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Book Review

Zaterka, Luciana and Mocellin, Ronei Clécio. *Ensaios de História e Filosofia da Química* (Essays on the History and Philosophy of Chemistry). São Paulo: Editora Ideias e Letras, 2022, 328 p. ISBN 978-658729531-2

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This just-published book is like a blast of fresh air in the Brazilian intellectual milieu, which still lacks works bringing together chemistry and philosophy. Thus it is quite welcome in filling in a positive way a gap in our academic literature.

The book is divided into an introduction and five chapters, followed by Final Considerations, References and Indexes. The text is preceded by a preface by the historian and philosopher of chemistry Bernadette Bensaude-Vincente, from the University of Paris.

The Introduction brings forth a series of relevant discussions, which are worth mentioning here, even though only in part. Beginning with the rhetorical question "would chemistry present any interest for philosophy in general and the philosophy of science in particular?", there follow pertinent queries and reflections. An initial observation is the relative unimportance generally conceded to chemistry in the philosophical treatment, which is so present as regards physics, and to a lesser degree biology, in contrast with the modest role reserved to chemistry in this respect. However, so goes the authors' argument, this is a posture much more present in the English-language literature, contrarily to other intellectual traditions. The authors argue that this difference is visible in the preference for the expression *philosophy of science* in English, in contrast with the French form *philosophie des sciences*. The French expression is more encompassing by the use of the plural, which comprises all the sciences. The relative disdain to philosophize in chemistry is thus more present in English than in French. They also point out how the more recent historiography, along the last 50 years, had a relevant role in many discussions involving the philosophy of chemistry. In contrast with the little emphasis given to philosophical studies of chemistry in a good part of the nineteenth and twentieth centuries, in previous periods things took place in a different manner. It suffices to remember the influence exerted by Francis Bacon on Boyle or by Étienne Bonnot de Condillac on Lavoisier. In her 1965 book *Robert Boyle on Natural Philosophy*, Marie Boas Hall says: "Though it was Bacon who mainly inspired Boyle, he was influenced by Descartes as well" (Hall 1965, 63). Further on, the same author emphasizes that Boyle's actual contribution to the development of chemistry consisted in

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"that he did successfully deal with chemical experiment and theory as a part of natural philosophy, and that by precept and example he persuaded others to do the same" (Hall 1965, 85). In the case of Lavoisier, it is noteworthy that the French chemist opens up the first page of his main work, the *Traité Élementaire de Chimie*, relating the importance received from his philosophical mentor, Condillac. Lavoisier openly avows that he "felt the evidence of the principles established by the Abbé de Condillac in his logic and in some of his other works". The two authors mentioned, Boyle and Lavoisier, belong to different centuries, but confess their debt to the philosophical teachings of their predecessors. Lavoisier's Treaty is traditionally described as a sort of fountainhead of modern chemistry, that new chemistry which came to develop so extraordinarily in the nineteenth century. How many chemistry texts can we cite, starting from the nineteenth century, which so openly acknowledge the union between chemistry and philosophy? This divorce between the two lasted for a century and a half. A non-negligible aspect of this phenomenon is perhaps linked to the manner how chemistry came to develop during the nineteenth century. The progress of chemistry along that century constitutes an outstanding case of a science of the group of the so-called "exact" sciences, which grew and expanded throughout the century with hardly any use of mathematics, in opposition to thermodynamics, optics, astronomy, and several other sciences. In the nineteenth century, the majority of chemists did not use any mathematics beyond elementary arithmetic in order to perform stoichiometric calculations or to determine the yield of reactions. It was a highly empirical science, focused on the increase in the scope of topics comprising the nature, properties and transformations of matter. I have witnessed a certain air of perplexity many times, moreover in physicists, when I call their attention to this point. Then, they ask me, how does chemistry intend to be scientific? Well, mathematics is an instrument, and amongst the most important in science, but it is **not** chemical science. Evidence that the development of chemistry in the nineteenth century occurred in an absolutely rational and logical way, which are qualities inherent to science, was that chemistry gave birth to the industrial revolution in Germany. That country was disunited until 1870, forming a myriad of independent states, and arrived late at the industrial revolution that had taken place above all in Britain and in France. Germany in the second half of the nineteenth century contrived to "invent" a new industrial specialty, the chemical industry, which took the country to the forefront of industrial nations. Even today the so-called "five sisters", the conglomerates represented by Basf, IG Farben, Hoechst, Merck and Bayer make up the biggest industrial group in chemistry in the world. At the end of the nineteenth century, however, the situation began to modify, and mathematical analysis came to play a growing role in chemical science. It had been necessary first to accumulate an enormous set of empirical knowledge about millions of compounds, their composition, chemical arrangements, and behaviour. Possibly, the historic development of nineteenth-century chemistry, above all utilitarian and pragmatic, has contributed to the phenomenon by which philosophical studies of chemistry have remained in second place.

Another aspect to be considered is also the significant increase in chemical education that started to take place from the end of the nineteenth century. Here it is important to point out that chemistry is perhaps the science that causes the greatest perplexity, for what many call its "esoteric" language, which is seen by many laypeople as impenetrable. In spite of the great effort to create a rational and logical system of nomenclature for chemical compounds, one must acknowledge that the subject is still quite thorny, both to laypeople as well as to professional chemists, in view of the gigantic number of compounds which ought to have an unambiguous name, around 15 million. Here another topic must also be pointed out, and it is the notable fact that the number of synthetic compounds may have outnumbered that of natural compounds. This fact contains an important philosophical interest, for it shows that chemistry is a science capable of creating its own object of study, in synthetizing compounds which do not exist in nature.

During the last decades of the twentieth century philosophical studies regarding chemistry acquired particular importance, as the authors of the present book are keen to say, and this was due "not only to the need to build the concepts used in the teaching of chemistry, to the particular 'chemical vision' of the world and its place in the spectrum of scientific knowledge, but also to the manner by which chemists have defended the epistemic identity of their science along its history and in discussions of ethics in chemistry, a discussion of paramount importance in the present historical moment, when many anathematize chemistry as the source of countless evils of humankind, often condemning it without any profound knowledge of chemical science or of its idiosyncrasies. The theme of ethics, of enormous actuality, is retaken in other passages of the book, as well as the relation between the philosophy of chemistry and the teaching and the learning of the science. There is a very competent discussion of the contradiction in our present society between the easy demonization of chemistry, and the gluttonous desire to savour all of its conquests and achievements. This is a contradiction which gives way to many philosophical inquiries, which can be amplified when one considers the already mentioned aspect that the number of artificial compounds outnumber that of natural ones, making chemistry a particularly interesting science in that it can fabricate its object of study, in contrast with other sciences. This topic can lend itself to many philosophical discussions of different degrees.

As one sees, the problems pointed out and discussed in the introduction are sufficient to judge how opportune was the publication of this book.

The chapters follow, discussing themes of great pertinence and relevance. They are:

1. Alchemy and chemistry: permanence and rupture, with a distancing from traditional historiography when dealing with the topic;
2. Natural history, experimental philosophy and the emergency of chemistry;
3. Chemistry and medicine: blood, longevity and the emergency of modern chemistry;
4. Chemistry and the biography of its materials;
5. Agricultural chemistry, genetically modified organisms and human responsibility;
6. Final considerations – chemistry, society and responsibility.

The present essays are so rich in the questions discussed and in the way they are treated that it is difficult to mention here more than a few cursory points. The chapters follow one another catching the reader's attention, in an always captivating text. However, I think it important to repeat part of the Preface, written by Professor Bernadette Bensaude-Vincent, which summarizes well the book's aim: "in the twentieth century, chemistry shone by its absence in the philosophical field, although its products, omnipresent in daily life thanks to the replacement of traditional materials by synthetic materials became the driving force of economic prosperity. Why philosophers of science only talked about physics, when chemistry, in the heyday of its glory, shaped modern culture, impregnating it with values associated with artifice and progress? Would the philosophers go against the flux of public opinion and prevailing culture?" The French researcher concludes that "this book suggests exactly the opposite. It shows that the philosophy of chemistry can help us to think about the disruptive world in which we live".

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