Series

What history tells us V. Emile Duclaux (1840–1904)

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1. A limited place in scientific historiography

Emile Duclaux was the first collaborator of Louis Pasteur, and remained the closest of all throughout his life. He succeeded Pasteur as the Head of the Pasteur Institute, and had a very active part in its early development. He wrote many books including a monumental treatise on microbiology.

Despite this close link, Emile Duclaux is far less known than other collaborators of Pasteur such as Jules Raulin, Emile Roux, Charles Chamberland and Albert Calmette. An alleged reason is that unlike these other collaborators of Pasteur, Emile Duclaux did not make a major scientific contribution: Jules Raulin gave the first description of a pure medium for cultivating a microorganism (*Aspergillus niger*), Chamberland adapted the use of filters to retain microorganisms – which became the major criterion to distinguish viruses from bacteria in the first decades of the 20th century, Emile Roux demonstrated the efficiency of serotherapy against diphtheria, and Albert Calmette developed the first vaccine against tuberculosis.

These facts are true, but constitute only one part of the story. Duclaux also made important scientific contributions, which have not been acknowledged for reasons that we shall discuss. In particular, the legend that grew around the work of Pasteur prevented full recognition of the contributions of his closest collaborators. The major contributions of Duclaux were also of a different nature. The limited place that Duclaux has in the official history of the biological sciences demonstrates that contributions that are decisive for the progress of science but which do not lead to a discovery are frequently undervalued by the scientific community.

2. A short biographical sketch

Duclaux was born in 1840 in Aurillac, a small city in central France. His intellectual capacities were soon recognized by his teachers, and he traveled to Paris in 1857 to prepare for the competitive examinations for entrance to France's most famous "grande école" (prestigious higher education institute), the Ecole Normale Supérieure. He stayed where Pasteur had when he had prepared for these exams some years before. Thus it was that the young Duclaux met Pasteur, who was then the director of scientific studies at the Ecole Normale Supérieure. Pasteur immediately appreciated Duclaux: he too came from a modest family living in a remote part of France. After his acceptance by the Ecole Normale Supérieure, Duclaux immediately started to work with Pasteur, and contributed to the demonstration of the non-existence of spontaneous generation. At the age of 27, he was named Professor of Chemistry at the University of Clermont-Ferrand, not very far from his birthplace, where he actively pursued research into the microbiology of milk and cheese, as well as the fermentation of beer, in collaboration with Pasteur, who had left Paris during the Franco-Prussian War of 1870-1871. He was appointed Professor of Physics at Lyon in 1873, and then returned to Paris in 1878 to teach physics and meteorology. He also ran a course in biological chemistry at the Sorbonne. This was a period of renewed active collaboration with Pasteur. Duclaux played an active part in the organization of the Pasteur Institute, where he joined Louis Pasteur in 1887. As editor-in-chief of the Annals of the Institute, he wrote many critical reviews on recent accomplishments in the field of microbiology. He succeeded Pasteur in 1895, and contributed to the enlargement of the Institute, with the creation of a hospital and of a new Department of Biological Chemistry. During these years, he was actively engaged in French political debates, and supported Captain Dreyfus, a Jewish army officer falsely accused of treason (Finkelstein 2001).

3. Some unrecognized contributions

Emile Duclaux made original contributions to science that have not been acknowledged for four different reasons.

The first was his close association with Pasteur. Duclaux worked directly with Pasteur on silkworm disease, the spontaneous generation debate, and the fermentation of beer. In all three cases, history remembers only the name of Pasteur.

This is unjust, particularly in the case of fermentation of beer, where Pasteur put his name alone to work done in collaboration with Duclaux.

The second reason is that Emile Duclaux covered a broad range of subjects, but did not focus on any one in particular. Let me give one example of the brilliant intuitions of Duclaux, which were pursued by others. The phenomenon of enzymatic adaptation played a major role in the development of the first models of genetic regulation. Its description is traditionally attributed to Henning Karström in the 1930s (Karström 1938). Benno Müller-Hill (1996) noticed that the first precise description had been given earlier, by Frédéric Dienert in 1900 in the *Annales de l'Institut Pasteur* (Dienert 1900), mentioning earlier work by Duclaux on *Aspergillus*. Bünning has proposed that the real discoverer was Pfeffer in 1900. He says: "It is often believed that the discovery of adaptive enzymes is one of the laurels of modern microbiology. But actually this discovery was made in Pfeffer's laboratory in 1900 and continued to be a topic of research in that laboratory for several years" (Bünning 1977). In fact, the first experimental observations were made by Duclaux on *Aspergillus glaucus* and *Penicillium glaucum*, and reported in the 5th chapter of the second tome of his treatise on microbiology (Duclaux 1899). The conclusions Duclaux drew from his observations were clear: "In summary, we have seen that, in these two microscopic organisms, the production of diastases (enzymes) is related to added nutrients". Maybe the lack of recognition of Duclaux results from the fact that these observations were 'lost' in this huge treatise on microbiology. The experiments were not precisely described, as they would later be in Dienert's article. In addition, in some other parts of the chapter, Duclaux did use the word 'secretion', leaving open the possibility that the enzymes were already present before the addition of nutrients.

The third reason is that most of the scientific work of Duclaux was devoted to practical applications. He made huge contributions to the characterization of the physico-chemical transformations of milk during the formation of cheese under the action of different microorganisms. He was one of the first to recognize the major role of microorganisms present in the soil in the nutrition of plants, and the sterilizing action of ultraviolet (UV) light: he is widely considered to be responsible for the present use of UV radiation to sterilize hospital rooms and other places that must be germ-free.

The fourth and last reason for the failure to recognize the contributions of Emile Duclaux is that they differ in nature from those generally acknowledged by scientific institutions, because they cannot be summarized in one experiment, but instead in the establishment of a new vision which opens new lines of research and ways of fighting disease. An example is the new understanding of the role of microbes in the development of diseases that emerged from the work of Pasteur, Koch and the early microbiologists. The initial error was to link the outbreak of a new disease with the emergence of a new pathogenic agent. This model did not fit the evidence that the major diseases are common, and their agents everywhere in the environment. It transformed the fight against disease into a desperate enterprise. Emile Duclaux was among the first to replace this simplistic model by a more sophisticated one in *Ferments et maladies* (Ferments and diseases) published in 1882 (Duclaux 1882) and in *L'hygiène sociale* (Social hygiene) completed in 1902 (Duclaux 1902). Most pathogenic microorganisms are in equilibrium with their hosts, and new epidemics arise when this balance is upset, usually by human beings themselves, as their activities give microorganisms new ways to spread and create for them new habitats, what ecologists today would call new 'niches'. The originality of Duclaux in these matters is obvious in comparison with Pasteur. He anticipated ideas which were subsequently developed by Charles Nicolle and other microbiologists in the first decades of the 20th century (Mendelsohn 1998; Pelis 2006) – without acknowledging the contribution of Duclaux.

This new vision of the relations between pathogens and their hosts have clear implications for the fight against disease. Action has to be taken against the microbe, but also against the social conditions and the habits that favour the dissemination of the microorganisms. Even measures that are weak or not very efficient – such as the filtration of water, an example discussed at length by Duclaux – can have a dramatic effect on the spread of an epidemic. The goal should not be to eradicate the disease, but rather to shift the equilibrium so as to disadvantage the pathogens. To be able to advise politicians on the measures that have to be adopted, the microbiologist must not only use his precise knowledge of the characteristics of the pathogenic agent, but also take into account the general knowledge of the relations between the pathogen and its host.

4. In the shadow of Pasteur

Gerald Geison has proposed that the closest collaborators of Pasteur were poor scientists, and that the creation of a Pasteurian legend was the best way for them to mask their weaknesses (Geison 1995). This harsh judgment does not apply to Emile Duclaux. He had a huge admiration for Pasteur, and a sincere affection for him. But it did not prevent him from seeing Pasteur's errors. His biography of Pasteur, *Pasteur: Histoire d'un esprit* (*Pasteur: the history of a mind*) (Duclaux 1896) published only one year after his death, is one of the best scientific biographies ever written, full of acute epistemologic and sociological remarks, from which later biographies have borrowed amply, without acknowledging their debt (Dubos 1960; Debré and Forster 1998). Emile Duclaux was a free spirit, and his admiration for Pasteur did not prevent him from commenting

enthusiastically on Büchner's observation of *in vitro* fermentation, a discovery considered by many as a blow to the link established by Pasteur between fermentation and the presence of living microorganisms.

Both Emile Roux in his scientific biography of Emile Duclaux (Roux 1904), and the second wife of Duclaux, Mary, in her own biography (Duclaux 1906), helped to give Emile Duclaux a saintly – but false – image. He was the Pasteur's "Saint Paul", the one who consolidated the foundations laid by the genius, and helped to disseminate the Master's message.

It is probably in the creation of the Pasteur Institute that the influence of Emile Duclaux is the most underestimated. Pasteur, by then aged and handicapped by disease, would not have been able to organize *ex nihilo* a huge research institute. Duclaux was the main organizer, the one who introduced to the Institute a spirit of freedom and equality. It is a shame – and perhaps the consequence of the troubles that affected the Institute last year – that the 100th anniversary of the death of Emile Duclaux was not better commemorated!

5. At odds with the perceived image of a scientist

There are three more characteristics of the activities of Duclaux that contributed to his exclusion from the Pantheon of great scientists. The first is the wide-ranging nature of his work. The diversity of scientific matters he touched on far exceeds the already numerous examples we have described. Emile Duclaux also wrote a book on physics and meteorology (Duclaux 1891), contributed to the study of human diseases, worked on capillarity and the distillation of alcohols.

This broad outlook was supported and encouraged by his teaching activities. Duclaux was an excellent professor, and he saw his teaching duties as a major part of his scientific work. Politically left-wing, Duclaux considered it his personal duty to popularize the results of microbiology by giving many lectures in the popular universities that flourished in France at the end of the 19th century.

But for most scientists Duclaux's major sin is probably his active involvement at the end of his life in the defense of Dreyfus. This political commitment was fortuitous: Emile Duclaux was contacted by a supporter of Dreyfus and asked to comment, as a scientist, on the quality of the evidence brought against Dreyfus. Duclaux answered as a scientist, saying that the evidence was weak and that a scientist would never use such shaky arguments to support a theory. Duclaux believed that science was the model of rationality, and that scientists should help the rest of society by teaching what their work as professional scientists has taught them about how to reason logically. Emile Duclaux is considered as one of the first intellectuals of the 20th century. But, for most scientists, it is impossible simultaneously to be involved in politics and do excellent science.

6. Conclusion

Perhaps we should be more cautions in our vision of how a scientist should behave, a perception closely tied to the present-day organization of scientific research – with its extreme specialization. Is the present situation optimal? And was not the huge spectrum of activities and interests of Emile Duclaux also necessary for the rapid development of microbiology and its general acceptance? We should not reduce the history of medicine to a catalog of the discoverers of diseases. As a scientific organizer, and a prime mover in the development of microbiology, Emile Duclaux deserves a place in our memories.

Let us end with a final anecdote about the personality of Emile Duclaux (Le Dantec 1904). Recently published studies had convinced him that alcohol was a nutrient. He compiled a summary of these studies in the *Annales de l'Institut Pasteur*, and responded in later publications to those who contested the value of the scientific evidence or simply, as the Academy of Medicine did, considered that it was inappropriate to publicize results that could apparently support the use and abuse of alcohol. In fact, the scientific convictions of Emile Duclaux did not blind him to the consequences of alcohol abuse or prevent him from acknowledging the need to reduce alcohol consumption among the general population. Rather, he saw the debate as evidence that the truth, whatever it is, must always be stated, and that good objectives must never be supported by false or biased arguments. With our experience of all the drama of the 20th century, we are no doubt more at one with Emile Duclaux's attachment to truth than with the Academy of Medicine's strategic stance!

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