

zada fue otro de los focos de atención, conflicto y colaboración entre médicos y pedagogos que, partiendo de premisas y argumentos diferentes, propugnaban una pedagogía médica o una educación especial como respuesta social y educativa ineludible ante la «infancia anormal».

En la segunda parte, denominada «De las palabras a los hechos: la asistencia a los niños anormales en España (1900-1939)», se analizan las soluciones emprendidas por instituciones y centros públicos y privados emblemáticos de nuestro país en la atención a la anormalidad infantil. Iniciativas públicas como las del Patronato Nacional de Sordomudos, Ciegos y Anormales, creado en 1910, la Escuela Central de Anormales, fundada inicialmente en 1922 bajo la denominación de Escuela Especial de Anormales, o la Escuela Municipal de Deficientes de Barcelona gestada en 1910, que a pesar de contar con ambiciosos proyectos se vieron sometidas desde su fundación a problemas de financiación y de funcionamiento. La asistencia privada también padeció serias limitaciones. Así pues, como expresa la autora de este estudio, las primeras décadas del siglo XX fueron testigo del nacimiento, difícil y lento de la asistencia a los niños con discapacidad mental. ■

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■ **Miguel García-Sancho. *Biology, Computing and the History of Molecular Sequencing. From Proteins to DNA, 1945-2000.*** London: Palgrave Macmillan; 2012, 256 p. ISBN: 978-0-230-25032-1, € 64.

Contemporary biological research heavily relies on computers and the automation of procedures that range from the mechanization of experiments to the uses of software for analytical purposes. Nowhere is this symbiosis between biology and computing closer than in contemporary genomics, almost a synonymous word for bioinformatics. The highly technical nature of today's genomic research, concentrated in large automated facilities requiring large amounts of public and private financing, its contentious marketing of recreational genetics services, and its vociferous promises for individualized medicine, have made it a research heaven for sociologists of science. By contrast, genomics —and the confluence of biology and computing, in general— has

proved highly elusive for the professional historian of science. This is so for several reasons, some of them deriving from the very recent character of these practices (see below), but others more related to the disciplinary constraints of the historian of science, who has been trained either in the history of biology or in the history of computers, but not both. Miguel García-Sancho's book represents an outstanding accomplishment in bringing together those two realms, contributing to our understanding of the complicated history of how an important segment of biological research became the computerized and highly automated practice of today's genomics.

For historians of the life sciences in the 20th century, *Biology, Computing and the History of Molecular Sequencing* represents a big leap in bringing together histories from molecular biology, computer science, mathematics and even evolutionary biology. Supported by an impressive archival and oral research, and by a thorough revision of the secondary literature of the field, García-Sancho's book is a celebration of what the history of recent and contemporary science can achieve, and for years to come it will remain as an obliged reference not only for historians of science, but for sociologists and all those interested in the detailed development of the industrialized-information society.

The book's virtues are many. As mentioned before, bridging the gap between the history of biology and the history of computing (but also, the history of technology and the history of science) is perhaps the most notable one for the general reader. No less important is García-Sancho's narrative, written in a fluid, clear and reader-friendly style, and supported by appropriate historical photographs and excellent explanatory figures elaborated by the author. The general structure of the book certainly contributes to the narrative's clarity, each of the three parts being devoted to each of the major developments in the long history of sequencing: part one, on the emergence of protein (chapter 1) and nucleic acid (chapter 2) sequencing in the work of Frederick Sanger between 1943 and 1977; part two, on the automation of assemblage of data and the creation of the first sequencing software (chapter 3) and databases (chapter 4) between the 1960s and 1980s; and finally, part three devoted to the development (chapter 5) and commercialization (chapter 6) of the first automatic sequencers between 1980 and 1998. As can be inferred by this description alone, the book covers the main events in the trajectory that has resulted in the current symbiosis between biological research, automation and computers.

However, for the historian of science, and in particular for the historian of recent biological sciences, an equally important contribution of García-Sancho's work stems from its sophisticated historiographical perspective. This

is reflected in three major ways. First, García-Sancho's convincing and thorough argumentation of sequencing as «the result of the confluence of a variety of practices in a *form of work*». Following the influential categories of John Pickstone of ways of «knowing» and «working» in the history of science, and his more recent proposal of «working knowledge», as a way to «analyze the proliferation of analytical and rationalized working knowledges after the 1970s» (p. 12), García-Sancho embarks on a long-term convincing narrative of sequencing as a form of work. He refuses to interpret sequencing in the way molecular biologists and genomicists do: as a tool subordinated to their disciplinary practices. In doing so, his account is able «to link sequencing with a multiplicity of actors—molecular biologists or not—who, in finding responses to practical problems, crossed disciplinary boundaries» (p. 12). His choice allows the author to narrate a coherent history of practices, tools, actors and disciplinary cross-overs around sequencing, that extend along half a century of research, from Frederick Sanger's protein sequencing techniques in the 1940s and 1950s, to the automated DNA sequencers of the late 1980s and 1990s. In a highly specialized field, like today's history of science, this is a notable achievement, given the fact that the author provides a thick reconstruction and not a general account. As a historian of science, I must acknowledge that García-Sancho's narrative may be one of the most fruitful applications of Pickstone's categories to date.

Second, García-Sancho's historiography reflects his solid awareness of the dangers of writing history of recent and contemporary science, and in particular writing the history of genomics, a field empowered by the notable characters of its main actors (Craig Venter, James Watson, among others), and by the salient place it has cultivated within contemporary science and society at large. Having myself warned of the risks faced by historians in legitimating the genomicists' narrative of their own field, I cannot but appreciate the fact that García-Sancho has incorporated previous findings on the connection between evolutionary biology and the development of the first computer tools for sequence analysis. As García-Sancho convincingly argues, and I have argued before, some of the first analytical and comparative tools of today's bioinformatics originated in the field of evolutionary biology. This genealogy, however, is totally erased in the genomicists' accounts, who tend to see themselves as heirs of the molecular biology revolution. Among other undesirable consequences of these accounts it is important to mention how disciplinary hierarchies and science policy priorities have been shaped—and continue to be—by the attribution of every major development in 20th century life sciences to the iconic developments surrounding Watson and Crick's double helix model of DNA. By selectively

eliminating actors in their personal narratives (in this case evolutionary oriented scientists), the genomicists not only deliver a monophonic history, but influence the present and future trajectories of science.

Third, García-Sancho's historiography is an important reminder of the benefits of using new and diverse resources in the writing of recent and contemporary science. He does so in particular in chapter 6, by recurring to the history of business and corporate culture of Caltech, and by appealing to a comparative account of the different cultures of scientific institutions to account for the divergent trajectories of sequencing automation and the further commercialization of sequencers. Again, the author's historiographical decisions have further implications, since he demonstrates that institutional cultures are more important than supposed national styles in explaining the development of commercialized automatic sequencers and the different approaches in the private and public attempts to sequence the entire human genome in the late 1990s.

Making use of those historiographical tools, García-Sancho puts together a lot of previous scattered historical research, done by historians of biological sciences and of computing science in the last 15 years. The research culture at Cambridge's Laboratory of Molecular Biology and the career of Frederick Sanger being, for instance, one of the best documented episodes in the field. Nevertheless, the book offers refreshing interpretations and new historical research, in particular in parts two and three. Among those that I profited the most are the historical account of the automation of sequence assemblage and the different paths of the introduction of computers to biological research at Cambridge (which opens a door to analyze the resistance of biologists to full automation), the detailed historical reconstruction of the first DNA database in 1980 at the European Molecular Biology Laboratory in Heidelberg (including a thorough discussion of the role of «information engineers» and the evolving disciplinary hierarchies between computer scientists and biologists), and the development and commercialization of automatic sequencers at Caltech (in which the corporate and marketing culture of science at Silicon Valley enters the history of science).

In brief, I cannot do other than praise the publication of Miguel García-Sancho's book, as an important contribution that summarizes not only the empirical results of previous historians and his own research results, but the conceptual and theoretical advances of recent history of science as a mature field of research. ■

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