
Concepts have a life of their own: Biophilosophy, History and Structure in Georges Canguilhem

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Georges Canguilhem only rarely expressed himself programmatically on the history of science. When he did so, he left scarcely any doubt that to him the history of science was above all a history of concepts. In 1963, in a historical introduction to the physiology textbook of Charles Kayser, he wrote: “History of science cannot be a simple collection of biographies and even less a chronological chart decorated by anecdotes. It also has to be a history of the formation, deformation and rectification of scientific concepts” (Canguilhem 2002c: 235). [1]

Here, it still might seem as if it was only a question of complementing contemporary history of science as it was established in the early 1960s. Elsewhere Canguilhem made clear that, in fact, he meant its replacement. That same year, in an article on Gaston Bachelard, he called for a “new art” of writing the history of science: “This history cannot any longer be a collection of biographies or a chart of doctrines in the manner of natural history. It has to be a history of conceptual filiations” (Canguilhem 2002b: 184).

Even more explicit is his article on “The Object of the History of Sciences.” There Canguilhem distinguished several levels of objects within the theoretical domain

that he considers to be specific to the history of science: “Documents to catalogue, instruments and techniques to describe, methods and questions to interpret, concepts to analyze and criticize.” Then, he added: “This last task alone confers upon the preceding ones the dignity of the history of science” (Canguilhem 2005: 204).

Given the current interest in the material culture of science, its experimental practice and the pictorial as well as textual media for representing scientific knowledge, these statements might sound strange, if not anachronistic. But even in recent years, historians of science have kept a strong interest in the history of concepts and conceptual practices.

In an edited volume, Isabelle Stengers has explored the trajectories of scientific concepts and, together with Judith Schlanger, she has devoted a book length study to the peculiar “power” of these concepts. Andrew Pickering has dealt with conceptual practices in the “mangle-ish” history of mathematics. An entire volume concerning the historical and epistemological aspects of the gene concept was carefully compiled by Peter Beurton, Raphael Falk, and Hans-Jörg Rheinberger. And Arnold Davidson has investigated the formation of concepts with respect to the “emergence of sexuality.” [2] Over the last few years, the publication of a number of dictionaries concerning the language of the sciences and the history and philosophy of science has underscored the importance of this perspective. [3]

In this situation, the relevance of Canguilhem’s work resides in the fact that it allows us to understand concepts as vital components of scientific practice, as the smallest units of epistemic integration that, in their emergence as well as in their usage, are closely tied to technological practices, without being reduced to mere instruments or tools of research. In addition, Canguilhem suggests that concepts should not be equated to theories or exclusively seen as tied to theories. Rephrasing a famous sentence by Ian Hacking, one might say then that for

Canguilhem concepts have “a life of their own,” in practice as well as in theory (Hacking 1983: 150). [4]

In his studies on the history and philosophy of medicine and biology, Canguilhem responded in numerous ways to his programmatic statements. Already his first book, the 1943 *Essay on some problems concerning the normal and the pathological*, comprises a section focusing on the “Critical Examination of Certain Concepts”, i.e. “The Normal,” “Anomaly and Disease,” and “The Normal and the Experimental.” In the following years, he devoted articles to investigate concepts such as “Cell,” “Milieu,” “Development” and/or “Evolution,” “Method,” “Life,” “Regulation,” and “Health.” [5] Even in studies that have a different focus one finds detailed considerations concerning the etymology, history and use of biological and medical concepts, e.g., in his articles on “Monstrosity and the Monstrous” and “The Physiology and Pathology of the Thyroid in the 19th century.” [6]

Given the fact that Canguilhem studied predominantly concepts of the biological and biomedical sciences, and given the current role played by language in public discussions on the life sciences, Paul Rabinow has reminded us how fruitful these studies are: “Canguilhem has spent his life tracing the liniments of a history of the concepts of the sciences of life. Let us suggest today that it is the biosciences – with a renewed elaboration of such concepts as norms and life, death and information – that hold center stage in the scientific and social arena; hence the renewed relevance of Canguilhem” (Rabinow 2000: 19).

However, it is only in passing that Rabinow mentions the most extended investigation that Canguilhem published on the history of a single scientific concept, i.e., his book on the formation of the reflex concept in the 17th and 18th centuries. [7] In fact, this book – long recognized in France as a “fundamental study” (Fichant 1973: 172) [8] – is his most extended contribution to a single topic in the history of science per se. Published in 1955, it made an essential

contribution to defining the “French style” of history and philosophy of science in the postwar period (Braunstein 2002).

The present paper takes Canguilhem’s book on the formation of the reflex concept as a starting point for reconstructing the basic ideas of his conceptual history of science. First, I will introduce the book by summarizing its central argument. According to Canguilhem it was not René Descartes but the English physician and natural philosopher Thomas Willis who created the physiological reflex concept. At the same time, I will discuss the context in which Canguilhem embeds this argument, i.e. the continuing debate between mechanism and vitalism. In this connection, Canguilhem depicts concepts as laboratory ‘actors’ that, tied to scientific instruments and other such devices, are able to produce perceptions – a feature that, however, does not anticipate the scientific value of the concepts in question, as we will see later.

Drawing on earlier texts by Canguilhem, e.g. the 1937 article “Descartes et la technique,” I show that this discussion of the role of concepts involves theoretical assumptions concerning the relation of science and technology, one of Canguilhem’s long term interests. In particular, I will demonstrate that Canguilhem argued in favor of separating science and technology, while highlighting the biological and anthropological importance of technological activities. In this perspective, technology appears as an almost natural element of scientific practice. However, in order to reach the specificity of scientific reasoning in biology, technology is not enough. According to Canguilhem, it must be left behind in order to fully grasp the nature of biological phenomena.

Secondly, I will depict the historiographical approach of the reflex book. Inspired by Gaston Bachelard, Canguilhem undertakes to write the history of reflex physiology as a “recurrent history,” i.e., a history not of the past but of the present. In 1950s France, cybernetics and Pavlov’s reflex theory were part of this present. They contributed to turning the reflex into a cultural fact, and the reflex

books takes issue with this development. At the same time, the book draws on criticism of mechanical reflex conceptions that, since the 1930s, were raised in the writings of clinical neurologist Kurt Goldstein, phenomenologist Maurice Merleau-Ponty, and Strasbourg physiologist Charles Kayser.

In a third step, I attempt to reconstruct the theory of concepts that underlies the reflex book. I distinguish three aspects in Canguilhem's understanding of concepts: their stratification, their function, and the process of their formation. Referring to earlier publications by Canguilhem, in particular the *Traité de Logique et de Morale* (1939), co-authored with Camille Planet, and his collection of articles "Knowledge of Life" (originally published as "La connaissance de la vie" in 1952) I show that his theory of the concept is eventually grounded in biology, in particular general biology. [9] Following Goldstein, Jakob von Uexküll and similar biologists, Canguilhem argues that human knowledge (*connaissance*) is a "general method for the direct or indirect resolution of tensions between man and milieu" (Canguilhem 2008a: xviii). As we will see, this argument provides the larger framework for understanding the vital role of concepts in scientific practice.

In the conclusion I try to characterize Canguilhem's approach as a 'biological structuralism.' Similar to phenomenologists such as Merleau-Ponty, Canguilhem often referred to and relied on the tradition of general biology (von Uexküll, Buytendijk, Goldstein, etc.). At the same time, his philosophical project clearly differs from phenomenological approaches. To quote Michel Foucault's famous genealogical scheme, Canguilhem did not contribute to a "philosophy of experience, of sense, and of subject" (Foucault 1989: 8). However, his notion of knowledge and rationality remains tied to a conception of life that can also be found in Sigmund Freud, Friedrich Nietzsche, Henri Bergson and others. According to this conception, life predominantly manifests itself in organic individuals that act and react within specific environments which, in turn, are defined by the needs and tendencies of these individuals. [10]

A gallery of acephals

Read with an eye on the material culture of scientific practice, Canguilhem's book quickly turns into a gallery of acephals. A frog whose brain was separated from the spinal chord: stimulation of its feet causes it to contract; a rabbit body that was decapitated: if artificial respiration is applied it remains able to move in various ways; lizards without heads: during several days they remain able to walk and even to copulate. An entire chapter is indeed devoted to "Decapitated Animals." But elsewhere they surface too: decapitated and decerebrated vipers, salamanders, tortoises, chickens and dogs, and even acephalous fetuses that survived in their mother's uterus and were able to move their limbs even after they were born.

The story that unfolds as one passes through this gallery is the story of a Copernican revolution in the history of physiology. Canguilhem's main argument is that the concept of reflex was formed under the sign of "a negation of the cerebral privilege in the realm of the sensori-motricity" (FR 77). Until the end of the 18th century, observations and explanations concerning the physiological mechanism of involuntary movements inscribed themselves into an anthropocentric vision of the organism. This vision displayed some striking similarities with pre-Copernican cosmology: "The heart or the brain were taken to be the respective centers of the animal body around which it turned. They corresponded to what man, in Ptolemaic astronomy, was for the stars that rose and set with respect to his earthly being, to what the King, in monarchical states, was for his obedient subjects. The Copernican Revolution in the physiology of movement is the dissociation of the notions of the brain and of the sensori-motor center, the discovery of eccentric centers, the formation of the reflex concept" (FR 127).

The peculiarity of this physiological revolution lies in the fact that, in contrast to astronomy, it is not linked to a single name. And it did not happen in a short period of time. The concept of reflex took more than 150 years to become a fact (see FR 169). Thomas Willis made the first step in the last third of the 17th century. In contrast to Descartes, Willis assumed a basic symmetry between the centripetal and centrifugal process of sensori-motricity. Hence he was capable of conceiving the relation between sensation and movements as similar to a reflection, a reflux, or an echo. In addition, Willis was the first to attempt to localize voluntary and involuntary movements with respect to their anatomical basis, by distinguishing the structures of brain and cerebellum.

In the 18th century, the theory of organic “sympathies” and the disconnection of sensation and consciousness gradually contributed to a focus on the periphery of neuro-anatomical structures and psycho-physiological processes. Jean Astruc (1684-1766), Robert Whytt (1714-1766), Johann Unzer (1727-1799), and Julien Legallois (1770-1814) demonstrated that reflex movements could not just be localized in the cerebellum, but also in the spinal chord and even in paracentral nerve tissue. It also became clear that sensations which triggered reflex actions were not necessarily accompanied by consciousness, although they could be.

Eventually, reflex actions were increasingly discussed with respect to their usefulness for the organism as such. Following Whytt, Georg Prochaska (1749-1820) in particular subordinated the peripheral mechanism of the reflex to an instinct of self-preservation, a principal of organic utility or teleology. In the final stage of these developments emerged the idea of a neuromuscular apparatus that “was not just a system, but is a system of systems, and accordingly allows for a certain independence of the partial automatisms while securing the functioning of the organism as a whole” (FR 127-8). This meant that the coordination of sensibility and movement in the organism was not organized similar to a monarchy of divine right – top down, by delegation of the central power – but was structured as in a federal republic – bottom up, by integration of local

potentates. What seemed to be a mere physiology of automatism, revealed itself in this sense as a physiology of “autonomy” (FR 7).

One of the surprising features of Canguilhem’s historiography of the reflex is that it does not go beyond 1800. As well-known, the experimental physiology of the reflex only started in the first half of the 19th century, with the research on reflex actions conducted by Marshall Hall and Johannes Müller in 1832/33 and the first scheme of the reflex arc devised by Rudolf Wagner in 1844. What Canguilhem offers, then, seems to be a pre-history of the reflex concept, perhaps even just a history of the pre-scientific reflex concept.

Another striking feature of his historiography is the following: save for Astruc, all the historical actors mentioned by Canguilhem are usually regarded as vitalists. In the 19th century, however, the reflex was considered a basic fact of mechanist physiology, an achievement of “organic physics.” Within this context, some mechanist physiologists, most prominently Emil du Bois-Reymond (1818-1896), became interested in the history of the reflex concept. In their publications on the topic the contributions of scholars such as Unzer and Prochaska, if mentioned at all, are considered to be extremely poor. Since they “were” vitalists, they could not – *per definitionem* as it were – contribute productively to the investigation of reflex phenomena. In other words, a certain kind of “logic” (the reflex is a mechanical phenomenon, hence only mechanists could have contributed to its explanation) inspired a specific kind of “history” (see FR 5).

What Canguilhem offers then is not any kind of prehistory, but an authentic ‘anti-history:’ he re-introduces a whole tradition of vitalist reflex scholars that had almost been forgotten. According to his account, the late 18th century had already developed a scientific conception of reflex action. However, this conception was only resurrected in the early 20th century, when Charles Sherrington established experimentally that reflexes were not just simple, quasi-mechanical phenomena, but elementary manifestations of the integrative

function of the nervous system, contributing to the existence of the organism in its entirety.

Concepts and instruments

How could the mechanist conception of reflex action become so predominant in the 19th century that it resulted, among other things, in a distortion of the past? Canguilhem's answer brings technology into play: "Around 1800 the concept of reflex is without any doubt a 'good' concept, but it is not yet good for anything. It is discussed, but one knows nothing about it, because one does not make something out of it. It is only inscribed into the books. In 1850, the concept of reflex is inscribed into the books and the laboratory, in form of exploration and demonstration apparatuses that are assembled for it, that would not be there without it. The reflex ceases to be a mere concept in order to become a percept. It exists because it gives existence to objects that it makes understandable" (FR 161).

It is true that 19th-century laboratories of physiology were full of instruments and devices for exploring and illustrating involuntary movements in organisms or parts of organisms: various stands and fasteners for demonstrating the effects of decerebrations in frogs and rabbits, devices for dissecting and stimulating the spinal chord, du Bois-Reymond's contraction telegraphs and frog pistols, and complex frames for investigating the knee jerk in human test subjects (Fig. 1).

However, this arsenal says little about the significance of the mechanist reflex concept. It is undeniable that this concept (the "reflex 1850," as Canguilhem calls it) was coupled in multiple ways to the laboratory and explained a large number of phenomena found and created in the lab. But according to Canguilhem, these facts do not decide on the scientific value of the concept in question. The scientific value of the concept does not derive from the possibilities of connecting it to instruments, but from the number of research perspectives it suggests and

opens. In this connection, Canguilhem quotes Paul Valéry who, in his *Introduction à la méthode de Léonard de Vinci*, argues that a theory proves itself only “by virtue of its theoretical and experimental deployment” (see FR 74). Canguilhem himself says elsewhere that “the theoretical efficiency or the cognitive value of a concept” lies in the possibilities that it creates for “the development and progression of knowledge” (Canguilhem 2002f: 360).

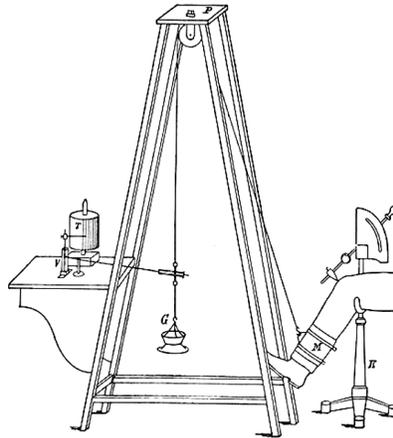


Fig. 1 “Reflex multiplier” according to Robert Sommer. This device was used for investigating the knee jerk reflex by means of the graphical method. Reproduced from Zimmermann 1912: 4.

These statements seem to be informed by a pragmatist perspective on the question of concepts in science. The passage quoted at the beginning of this section alludes to William James’s discussion of “Percept and Concept” in *Some Problems of Philosophy*, originally published in 1911. James assumes that concepts not just develop from perceptions, from which they are “distilled,” but are fed back into perceptions that then are altered and transformed. In other words, the full potential of concepts manifests itself only when recombined with perceptions: “Concepts not only guide us over the map of life, but we *revalue* life by their use.” Differently put: “With concepts we go in quest of the absent, meet the remote, actively turn this way or that, bend our experience, and make it tell us whither it is bound” (James 1996: 71). Canguilhem seems to say something

very similar about the role of concepts in scientific practice. Just as James, he underscores the constructive character of concepts. Concepts do not (only) represent perceived realities, nor do they only depict these realities. They also *make visible*, produce realities and perceptions, and stimulate research activities.

What is at stake here is not simply pragmatism, however. Canguilhem's remarks about the interplay of concept and instrument are connected to a topic that he was interested in and dealt with since the late 1930s, i.e. the relation between technology and science. [11] Following Bergson's theory of *homo faber* and partly responding to discussions between members of the Frankfurt School concerning the social origins of mechanist philosophy, Canguilhem argued against the view that technology is a mere result of applied science. In his eyes, technological practice, initially, is independent of scientific action. Technology represents a kind of primary mode in which humans respond to and intervene creatively in their milieu. [12] Ultimately, tools and machines are "organs" of the human body. As Hacking has put it in his Canguilhem cyborg essay, tools and machines are "*extensions of life, of vitality, of living,*" (Hacking 1998: 207, emphasis in the original) i.e. they broaden and intensify life, but may also threaten and endanger it.

Despite the fact that Canguilhem occasionally quotes Ernst Kapp and Alfred Espinas in this context, he does not subscribe to the theory of organ projection. The 'entities' that he relates to the tools, machines, and other technological devices are not the ready made organs of the human body, but the "needs," "desires," and "manifestations of will" in a vital organism that responded to them by means of technological fabrications (Canguilhem 1937: 84). In this quasi-biological vision of technology, the "failures" of technology, its collapsing leads to the call for science. In other words, the resistances encountered by the human arts stimulate human thought "to consider the obstacle as an object that is independent of human wishes" (Ibid: 84). It is in this sense that Canguilhem describes the relation between action and knowledge in his 1937 article

“Descartes et la technique” and the relation of medicine and physiology, the clinic and the laboratory, in the *Essay* of 1943.

The “rashness” of technology anticipates the “prudence” of knowledge (Canguilhem 1989: 105). For the very reason that technology is a primary mode of human interaction with the milieu, it cannot be the last word when it comes to science. The couplings between the concept of reflex and the exploration instruments were certainly productive for 19th-century physiology. But they could only be a first step toward the proper scientific understanding and explanation of reflex phenomena. Only by overcoming the firm alliance between conceptual and instrumental mechanism did it become possible to conceive of the reflex as an authentic biological phenomenon.

This line of argument paves the way for Canguilhem’s redefinition of “vitalism” in the reflex book. He no longer identifies vitalism with specific topics or themes (“vital force,” “vis vitalis,” “vis insita,” etc.), but describes it as an epistemological attitude in biological research. For him, vitalists are not “metaphysical thinkers,” but rather “cautious positivists” (FR 113), not least because they envision the interrelations between technology, science, and life from a specific angle: “[E]very attempt to reduce organic functions to mechanical systems simply neglects the fact that this is not the ultimate form of knowledge in this area. Perhaps vitalism is merely the presentiment of an ontological, i.e., chronologically irreducible anticipation of knowledge with respect to mechanical theory and technology, intelligence and the simulation of life” (FR 122). Put differently: mechanist physiology did not leave technology behind, which, according to Canguilhem, is necessary in order to reach scientific concepts that are appropriate for the object of biology, i.e. life. In other words, even in laboratory-based biology it is not sufficient to turn concepts, by means of machines, into percepts.

A history of the present

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“Eventually a library annexed to a laboratory is divided into two departments: a museum and a work shop. There are books that you leaf through like you contemplate a stone ax. There are others that you open like you use a microtome. But where is the border-line between the museum and the work shop? Who traces it? And when does it move?” (FR 156) The library that Canguilhem alludes to is the library of the physiological institute in Strasbourg. Large parts of the reflex book were written in this library (Fig. 2). What Canguilhem once noted with respect to physiologist Johannes Müller and his home town Koblenz might also be said about this library and the city of Strasbourg: To someone faced with quickly shifting political and linguistic borders it is sometimes enough “to stay in place in order to become cosmopolitan” (Canguilhem 2002c: 248-249).

In 1885, the Strasbourg institute was founded by the Germans, the founding director being Friedrich Goltz; in 1918 the institute was re-appropriated by the French; the Nazis took hold of it in 1940; in 1945 Charles Kayser was reinstated as director of the institute – and its library. [13] Even today, many of the historical texts that Canguilhem quotes and references in the reflex book can be found in this library, e.g. Georg Prochaska’s *Lehrsätze aus der Physiologie des Menschen* (1797), Robert Whytt’s *Essay on the Vital and other Involuntary Motions of Animals* (1751) and, of course, Müller’s *Handbuch der Physiologie des Menschen* (1833/40). [14]

Regarding the question as to who traces, for the historian of science, the border between the library-museum and the library-workshop, Canguilhem offers a clear answer: the present. Quoting Bachelard, he presents his book as shedding light on the “current past” of a science and not as a quasi-palaeontological study of a scientific project that has long since vanished: “In writing the history of the formation of the reflex concept for the 17th and 18th centuries, we wanted to contribute to something that, with Bachelard, we call in reference to biology ‘a recurrent history, a history that is illuminated by the finality of the present’” (FR

167). It is important to note that Canguilhem derives this “finality of the present” not only from the current state of *physiological* research. The principal goal of his book does not consist in criticizing the reflex physiology of ‘then’ in light of the reflex physiology of ‘now.’ The starting point for his investigation is a different one. It is the observation that the concept of reflex has become part of the vernacular.

In 1950s France, the reflex has turned into a “fact of public utility and general knowledge,” says Canguilhem, and he adds: “Insofar as his work or his way of life depends on it, everyone knows today or would like to know if he has good reflexes or bad ones” (FR 163). This state of affairs is not only caused by the fact that examining reflexes had become a routine in medical hospitals and practices. Around 1950, the reflex in that sense was complemented, perhaps even out-dated by a generalized understanding of “reflexes.” According to Canguilhem, the cultural preference for the ideals of industrial civilization was decisive in this regard. This civilization demands and supports reflex reactions, in particular in interactions with machines. Applied psychologists (“*psychotechniciens*”) and engineers aim at “adapting the velocity and uniformity of movements – decomposed into elementary gestures in ever more efficient ways – to the functioning of machines and the earnings of big companies” (FR 165-6).

One may note that not only the “taylorist fetishism of speed” (FR 166) contributed to turning the concept of reflex into a popular element of French culture by 1950. By way of a remarkable ‘parallel action’ initiated by Anglo-American cybernetics and Russian physiology, the reflex was pushed to leave the clinic *and* the laboratory during this period. In 1951, Pavlovian psychiatrist Grey Walter demonstrated his artificial tortoises in the context of an international cybernetics meeting in Paris. Initially, these devices were meant to imitate the movements of animals across space. In a further step they were improved by means of a circuit Walter called CORA – Conditioned Reflex Analogue. This circuit turned the tortoises, as their creator explained, into “machines that can be

taught easily.” [15]

After Walter’s demonstration, a French journalist reported enthusiastically in the popular *Larousse mensuel* that the artificial tortoises learned without any difficulty to react “in a reflex-like manner” to a specific whistling tone of a pipe. Shortly later, popular books were published showing photographs of the conditioned tortoises that populated Walter’s living room and participated in his family life. Special issues of journals such as *Esprit*, *La Pensée*, and *La Nouvelle Revue Française* discussed the perspectives and consequences implied in the emergence of such reflex machines.

In 1954, psychoanalyst Jacques Lacan made reference to Walter’s tortoises in his seminar in order to update his theory of the imaginary (Lacan 1991: 51-52). In a striking experiment, Walter had placed one of his turtle robots in front of a mirror. The light beam emitted by the robot that, in combination with a light-sensitive receptor, served the purpose of orientation was reflected and caused the turtle to react to its own image – an effect evocative to the “mirror stadium” of the human infant described by Lacan.

Even the young Foucault was impressed by the “reflex 1950,” albeit in a slightly different manner. In 1954, in his first book *Maladie mentale et personnalité*, he writes affirmatively about Pavlovian reflex theory. In his eyes, this theory provided the basis for a “holistic” psychiatry firmly grounded in Marxism (Foucault 1954: 109).

Canguilhem quotes the tortoises in the reflex book, when reinforcing his criticism of mechanism with respect to current developments in cybernetics (see FR 122). To him, the importance attributed to reflex machines symbolized the lack of an authentic biological comprehension of the organism.

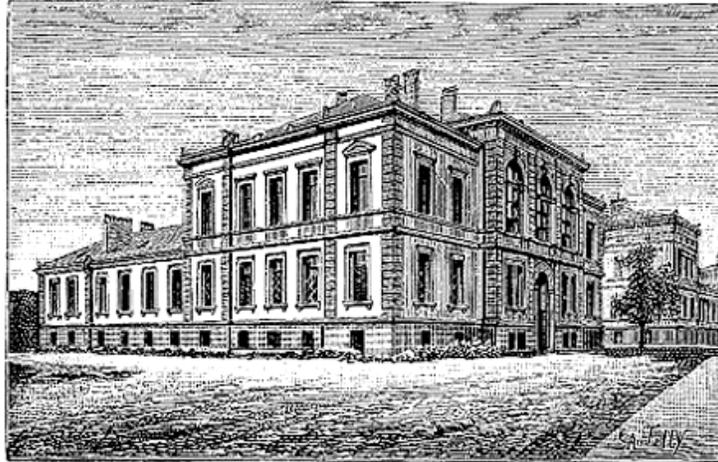


Fig. 2 The Physiology Institute at Strasbourg in 1885. When Canguilhem was working there, the library was situated on second floor in the left wing of the building. Today, the physiology institute and its library are located in the central research building on the Strasbourg medical campus. Reproduced from Goltz (1885: 71).

The impact of general biology

Highlighting the cultural presence of the reflex concept in 1950s France should not block from view the academic publications that Canguilhem could use “like a microtome” for his study. In the first place, one has to mention here Maurice Merleau-Ponty’s *La structure du comportement* (1942). In this book, Merleau-Ponty provides an extended criticism of mechanist reflexology, of traditional localizationism and of learning theories purely based on associationism. He also deploys the basic features of the “vitalist” conception of the reflex that Canguilhem departed from in his historical analysis. Following Sherrington, Merleau-Ponty argues, for example, that even reflexes involve the entire organism. In addition, his section on “Reflex Behavior” quotes a number of contemporary reflex scholars that Canguilhem equally relies on, e.g. Viktor von Weizsäcker, Frederik Buytendijk, and above all Kurt Goldstein (Merleau-Ponty 1963: especially 7-51).

The French translation of Goldstein's *Der Aufbau des Organismus* (1934) was published in 1951. This book contains an extended presentation and discussion of reflex phenomena, as Canguilhem explicitly notes (FR 164). Against the background of clinical and experimental findings, Goldstein criticizes the "doctrine of the reflex structure of the organism" and repeatedly questions the current concept of reflex. According to Goldstein, it is impossible to "directly" observe the phenomena that correspond to "the strict reflex concept." According to him, these phenomena are a result of "extremely artificial" experimental situations. Goldstein even goes so far as to claim that the mechanist concept of reflex is almost "completely" preventing the progression of research (Goldstein 1995: 78 and 82).

Another text can be named that Canguilhem could directly use for his study: the two lectures on "Réflexes et comportement" published by the director of the Strasbourg physiology institute, Charles Kayser, in 1947. Kayser introduces his topic by way of an historical overview that, according to Canguilhem, is "the best" (FR 154) that was published by a physiologist in the 20th century. (This judgment is not entirely neutral, since Kayser credits Canguilhem for his help in conducting historical research at the end of his second lecture.) In the systematic part of his lectures, Kayser mentions Merleau-Ponty and refers to the scientific work of scholars such as von Uexküll and von Weizsäcker. As has already been noted, Canguilhem repeatedly relies on these authors in the reflex book as well as in *Knowledge of Life*.

How closely Canguilhem was connected to general and holistic biology is perhaps best illustrated by the fact that, in the reflex book, he refers not only to Bachelard when explaining his conception of "recurrent history," but also to von Weizsäcker. He quotes at length from von Weizsäcker's introduction to the historical study of the reflex published by Ernst Marx in 1938: "There is no path without direction, no direction without goal. It is not by intention but by inescapable necessity that the goal of historical research is not situated in history

itself, but in the present. [...] The reflex is certainly a historical concept, but is also a concept that we still use today. In this way, the historical study intervenes in the direct investigation of nature" (FR 167 and von Weizsäcker 1938: 4). [16]

The stratification of concepts

Although the reflex book does not contain an explicit theory of concepts, its historical analysis allows for a reconstruction of the basic features of such a theory. Canguilhem's study of concepts is concerned with three aspects: first, the stratification of concepts; second, their function; third, the process of their formation.

Canguilhem conceives of concepts as complex entities consisting of three components: a phenomenon, a denomination, and a definition, or: a thing, a word, and an explanatory sentence. In the reflex book, the existence of these components is largely derived from the critical discussion of the argument that Descartes is the originator of the physiological reflex concept. Following du Bois-Reymond, this argument was taken up and developed, in one way or the other, in historical and systematic accounts by authors such as Henri Milne-Edwards (1878), Conrad Eckhard (1881), Mieczyslaw Minkowski (1924) as well as Hebbel E. Hoff and Peter Kellaway (1952).

Two passages from Descartes's *Passions de l'âme* are normally referred to in their accounts: article 13, where Descartes describes movements that are triggered, independently of the soul, by the effect of exterior objects on the sensory organs; and article 36, where Descartes discusses the processing of sensory impressions in the brain as well as the resulting body movements and uses the term "esprits réfléchis." In the first passage, Descartes describes the involuntary shutting of the eye as a reaction to objects that suddenly approach it. According to Canguilhem, this is "without any doubt a reflex" (FR 42). In other words, the thing is appropriately described but the word is missing.

In the following, Canguilhem does not dispute the fact that the word “reflected” is used in the second passage. Rather, he argues that it concerns a pattern of behavior that is much more complex than any reflex action. What is missing then is the link between thing and word, i.e. a definition. Canguilhem underscores that he is not trying to ask a 17th-century philosopher and physiologist for a definition of mathematical precision. His point is that Descartes does not offer any explanatory sentence apt to fix the “sense” of the phenomenon in question (see FR 30-42).

The reason for this lack of explicitness lies in Descartes’s assumption that the centripetal and the centrifugal mechanisms of sensori-motricity are essentially heterogeneous. Descartes conceived of the sensory stimulation as an authentic pulling of the nerves, whereas he understood the motor reaction as being triggered by the transport of fluids (*esprits*) through the nerves to the muscle. The first process resembled the tolling of a church bell, the second was similar to blowing air into an organ pipe. According to Canguilhem, this asymmetric conception of sensori-motricity also explains why Descartes uses the term “reflected” only once in his physiological texts. It is a word suggesting an analogy that in Descartes’s physiology had no extended explanatory function.

Strikingly different is the case of Willis. Willis almost constantly uses the term “reflex” in his writings. The word “reflection,” “reflected,” and “reflex action” are in fact so frequent in Willis that, as Canguilhem says, “an inventory would be boring” (FR 66). In addition, Willis uses other words that convey the same idea, e.g. “retortion,” “reflux,” “echo,” etc. Canguilhem adds that in *De motu musculari* Willis uses the word “reflected,” elaborates the specific sense of this word and at the same time refers to the example of the scratch reflex. The decisive passage reads: “[...] or the motion [...] is reflected, to wit, which depending on a previous sense more immediately, as an evident cause or occasion, is presently retorted; so gentle titillation of the Skin causes a rubbing of it [...]” (Willis 1681: 34). The

conclusion is that, with respect to the concept of reflex, Willis gives the thing, the word *and* the definition. He, not Descartes, is the originator of the reflex concept (FR 60-69).

However, if the history (*Geschichte*) of concepts seriously takes into account the stratification (*Schichtung*) of concepts, it will be confronted with rather complex relations. A certain word can be used, the thing in question can be described, but a definition is lacking. Or: the thing is described and appropriately defined, but the word is missing. Precisely such relations cause the difficulties and misunderstandings in identifying the originator of a concept. According to Canguilhem, those historians of physiology who have identified Descartes as the originator of the reflex concept mistook a description for a definition and a word for a concept. Following du Bois-Reymond, they have treated the concept of reflex as a merely textual element that only served one purpose: to establish an immediate connection between their mechanist present and the mechanist past. The result is not providing an account of history, but telling a legend (FR 36-37).

The option to separate the components of concepts from one another and to use them independently has another aspect, however. It allows the scientists to 'cultivate' scientific concepts on different "theoretical terrains" (FR 6, 171). Because their stratification concepts are "theoretically polyvalent" (FR 6), which makes them relatively independent of specific theory territories. In the mid-19th century, the concept of reflex is certainly embedded in mechanist physiology. At this point, it is almost forgotten that it has its origins in the vitalist thought of the 17th and 18th centuries. Only toward the beginning of the 20th century does the concept of reflex become 'transplanted' onto other theoretical grounds. Insofar it is almost literally the question of "conceptual filiations," of different generations of concepts that have to be dated and localized. In addition, Canguilhem's genealogical study demonstrates that the history of concepts has its own kind of "humor" (FR 171) – what mechanists considered as an crucial element of their kind of physiology turns out be invented by their worst enemies, i.e. the vitalists.

Concepts, problems, and forms

The main function that Canguilhem attributes to the concept formed by Willis is the following: it provides “the possibility of a judgment” (FR 69). The initial form that this judgment takes is an “identification and classification” (ibid.) of experiences. In other words, concepts initially ‘do’ nothing else than discriminating and circumscribing specific sensations and perceptions. Coupled to instruments and devices, the mid-19th-century concept of reflex was able to produce percepts; in the 17th century, however, percepts led to the construction of concepts or, more precisely: the active delineation and ordering of observations prepared the formation of a concept. When it was formed the concept could perhaps be understood as a scheme, a rough sketch that was able to direct us toward and focus our attention on certain phenomena. In the context of science, the initial roughness of the drawing is not simply a disadvantage. It also is the potential for further developments, for increasing the clarification of the phenomenon in question.

In the *Traité de Logique et de Morale*, Canguilhem speaks of the concept as the “enunciation of a problem to be solved.” Concepts are “waiting positions” on the road to more precise knowledge (Canguilhem and Planet 1939: 94). These remarks suggest that the conceptual identification and classification of experiences does not proceed arbitrarily or at random. In fact, the *Traité* underscores in a rather Bergsonian manner that, taken as such, “concepts cannot be truths.” Rather, they “suggest problems” (Ibid: 96). Concepts mark or designate questions. They may hint at first answers, but these will always be object to examination and revision.

The specific problem that the reflex concept stands for is the distinction between voluntary and involuntary actions. In Canguilhem’s eyes, this problem ultimately refers to the experience of guiltiness and responsibility: “If the

distinction between voluntary and involuntary movements has become a problem of physiology, then only because of the meaning that this distinction first received from its religious, ethical and juridical aspects" (FR 148-9). This then would be the place where the prehistory of the reflex concept would be located.

As a consequence the formation of the reflex concept cannot be seen as a simple result of experimental work in the laboratory. Instead it stems from "speculative modifications" (FR 62) of older theories and above all from the use of "analogical imagination" (FR 170). The most general prerequisite for this speculative and imaginative practice is the existence of forms that can be related and "assimilated" to one another. With regard to Descartes and Willis, Canguilhem mainly addresses the assimilation of two kinds of forms: biological and technological. Basically, the concept of reflex relies on assimilating a biological phenomenon to an optical phenomenon. The implication is: before the proper formation of the concept can take place, the phenomena themselves are endowed with a contour or delineation.

Precisely this is what Canguilhem says in his article on the reflex concept in the 19th century: "Within the kind (*genre*) of movements the concept of reflex circumscribes a specific species (*espèce*)" (Canguilhem 2002e: 295). It is as if the manifestations of life themselves come toward the formation of concepts. The rough sketch that Willis used to structure his perceptions can build on the formal organization embodied in biological phenomena. In "Le concept et la vie," Canguilhem speaks, in this connection, of the "invitation of life to the conceptualization of life by man" (Canguilhem 2002f: 352).

Simply put, Willis was able to formulate the concept of reflex because he took much more seriously than Descartes the assimilation of the involuntary to the reflection of light, and he further developed this assimilation, this analogy by "teasing out all of its consequences" (FR 66). The analogies that Willis based his

descriptions and explanations on are indeed often optical and at the same time technological. Repeatedly he refers to light machines and ballistic devices: glowing mirrors, Greek fire, canons, gun powder, etc. Willis conceives of the phenomena of sensori-motricity as explosions or detonations of animal spirits in the muscles, where they cause contractions and subsequent movements. He also sees the anatomical arrangement of nerves with respect to the brain as a system of light beams.

Life, insofar it is movement, resembles light for Willis, or more precisely fire, and for that reason he recognizes in the laws of light and fire an “archetype” (FR 72) for the laws of life. As a consequence, his physiology extends into a chemistry and energetics of the living body, whereas Descartes remains within the framework of elementary mechanics. The analogies preferred by Descartes are the lever, the winch, the tackle block, the clockwork, the organ and the fountain system in the garden of Saint-Germain en Laye. In other words, it is also a specific material culture that prevented him from formulating the concept of reflex.

Conclusion

Canguilhem’s history of a biological concept leads back to a biology of the concept. “Even for an amoeba, living means preference and exclusion,” he writes in an almost programmatic manner in the *Essay* of 1943 (Canguilhem 1989: 136). Canguilhem is certainly not the first and not the only author who attempted to ground the intellectual judgment function of human beings in life as such. Before him, Nietzsche and Freud did the same, and Bergson proceeded in a similar manner. [17] In particular, Bergson attempted to refer the formation of concepts to the relation between organic individuals and their milieu. In the second introduction to *La pensée et le mouvant*, he explains, for example, “that any being, perhaps even any organ and tissue of a living being generalizes, or one could also say, it classifies, because it knows, within the milieu where it resides, to

abstract from the various substances those parts or elements that can satisfy this or that of its needs; the rest is being neglected” (Bergson 1959: 1295).

Living beings isolate in their milieu features that they are interested in, and in this sense they already judge and abstract, they form concepts even before they think consciously. According to Bergson, this holds also true for human beings. Initially, they live and perceive the general more than they think it. Even without consciousness explicitly involved man is capable of subducting similarities from various objects, so that these objects can be grouped and handled in a quasi-conceptual way. Bergson adds, the general concept that is created in this manner relies “more on automatic reactions than it is proper thought” (Bergson 1959: 1296). In this sense, one could perhaps even say that the concept is a reflex before the reflex is a concept.

Now, Canguilhem refers to life in general within the very domain that authors such as Ràdl, Nordenskiöld and Singer had established as the ‘history of biology.’ That is the striking difference with respect to Bergson, Freud and Nietzsche. The consequence seems to be that Canguilhem enters a vicious circle. Should his ‘method’ not clearly be distinguished from his ‘object’? Should the historian and philosopher not distance himself from the life sciences in order to better understand and explain these sciences? Canguilhem answers in the negative. Instead he claims, “The theory of life has to have its idea of the living from the living” (Canguilhem 2008a: xx). With von Weizsäcker, one could also say: “For studying the living, one has to participate in life” (von Weizsäcker 1958: 33).

Foucault has rephrased these thoughts with regard to Canguilhem’s contributions to the history of concepts: “Through the elucidation of the knowledge of life and from the concepts which articulate this knowledge, Canguilhem gets to the question of the *concept in life*” (Foucault 1980: 60). [18] The reflex book spells out this process by using history and philosophy in order

to relate one kind of biology to another. The development of the reflex concept in physiology is considered against the background of a general biology of the concept. It is no surprise, then, that Canguilhem explicitly describes his book as a product of the physiological institute in Strasbourg (FR 2).

Despite the fact that the reflex book refers to and relies on similar authors and findings as Merleau-Ponty and other phenomenologists, Canguilhem has clearly separated the history of concepts from Husserlian thought. Instead, he situated it close to structuralism. For example, when defending Foucault's *The Order of Things* against the polemic criticisms of Jean-Paul Sartre and his followers, Canguilhem assigned the following task of immediate interest to contemporary philosophy: "substituting for the primacy of experienced or reflexive consciousness the primacy of concepts, systems, or structures" (Canguilhem 1994: 88-89).

The author of the reflex book is surely not a structuralist in the sense of de Saussure or Lévi-Strauss. Concepts are smaller and more mobile entities than structures, and even if they display an interior stratification they keep a certain sedentariness and palpability, especially when compared to the complexities of the signifier/signified-relation. However, read from a historical perspective, the reflex book reconstructs an authentic structure of scholars contributing to the formation of the reflex concept. These scholars cooperate almost blindly with one another over time. Most of them are not contemporaries. And still, what one of these scholars neglects, might be highlighted by another. They use different instruments and tools, but pose similar questions. They come from different countries, were trained in different disciplines, and still they are connected – by means of a concept, a problem.

Read from an epistemological perspective, the reflex book confronts us with the formation of concepts as a process not only tied to the subjectivity and/or experience of scientists, but also to life itself. When Canguilhem speaks about the

“formation” of concepts, this can be taken in a biological sense. The formation of concepts usually seems to take a one-way street: from the subject to the relation between subject and object. According to Canguilhem, it equally follows the other way, i.e. it also goes from the object to the relation between subject and object. Life produces forms that prepare, that “invite” the formation of concepts. Long before life scientists started to grasp phenomena by means of technological analogies, long before they come up with drawings that allow for serialization and comparison, the structure of life manifested itself in similar manners, e.g. as circumscribed forms that reproduce themselves. In this sense one can speak indeed of “structuralism” with regard to Canguilhem, a structuralism that reconnects human knowledge to the evolving structures of life. This ‘biological structuralism’ should prompt further investigation of the role of biology and technology in the formation of scientific concepts.

Notes

[1] This paper is a condensed, revised and updated version of my introduction to the German translation of Canguilhem’s book on the formation of the reflex concept in the 17th and 18th centuries (Schmidgen 2008). An extended version of the present paper will appear in *History and Philosophy of the Life Sciences*. I would like to thank Karl Hall (Central European University) and Travis Gaug (Regensburg University) for their corrections of my English. Unless otherwise stated all translations from the French and the German are my own.

[2] See Stengers 1987; Stengers and Schlanger, 1989; Pickering 1995; Beurton, Falk, and Rheinberger 2000; and Davidson, 2001.

[3] See, among others, Serres and Farouki 1997; and Lecourt 1999.

[4] As one reviewer noted, this claim resonates with the philosophy of Gilles Deleuze. It is true that Deleuze has often alluded to the life of concepts, for

example in the introduction to *Difference and Repetition*, when crediting empiricism for the “most insane creation of concepts ever been seen or heard” (Deleuze 1994: xx), or in a dialogue with the Polish artist Stephane Czerkinsky when stating that concepts “are things, peoples, zones, regions, thresholds, gradients, temperatures, speeds, etc.” (Deleuze 2004: 312). In *What Is Philosophy?*, Deleuze argues and Guattari argue that the true object of science is to create functions; the object of art to bring forth sensorial aggregates; and that of philosophy to invent or create concepts (Deleuze and Guattari 1994: 201-217). The present paper contributes to questioning the sharpness of this distinction. With Canguilhem in mind, Deleuze’s claim about the philosophical creation of concepts can be understood as resulting from a strategic replacement of science through philosophy. I further discuss this issue in my paper “Cerebral Drawings between Art and Science: Gilles Deleuze’s Philosophy of Concepts”, to be published in *Theory, Culture & Society*.

[5] Canguilhem 1989: 29-229, in particular pp. 125-149; Canguilhem 2008b; Canguilhem 2008c; Canguilhem, Lapassade, Piquemal, and Ulman 1962; Canguilhem 2002a; Canguilhem 1973; Canguilhem 1988; and Canguilhem 2012.

[6] Canguilhem 2008d; and Canguilhem 2002d. Excerpts from the article “Vie” were published in English in Canguilhem 2000: 67-90. This volume also contains an extremely helpful “Critical bibliography” compiled by Camille Limoges, 385-454.

[7] Canguilhem 1955. In 1977, a slightly revised and enlarged version was published with Vrin. In the following I will refer to this latter version of the book as “FR” with page numbers and place these references in brackets in the body of the text. Excerpts from this book were published in English in Canguilhem 2000: 179-187; 193-194. In addition, one may note that Canguilhem has published a short article on the reflex concept in the 19th century in 1964. See Canguilhem 2002e.

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[8] For more specific studies see Macherey, 1964; and Lecourt 1972.

[9] On general biology, see Laubichler 2006. More broadly, see Harrington, 1996.

[10] This conception of life can be found in Max Verworn, Jakob von Uexküll, Frederik Buytendijk, and Kurt Goldstein, to quote only a few. As a point of reference in this connection, see, for example, Verworn 1895.

[11] For this paragraph and the following, see more extensively Schmidgen 2006.

[12] As far as I can see Canguilhem never explicitly addressed the issue of tool use in animals. Given his interest in evolutionist and developmental reasoning, I assume that he would have argued in favor of the existence of tool use in species other than *homo sapiens*.

[13] On the early history of this institute, see Bonah 2000.

[14] I would like to warmly thank the Strasbourg physiologist Bernard Canguilhem, the son of Georges Canguilhem, for having shown this library to me.

[15] On Walter's tortoises, see Hayward 2001; and Pickering 2002.

[16] For reasons of genealogical completeness one may add that von Weizsäcker's chef d'oeuvre, *Der Gestaltkreis*, was published in French in a translation by Michel Foucault and Daniel Rocher (von Weizsäcker 1958).

[17] For the experimental background of the corresponding writings, see Johns Schloegel and Schmidgen 2002: 640-645.

[18] I follow here a different and sometimes more pertinent translation of Foucault's "Introduction" to *The Normal and the Pathological*.

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