencia, when he questioned the measures proposed by Ferran.

Cajal spent only a short time in Barcelona, less than four and a half years, but the work he conducted here was of crucial importance to the development of histological research and organisation, especially with regard to the study of the central nervous system. Although the microscope had been invented in the seventeenth century and a number of highly significant observations had been made, the instrument's use had not led to the establishment of a new, productive field of research. In many cases, new discoveries were only possible with a technique that allowed scientists to observe preparations with sufficient contrast. This was achieved by the introduction of staining techniques. Until staining became routine, the microscopic study of tissue was severely limited. Staining techniques began to be used to effect during the first half of the nineteenth century.

By Cajal's time staining was standard practice, but the nerve tissue was ill suited to the colours normally used. New techniques were needed, which were slow to evolve. They exploited the tendency of certain metallic salts to form precipitates in nerve tissue. In Italy, Camillo Golgi had developed a method to stain nerve tissue with silver salt deposit, a technique that bore certain resemblances to photography. In Spain, the technique's leading proponents were Maestre de San Juan and Simarro.

Cajal learnt the techniques and acquired great skill in obtaining contrasts demonstrating the intricate structures of the nervous system. The study of these structures was an important area in basic medical sciences, but at that time medicine was dominated by the microbial studies of Pasteur, Koch and their schools, and the use of antiseptics and asepsis in surgery, in which Lister was the pioneer. Histology, in spite of its importance, was only a secondary priority.

Cajal's research produced solutions to a number of problems, and he was accorded wide recognition during his life time. His influence endured for many years, until the extraordinary boom of the neurosciences. Among his numerous discoveries, the most important is what is known as the «neuron theory».

The structure of the central nervous system is highly complex. Some of its cells are involved in a large number of processes: the axon, which transmits impulses from the neuron, and the dendrites in another neuron that receive them. The processes of neurons in certain areas could be compared with the branches of a tree in a forest. The concept presented a number of problems, of which one was fundamental: did the neurons bind with their processes, like a net? Was the nerve tissue continuous? Or, alternatively, were the neurons independent cells which touch each other, but do not bind to-

gether? Broadly speaking, there were two theories: the reticular theory, which held that the neurons bound together, and the neuron theory, which held that cells were independent.

The solution to the problem was by no means simple, especially considering the means at the disposal of researchers at that time. The reticular theory provided a simpler explanation of the activity of the neurons; the neuron theory had to explain how the independent cells communicated with each other. Cajal adamantly believed that the cells were independent, but that they came into contact with each other in an area called the synapse, yet he did not explain in detail how this happened. His belief was to be proved right; in time, it became clear that his model was correct. This is perhaps his greatest contribution to science.

Cajal concentrated on this problem during his period in Barcelona, and it was during this time that he made his name in the field of histology. He began most of his studies on the central nervous system here, and in his first four years working in this area he formulated his most important ideas. We will now analyze his activity and achievements during his Barcelona years.

Cajal's work in Barcelona

Cajal's autobiography *Recuerdos de mi vida* lists his publications. In all, he wrote 266 scientific studies, of which fourteen were books. At a time when scientific productivity was low and the system of team publications hardly existed, this volume of output was extraordinary; Cajal had a phenomenal capacity for work. The first edition of his manual of patho-

logical anatomy was published in Barcelona in 1890. His manual of histology had been published earlier, in Valencia, in 1887.

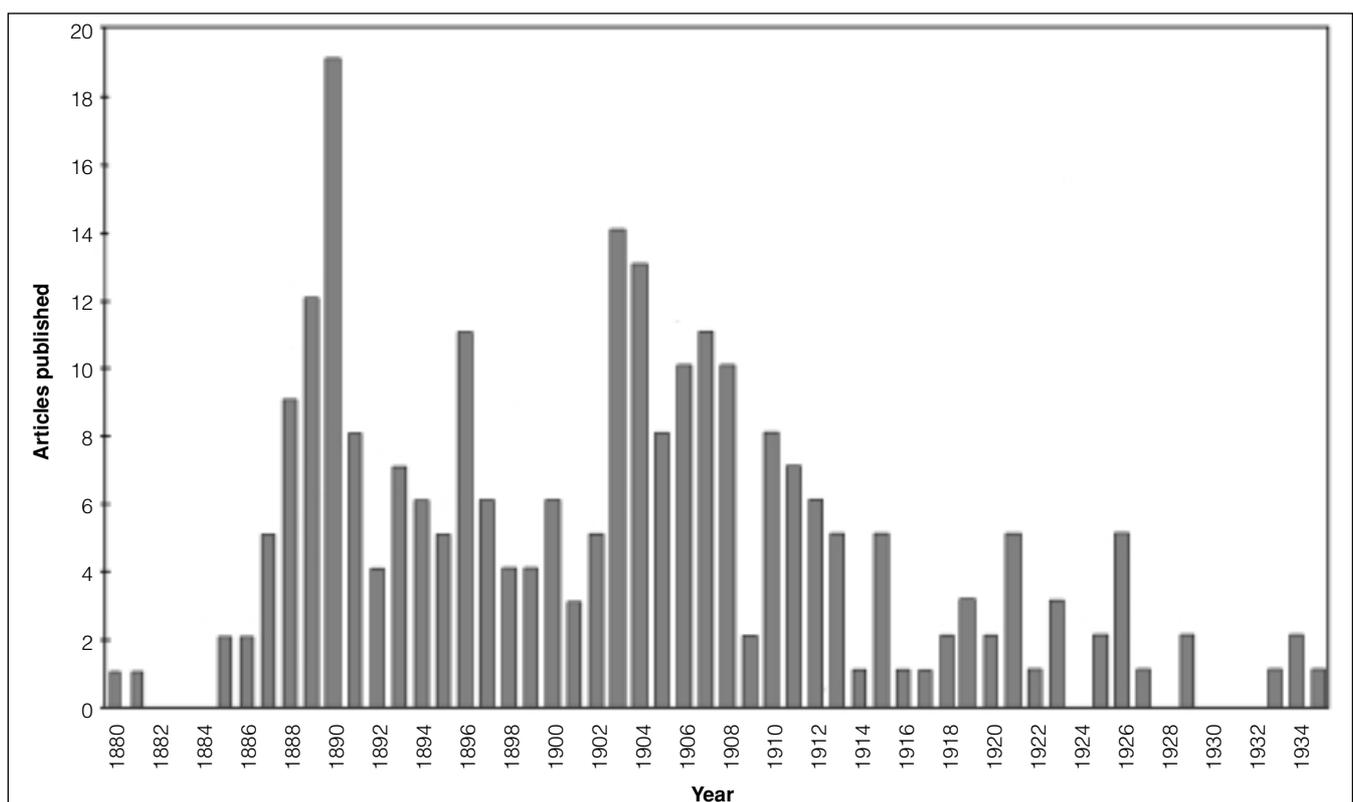
Five aspects of his scientific publications during his Barcelona period deserve mention:

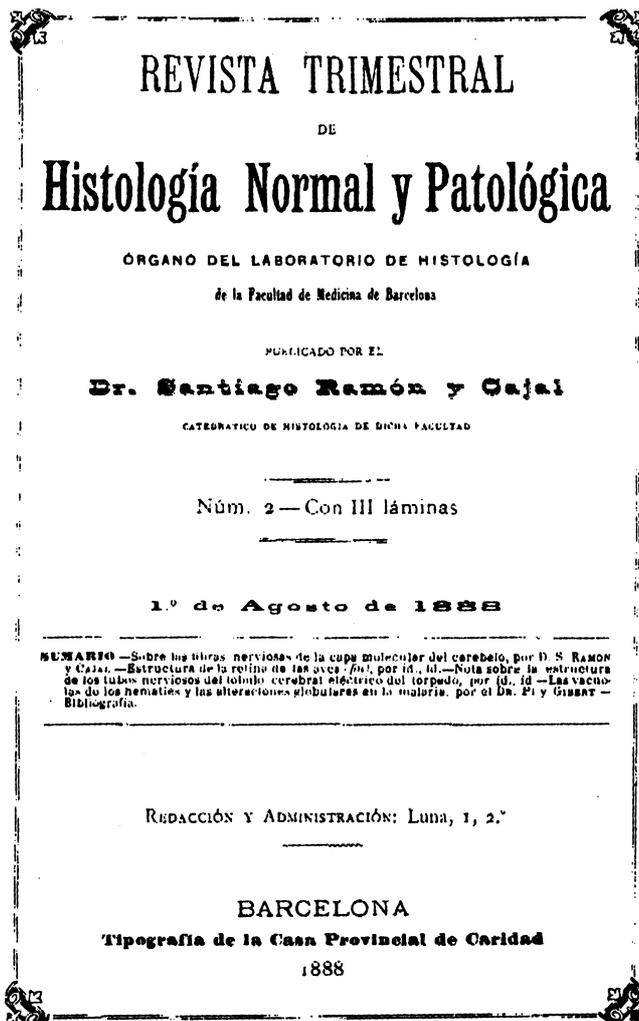
- **Productivity:** During his time in Barcelona, Cajal published 49 articles, eleven of which were published abroad. In 1888 he published nine studies; in 1889, twelve; in 1890, nineteen; in 1891, eight; in 1892, one. He left Barcelona early in 1892. This was the most productive period of his life; only in 1903-1904, when he published a total of twenty-seven articles, did he ever approach the output he achieved in Barcelona.

- **Subject area:** Cajal concentrated on nerve tissue. Although his time in Barcelona was short, there is a certain evolution in the areas that he examined. Among his major studies we should mention his writings on the nerve structures associated with vision, conducted mainly in birds; his work on the structure of the cerebellum; and, slightly later, his studies of the brain.

One of his articles, on peripheral innervation in the pancreas, was written in conjunction with Claudi Sala, from Artés. It is one of the few articles by Cajal in Barcelona that bear the signature of a co-researcher. Many of Cajal's studies were performed on material from embryos, whose structures are the simplest to interpret.

- **The journal:** Cajal published mainly in the *Revista Trimestral de Histología normal y patológica* which he founded, and financed in 1888 and 1889. Significantly, Cajal was the editor of the most important journal ever published in





Spain in terms of scientific results. He funded the journal himself, and published only a few issues; today it is a collector's item. He also published articles in the *Gaceta Médica Catalana* edited by Rodríguez Méndez. This journal was published for over forty years, from 1878 to 1921, and was the most important vehicle for the introduction of European science into Catalan medicine at that time.

Cajal also published a number of articles in the *Gaceta Sanitaria de Barcelona*. Curiously, his only clinical study – at least, the only one that we know of – deals with hypnosis and labor pains, and was published in the *Gaceta Médica Catalana*.

- **Journey to Germany:** Cajal made extremely important discoveries, but he published mainly in Spain, and his findings were not known outside the country. The most fertile scientific climate was abroad. Cajal decided to attend a congress in Berlin, where he could present his discoveries. The journey was complicated, and he did not find it easy to make contacts, but when he persuaded Kölliker, one of the leading medical lights of the moment, to look through his microscope, his scientific reputation was made.

- **Cajal's own assessment of his time in Barcelona:** Cajal worked intensely during his time in Barcelona, and he had fond memories of the period, especially of the year 1888 – his first complete year in the city. «And the year 1888 arrived, my *outstanding year* (his emphasis), my year of fortune. Because in that year (...) those interesting discoveries, so fervently awaited, finally arrived».

At that time, then, the city had a learned professor. No one in Catalonia has matched the scientific prominence that Cajal attained while living here. But after little more than four and a half years, he left. What is more, he did not simply apply for a transfer to another city, which would have been a straightforward enough step, involving a little paperwork and nothing more; he sat a competitive examination, which was by no means a formality. There may have been a number of reasons for his decision. One may have been the unfortunate laboratory accident which killed Maestre de San Juan, who would have been professor at Madrid for many years to come. In any case, Barcelona was unable to keep Ramon y Cajal any longer.

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