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Dossier Georges Canguilhem

Science and History of Science: between Comte and Canguilhem

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Abstract
In the present article, we discuss the specificity of the object of the history of science as an autonomous and interdisciplinary field of studies by nature and origin, placed at the interface of history, epistemology and science, and focus on some key historiographical views. Within this context, Georges Canguilhem stands out for contributions such as calling the attention to the relevance of epistemology in science history research and the discontinuity-continuity antithesis, among many others. An accurate understanding of Canguilhem's ideas demands an unbiased review of Auguste Comte's work, particularly his views on science in general, the various sciences in particular and the methods to present them, to wit, the historical and the dogmatic. We finish with a short description of our theoretical-methodological work and its implications for studies in the history of science.

Keywords:
History of science; Historiography; Auguste Comte; Georges Canguilhem

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Introduction

Why would one come back – again – to the views of Auguste Comte (1798-1857) and Georges Canguilhem (1904-1995)? As historians of science and supervisors of graduate students, our interest was a natural offshoot of the necessary analysis of the historiography of the history

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of science,[4] i.e., the changing criteria that orient or impregnate research in the history of science over time. We should observe from the very beginning that we do not consider the history of science to be a subfield of general history, but rather as an autonomous and interdisciplinary field of studies with characteristics of its own, in which philosophical and epistemological aspects play a major and necessary role.[5] It is thus not by chance that Comte, Canguilhem – and many other scholars that contributed to the development of our field – are discussed in many of our studies.[6] In the particular case of Comte, our interest was also awakened by the fact that his works seem to be much more imagined than actually read or analyzed, as also other scholars noticed (Bensaude-Vincent 2008, 199-249).

A thorough analysis of Comte's work afforded us a more accurate understanding of several among the methods for studies in the history of science formulated at the time of the early institutionalization of this field at the beginning of the twentieth century. We naturally allude to George Sarton (1884-1956) who did not only draw clear outlines for the discipline but also published countless studies, founded a specialized journal that survived to this day and set the grounds for the professional training of historians of science. In-depth study of Comte's ideas reveals the sources for Sarton to advocate writing a progressivist history of science.[7]

In turn, Canguilhem – whom we relate to Gaston Bachelard (1884-1962) and sometimes also to Michel Foucault (1926-1984) within this particular context – is one of the representatives of the view that posits breaks (but not only, as we discuss below) in the production of knowledge against the advocates of utter continuity. [8] Interestingly, Canguilhem paid much attention to Comte's work in general, and the life sciences in particular – certainly, not without a healthy measure of criticism.[9] And the question soon arose: how much of Comte's ideas one would find in Canguilhem's work? Moreover: was there some common factor that led both to look close into the life sciences?

To begin our discussion we would like to quote from a study by Mauro Condé on Ludwig Fleck (1896-1961) and Canguilhem, where he said that "each in his own way [reacted] to the older view on history of science, [one] legitimized by a positivistic epistemology" (Condé 2016, 53). Both realized there was a need for "a new epistemological model for the understanding of the history of science, this is to say, for the development of a historical epistemology" (Condé 2016, 53-54),[10] the basic reference for which was the "contribution of the biological matrix, or the life sciences" (Condé 2016, 51). As a result, Fleck and Canguilhem became "included within a long tradition far away from the epistemological views in vigor until the beginning of the 1930s largely grounded on the physical sciences" (Condé 2016, 53).

It would seem that Fleck and Canguilhem's familiarity with medicine and its inherent focus on complex phenomena facilitated a perception that such phenomena could not be

[4] As a result, along more than 20 years since the creation of CESIMA and Graduate Program in History of Science, PUC-SP, we published several works partially or fully devoted to aspects of writing history of science; see e.g. Alfonso-Goldfarb and Beltran (2004); Alfonso-Goldfarb and Ferraz (2009).

[5] See, e.g., Gayon and Bitbol (2015); Dalaporte (1994); the various contributions in "Georges Canguilhem, a história e os historiadores", *Intelligere*: *Revista de História Intelectual* v. 2, nº 1, 2016; and the proceedings of the meeting held in 2012 at Max Planck Institüt für Geschichte der Wissenschaft on Bachelard and Canguilhem (Schmidgen et al, eds. 2012).

[6] See the references quoted in note no. 1.

[7] References to Comte and Positivism are ubiquitous whenever Sarton is mentioned, not less because Sarton frequently quoted him in his publications, which are too numerous to be listed here.

[8] For authors discussing this topic, see Alfonso-Goldfarb, Ferraz and Beltran (2004).

[9] Of interest for our purpose in the present article, see Canguilhem's (1989b, 44) criticism of Comte's dogmatic method, which is discussed below.

[10] Following Yves Gingras, Condé observes that term 'historical epistemology' was not used by neither Fleck nor Canguilhem, but was introduced with its current meaning by Dominique Lecourt (1969); see also Schmidgen et al. (2012, 8).

harnessed to the laws of causation, as in such case they would become axiomatized. As a result, both broke away from Comte's view on the development of science, as well as from Positivism and its intrinsic association with the notion of progress. If this is true for Fleck and Canguilhem (and we believe it is) let us see if it also applies to Comte.

Comte: between the Sciences and their History

As is known, Comte was compelled to leave Paris (and the Polytechnic School) in 1816 to return to his birthplace, Montpellier, where he attended some courses at the medical school (Pickering 1993 v. 1, 26-33). It is safe to assume that these medical studies influenced Comte's thought about science, its methods and development. Indeed, several scholars emphasized the relevance of physiology (or organic physics) – addressed in *Cours de philosophie positive* and other writings – for Comte's larger project, to wit, the creation of social physics (Gayon and Bitbol 2015, 6-7). Naturally, also the season spent at *École Polytechnique* deeply shaped Comte's thought on science and its development.

Having this background in mind, we will move on now to some of Comte's ideas on the sciences, their organization (or classification) and purposes. In this discussion, we do not address the well-known 'law of the three stages' – theological, metaphysical and positive – which each and every field of knowledge undergoes, although it is latent all throughout our reflection. Instead, we prefer to begin by reminding that according to Comte (1830 v. 1, 15) all phenomena could be explained based on natural laws. Thus, for instance, the law of gravitation could account for the general phenomena of the universe.

Comte (1830 v. 1, 14) strongly believed that the natural laws were invariable. His construction is evocative of Francis Bacon's (1561-1626) representation of the cause-effect relationship. And, indeed, not only did Comte quote Lord Verulam rather often, but when he did not mention his name explicitly, the latter's ideas are easily recognizable. Yet Comte observed that the causes of the phenomena did "not belong to the domain of the positive sciences" (Comte 1830 v. 1, 14-15). If here we omit the reference to the 'positive sciences', some previous thinkers immediately come to mind, Isaac Newton (1642-1727) to begin with, and his vehement injunction to dismiss the question on 'why' to focus only on 'how' phenomena do occur. The natural consequence of this shift was the priority given to observation. And to illustrate the difficulty, or full impossibility of determining the causes of phenomena, Comte mentioned recent studies on heat which had resulted in exact laws with no mention whatsoever of the "intimate nature" of heat (Comte 1830 v. 1, 16-17).

Another aspect deserving of attention is Comte's perception of the difficulty inherent to the attempts at thorough investigation of each of the contemporary sciences in itself. Science had gradually specialized through continuous and gradual revolutions, giving rise to astronomy, physics, chemistry and physiology – while only a science of the social phenomena was still lacking (Comte 1830 v. 1, 18-22) which as is known was one of his main concerns. In consequence, rather than approaching each individual science in itself, Comte advocated approaching the general aspects of science (Comte 1830 v. 1, 43). However, this did not mean that one single law ruled over all the phenomena – not even the law of gravitation, although Comte (1830 v. 1, 91-92) admitted it applied also to the chemical phenomena. The unifying factor underlying all the science was, instead, their unity of method, i.e., the method, in essence, was one and the same for all the sciences, which only differed in their individual procedures (Comte 1830, v. 1, 108).

As one of Comte's main concerns was with the teaching of science, he devoted much attention to the content of the curricula. Within this context, he divided knowledge into two categories, speculative (abstract) and applied (concrete), or alternatively, theoretical and practical (Comte 1830, v. 1, 75-76). Theoretical knowledge corresponded to the sciences proper, which he further subdivided into general and particular. As examples Comte

mentioned chemistry and mineralogy, respectively, because the former provided the rational basis for the latter, given that chemistry considered all possible combinations of particles under any imaginable circumstances, and mineralogy only encompassed combinations related with the formation of Earth, i.e., under specific circumstances (Comte 1830, v. 1, 71-72).

Still in regard to the classification of the sciences, Comte introduced one further principle: phenomena – and thus the corresponding sciences – ought be always tackled from the most simple to the most complex:

> Therefore, it is by the most general or most simple phenomena that we should begin, to then successively move on until the most particular or complex, if we want to conceive of natural philosophy in a truly methodical manner; because this order of generality or simplicity, necessarily determining the rational connection of the various fundamental sciences through the successive dependence of their phenomena, thus fixates their degree of facility. (Comte 1830, v. 1, 87)

All possible sciences were categorized as physics of the heaven and physics of the earth; in turn, the bodies studied by these sciences could be brute or organized (Comte 1830, v. 1, 88-89). 'Rational' combinations of these multiple divisions gave rise to his 'encyclopedic classification' or 'hierarchy of the positive sciences', as follows:

I- Physics of the heaven: investigated by one single science, astronomy, which studied brute bodies

II- Physics of the earth: divided in two groups,

a) one concerned with brute bodies, corresponding to two sciences, physics proper and chemistry

b) one concerned with the study of organized bodies, including organic physics (physiology) and social physics (social science) (Comte 1830, v. 1, 90-96, 115)

As is immediately evident, mathematics is not included in this list. The reason is that Comte believed it should be regarded "(...) less as a part of natural philosophy proper, than – ever since Descartes and Newton – as the true fundamental basis of all this philosophy [...] thus constituting the most powerful instrument the human spirit might employ in the search for the laws of the natural phenomena" (Comte 1830, v. 1, 112). As a result, it preceded all the other sciences in the encyclopedic classification.

In turn, the five sciences composing natural philosophy ought to be classified in increasing order of the complexity of their objects, as follows: astronomy, physics, chemistry, physiology and social physics. This sequence also reflected the mutual relationships among the sciences, the order in which they had attained (or would attain) the positive stage, and the order in which they should be taught. Astronomy had attained the positive stage before physics, which depended on it and thus could only be learned after it; but physics exerted no influence on astronomy. In turn, chemistry depended on both physics and astronomy, and so forth (Comte 1830, v. 1, 91-93).

At this point it is worth observing that Comte never was a reductionist. To substantiate this assertion it suffices to evoke: 1) his remarks on the possibility/difficulty to unify both phenomena and sciences (Comte 1830, v. 1, 108-109), and 2) in regard to physiology, his

resistance to acknowledge the cell as the fundamental particle at the basis of life (Canguilhem 1989b, 63-80, esp. 66). Following Canguilhem (1989b, 75) we call the attention to Comte's view on the relationship between chemistry and the life sciences, explicit in his assertion that until the eighteenth century chemistry had depended on medicine, while some of his contemporaries were attempting at attributing to it the status of explanation of the life phenomena (Comte 1880, 569).

We will not examine here the fine detail of Comte's position vis-à-vis the main authors on the life sciences (or medicine) in his time, since it has extensively discussed by Canguilhem (1989b, 59-98) among others. We merely observe that Comte's knowledge of the contemporary medical ideas and controversies contributed to shape his ideas. Comte was well within his *Zeitgeist* when he chose, for instance, to follow Paul J. Barthez (1734-1806).

Once the order of the study of the sciences and a part of the method were established, the next point was how to present the sciences. According to Comte, the paths were two: the historical and the dogmatic. According to the former, all human knowledge should be presented in the same order it had been attained, which meant approaching "in chronological order the various original works which contributed to the progress of science." In turn, the dogmatic method could only be applied to highly developed sciences, since it consisted in presenting "the system of ideas such as it could be conceived of at the present time by one single spirit, which if in the right place and having the required knowledge, would engage itself in reconstituting the science [in question] as a whole" (Comte 1830, v. 1, 77-78). This is to say, the dogmatic method was not intended to present details, which only increased and accumulated by the day. For this reason, the dogmatic was advantageous over the historical method, which was proving to be increasingly impracticable by comparison to older times, when the number of works to study was small (Comte 1830, v. 1, 7-8).

Yet, Comte (1830, v. 1, 80-82) observed "that it is easy to see that there is only an apparent relationship between studying a science according to the historical method and having true knowledge of the effective history of such science." The progress of the sciences and the arts was mutually dependent, i.e., the sciences developed through their mutual relationships, and thus were linked to the overall development of the human society. As a result, accurate knowledge of the history of the various sciences had utmost importance, because one could only learn a science entirely by learning its history. Given such relevance and the mutual connection among all the sciences, including the social sciences, in the second part of *Cours de philosophie* Comte gave more emphasis to the history of their progress.

It is interesting to remind the influence of these ideas on the work of George Sarton, more particularly his formulation of a progressivist history of science, i.e., a history of the positive sciences, which meant the history of the physical-mathematical sciences, without much room for the life sciences (Debus 2004, 31-35).

Canguilhem: between Continuities and Discontinuities

Let us move on now to some of Canguilhem's views on the history of science, in which epistemology plays a crucial role. Interestingly, Canguilhem acknowledged it would be vain to reproach eighteenth- and nineteenth-century historians "for not having considered any of the notions epistemologists currently strive to establish as writing or composition rules for all those who practice or produce the history of science" (Canguilhem 1993, 12). The reason was that also the history of science has a history of its own

Indeed, Canguilhem criticized the history of science "impersonally written within the doctrine of the indefinite perfectibility of the human spirit, legitimized by a rather continuous succession of revolutions [...] only to anticipate the progress of science under the exclusive aspect of continuity" (Canguilhem 1993, 12). In such case, "The history of a science [becomes

just] an abstract of the readings made at a specialized library" (Canguilhem 1993, 14) built in the past by all those who devoted themselves to such science.

Rather an ordered description of a science resulting from reading all the works seemingly related to it in the past, Canguilhem advocated a history of science based on epistemology. In other words, to replace the history of the sciences by the sciences according to their history. Only in this way science could be distinguished from other cultural manifestations. Within this context, Canguilhem distinguished between the past of a science and how such science was in the past. To illustrate the notion of a history of science fully free from 'any epistemological contamination' he quoted an example from botany. A 'pure' history of botany would merely consist of what scholars established over time as the proper object of such science, as well as their perspectives of approach. The result would be the reduction of "a science at a given moment, for instance, plant physiology in the eighteenth century, to an exposition of the chronological and logical connections between different systems of propositions relative to certain classes of problems or solutions" (Canguilhem 1993, 13). As such, the past of the present plant physiology would comprise all which botanists, physicians, chemists, horticulturalists, etc. ever wrote on the relationship between the structure and function of plants (Canguilhem 1993, 14).

Differently, a history in which epistemology plays the key role allows selecting from the past the ideas that shaped the object of a science within an 'ideal' temporal frame. Historians thus 'choose' amidst the past some ideas which history they will write pointing to (epistemological) discontinuities in their temporal development. Thus they devise a definite past for a science, rather than a succession of ideas, and no longer ask theories formulated in the past the reasons for their lack of logical maturity (Canguilhem 1993, 22).

The type of history Canguilhem had in mind upon attacking the notion of progress and by revealing discontinuities also eliminated the so-called precursors, so dear to progressivist history.

To be sure, Canguilhem's history is a history of breaks, but not in the style of Thomas S. Kuhn (1922-1996) whose proposals did not derive from philosophical criticism, but from social psychology. As is known, Canguilhem's source was Bachelard and his notion of epistemological breaks (Canguilhem 1993, 20). More particularly, Canguilhem stressed Bachelard's agreement with Jean Cavaillès (1903-1944) on the notion of progress:

> Indeed, one of the essential problems of the doctrine of science is precisely that progress should not mean an increase in volume by juxtaposition, the older subsisting with the new, but perpetual reviewing of contents through in-depth [study] and erasures. That which comes later is more than what there was before, not because the former contains, or prolongs the latter, but because it necessarily comes from it and includes the always singular mark of its superiority in its comprehension. (as cited in Canguilhem 1993, 23-24)

Thus Canguilhem was able to assert "Within a historical weft some threads might be fully new, while others are obtained from older textures" (Canguilhem 1993, 25).

To summarize: discontinuities, but also continuity in the development of knowledge. Historians of science may not dismiss this injunction. We believe that this is one of the main aspects to bear in mind when writing the history of science, which necessarily demands the guidance of epistemology.

Revisiting the Object of the History of Science

To conclude, we would like to briefly comment on our work and approach as researchers and supervisors of students at Graduate Program in History of Science / Center Simão Mathias in

History of Science (CESIMA), Pontifical Catholic University of São Paulo. The historiographical sketch we present next is a fruit of our work and thought along more than 20 years.[11] And as it will be immediately seen, Canguilhem is mentioned quite often, because he was one of the main sources for our reflection.

Sarton's ideas on the development of science, with their emphasis on scientific notions and the corresponding approach to science, were the target of much criticism especially from the 1930s onward. At the time when technology began to enter the scope of the studies in the history of science, science came to be seen as belonging with specific historical contexts, rather than as detached from spatial and temporal determinants. Here we should call the attention to Boris Hessen (1893-1936), who surprised the audience at the Second International Congress of History of Science, in London, in 1931, with a groundbreaking paper on the social determinants of Newton's scientific activity (Hessen 2009, 41-101). This was the trigger for a view that came to be known as 'externalism', especially influent in Britain at the time of the Cold War (Goldsmith and Mackay 1975). In time, as any polar position, also externalism compromised with its antithesis (Bernal 1975, 224), 'internalism', namely the purely epistemological focus on the history of science, and which traditionally had represented the main approach to writing the history of science. This process was natural in a way. According to Canguilhem, "without a reference to epistemology, the theory of knowledge would be an empty meditation; without a relation to the history of the sciences, epistemology would amount to a completely superfluous doublet of the science it is supposed to discuss"[12] (Canguilhem 1989b, 11-12). Along the same line Imre Lakatos (1922-1974) observed, "epistemology without history of science is empty, history of science without epistemology is blind" (Lakatos 1970, 91).[13]

However, Walter Pagel (1898-1983) had already established a major milestone in the 1940s, with his "vindication of rubbish" (Pagel 1945). In simple terms, Pagel considered that the past of science should not be judged based on current standards, but should be understood in its own terms, which thus requires sound analysis of both the historical-social and the epistemological aspects together. Not surprisingly, this view emerged from Pagel's field of expertise, viz., alchemy, which up to that time had been considered a proto-, pre- or pseudo-science predating modern chemistry (Pagel 1982). This approach was further developed by Pagel's two main disciples, Debus (1965; 1968; 1977; 1978; 1991a; 2001; 2004; 1991b, where he discussed his methodological assumptions) and Piyo M. Rattansi (1988; 1972; 1964; 1963; McGuire and Rattansi 1966).

In time, analysis came to show that the demarche of science does not only involve breaks, but also aspects of continuity. And it is precisely within this context that the work of Canguilhem stands out. Although he agreed with Bachelard on that science does not advance in a linear and cumulative manner, he believed that the alleged breaks were not as radical as imagined. Instead, the newer models of science include previous theories and practices, albeit modified and recontextualized. As we have discussed above, Canguilhem's point of the departure was the definition of the object of the history of science, which he emphatically asserted could not be confounded with the object of science. While the latter is constructed

[11] See Alfonso-Goldfarb and Ferraz (2009); Alfonso-Goldfarb, Ferraz and Beltran (2004) where projects and some of our work at PUC-SP are described; for more recent work, see e.g. the thematic projects funded by the São Paulo Research Foundation (FAPESP) chaired by Alfonso-Goldfarb, which abstracts are available at http://www.bv.fapesp.br/pt/pesquisador/478/ana-maria-alfonso-goldfarb/.

[12] "sans référence à l'épistémologie une théorie de la connaissance serait une méditation sur le vide et que sans relation à l'histoire des sciences une épistémologie serait un doublet parfaitement superflu de la science dont elle prétendrait discourir".

[13] Seemingly, both are paraphrases of the classic Kantian locus "Gedanken ohne Inhalt sind leer, Anschauungen ohne Begriffe sind blind" ("Thoughts without content are empty, intuitions without concepts are blind"). (Kant 1799, 75).

through methodological reflection on the phenomena of nature – and thus are first-order epistemic objects – the former is the product of the historicity of scientific discourse, and consequently a second-order object (Alfonso-Goldfarb, Waisse and Ferraz 2013; Rheinberger 2010).

Considering Canguilhem's, Pagel's and derived views, we believe we are in conditions to attempt a working definition of the object of history of science, which we place at the intersection of three spheres of analysis. The first sphere concerns the intrinsic features of scientific theories or practices through combined textual criticism (derived from the philological tradition) and internal theoretical-contextual analysis (i.e., epistemological analysis of the main notions and arguments). The second is a properly historiographical sphere, which targets the main approaches to the analysis of a given problem, document, etc., over time. The third sphere focuses on the general historical context, with emphasis on the circumstances under which the documents under analysis were produced. Without pretending to settle the matter once and for all, we might say that historians of science operate on notions reconfigured differently by different actors over time (Alfonso-Goldfarb, Waisse and Ferraz 2013).

To summarize, the simultaneous or concomitant operation of the three aforementioned spheres allows for a working definition of the object of the history of science, bearing in mind that these spheres of analysis are always modulated by documents. And by documents **in** and **for** the history of science we understand any kind of material vestige provided it is set into the framework proper to the object of history of science. As a result, such framework gives life not only to published works or manuscripts, but also to laboratory notebooks, letter, images and things, among many others types of documents (Alfonso-Goldfarb, Waisse and Ferraz 2013).

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