A Contribution to the Pasteur-Pouchet Controversy: Pouchet as a Philosopher and Historian of the Natural Sciences

Antonio Piccolomini d'Aragona*

Abstract: Building upon Raynaud's analysis of the controversy between Pasteur and Pouchet over spontaneous generation, I single out the philosophical and historical reasons which led Pouchet to defend the idea that life can appear in the absence of parents. In particular, I retrace the theological arguments used by Pouchet for showing that spontaneous generation copes with the Christian doctrine. Then, I provide an outline of Pouchet's interpretation of the development of natural sciences in the Middle Ages. Finally, I argue that Pouchet's endorsement to spontaneous generation was determined by his looking upon Albert the Great's philosophical and scientific heritage as a combination of *both* theological orthodoxy *and* experimental attitude, a mix that satisfies the metaphysical and epistemological tenets of Pouchet's philosophy of the natural sciences.

Keywords: Pasteur, Pouchet, spontaneous generation, controversy, SSK.

1. *Introduction*

The controversy between Pasteur and Pouchet is a paradigmatic case-study in the *sociology of sciences* – in particular, in the sub-field known as *sociology of scientific controversies*[1]. The debate took place in France in the

[1] Some titles are John Farley and Gerald Geison, *Science, politics, and spontaneous generation in Nineteenth-Century France: the Pasteur-Pouchet debate*, in *Bulletin of the history of medicine*, 48, pp. 161-198, 1974; Erich Mendelsohn, *The political anatomy of controversy in the sciences*, in H. Tristam Engelhardt and Arthur L. Caplan (eds.), *Scientific controversies*, Cambridge University Press, New York, 1987, pp. 93-124; Bruno Latour, *Pasteur et Pouchet: hétérogenèse de l'histoire des sciences*, in Michel Serres (ed.), *Élements d'histoire des sciences*, Bordas, Paris, 1989, pp. 423-445; Harry M. Collins and Trevor J. Pinch, *The Golem. What everyone should know about science*, Cambridge University Press, Cambridge, 1993; and Dominique Raynaud, *Scientific controversies. A socio-historical perspective on the advancement of science*, Transaction Publishers, New Brunswick and London, 2015. The best source book on Pouchet is undoubtedly Marilyne Cantor, *Pouchet savant et*

* Università di Siena.
antonio.piccolomini@unisi.it

years from 1859 to 1864, and involved Pasteur, who stands in need of no presentation, and Pouchet, who was the Director of the Natural History Museum in Rouen, and who had made himself a name with studies and discoveries in botany and, above all, biology – in the latter with e.g. relevant results into the ovulation of mammals[2]. The dispute originated from a prize that the *Académie des Sciences* intended to award whom had settled the experimental validity of *spontaneous generation* (henceforth SG), i.e. the theory that new organisms may appear without parents, and by purely environmental causes. Pouchet had just published *Hétérogénie, ou Traité de la génération spontanée*[3], a 672-page treatise where he defended SG with both metaphysical arguments and alleged experimental evidences – and which he possibly considered as his masterpiece. Pasteur had in fact been stimulated to deal with SG by Pouchet himself, who asked him about a note on lactic fermentation appeared in the *Comptes rendus* of the Academy, where Pasteur seemed to question the conclusions of Pouchet's *Hétérogénie*. After a number of vicissitudes, the controversy eventually resulted in the complete victory of Pasteur, mainly thanks to his 1861 *Mémoire sur les corpuscules organisés qui existent dans l'atmosphère*, a seminal paper in germ theory, which won him the *Alhumbert Prize* competition in 1862[4].

I will not dwell upon the chronological and conceptual development of the debate, which has been told and retold many times, and from many different (not always compatible) standpoints. Nor will I dwell upon its episte-

vulgarisateur. Musée et fécondité, Z'éditions, Nice, 1994. See also Bénédicte Percheron, *Les sciences naturelles à Rouen au XIXe siècle. Muséographie, vulgarisation et réseaux scientifiques*, Éditions Matériologiques, Paris, 2017, pp. 210-218, for the placing of Pouchet's theories on spontaneous generation in the scientific and cultural context of natural sciences in Rouen in the 19th century – Percheron speaks of a Rouen's "school of spontaneous generation".

[2] Pouchet's major works in these fields are Félix Archimède Pouchet, *Zoologie classique ou histoire naturelle du règne animal*, Roret, Paris, 1841; F.A. Pouchet, *Théorie positive de la fécondation des Mammifères*, Paris, Roret, 1842; F. A. Pouchet, *Théorie positive de l'ovulation spontanée et de la fécondation des mammifères et de l'espèce humaine. Ouvrage qui a obtenu le prix de physiologie expérimentale à l'Académie royale des Sciences de Paris au concours de 1845*, Baillière, Paris, 1847. In the books about the ovulation of mammals, Pouchet introduces ten laws, known as *Pouchet's laws*. For these laws, as well as for further details about Pouchet and his complete bibliography, see M. Cantor, *Pouchet savant et vulgarisateur*, cit. For the scientific context, see B. Percheron, *Les sciences naturelles à Rouen*, cit. Concerning Pouchet's work, besides an obvious reference to Cantor's major monograph, Percheron also mentions Landreat's doctoral dissertation in medicine which, however, I could not find anywhere – precise reference as given in Percheron's book: A. Landreat, *Félix-Archimède Pouchet, précurseur de la cytologie vaginale*, University of Rouen, doctoral dissertation in medicine, supervisor R. Laumonier, 1974.

[3] F.A. Pouchet, *Hétérogénie, ou Traité de la génération spontanée*, Baillière, Paris, 1859.

[4] Louis Pasteur, *Mémoire sur les corpuscules organisés qui existent dans l'atmosphère*, ain P. Vallery-Radot (ed.), *Oeuvres de Pasteur. Vol. 2: Fermentations et générations dites spontanées*, Masson, Paris, 1922, pp. 210-320.

mological and sociological evaluation[5]. Rather, I will concentrate on one of these evaluations, i.e. the one put forward by Raynaud[6], and use it as a starting point for investigating the philosophical stances which, based on what one can read both in *Hétérogénie* and in *Histoire des sciences naturelles au Moyen Age*[7], seem to underlie Pouchet's endorsement of SG.

In his reconstruction of the controversy, Raynaud has suggested that Pouchet's faith in SG, although supported by alleged experimental evidence, may have relied upon mainly metaphysical grounds. Also, given that some outcomes of Pouchet's former researches on *infusoria* seem to contradict SG[8], and given that, between these researches and *Hétérogenie*, Pouchet had worked for almost ten years on his *Histoire*, Raynaud infers that Pouchet's "conversion" to SG might be traced back precisely to *Histoire*, and in particular to the *apologia pro* Albert the Great that he puts forward therein.

The main claim of my paper is that both these conclusions of Raynaud are correct and, more precisely, that they are *jointly* correct: Pouchet's endorsed SG since he found, in what he calls the "experimental school" of Albert the Great, an ideal mix of metaphysical and theological orthodoxy, on the one hand, and of scientific concern for empirical matters on the other. This is in line with the broader philosophical remarks that Pouchet raises at the end of the metaphysical chapter of his *Hétérogenie*.

In Section 2, I sum up the points of Raynaud's interpretation which are more relevant to my purposes. In Section 3, I provide an outline of Pouchet's theological arguments in support of SG, as they are found in *Hétérogenie*. In Section 4, I discuss Pouchet's view on the history of the natural sciences in the Middle Ages, in particular the importance he deserves to Albert the Great. In Section 5, I return to *Hétérogenie*, and argue that the perspective under which Pouchet looks upon the tradition dating back to Albert the Great copes with Pouchet's privileged philosophical attitude in biology and akin sciences.

2. *Raynaud on Pouchet*

Raynaud's analysis of the controversy between Pasteur and Pouchet[9] is in many respects critical to others that have been put forward in the literature[10].

5 See footnote 1.

6 D. Raynaud, *Scientific controversies*, cit.

7 F.A. Pouchet, *Histoire des sciences naturelles au Moyen Age: ou, Albert le Grand et son époque considérés comme point de départ de l'école expérimentale*, Baillière, Paris, 1853.

8 F.A. Pouchet, *Notes sur les organes digestifs et circulatoires des animaux infusoires*, in "Compte Rendus de l'Académie Royale des Sciences", 28, 1848, pp. 516-518.

9 D. Raynaud, *Scientific controversies*, cit., pp. 51-94.

10 See footnote 1.

Latour is e.g. said to violate Bloor's *principle of symmetry*[11], while aiming to respect it. *Contra* Latour's claim that: "the winners do not need to be *protected* by the historian, but the losers do, to whom one will grant [...] *a second chance* before the *tribunal of history*"[12]. Raynaud remarks that Bloor's principle

> signified that one must treat beliefs, whether they are true or false, in the same way [...] yet the very notion of "defending the vanquished" contradicts the principle [...] one is no longer defending the "strong" but the "weak"[13].

To what he calls sociological relativism, too often hesitant between historical description and historical judgment, Raynaud prefers Merton's standpoint based on the identification of ethical principles which should normatively guide one's scientific activity, and which may hence play the role of coordinate system for the sociological assessment of scientific controversies[14]. According to Raynaud, many sociological depictions of the Pasteur-Pouchet debate thus suffer from two flaws, both stemming from the tendency to side with the vanquished and, therefore, to counter-balance an allegedly biased *a posteriori* evaluation with an equally unbalanced judgement of opposite sign:

(a) the over-estimation of the importance of certain asymmetries, and the consequent concealment of others, which instead qualify as sociologically significant;

(b) the idea that the duality between defenders and opposers of SG overlaps with other, deeper dualities at play in the philosophical, scientific, or more generally cultural *milieu* of the controversy, e.g. radicals *vs* conservatives, materialists *vs* spiritualists, creationists *vs* evolutionists, and so on.

In what follows, I will not deal with point a) above. I will just limit myself to remarking that Raynaud convincingly maintains that many asymmetries, which are supposed to show that Pasteur occupied a sociologically stronger position than Pouchet, are in fact pseudo-asymmetries. They can be often turned upside down, in favour of Pouchet, or at least return a substantial identity in social strength between the two poles. On the other hand, Raynaud highlights many hidden asymmetries, in the light of which Pouchet may be decidedly said to stand in a better position than Pasteur. This strategy eventually led Raynaud to discover a letter which, originally sent to Pouchet by Geoffroy Saint-Hilaire, was revealed (by stylistic and graphological anal-

[11] David Bloor, *Knowledge and social imagery*, London, Routledge, 1976.

[12] B. Latour, *Pasteur et Pouchet*, cit., p. 430, translation and italics as found in Raynaud's quotation.

[13] D. Raynaud, *Scientific controversies*, cit., p. 81.

[14] Robert K. Merton, *The sociology of science. Theoretical and empirical investigations*, Chicago, The University of Chicago Press, 1973.

ysis) to have been counterfeit by the former, in an anti-Mertonian attempt at improving his position in the debate[15].

Point b) is instead more relevant to my purposes. It is a largely shared view that Pouchet was handicapped by a division of the *forum* of the debate into a conservative-spiritualist-creationist pole, on the one hand, and a radical-materialist-evolutionist one on the other. Given the general situation of Napoleon III's France, the former pole was at that time much stronger than the latter, and since opposers and defenders of SG were ascribed to the former and the latter pole respectively, Pouchet had a weaker starting position than Pasteur. This stigma was the sword of Damocles of his inevitable defeat, no matter how many and strong experimental evidences he would have produced in defence of SG.

While the duality between the two poles is unanimously looked at as relevant to the Pasteur-Pouchet controversy, the "spin" of the social effect of the duality undergoes – not so slight – distinctions. Some (like Latour[16]) take the content of the duality itself to have an influence on the scientific dispute, while others (like Geison[17]) maintain that, quite on the contrary, the dispute offered results which could be used the other way around, to animate the social opposition. Therefore, Raynaud remarks,

> some believe that sociological factors conditioned the scientific debate (society → science) over spontaneous generation, others detect the recovery and confirmation of ideological concepts from the scientific results (science → society)[18].

If now, following the "double spin" identified by Raynaud, we try to estimate the burden put on science by the social factors at issue (or vice versa), we end up seeing that it is at least questionable to claim that Pouchet had a worse position than Pasteur *simply because* he defended a theory that was looked upon as radical, materialist or evolutionist. There are in fact two problems. First, by his explicit admission, Pouchet believed in *fixism* and, hence, he was against evolutionism[19]. Also, as we shall see in Section 3, the

[15] On this point, besides D. Raynaud, *Scientific controversies*, cit., see also D. Raynaud, *La correspondence de F.-A. Pouchet avec les membres de l'Académie des Sciences: un réévaluation du débat sur la génération spontanée*, in "European journal of sociology", 40, 1999, pp. 257-276.

[16] B. Latour, *Paster et Pouchet*, cit.

[17] G. Geison, *Pasteur*, in C. C. Gillispie, *Dictionary of scientific biography*, New York, Charles Scribner's Sons, 9, pp. 350-414.

[18] D. Raynaud, *Scientific controversies*, cit., p. 82.

[19] This Pouchet says in his post-*Hétérogénie* book *Nouvelles expériences sur la génération spontanée et la résistance vitale*, Paris, Victor Masson Et Fils,1864. A revealing quote is: "in spite of Mr. Darwin's claims, the fixity of the species is, for natural history as a whole, the most important and the best established fact, as Mr. Flourens put it", F.A. Pouchet, *Nouvelles expériences*, cit., p. 199. On this point see also D. Raynaud, *Scientific controversies*, cit., pp. 83-85. Percheron on the contrary maintains that, at least at the beginning of his career, Pouchet *did not* believe in fixism.

metaphysical part of *Hétérogénie* seems to cast little doubts on the fact that Pouchet was *not* a materialist. Finally, there seem not to be enough elements to establish whether, at the political level, Pouchet was a radical, or rather a conservative[20]. Second, the family of the heterogenists was a very variegated one, whence the dichotomy SG/evolutionism *vs* anti-SG/creationism may turn out to be nothing but a void sociological invention:

> one of the problems [...] in associating evolutionism and spontaneous generations rests […] on the diversity of opinions held by naturalists and microscopists. There were evolutionists heterogenists just as there were creationist heterogenists, evolutionists homogenists just as there were creationist homogenists, and hence there was a range of opinions from which one cannot reasonably draw any conclusion[21].

An example of this diversity may be given *precisely* by Pasteur and Pouchet. As said, Pouchet was not an evolutionist, although he defended SG; at the same time, before speaking of Pasteur as a creationist *qua* opposer of SG, we should bear in mind Raynaud's "double spin" *society* → *science/science* → *society*, in the light of which such an ascription may reveal itself to be only

> a "personal correlation" with no connection to the theory of the social determination of scientific knowledge, and at a worst a grave error of assessment which perceives the influence of social factors where in fact there was none[22].

However, Percheron also remarks that Pouchet's mentor, Alexandre-Louis Marquis, was indeed a fixist. See B. Percheron, *Les sciences naturelles à Rouen*, cit., pp. 101-111. I think one could safely claim that Pouchet moved from a *weak* to a *strong* faith in fixism throughout the development of his scientific beliefs. For the religious aspects in the Pasteur-Pouchet controversy, see also Juliette Azoulai, *L'imaginaire religieux dans la controverse sur la génération spontanée (Pasteur-Pouchet)*, in L. Dahan-Gaida, C. Maillard, G. Seginger and L. Talairach-Vielmas (eds.), *Penser le vivant*. Éditions de la maison des sciences de l'homme, Paris, 2021, pp. 175-192.

[20] Raynaud himself remarks that Pouchet had relatively strong political connections, sometimes very close to Emperor Napoleon III (e.g., Napoleon's cousin Charles-Lucien Bonaparte), and that he often appealed to them for improving either his academic position, or his strength in other controversies, see D. Raynaud, *Scientific controversies*, cit., p. 64. However, given the development of Napoleon III's political attitudes from 1848 onward, I think that Pouchet's connections to the political establishment cannot serve to argue that he was a *conservative* – this would be as strong as claiming that Napoleon III has always been a conservative. Be that as it may, based on what is said in M. Cantor, *Pouchet savant et vulgarisateur*, cit., Pouchet's could be considered as a progressive rather.

[21] D. Raynaud, *Scientific controversies*, cit., p. 86. Cantor also highlights that the interpretation of many basic terms in the debate between Pasteur and Pouchet was not neutral. Such words as *germ*, *heterogeny* or *spontaneity* were liable to different, and often incompatible readings, whose choice affected the scientific and sociological standpoint from which the different poles of the controversy looked at SG, see M. Cantor, *Pouchet savant et vulgarisateur*, cit., pp. 161-165. At the pages 167 and 168 of her book, Cantor also provides a most interesting discussion of the relation between SG and Darwinism within the context of the Pasteur-Pouchet controversy over SG. For the dissemination of such theories as evolutionism in Rouen's cultural and scientific context during Pouchet's times and beyond, see B. Percheron, *Les sciences naturelles à Rouen*, cit., in particular Chapter 2 of Part II.

[22] D. Raynaud, *Scientific controversies*, cit., p. 86.

Now, there are two aspects of Pouchet's scientific attitude, both highlighted by Raynaud, and both relative to the "double spin" assessment of the controversy between Pasteur and Pouchet. The first is that "Pouchet supported his thesis [...] with proofs derived from his religious orthodoxy"[23]. The second is that Pouchet's "extra-scientific faith" in the validity of SG, which in fact contradicts some results obtained by Pouchet himself much before the publication of *Hétérogénie*[24], did not come out of the blue, but was "prepared" by Pouchet's work as a historian of the natural sciences in the Middle Ages. Pouchet's *Histoire* would indeed contain, for Raynaud, the key for explaining why and how Pouchet changed his mind about SG, as the book amounts to an *apologia* for Albert the Great, and thus "sheds light on the origins of the quasi-religious manner in which Pouchet would later address the questions of spontaneous generation"[25]. So, Raynaud claims two things. First of all, that Pouchet had mainly metaphysical and theological, rather than experimental reasons, for believing in SG. Secondly, that the source of these reasons is to be found, not only in the metaphysical and theological "proofs" put forward in *Hétérogénie*, but also in Pouchet's interpretation of the historical development of natural sciences in the Middle Ages, especially from Albert the Great onward. One may now ask how these two claims interact, i.e. whether Albert the Great and his legacy provided Pouchet with direct metaphysical and theological arguments, or with some other grounds that convinced the French naturalist of the truth of SG (or both these things). The answer actually stems from a passage of Pouchet's *Histoire* also quoted by Raynaud. Pouchet maintains that Albert the Great embraced

> the universality of both the human and the sacred sciences […] the natural sciences could appear in their fundamental character: their physical utility and their theological utility[26].

But how did this happen? What is the historical significance of Albert the Great, in the framework of (Pouchet's reconstruction of) the development of the natural sciences in the Middle Ages? How could this influence Pouchet's eventual faith in the validity of SG? Of course, we cannot expect Albert the Great to have offered any experimental evidences which could satisfy a naturalist of the 19th century. The answer must hence lie somewhere else. In the next sections, I set up to shed light on this issue, and thus to unfold some aspects which I take to be implicit in Raynaud's analysis, when he says e.g. that Pouchet interests in SG came from the

23 Ivi, p. 83.
24 F.A. Pouchet, *Notes sur les organes digestifs et circulatoires des animaux infusoires*, cit.
25 D. Raynaud, *Scientific controversies*, cit., p. 84.
26 F.A. Pouchet, *Histoire*, cit., pp. 214, 320, translation by Raynaud.

discovery of the medieval theory of heterogeny, referring to the model of Albertus Magnus […] articulated within the framework of Christian theology[27].

3. *Pouchet's theological arguments in* Hétérogénie

The second chapter of *Hétérogénie* offers a theological, metaphysical and epistemological support to SG. Its importance within Pouchet's line of thought is underlined by a number of aspects. Besides the structural and quantitative role that, as remarked by Raynaud[28], the chapter plays in the overall architecture of the volume, we may for example quote from the Preface where, while specifying that

> this work can be naturally divided into two sections: the experimental part, which is the fundamental one, and the theoretical part, which is nothing but an ancillary fragment of the first[29],

Pouchet nonetheless admits that he was led to acknowledge the validity of SG, not by the experimental evidences which are to constitute the "fundamental part" of his volume, but by "meditation", i.e.

> as soon as, *upon meditation*, it became evident to me that spontaneous generation was still one of the ways employed by the nature for the reproduction of beings, I applied myself to discover the processes via which one could make these phenomena evident[30].

Also, in the first chapter of *Hétérogénie*, concerning the history of the different positions on SG from antiquity to Pouchet's times[31], the French biologist often presents the theories of his colleagues from the past as *rationally*

[27] D. Raynaud, *Scientific controversies*, cit., p. 84.

[28] *Ibidem*.

[29] F.A. Pouchet, *Hétérogénie*, cit., p. VII. Here and in what follows, the translations of Pouchet's passages are mine.

[30] *Ibidem*.

[31] It may be instructive to remark that, in this historical chapter, the section about the Middle Ages is the *shortest* one. Far from refuting Raynaud's claim that Pouchet's conversion to SG may have been determined by his work as a historian of the natural sciences in the Middle Ages, this seems rather to *confirm* the claim: it is *precisely* because he had already written a whole book on the history of the natural sciences in the Middle Ages, and because of the fact that this book was to his mind a sort of "preparation" to a major discussion of SG, that Pouchet deemed it unnecessary to return to the issue. This is symmetrical to what happens in Pouchet's *Histoire*, where we find very few references to medieval theories on SG (Albert the Great included), which led Raynaud to ask whether Pouchet "was [...] reserving a more thorough examination for a future study", in D. Raynaud, *Scientific controversies*, cit., p. 84. Significantly, Albert the Great is indeed mentioned in *Hétérogénie*, but in the *metaphysical* discussion.

fine, but incapable of being verified for lack of suitable scientific instruments. In the case of Buffon, Pouchet says for example that

> although starting from incorrect observations, the illustrious naturalist was nonetheless following a rational line of thought. It simply sufficed to bring his conceptions in the unknown molecular world[32].

Likewise, but the other way around, the moments when SG could count on more partisans have been for Pouchet those during which new instruments gave theoretical *hypotheses* a firm empirical grounding. E.g., in the section titled *Compound microscope* (i.e. optical microscope), Pouchet writes that

> the animalcules of infinite smallness, which this instrument revealed where their existence was expected the least, naturally led to believe they were born spontaneously. And maybe never could the hypothesis of heterogeny count on a more compact army of partisans than during this second stage of micrography[33].

In a nutshell, Pouchet's attitude towards SG seems therefore to be that a prior theoretical hypothesis, whose acceptability may vary depending on the current state of technological development, is then tested against experimental evidence which, again depending on the available instruments, is *expected* to ground it empirically. As we shall see in Section 5 below, this "teleological positivism" also depends on Pouchet's philosophical view on how biology, and natural sciences in general, should proceed – a standpoint that Pouchet shared with other naturalists of his times[34]. In the first part of the philosophical chapter of *Hétérogénie*, from page 95 to 105, Pouchet puts forward a number of arguments aiming to show that SG is *not* incompatible with the Christian orthodoxy. Many of the arguments presuppose some kind of creationism, so that SG is shown not to cope with evolutionism, and to reinforce the tie between science and religion. Ten arguments, often intertwined with each other, can be identified. Let me sum them up. The first six arguments are *theoretical-theological* in spirit, and they run as follows:

[32] F.A. Pouchet, *Hétérogénie*, cit., p. 44.

[33] Ivi, p. 39. The first stage that Pouchet refers to is that of the *simple* (i.e. non-optical) *microscope*.

[34] The "teleological positivism" that I have referred to should not be confused with the idea that experiments, or more in general experience, *must* adapt to preconceived ideas. In some places, Pouchet criticises this attitude, especially in connection with empirical findings obtained thanks to new scientific instruments, whose biased interpretation is then *required*, rather than expected, to confirm a given theory. Pouchet is a positivist, whence he tributes much importance to an as "neutral" as possible treatment of facts. Still, as we shall see below, Pouchet is also influenced by the (mostly philosophical) tenets of the *Naturphilosophie*, whence his "teleological positivism". For this point, see M. Cantor, *Pouchet savant et vulgarisateur*, cit., pp. 60-61, p. 119, p. 130, and Nils Roll-Hansen, *Experimental method and spontaneous generation: the controversy between Pasteur and Pouchet – 1859-1864*, in "Journal of the history of medicine and allied sciences", 3, 1979, pp. 273-292.

(1) the *fiat lux* is nothing but an instance of SG, "working under divine influence"[35];

(2) if SG exists, then it was wanted by God. We may not be in the position to understand God's decision, but we should even the less oppose to it, if it is the case. Observe that this is a conditional, and partly ethical argument, which seems to involve two presuppositions: first, that phenomena, or at least some of them, exist because God wanted so; second, that SG is compatible with the natural world created or wanted by God;

(3) it would be an irrational, or at least unlikely, limitation of God's powers if He could not animate inert molecules, given that He can on the other hand

> survey the deepnesses of the skies, and weigh the globes spread in the immensity; then, too cramped in his Earth's shore, soar in the infinite spheres and penetrate the uncreated mysteries[36].

This argument is of course in line with argument (2) above.

(4) God can modify the course of natural history. For example, he can provoke the sudden disappearance of certain species, or even violate and reverse the immutable laws of the Universe through miracles and similar events. Why then, given such capabilities, should He not be able to create a mite in the absence of parents?;

(5) it is true that Genesis says that, after the 6th day of the creation, God took a rest. But Genesis *does not* say that God renounced forever using His creative faculty;

(6) even if we insisted on denying that God could actually operate a "daily"[37] spontaneous creation of new beings, we should not deny, on pain of limiting His omnipotence, that He could have laid down some laws of matter "determining the circumstances in which the organisational power can manifest itself, and give birth to new combinations"[38]. Such laws would ultimately make of SG nothing but a variant of "sexual reproduction, fission, budding, etc."[39].

The last four arguments are instead *biblical* in spirit, or more generally, they qualify as *ex auctoritate*, since they appeal to textual evidences to be found in the Scripture, and in the writings of some Church Fathers or of philosophers whose ideas have become part of the Christian dogma:

35 F.A. Pouchet, *Hétérogénie*, cit., p. 95.
36 Ivi., p. 96.
37 Ivi, p. 97.
38 Ivi, p. 98.
39 *Ibidem*.

(7) Pouchet repeats argument (5), as he remarks again that the author of the Genesis does not say anything about what God did after resting on the 7th day, so that nothing impedes that He allowed himself to use again and again His creative faculty. But now Pouchet goes deeper into a sort of "exegetical analysis": since the account of such a magnificent event as the creation "barely takes few lines"[40], we should not expect to find a detailed description of what God did afterwards, since this "naturally derives from the Creator's supreme intelligence and relentless activity"[41]. This argument is partly based on other sources than the Scripture, which Pouchet uses for arguing that, even if the Genesis "does not entitle one to suppose that God could return to His creative activity"[42], it does not exclude either that He "forced himself not to return to His work". Rather,

> from place to place, the Scripture speaks against the rest which the Eternal spirit would be uselessly chained in. Instead, everything seems to indicate that He is never inactive[43];

(8) this latter fact also holds of the creation itself, i.e. "our sacred books speaks against the immobility which we pretend to pin on the creation"[44];

(9) Aristotle was a partisan of SG, so that we should not be surprised if his ideas on this topic come back in the writings of prominent Christian philosophers of the "nice times of the Church"[45], like Saint Augustin or Saint Jerome. As for Saint Augustin, his authority is to Pouchet the "evident proof that the pretences of the heterogenists have never derogated from orthodoxy"[46], and the French naturalist is ready to affirm that

> it is [Saint Augustin's] thesis that we aim at developing here, with the certainty and exactitude that sciences provide us with in the nineteenth century[47];

(10) Aristotle's theses on SG also occur in authors from the Scholasticism or the Society of Jesus. In the former case, Pouchet mentions his medieval champion, i.e. Albert the Great, "Saint Thomas' friend"[48].

While still philosophical in nature, the second part of the second chapter of *Hétérogénie* seems instead to be much less theological, and much more oriented towards some form of metaphysical epistemology of the natural sciences.

40 Ivi, p. 100.
41 Ivi, pp. 100-101.
42 Ivi, p. 100.
43 Ivi, p. 98.
44 Ivi, p. 101.
45 Ivi, p. 103.
46 *Ibidem*.
47 *Ibidem*.
48 Ivi, p. 104.

Before dealing with this, I shall go back to Pouchet's *Histoire*; this will be helpful for a better understanding of Pouchet's point of view in Section 5.

4. *Pouchet on Albert the Great and the natural sciences in the Middle Ages*

Pouchet's *Histoire des sciences naturelles au Moyen Age*, whose sub-title reads *Ou Albert le Grand et son époque considérés comme point de départ de l'école expérimentale*, is a 656-page treatise on the history of natural sciences in the Middle Ages[49]. It is organised in five chapters (plus preface and introduction), one for each of the five "schools" which, in Pouchet's analysis, the medieval history of the natural sciences can be split into. Here is a list of the schools, together with their respective page-numbers:

- Scandinavian school, from page 11 to 36;
- Franco-Gothic school, from page 37 to 110;
- Byzantine school, from page 111 to 137;
- Arab school, from page 138 to 202,
- experimental school, from page 203 to 614[50].

This is not to be taken also as an order of chronological development. In the introduction, Pouchet remarks that none of the schools can be

> circumscribed to a given period or a given country. The schools […] do not provide an identity of time, nor of places. Distinctive features are provided only by the forms which scientific doctrines are informed by[51].

However, this does not mean that all the schools are on a par. In fact, two (interrelated) remarks can be drawn from the list above. First, the experimental school takes more than two thirds of the book. For Pouchet, thus, this is the most relevant school, which "flows" directly into the modern tradition of the

[49] For an overview on the relation between Pouchet's historical work and the writing of histories of natural sciences in the 19th century, see B. Percheron, *Écrire l'histoire naturelle au XIXe siècle. Le style de Felix Archimede Pouchet*, in "Arts et savoirs", 14, 2020. For the relation with the wider context of the natural sciences in Rouen in the 19th century, see instead B. Percheron, *Les sciences naturelles à Rouen*, cit., in particular see Chapter 3 of Part I and Chapter 1 of Part II therein. See also M. Cantor, *Pouchet savant et vulgarisateur*, cit., pp. 74-77.

[50] While it is clear what the Franco-Gothic school, the Byzantine school and the Arab school are, the Scandinavian school requires some clarification. It is given by the "scientific" knowledge, mainly zoological and geographical in nature, stemming from Scandinavian sagas, or from documents connected to early Scandinavian kingdoms.

[51] F.A. Pouchet, *Histoire*, cit. pp. 9-10.

16th-17th century.[52] Second: in spite of the sub-title of the book referring to Albert the Great and his legacy as only the *starting point* of the experimental approach, Pouchet in fact considers Albert the Great and those following his theories as constituting a *full-fledged* form of experimentalism[53]. The latter is understood by Pouchet as the natural evolution of an observational attitude which constitutes in turn a *conditio sine qua non* for natural sciences. And it is precisely during the mid-13th century that such an evolutionary step took place:

> in natural sciences, the observation stage comes necessarily first […]. Aristotle is maybe the deepest observer we can mention. But, after this great man, the rational method became weaker and weaker, and ended up being entirely lost. For a number of centuries, sciences abandoned the sole path along which they could make progresses, and stayed almost sterile into the hands of people whose work was just scholarly research. […] However, to these two periods inaugurated by antiquity, the Middle Ages added a third one: *experimentation*. The power and fruitfulness of the latter, which had been neglected up to that moment, and from which all the brightness of our current knowledge can be derived, was understood by two man of the 13th century: Albert the Great and Roger Bacon[54].

The importance which, in this framework, Pouchet attributes to Albert the Great is seen already from how the part of the book devoted to the German

[52] It is not clear whether Pouchet would consider Renaissance science, or parts of it, as still belonging to the medieval period, or as being, rather, part of modern science. Because of Pouchet's conception of what he calls "experimental school", the commonly adopted criteria for the splitting of the history of science become much "fluid", so different ages overlap, in a somewhat stronger sense than when saying that authors at the crossroads of two periods belong to both these periods. Thus, e.g., Nicholas of Cusa, Regiomontanus and Copernicus are dealt with in the astronomy section of the experimental school, see F.A. Pouchet, *Histoire*, cit., pp. 614-622, and even Leonardo da Vinci is one of the authors mentioned in the section on geology, see Ivi, pp. 508-510.

[53] This is not to say, however, that Pouchet fails to see the differences between medieval experimentalism and modern science. In the introduction he writes for example that he does not aim at "pretending that the medieval age can be compared to ours. The centuries that the Middle Ages laboriously crossed cannot aspire to the fruitfulness or height that modern sciences have achieved", F.A. Poucher, *Histoire*, cit. p. 7. On the other hand, the reason for this seems for Pouchet to be mainly sociological and political: "the status of the society ostensibly explains the causes of this inferiority: the Roman Empire, stressed and languishing, suffered from sterility; the Francs and the people from Germany […] were still too young to give birth to mature productions". Ivi, pp. 7-8.

[54] F.A. Pouchet, *Histoire*, pp. 203-204. Observe that, in outlining the shift from the observational to the experimental stage, no role is attributed to the previous schools which Pouchet dealt with in first four chapters of his book. The approach stemming from Albert the Great and Roger Bacon would thus seem to be directly connected to the Greek and Latin traditions (and, forward, to modern science), not only because of some inherited knowledge – which was already the case for the other schools – but above all because of a shared (and improved) *method*. I think that, based on Pouchet's analysis, a preparatory epistemological role could be attributed to the other medieval schools too, but I cannot deal with this issue here.

philosopher and scientist is structured. While still being "heroic"[55] in spirit, i.e. based on a case-wise survey of single scientists, and while still providing an outline of the historical context which the authors' reference schools stems from, Pouchet overturns the order of the relation between Albert and the sciences he contributed to. For, whereas the other authors are subsumed to macro-sections concerning specific sciences, Albert is, so to speak, a macro-section in himself, which sciences are subsumed to. For example, in spite of the fact that Roger Bacon is said by Pouchet to be on a par with Albert as a founding father of the experimental school, his name is mentioned only in the section for Physics. Albert's section is instead structured as follows:

- general introduction and life;
- works;
- philosophy;
- zoology;
- botany;
- mineralogy;
- physics.

Where it is to be remarked that *each* of these sub-sections also occurs as a macro-section on its own in the chapter on the experimental school (as in the already mentioned case of physics, and as happens for the other schools)[56]. The description of Albert's life, works and theories starts with an *apologia* where it is difficult not to detect Pouchet's enthusiasm in presenting his medieval champion. Here is a piece of textual evidence:

> they called him *Magnus* […] after his vast knowledge in philosophy, theology, mechanics, chemistry, physics, and natural history. […] the Middle Ages cannot offer anything which surpasses him. He deserves the glory of having traced the widest picture of the human knowledge of those times […]. Deep scientist, and immense and immortal figure, he alone would suffice to glorify an entire age! For no one may have ever en-

[55] I am borrowing this way of describing Pouchet's style from M. Cantor, *Pouchet savant et vulgarisateur*, cit., p. 75.

[56] Let me also remark that the section on Albert the Great goes from page 210 (or the like) to page 320, i.e. one fourth of the whole chapter on the experimental school, and one sixth of the whole book. Therefore, this section is a sort of book in the book – perhaps the very initial project, which Pouchet *later on* expanded so to include all the Middle Ages? Be that as it may, this shows that Pouchet worked intensively on Albert the Great, which may confirm the hypothesis formulated by Raynaud, i.e. that the reason why in the *Histoire* there is no mention to Albert's theory of spontaneous generation is that Pouchet planned to expand this as a separate part of his work, later materialised with *Hétérogénie*. In this perspective, Pouchet's *Histoire* may be well conceived of a sort of "preparatory" book for *Hétérogénie*, where the earlier historical (and conceptual) background of the theory of spontaneous generation is shown and laid down.

joyed a greater intelligence than Albert since […] he may have attained the last term of human science[57].

Albert's prominence lies in the fact that he brought experimentalism into medieval natural sciences. This is an achievement he shares with others, like Roger Bacon, but one of the reasons why Albert's experimentalism qualifies as more important is that he was familiar with a *wide* range of sciences[58]. So, experimentalism led him to innovative results in much more fields than, e.g., just that of physics, as was for Bacon. In this sense, Albert offers a synthesis between the encyclopedic tradition which he inherits from the previous centuries (and which Pouchet had dealt with, for the European context, mostly in the chapter about the Franco-Gothic school), and a new scientific method which will later on materialise in Renaissance and modern science. Zoology and botany are, for Pouchet, two sciences where Albert's approach was most fruitful (and which are of special interest for us here)[59]. As for the first, Albert is credited with the discovery of the *animal series* and of the principle of zoological *classification*:

> here we find laid down for the first time the foundations of the animal series! A truly gigantic idea for an age where observation raised such insurmountable problems, and one which had to cross many further centuries before being accepted by the most prominent naturalists. As regards *classification*, our scientist […] starts by declaring the stability of the species that come into the domain of the creation. His method is entirely based on this point. […] But he goes further than that. For the first time he defines what a species is, and shows us the mechanism by which genders are drawn out of species[60].

As for botany, after depicting Albert's experimental achievements in such fields as vegetal anatomy or physiology, especially in connection with the reproductive organs of the plants, as well as in classificatory concerns

57 F.A. Pouchet, *Histoire*, cit., pp. 211-212.

58 For Albert's scientific work in the context of Albert's wider epistemology, see Loris Sturlese, *Il razionalismo filosofico e scientifico di Alberto il Grande*, in *Documenti e studi sulla tradizione filosofica medievale*, 1(2), 1990, pp. 373-426. For a general introduction, see Alain de Libera, *Albert le Grand et la philosophie*, Vrin, Paris, 1990, as well as David Twetten and Steven Baldner, *Introduction to Albert's philosophical work*, in I. Resnick (ed.), *A companion to Albert the Great. Theology, philosophy, and the sciences*, Brill, Leiden, 2012, pp. 163-172.

59 On zoology and botany in Albert the Great, see Gila Wöllmer, *Albert the Great and his botany*, in I. Resnick (ed.), *A companion to Albert the Great*, cit., pp. 221-267, Miguel de Asúa, *War and peace: medicine and natural philosophy in Albert the Great*, in I. Resnick (ed.), *A companion to Albert the Great*, cit., pp. 269-297, Marina Panarelli, *How do plants live and grow? Radical moisture and digestion in Albert the Great's* De vegetalibus, in "Quaestio", 20/2020, 2020, pp. 347-367, and M. Panarelli, *Converting death into life: spontaneous generation from Aristotle's biology to Albert the Great analysis of plants*, in "Quaestio", 22/2022, 2023, pp. 493-508.

60 F.A. Pouchet, *Histoire*, cit., pp. 278-279.

similar to those at play in zoology[61], Pouchet concludes that

> summing up Albert's writings on botany, we recognise he gave this science genuinely good grounds. […] In the 13th century he argued for the very same theses as those we develop today in our amphitheatres. […] In physiology he was, if not the precursor of our age, at least the daring explorer of a number of phenomena which we had to deepen rigorously afterwards[62].

However, it is clear from other substantive parts of Pouchet's presentation of Albert that the experimental achievements of the latter are definitively *not* the sole reason why he is worth being looked upon as the crucial scientist of the Middle Ages. Science is nothing without the right context. Science is nothing without (Christian) faith[63]. Albert's greatness depends on the fact that his having traced the widest picture of the human knowledge of his times, as mentioned in the quotation above, was by him "closed in a circle under the Christian viewpoint, encompassing nature, man, and God"[64]. And even the whole *point* of Albert's research is not science for the sake of itself, but

> the glorification of the Eternal. […] God is revealed to man through his words and works. The creation is the true domain of sciences, so that the latter have become the most powerful lever we can use for proving metaphysical ideas. Albert acknowledged this first, and first used the study of science to support the science of God or theology. This is how he closed the circle of our knowledge[65].

To my mind, the last quotation is crucial if we aim at understanding, not only Pouchet's conception of medieval natural sciences, but his conception of natural sciences *as such*. This is textually highlighted by the fact that Pouchet shifts from speaking of Albert as the one who closed in a circle the knowledge *of his times*, to the much stronger claim that this closure concerns *our* knowledge. So we are told that the domain of the natural sciences is, not

61 Ivi, pp. 302-307.

62 Ivi, p. 308.

63 It may be worth remarking that another author mentioned by Pouchet in connection with more than one science is Avicenna, who is dealt with in the chapter on the Arab school (of course) with reference to medicine, geology, and chemistry. That Avicenna is not for Pouchet as crucial as Albert the Great (possibly because he lacked precisely that Christian side which was so fundamental in the case of Albert) is shown for example by the editorial choice of not having a special section on Avicenna, with specific sub-sections for the sciences which he contributed to (as is for Albert). Rather, Avicenna is *one* of the authors mentioned in the sections of medicine, geology and chemistry in the Arab school, among many other names. See F.A. Pouchet, *Histoire*, cit., pp. 456-458, 477-478, 487-488.

64 Ivi, p. 211.

65 Ivi, pp. 214-215. For the relation between nature and creation in Albert the Great, see Maria Evelina Malgieri, "Universale latissimae universalitatis"*: origine della creazione e natura del fluxus nel* De causis *di Alberto*, in "Quaestio", 20, 2020, pp. 389-413.

the nature, but the creation. Natural sciences work as a lever for proving metaphysical ideas. Albert was the first to understand this, since he used natural sciences as a support for theology. In *this* way, he attained that closure thanks to which he can be considered as the most important scientist of the Middle Ages. And it is perhaps under a closure of this kind that, as suggested by Raynaud in the quotation I have reported at the end of Section 2, Pouchet may conceive of his theory for SG.

However, this is not to say that Pouchet's scientific work is biased by metaphysical ideas, nor that he cannot be considered under all respects as a positivist of his times. The point is not Pouchet's science, but Pouchet's view on what science is about. Of course, if the domain of science is the creation, and if the creation is nothing but the nature looked at from Christian perspective, then science must include an experimental method. But the experimental level is only part of the story. Again because nature is creation, after studying the phenomena experimentally we should go back from the *creata* to the *Creator*. It is of course possible to do science for the sake of itself, namely, without ascending to any transcendental plan. But science is best, maybe properly used as a lever for proving metaphysical ideas. We are thereby back to what in Section 2 I called the "teleological positivism" of Pouchet.

5. *Pouchet's epistemology in* Hétérogénie

Natural sciences are instrumental to proving metaphysical ideas. From this point of view, Pouchet's theological-exegetical arguments in support of SG in the first of part of Chapter 2 of *Hétérogénie*, which I reported in Section 3 above, are *not* misplaced. They could just complement the experimental part, and qualify as even more important than it, as they complete the transcendental ascent when going, so to say, from nature to creation[66]. Thus, the arguments may not simply play the role of providing Pouchet with some "precaution" against potential charges of radicalism, materialism, and evolutionism, but constitute an integral part of what is required to Pouchet's epistemological framework for it to function consistently.

Now, the nature, structure, and sources of this epistemological framework are very clearly stated by Pouchet himself in the second part of Chapter 2 of *Hétérogénie*, which starts by outlining some broad methodological tenets. Pouchet acknowledges the importance of the experimental attitude in the natural sciences:

[66] A very thorough reconstruction of Pouchet's scientific methodology, mainly as applied to his investigations into the ovulation of mammals and into SG, can be found in M. Cantor, *Pouchet savant et vulgarisateur*, cit., in particular pp. 110-112, 130, 151-152, 165-166.

the surest path to follow is, almost always, the experimental approach, which made natural sciences advance very much since Galilei. This approach consists in taking the observation of phenomena as a starting point, and in seeking their causes[67].

The experimental method works locally but, when referred to such delicate issues as SG, which may require one to answer some *ultimate* problems in a given scientific field, say the origins of life, it also proves to be insufficient:

elucidating the important issue of spontaneous generation requires one to appeal to all the resources of human mind, and to put into practice its noblest faculties. […] we can repeat here what Is. Geoffroy Saint-Hilaire said of natural sciences: the observation and the analysis are indispensable, but they are not enough. Reasoning and synthesis also play a role[68].

Therefore, when dealing with SG, we should bear in mind that experimentation is, on the one hand, a *conditio sine qua non* of natural sciences, but also that, on the other, it should not lead us to "the deepest scepticism for everything which does not derive from it"[69]. For this would mean "drying the most fruitful sources of every progress, i.e., the criterium of the intellect, which discusses and judges"[70]. The opposite would amount to disregarding the role played by experimentation, and demanding too much to reasoning, synthesis and intellect. This was the flaw of previous researches on SG, where scientists "pushed their pretences too far, by attributing to heterogeny a fancy power"[71], and this is what obtains in certain tendencies of the *Naturphilosophie* stemming from Schelling:

experimentation, as Schelling understands it, is just the verification of some pre-existing idea. According to his view, material facts should be investigated only for the sake of somehow confirming the prophecies of intellect. However, in our opinion, the German philosophy is here renouncing one of the most fruitful results of experiments. For, if it is true that the latter often torture the matter and its organisation, in order that it testimonies in favour of some pre-conceived ideas, it is also true that the scientist, by acknowledging unusual or unexpected facts that may occur during his operations, derives from that, *a posteriori*, some laws which would have never come up spontaneously[72].

One should thus seek a sort of intermediate way, where "intelligence and experimentation be strictly intertwined"[73]. Here, Pouchet's epistemological champion is Saint-Hilaire who, through an approach which is tied "neither

67 F.A. Pouchet, *Hétérogénie*, cit., p. 105.
68 Ivi, p. 106.
69 *Ibidem*.
70 *Ibidem.*
71 Ivi, p. 107.
72 F.A. Pouchet, *Hétérogénie*, cit., p. 108.
73 *Ibidem*.

to the temerity of the *philosophy of nature*, nor to the shy reservations of the *school of facts*"[74], is able to lead us in a framework where

> the intellect is fertilised by the facts […] in its most daring deductions, it always relies upon known elements, abstracting theories from them. […] We introduce in the natural sciences precisely the same elements as those introduced by the leading author of German philosophy but, contrarily to him, we aim to essentially *deductive* theories, rather than to *intuitive* theories[75].

But this also means that, in spite of the criticism to Schelling's approach, Pouchet is not ready to completely renounce a certain understanding of experimentation. That the latter is still looked at from an idealistic or romantic perspective clearly emerges from the first quotation above, where Pouchet illustrates what *rough* experimentalism is expected to be. *Contra* an as much neutral as possible reconstruction of the "schools of facts", Pouchet claims that experimentation is concerned, not with phenomena *as such*, but with a *causal* observation of them. This is in sharp contrast to a by then a classical way of conceiving of experimentation which, in France, had been developed by François Magendie, and which, in Pouchet's times, was upheld by, e.g., Claude Bernard[76].

In line with what Pouchet said in his *Histoire*, natural sciences are understood as a sort of peculiar framework where experimentation is not used for explaining facts in a case-wise manner, but for proving metaphysical ideas, which now boils down to abstracting general theories where facts can be given their right place within the context of a broader and all-encompassing picture[77]. On the other hand, however, the picture cannot obtain by merely putting facts of a given collection side by side. One needs a sort of bird's-eye view, which cannot be provided by experimentation, but stems from faculties of another sort, namely, reasoning, synthesis, and intelligence. The metaphysical flavour here is quite sharp, e.g. it copes well with the typical stance of medieval ontology that the Being is not reducible to a collection of *entia*[78]. A

74 *Ibidem*, Pouchet's italics.

75 F.A. Pouchet, *Hétérogénie*, cit., pp. 109-110, Pouchet's italics.

76 On these points see e.g. Georges Dillemann, *L'éloge de Magendie par Claud Bernard*, in "Histoire de la médecine", 17(4), 1983, pp. 345-349, and Paul Mazliak, *François Magendie. Créateur de la pharmacologie, inspirateur des recherches de Claude Bernard*, in *La revue du praticien*, 63, 2013, pp. 1030-1033. For a more general point of view, one may refer to Laurent Loison, *L'expérimentation dans les sciences de la vie*, in C. Allamel-Raffin, J.-L. Gangloff and Y. Gingras (eds.), *L'expérimentation dans les sciences*, Éditions Matériologiques, Paris, 2022, pp. 51-64.

77 One could argue that abstraction towards all-encompassing theories is not required, nor can it be, in what Pouchet takes chemistry to be, as shown by Pouchet's later criticism to Pasteur. See for example M. Cantor, *Pouchet savant et vulgarisateur*, cit., pp. 172-175, and D. Raynaud, *Scientific controversies*, cit., pp. 67-73.

78 A typical reference here is St. Thomas Aquinas, *Concerning being and essence*, Aquinas Press, 2007.

theory of the kind which Pouchet has in mind here cannot reduce to a sum of facts observable in relevant experiments. It will transcend any and all of them by introducing some unity which is "seen" in an intellectual and synthetic way. SG is precisely expected to provide one such picture. Thus, Pouchet has now to apply his epistemological architecture to a justification of both SG as a licit scientific issue, and of the multi-faceted plethora of methods he will use throughout *Hétérogénie* to prove that, in some specific but relevant cases, SG is true[79].

This is what Pouchet does in the remaining pages of the second part of Chapter 2 of his book, starting from a classification of three hypotheses which, in his opinion, have been put forward for explaining the "phenomenon of life"[80]. The first hypothesis, which we may qualify as *materialist*, maintains that life essentially obeys the laws of the matter. It splits into two sub-groups, both stemming, in Pouchet's interpretation, from Descartes: *iatromechanicists* believe that life obeys *mechanical* laws, while *iatrochemists* believe it obeys *chemical* laws[81]. The second hypothesis, called by Pouchet *spiritualism*, claims that life depends on "an immaterial and intelligent principle, which grounds and mysteriously regiments all life acts"[82]. This has a degeneration, called by Pouchet the *mystic school* (e.g. Paracelsus)[83]. The third standpoint is *vitalism*. It "derives fraudulently from the previous two"[84], and argues that life results "neither from some immaterial and intelligent principle, nor from laws governing rough bodies, but from a particular force, which is inherent to organisms"[85].

Pouchet notes that "the essence of the vital principle is as difficult to determine as that of the immaterial principle"[86] used by the spiritualists. In spite of this affirmation, Pouchet seems to have some preference for spiritualism, particularly when the latter is "informed" by the biological flavour of the vitalist approach. Overall, Pouchet can be said to belong to what, in Lakatosian terms, we may call the "vital principle"[87] research programme. The latter constitutes a sort of compromise between materialism and spiritualism, so that it may cope very well with the idea that natural sciences abstract theories (spiritualim-*Naturphilosophie*) from rough data (materialism-experimentation)[88].

[79] For the multi-faceted character of Pouchet's argumentation strategy, see in particular M. Cantor, *Pouchet savant et vulgarisateur*, cit., pp. 174-175.

[80] F.A. Pouchet, *Hétérogénie*, cit., p. 114.

[81] Ivi, 114-115.

[82] Ivi, p. 115.

[83] Ivi, p. 115-116.

[84] Ivi, p. 116.

[85] *Ibidem.*

[86] Ivi, p. 118.

[87] *Ibidem*.

[88] Let me remark that SG is also understood by Cantor as a (Lakatosian) research programme

The alternative to an approach based on the idea of the existence of some "vital principle" or "vital force"[89] would be something in line with what Pouchet called materialism:

> Bichat and Broussais may very well protest that there is nothing in the organism but tissues or excitable and living devices, and that animism is a chimeric entity. Our inner sense revolts against such a pretension, which destroys human dignity. Everything suggests to the philosopher that, if it is true that in the game of the organism a number of acts may have their mover in certain forces inherent to the matter in itself, there are other forces of a higher order deriving from an immaterial power[90].

With this, Pouchet does not want to deny that the materialist explanation may have some effectiveness at some simple levels of the matter. The "vital force" essentially

> assembles particles, and forms organs out of them. But this force does not draw her materials from the chemical elements surrounding the places where it manifests itself. It just groups binary or ternary organic molecules[91].

Based on these general remarks, Pouchet then illustrates the positions of several authors who defended some form of spiritualism or vitalism throughout the centuries, starting from Epicurus (who however is looked upon as a materialist), Democritus and pantheism (with obvious references to Spinoza and Schelling, and less clear references to Kant), and passing through Van Helmont, Stahl (who had been already acknowledged as one of the fathers of animism), Müller, Leibniz (monadology), Plenck, Bremser, Brachet, Euler and Barthez[92], up to the *Naturphilosophie*, to which is due

> the most effective proof of the *eternal antagonism occurring between spirit and matter*, the ideal and the real. And, finally, the institution of this parallelism which is observed within the most sublime conception of the creation: the human species[93]!

Once again in line with the idea that, in investigating such ultimate issues as SG, we had better adopt a standpoint which be intermediate between rough experimentalism and pure idealism, however, Pouchet readily remarks that we should not go "too philosophically", as this would prove detrimental to the cause of SG itself. The methodological principle to be followed is rather the following:

in itself, see M. Cantor, *Pouchet savant et vulgarisateur*, cit., pp. 160-161, 168-171.

89 F.A. Pouchet, *Hétérogénie*, cit., p. 120.

90 Ivi, p. 119.

91 Ivi, p. 120.

92 Ivi, pp. 121-130.

93 Ivi, p. 130.

in each organised being there are two parts: the rough substance which this being is made of, and the vital power which underlies and rules all its elements. And it is this latter which we nonetheless forget about, in spite of the fact that it is this power which, ultimately, constitutes the sole biological essence of beings[94].

This tenet – which Pouchet takes to be respected by the two authors he mentions at the end of Chapter 2 of *Hétérogénie*, i.e. Burdach and Treviranus – finally leads Pouchet to SG properly, thus suggesting what kind of abstract theory he expects to be able to draw from the rough data of his experiments. The reader is thereby informed, *at the very outset of the investigation*, about the (bold) conceptual context she ought to accept *well before* knowing Pouchet's experiments. She is required to see those experiments under a correct light. As I already said, this is very different, not only from the standard understanding of experimentation (in France, in Pouchet's times), but also, *a fortiori*, from the method of Pasteur who, so to say, let the experiments "speak by themselves".

6. *Conclusion*

But also in the case of Pasteur, one might say, we ought to accept some broad conceptual framework before seeing that the experiments speak by themselves. To Pouchet's mind, for example, Pasteur's work may be biased by the unjustified (and wrong) assumption of some form of materialism (or iatrochemism), plus some ingredients of mysticism, since we know that, in private letters, Pouchet calls Pasteur a "modern Paracelsus"[95].

I think that Pouchet's epistemology is anyway weaker than Pasteur's. Even admitting that *both* Pouchet and Pasteur work under bold methodological assumptions, those at play in Pouchet's strategy are based on the idea that those at play in Pasteur's are wrong, whereas this *by contradictio* reasoning is not to be found in Pasteur, whose position may well be, in turn, compatible with some of the principles accepted by Pouchet (although not with all the experimental outcomes of these principles).

Be that as it may, it seems to me that no analysis of the Pasteur-Pouchet controversy can fail to take seriously into account the fact that Pasteur's and Pouchet's fields, chemistry and natural sciences respectively, were undergoing very different historical moments, and interacting differently with the overall scientific context of their times. They were simply responding to different research programmes, in Lakatos' sense. This may permit one to real-

[94] Ivi, pp. 132-133.

[95] See D. Raynaud, *Scientific controversies*, cit.

ise that one of these programmes (Pouchet's) was, again in Lakatos' terminology, both theoretically and empirically regressive, while the other (Pasteur's) was both empirically and theoretically progressive. Pouchet's methodological and experimental strategy is fine *within* the coordinates of the research programme which Pouchet belonged to, *hence* it is scientific (in Lakatos' sense), *hence* Pouchet may have won the debate. But the fact that, in the end, the winner was Pasteur, may not depend on sociological factors only; Pasteur's experimental programme was much more promising than Pouchet's, and it is a perfectly rational choice of the scientific community of those times to bet on chemistry and seemingly rough data, rather than on natural sciences, metaphysical ideas or abstract theories to be intellectually grounded by multi-sorted rhetorical and experimental heuristics[96].

[96] The differences between the natural sciences and chemistry in Pouchet's and Pasteur's times are discussed also by Raynaud, in D. Raynaud, *Scientific controversies*, cit., pp. 67-73, and, with focus on Pouchet or the natural sciences in general, in M. Cantor, *Pouchet savant et vulgarisateur*, cit., B. Percheron, *Les sciences naturelles à Rouen*, cit.