Dueling Scientists and Dueling Historians: Controversy Over the External History of Germ Theory

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Louis Pasteur and Félix Pouchet, two scientists studying the fermentation of organic media, engaged in debate concerning spontaneous generation before the French Académie des sciences in 1864. This instance of clashing paradigms is thought to be one of the most important moments in the historical development and establishment of the germ theory of disease. But was this confrontation an example of truth prevailing through purely scientific discourse, or were other external factors at play in determining the course of the debate? A review of the literature reveals a controversy about this controversy, where historians of science disagree concerning the extent to which external factors affected Pasteur’s success. Studying this scientific debate and the historiographical “meta-controversy” surrounding current scholarship informs an understanding of historical conflicts in science, their termination, and the overall process of acquiring scientific knowledge.
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Introduction

Germ-theory is one of the most important developments of biology seen in the past two centuries. The central claim of the theory is simple; the observed appearance of living organisms in fermentations or diseases can result only from the reproductive activity of parent organisms. The implications, however, were revolutionary. This understanding of microorganisms provided the groundwork for modern microbiology, which in turn developed the essential techniques for manipulating and investigating biological phenomenon at the cellular and molecular level. The application of germ-theory to disease lead to the rise of scientific medicine, where illnesses where characterized, organized, and investigated more systematically than they had ever been before. Indeed, the development of this theory appears to be a necessary causal event for the increasing success and social significance of biomedical science seen throughout its recent history. This is perhaps most convincingly apparent considering the importance of sterile techniques, a direct product of germ-theory, to the prevention of lethal infection in surgery and the avoidance of spurious results due to contamination in cell-culture.
This immensely important theory, however, was not the result of simple discovery and straightforward, unanimously accepted interpretation. Instead, it was the product of many long, lively debates between proponents of incompatible understandings of experimental phenomenon. Germ-theory developed against the backdrop of the long-held and widely accepted paradigm of spontaneous generation, which stated that, in some cases, organisms are capable of arising from non-living matter. Advocates of germ-theory squared off against those of spontaneous generation, constituting a rich, fascinating example of two clashing scientific paradigms. Historians of science, therefore, naturally take an interest in understanding this critical and controversial aspect of the history of biology and medicine.

The controversy over disease causation occurs over a very broad timeframe, arguably ranging from the Renaissance to modern discussions with advocates of alternative medicine. The development of germ-theory as we understand it today and the rejection of spontaneous generation in contemporary scientific medicine, however, is a 19th century phenomenon. Historians often focus on the pivotal debates between Félix-Archimède Pouchet, advocate of spontaneous generation, and Louis Pasteur, a key developer of germ theory, before the French Académie des sciences between 1859 and 1864. While we shall see that this is not the sole or even necessarily the most important time and place to this historical discussion, one should not understate Pasteur’s importance in establishing germ-theory as well as his association with modern and popular understandings of scientific methodology. Modern accounts of the Pasteur-Pouchet controversy often paint Pasteur as a model scientist who did not allow any biases affect his work. This description, often found in biology text books, informs the understanding of many students regarding the nature of science. A rigorous investigation into the true course of this debate is therefore worthwhile.
An Externalist Reevaluation

Farley and Geison introduced their landmark study of the Pasteur-Pouchet controversy as an attempt to challenge the common and popular account which “ignores the very real significance of the extra-scientific, political aspects of the debate.” They feel that this approach caricatures the complex discussion as a simple example of an experimental mind triumphing over a less-than-competent scientist, celebrating Pasteur and demonizing Pouchet. Their re-evaluation conveys the significance of the external circumstances to the course of the debate while providing a highly unorthodox assessment of Pasteur and Pouchet as scientists.

The Influenced Community

Spontaneous generation in one form or another has an interesting historical relationship with what one might consider non-scientific areas of thought. Contemporary discussion regarding abiogenesis and Darwinian evolution shows the continuity of this history with the present. For a while, “[spontaneous generation] long enjoyed the support of both natural philosophers and of Christian theology, only to be declared heretical by both in later years.” In France specifically, the early 19th century saw the development of a tight association between the doctrine of spontaneous generation and materialist atheism. Lamarckian transmutation involved the evolution of organismal complexity by a mechanism far different from that later proposed by Darwin. Spontaneous generation, advocated at the time by Geoffroy St. Hilaire, was an essential component of Lamarck’s fully-developed theory as it was thought to replace simpler species that had evolved into more complex higher organisms, filling in the progression of life-forms from the bottom up. Through the 1820s and 1830s, roughly four decades before Pasteur and Pouchet,

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2 Farley and Geison, p.163
Georges Cuvier engaged in an equally interesting debate with Geoffroy regarding both spontaneous generation and Lamarckian transmutation.

Calling primarily on the contemporary fossil record, Cuvier provided a strong, scientific refutation of these two intertwined theories that lead to their widespread rejection in France. It is also argued that Cuvier’s victory was supported by religio-philosophical and political associations made at the time.

> With the rise to power of Napoleon Bonaparte, followed by the Restoration under Charles X, Cuvier hastened to associate his opponents and their doctrines with the speculative and supposedly pantheistic Naturphilosopie of the German enemy and with the materialism of the late eighteenth-century philosophes and idéologues, on whom the public placed much of the blame for the chaos and terror of the French revolution.\(^3\)

Geoffroy continually attempted to dissociate his views with these external implications. Still, despite these attempts, in France spontaneous generation was linked to transmutation, and both were strongly linked to impiety, materialism, and revolution politics.

The political climate of France during the time of Pasteur and Pouchet was remarkably similar to that of Cuvier and Geoffroy. Louis Napoleon, nephew of Bonaparte, had established the conservative Second Empire by overthrowing the experimental and liberal Republic of the 1830s and 1840s. As France approached our period of study, the establishment once again swung to the right and, united with the Catholic Church, sought to counter liberal, impious views at every turn. One of these views was the newly developed theory of Darwinian evolution. Cuvier had established all schemes of transmutation as impious by his religious rebuke of Lamarck, and Darwin’s poor reception in conservative France additionally resulted from the first French version of his *Origin of Species*. In 1862, the revolutionary Clémence Royer prefaced the translation with a “diatribe against the Catholic Church, which she described as a ‘religion spread by an ignorant, domineering and corrupt priesthood’ and which she identified as the

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\(^3\) Farley and Geison, p.164
major cause of all societal ills.”

Clearly, the French linked Darwinian evolution to anti-religion and revolution politics from the moment it was first read in their own language.

The connection between transmutation and spontaneous generation was strong and remained so until challenged by Darwinians in Britain. Consequently, in France at the time of Pasteur and Pouchet, spontaneous generation carried all of the religious, philosophical, and political implications it had before. Richard Owen, a contemporary anatomist, commented that “the analogy of the discussion between Pasteur and Pouchet, and that between Cuvier and Geoffroy, is curiously close…Pasteur, like Cuvier, had the advantage of subserving the prepossessions of the ‘party of order’ and the needs of theology.” From their account of the debate, Farley and Geison show the ways in which the Académie allowed Pasteur to capitalize on his uniquely advantageous position.

The French Académie des sciences represented the final word on scientific controversies in the highly centralized French scientific community. In 1859 when Pouchet published Hétérogenie, his treatise on spontaneous generation, the tumultuous response prompted the Académie to appoint a commission that would settle the matter once and for all. Initially, this commission consisted of Flourens, Brogniart, Milne-Edwards, Serres, and Geoffroy St. Hilaire. The latter two were lost to the panel shortly afterwards, Serres by removal and Geoffroy by death. Once they were replaced by Claude Bernard and Coste, the panel was composed entirely of conservative scientists unanimously opposed to spontaneous generation from the start. When some members of the commission publically stated their positions before the presentation of

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4 Farley and Geison, p.166
5 Farley and Geison, p.167
evidence by either party, Pouchet withdrew from the contest leaving Pasteur victorious by default.  

Pouchet’s Pyrenees experiments, appearing to show growth in sterilized media upon exposure to microbe-free air, caused a stir at the *Académie* and prompted a second commission to assess the issue. From the previous panel, Claude Bernard and the only non-Catholic Coste were replaced by Balard, Pasteur’s former mentor, and Dumas, Louis Napoleon’s minister of agriculture. The strongly biased commission was once again skeptical of Pouchet from the start, but Pouchet presented his Pyrenees experiments with the hope that empirical evidence would overrule their preconceptions.

Pouchet and his collaborators boiled and sealed hay infusions that were subsequently opened at the edge of a glacier in the Pyrenees Mountains, where the air, according to Pasteur and proponents of germ-theory, was exceedingly devoid of microbes. Growth in these flasks indicated to Pouchet that spontaneous generation had occurred in hay infusions, given that growth resulted from exposure to germ-free, mountainous air. Rather than repeat the experiments himself, Pasteur criticized the experimental methodology of Pouchet, claiming that his sample-size was too small to indicate the statistical relevance of his data and that his sloppy technique likely caused the contamination of the flasks. The commission did not recognize Pasteur’s error in failing to refute Pouchet’s experiments by performing them with a greater sample-size and improved technique. Instead, they praised him for repeating his own successful experiments using a completely different media; an infusion made from yeast instead of hay.  

Pouchet once again felt his views were not receiving a fair hearing and subsequently withdrew.

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6 Farley and Geison, p.182  
7 Farley and Geison, p.192
Based on this account, it appears that the decisions of the *Académie* were ruled by a predisposition against spontaneous generation based on religious and political beliefs. In assembling a clearly and admittedly biased commission to evaluate this religio-politically significant scientific controversy, and in failing to recognize legitimate errors in Pasteur’s scientific methodology, the internal purity of this debate is questionable. Farley and Geison conclude that “in the end, one suspects that the *Académie* and the French scientific community allowed ‘external’ factors to shape their judgment at least as much as the internal scientific issues themselves."  

The Influenced Scientists

Farley and Geison also aim to reevaluate the common conception of both Pasteur and Pouchet as scientists. Pouchet is often understood as an incompetent scientist who allowed his preconceived belief in spontaneous generation to cloud his intellect and prevent him from seeing the overwhelming truth of Pasteur’s superior work. Conversely, Pasteur is a celebrated hero, even a founding-father of a modern scientific method devoid of external influence. After investigating the religious and scientific views held by both individuals, an interesting argument can be offered to the contrary.

Although many in France associated the views of Pouchet with atheist materialism, the pious scientist “went to great pains to insist on the compatibility of his views with Christian teaching and with the ‘laws of successive creations’ endorsed by most French geologists and biologists.”  

His controversial book *Hétérogenie* contained a number of passages directed at the religious and metaphysical implications of the theory. Much of his defense rested on the argument that a God capable of creating life at the initial point of creation was more than capable

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8 Farley and Geison, p.184
9 Farley and Geison, p.171
of creating life through the laws he imposed on matter from the beginning. A fear of creation in
the present day was illegitimate, “for if the phenomenon exists, it is because God has wished to
use it in his design.” Pasteur argues that Gods continuing creation would only demonstrate His
infinite power when he asks: “Where is the verse in the sacred text which tells us that he
imposed on himself never to resume his work? Or where is it said that after this rest, he has
broken his molds and annihilated his creative faculty?”

The careful examination of Pouchet’s actual views on spontaneous generation reveals
them to be far less materialist than a conservative in France might expect. His belief was that
“under the influence of forces still inexplicable, and which…will remain inexplicable, a plastic
manifestation is produced…which tends to group molecules and to impose on them a special
mode of vitality from which finally a new being results.” The force plastique “can also manifest
itself in plant and animal debris.” Pouchet saw inorganic and organic matter as fundamentally
distinct, and understood the latter as would a vitalist. The God-breathed plastique properties of
organic matter held it in a “narrow circle”: “It seems that for organic molecules, there is no
death, only a transition to a new life.”

Despite Pouchet’s perceived disconnect between his views and any form of materialism,
let alone atheism, Pasteur pressed the long-held link between the two in his famous Sorbonne
Lecture of 1864.

What a triumph, gentlemen, it would be for materialism if it could affirm that it rests on
the established fact of matter organizing itself, taking on life of itself…Ah! If we could
add to it this other force which is called life…of what good would it then be to have
recourse to the idea of a primordial creation, before which mystery it is necessary to
bow? To what good then would be the idea of a Creator—God?...Do you now

10 Farley and Geison, p.169
11 Farley and Geison, p.169
12 Farley and Geison, p.170
understand the link which exists between the question of spontaneous generations and those great problems I listed at the outset?  

While much of Pasteur’s victory speech drew this religious connection, he was quick to deny a causal link between his external views and his science.

Neither religion, nor philosophy, nor atheism, nor materialism, nor spiritualism belongs here...It is a question of fact. I have approached it without preconceived idea, equally ready to declare—if experiment had imposed the view on me—that spontaneous generations exist as I am now persuaded that those who affirm them have a blindfold over their eyes.  

For this declaration of science as independent from religion and all other preconceptions, Pasteur is remembered and revered. But did he live up to his own standard of reason free of passion, earning the heroic status he has among so many students today? Was Pouchet a villain, violating the divide and allowing his religious beliefs to affect his scientific work?

A second look at Pasteur’s views held before and after the monumental debate reveals a surprising discovery. From what looks like the start of his career, Pasteur believed that molecular asymmetry or optical activity, a property of molecules measured by their ability to bend plane-polarized light, was directly associated with life. Pasteur understood symmetrical and asymmetrical molecules as representing two different inorganic and organic worlds respectively. For most non-materialists of the day, living nature (exhibiting molecular asymmetry) was scrupulously distinguished from non-living nature (molecularly symmetrical), even to the point of Pasteur calling symmetrical molecules produced by organisms (e.g. urea) “excretions rather than secretions.”  

Like a good vitalist, Pasteur publically maintained the belief that inorganic substances could never cross the wall of separation and become asymmetrical or organic. Such a crossing would involve the transition of brute, dead matter into

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13 Farley and Geison, p. 189
14 Farley and Geison, p. 189
15 Farley and Geison, p. 177
the substance of life, carrying with it implications favoring materialism. Privately, however, Pasteur not only entertained but actively pursued the idea of jumping this vitalistic barrier and forming asymmetric, organic matter from artificial or mineral substances. In 1852, Pasteur used powerful magnets in an attempt to impart asymmetry upon inorganic elements commonly associated with life (i.e. carbon, hydrogen, nitrogen, etc.). From a number of his lectures on molecular asymmetry and attempts in his earlier and later career to create it, Farley and Geison argue that Pasteur held the “belief that asymmetric molecules (and thus life) could be produced artificially under the influence of physical asymmetric forces—that abiogenesis could occur under purely “mechanistic” conditions.”

This materialistic belief seems sharply inconsistent with the views Pasteur publically espoused during the spontaneous generation debates. The Sorbonne lecture flatly denies the possibility of any transformation between dead symmetrical matter and living organic matter while highlighting its destructive metaphysical implications. Crucially, Pasteur withheld the contrary beliefs he seems to have had from the public eye. But with a changing political landscape, “Pasteur’s public posture underwent a gradual and subtle change after the collapse of the Second Empire.” When the liberal Third Republic was in power, for the first time he openly described the abiogenic experiments he had conducted before, as well as his intent to complete them again.

The solution would consist in part in the discovery of spontaneous generation, if such is within our power...Were I to try some asymmetric combinations of simple bodies, I would make them react under the influence of magnets, solenoids, elliptically polarized light—finally, under the influence of everything which I could imagine to be asymmetric actions.

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16 Farley and Geison, p.178
17 Farley and Geison, p.176
18 Farley and Geison, p.194
19 Farley and Geison, p.196, emphasis added
Farley and Geison, showing how Pasteur remarkably seems to have changed his tune on the spontaneous generation debate, assert a powerful and fascinating argument, both that “Pasteur could deny the possibility of spontaneous generation only by suppressing part of his own scientific beliefs,” and that this suppression was directly correlated to the political state of France. 20

It appears that Pasteur did allow the dominant religious inclinations of the time period dictate his scientific beliefs. But was the science of Pouchet any less entangled in external factors? Throughout his work, Pouchet challenged the connection between heterogenesis and evolution, arguing that his views supported the idea of a divine creator. However, in his later career Pouchet wrote a letter to the French Darwinian Darius Rossi, admitting that spontaneous generation could in fact support Darwinian evolution. Despite this affirmation of the tension between his religious and scientific views, Pouchet remarkably maintained both. Though Darwinism was growing more popular in France, Pouchet continued his religious belief in successive creations. At the same time, despite the recognized link between religion and science, Pouchet continued his scientific belief in spontaneous generation. 21 While Pouchet’s work was not free of religious or political influence, it appears that his consistent scientific and religious beliefs in the face of their incompatibility is just as, if not more characteristic of the Pasteurian ideal than the beliefs of Pasteur himself.

**An Externalist Understanding of Controversy**

Historians of science have drawn on the work of Farley and Geison to show the importance of considering external factors in the study of scientific controversy. Everett Mendelsohn provides a detailed and thorough background of various historiographies of science,

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20 Farley and Geison, pp.179, 194-195
21 Farley and Geison, p.185
showing how one’s philosophical understanding of science plays an important role in one’s interpretation of scientific history. Some, like Robert K. Merton and Joseph Ben David, described science as a continuous system of knowledge that stands despite unwanted, external intrusions of conflict. A norm of universalism and shared intellectual methodology unite scientific activity in the resolution of conflicts and the pursuit of truth. Thomas Kuhn, Stephen Toulmin, and others proposed instead that conflict is a natural, and even essential component of the scientific enterprise. Helga Nowotny sums up this conflict model in Mendelsohn’s opening quote: “Controversies are an integral part of the collective production of knowledge; disagreements on concepts, methods, interpretations and applications are the very lifeblood of science and one of the most productive factors in scientific development.”

Scientific controversies, therefore, are a rich and important source of study for historians. But how one goes about this study largely involves the choice of the historian as to what elements of these controversies are worth considering. Mendelsohn critiques a standard historiography, saying

> Philosophers seem most often to find the “formal” factors of the sciences worthy of understanding, and the “idealized” structures with their focus on intellectual components, worthy of attention. Indeed, I often have the sense that philosophers in their discussions talk about the grounds on which the debate should have been fought, and the bases on which closure or resolution could have occurred, had the parties only behaved as their idealized model would have them behave.

Mendelsohn is skeptical of the notion of distinct internal and external aspects of scientific work, believing that drawing such a distinction is immensely difficult and that conventionally “external” elements can become central to the scientific work being done. Still, with qualifications, he aligns himself with Nowotny’s claim that “debates are fought for reasons

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23 Mendelsohn, p.96
which ultimately are to be found outside the realm in which they purport to be fought and for reasons that are extraneous to the intellectual content of the debate.”

Traditional views emphasized a divorce between this intellectual content and the political, religious, or philosophical circumstances of the debate. Proponents of this view often cite Pasteur’s claim in his Sorbonne lecture to be willing to accept spontaneous generation if the evidence supported it, despite the terribly atheistic implications he thought it would have. For Mendelsohn, however, Farley and Geison’s analysis shows that this controversy was in many ways driven to its termination, not by the intellectual force of the arguments on one side, but by the religio-political climate and its influence on the scientific authorities.

According to Mendelsohn, “the point to draw from this discussion,” particularly the example provided by the Pasteur-Pouchet debate, “is that science is a socially organized and institutionalized mode of the production of knowledge in which structures of social organization exist at every level of the institution and its activities.” External or social considerations should therefore be a focus of historical study.

**An Internalist Refutation**

Some historians of science have challenged externalist understandings applied both to the general interpretation of scientific controversy and to the Pasteur-Pouchet debate. Mendelsohn states “the ink on the Farley-Geison paper was hardly dry when a challenge was brought by another student of the debate, whose own study substantiated the traditional historiography.” This challenger, Nils Roll-Hansen, provides his own reevaluation of the circumstances of this

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24 Mendelsohn, p.96
25 Mendelsohn, p.98
26 Mendelsohn, p.106
controversy, drawing his own conclusions regarding the reasons behind Pasteur’s success and Pouchet’s failure.

The Superior Scientist

Roll-Hansen begins his study of these two scientists by looking at their own understandings of scientific activity. The statement made in Pasteur’s Sorbonne lecture stands as a consistent representation of his view of science as it relates to religion and other forms of thought. He felt science was a vehicle of social progress and was consistent with religion, but he also believed that “science, in its own field, produced absolute truth which religion had to respect.” This distinction provided him with objective ground upon which his refutations of materialism and atheism could stand.

Pasteur’s scientific method was sophisticated both in its isolation from external factors as well as in its handling of the difficult balance between fact and theory. “He stressed on the one hand that scientific conclusions must always build on empirical facts and on the other hand that hypotheses are needed to guide scientific inquiry.” This contributed to what Roll-Hansen describes as “a certain dogmatism” held by Pasteur regarding the certainty with which hypotheses could be determined true or false. His reliance on theory is confirmed by Claude Bernard, a soon-to-be member of the Académie panel, who criticized Pasteur for his hypothetico-deductive methodology, classifying him as an a-priorist.

Pouchet, on the other hand, was a strict empiricist who “appealed to immediately observable phenomenoa and distained theoretical arguments.”

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28 Roll-Hansen, p.277
29 Roll-Hansen, p.278
30 Roll-Hansen, p.278
work into what he called “the only fundamental,” experimental part and “an accessory fragment” of a theoretical part. Pouchet’s goal “to demonstrate a fact, not to discuss essences or nebulous theories” leads him to primarily criticize Pasteur for his “scholastic sophistry” in disregarding the facts laid before him. Pouchet did not seem to have a very sophisticated understanding of the role of theory in experimental method.

Pouchet also failed to produce these facts in a way that assured their validity to the satisfaction of the Académie or to the satisfaction of scientific-minded historians looking back, especially compared to Pasteur. Pasteur demonstrated a clear understanding of the methodological need of control experiments in isolating an independent variable. “The systematic use of control experiments, and the meticulous care about details which the experimental method demanded, was characteristic of Pasteur’s work.” Pouchet, on the other hand, failed to utilize control experiments properly whenever he used them at all.

The Pyrenees experiments described above formed an essential evidentiary piece of Pouchet’s argument for spontaneous generation. By showing the growth of microbes in media exposed to only pure, germ free oxygen, Pouchet demonstrated an instance of the phenomenon Pasteur saw as impossible. Pasteur and the Académie found the evidence to be insufficient given that Pouchet had not strictly followed Pasteur’s guidelines concerning sterile technique. In breaking the vials, Pouchet and his collaborators used a heated file instead of sterilized pincers, increasing the likelihood of touching their hands to the open tip of the vial and introducing the germs on their hands into the media. Additionally, by shaking the culture media after the exposure to air and before sealing the flask, their technique increased the chance of contaminants entering the sterile system.

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31 Roll-Hansen, p.279
32 Roll-Hansen, p.277
Pouchet’s initial reports indicated that only two of the four flasks exposed to air in the village street and two of the four exposed to pure, mountain air exhibited growth. This indicates two cases where media exposed to pure oxygen does not exhibit spontaneous generation, a result that “would confirm rather than refute Pasteur’s work.” After being asked about this crucial point, Pouchet had to consult his collaborators who then confirmed that the remaining flasks did eventually exhibit growth, and that all four of the flasks exposed to pure oxygen alone did generate microbes. In addition to their incomplete reporting, Pasteur also criticized what he saw as an insufficient sample size upon which Pouchet was basing his conclusions. Even if all four flasks from the mountains immediately exhibited growth, the odds of contaminating four flasks with improper technique are high enough to question the validity of the data.

As long as [Pouchet and his collaborators] cannot confirm that by opening in an arbitrary location a large number of flasks, prepared precisely according to the directions of my memoir, none will remain intact, all will be altered, they have done nothing but confirm perfect correctness of the claim in my memoir which they pretended to refute.

This challenge would appear to be methodological nitpicking if it weren’t for Pasteur’s commitment to statistical relevance demonstrated in his own work. Pasteur performed a similar experiment at the foot of a mountain, the top of a mountain, and the edge of the glacier, exposing and sealing twenty flasks at each location. Pasteur’s experiments correlated the number of growing flasks to the inverse of the altitude of exposure, verifying his understanding of airborne germ distribution with a greater degree of statistical persuasiveness.

Perhaps the most striking failure in Pouchet's scientific thinking throughout the debate was his apparent misunderstanding of germ theory all together. Many of Pouchet's experiments were directed toward showing that airborne “spores of plants and eggs of infusoria” were

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33 Roll-Hansen, p.288
34 Roll-Hansen, p.288
“infinitely rare.” According to Pasteur, one of these “infinitely rare” microbial germs, upon entering the culture media, divides and grows exponentially until the media is saturated with life. Pouchet however “disregarded the rapid multiplication of microorganisms” in his assessment of the feasibility of germ-theory.¹³⁵ Pouchet thought that, according to germ-theory, every individual cell found in culture represented a cell that originally fell into the media upon exposure to air. For this misconception to be true “one must find as many eggs in the air as there are animacules produced.”³⁶

Farley and Geison present Pouchet as a scientist on par with Pasteur, implying that if Pouchet was given a fair hearing, the outcome of the scientific controversy could have been different. Roll-Hansen argues that Pasteur was in many ways the superior scientist and goes further to claim that the Académie impartially supported his work, not out of their religio-political inclinations but because Pasteur’s argument was more scientifically viable. Historians looking for examples of external influences on the outcomes of scientific controversies, or on the scientific process as a whole, are therefore disappointed when honestly assessing this debate, which according to Roll-Hansen, “is better suited to support the traditional internalist view,” of a “methodologically pure” science.³⁷

Internal Primacy

In the construction of historiographical theories for the study of scientific controversy, a meta-controversy among historians of science has developed. Eranan McMullin outlines a rigorous framework for organizing scientific controversies and the means by which they are

³⁵ Roll-Hansen, p.285  
³⁶ Roll-Hansen, p.286  
³⁷ Roll-Hansen, p.292
terminated, either by resolution, closure, or abandonment. Concluding his taxonomic scheme, McMullin challenges the arguments and implications of Mendelsohn’s essay, described above. Along with most historians of science, McMullin agrees that external factors are important in understanding science as “a complex human action in which socio-psychological factors inevitably play a part.” Mendelsohn, building a case upon Pasteur and Pouchet, among other examples, argues for a central, driving role of external factors in the course of scientific debates. While this externalist historian advocates a more balanced consideration “of both the intellectual content of the discussion and the context of social interests that guided the participants,” some go further than Mendelsohn, arguing that all scientific knowledge is socially constructed, making “social analysis the ultimate explainer of all aspects of the history of science...”

McMullin highlights two key flaws in Mendelsohn’s historical argument for the significance of external factors. Firstly, Mendelsohn fails to present a representative sample of historical scientific controversies from which inductive conclusions about the nature of general scientific debate can be drawn. His sample, “appears to be chosen in order to make the very point that Mendelson is attempting to establish.” The few examples presented could easily be seen as unique instances of political or social forces affecting the outcome of the controversy while numerous historical controversies remain purely internal debates. Secondly, of the two examples that truly were controversies within the scientific community, neither (notably the Pasteur-Pouchet debates) were as socio-politically determined as Mendelsohn and others have presented them to be. While the Académie required “precise and rigorous experiments” from both factions of the debate, “They had no difficulty in deciding that Pouchet had not satisfied this

39 McMullin, p.83
40 Mendelsohn, p.121, McMullin, p.84
41 McMullin, p.85
According to McMullin, externalist historians have not sufficiently shown that the Académie did allow their political and religious biases to affect the outcome of the debate.

Even if this was to be sufficiently demonstrated, looking at the broader historical debate between germ theory and spontaneous generation complicates any broader conclusions one can make regarding this controversy or scientific controversies generally. France had a centralized scientific authority judge and close this debate in a manner that was unique in contemporary European science. Furthermore, thanks to the efforts of men like John Tyndall to link Darwinism with prevailing scientific theories, socio-political influences were reversed in England, where spontaneous generation was associated with traditional religion and germ Theory was associated with materialist atheism.

Mendelsohn argues that, due to the intimate, causal relationship between science and its socio-political context, resolutions in scientific controversy are difficult or impossible. Controversy more often ends through a socially constructed closure of the debate. McMullin calls for restraint on the part of externalist historians in applying theories of social causation to science. He argues instead that a true resolution, where one of the competing theories, or some synthesis of each, becomes accepted, is both a possible and common means by which scientific controversies are terminated. While external factors play a role in the course of that process, internal or epistemic factors “are more likely to be determinative.”

**Analysis and Conclusions**

This study presents two groups of positions, each containing rigorously constructed, historically grounded arguments that completely contradict one another. This makes constructing a productive synthesis difficult for a historian of science or a scientist interested in

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42 McMullin, p.87
43 McMullin, p.88
an honest history. After an evaluation of these positions, however, such a synthesis does appear possible.

While Nils Roll-Hansen presents a traditional understanding of the Pasteur-Pouchet debate, he does a reasonable job reaching beyond that tradition, supporting his argument with strong evidence of Pouchet’s scientific shortcomings. The case against Pouchet, that “his grasp of experimental reasoning was feeble,” is convincing and its implications concerning the role of external factors in the debate are clear. However, Roll-Hansen could have done more to spell out these implications by showing more explicitly that the Académie did remain evenhanded despite their biases. At one point, he describes a case where Pouchet presents experimental evidence with a clear and thorough explanation, only to have Milne-Edwards tersely reply that he was not satisfied with his reasoning. To a historian looking for instances of impartiality on the part of the conservative commission, this point is similarly unsatisfactory.

Roll-Hansen for the most part presents a stand-alone argument, though he does take time to critique some of the arguments presented by Farley and Geason. For some reason, however, he fails to address one of the more crucial arguments for Pouchet’s scientific purity and Pasteur’s mixing of science and politics. Pouchet held fast to a belief in spontaneous generation even after recognizing the conflict it had with his rejection with Darwinism, while Pasteur appears to have flip-flopped on the issue depending on the political implications of the ever changing French government.

After a closer look at Farley and Geison’s argument, some important flaws begin to appear. In his work discussing the spontaneous generation debates in England, James E. Strick makes a crucial point about distinguishing two terms that are often used interchangeably by both historians and participants of this debate. Abiogenesis refers to the generation of life from

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44 Roll-Hansen, p.280
inorganic matter while heterogenesis describes the transition of organic compounds into living organisms. Throughout the discussion regarding Pasteur’s views on molecular asymmetry, Farley and Geason fail to show that Pasteur believed in spontaneous generation as Pouchet would understand it. If Pasteur did think spontaneous generation were possible, he never applied that belief to heterogenesis and fermentations. Instead, his lectures and experiments seemed to merely indicate a belief in the possibility of creating organic matter from inorganic matter using “asymmetrical” physical forces. Claiming that “Pasteur could deny the possibility of spontaneous generation only by suppressing part of his scientific beliefs” assumes a false interpretations of Pasteur’s work on abiogenesis. If Pasteur never agreed with Pouchet on heterogenesis, then the argument quickly begins to break down. Pasteur’s beliefs concerning abiogenesis did not need to be suppressed in the debate because they had little if anything to do with refuting Pouchet. At most, Farley and Geason can claim that Pasteur kept quiet about his beliefs under conservative regimes hearing they would adversely affect his career. This is a case of a scientist allowing political forces to dictate the public expression of science, not necessarily allowing them to direct the science itself.

It appears then that Pasteur was in fact the superior scientist, and that the rejection of spontaneous generation was more a result of Pouchet’s failures as a scientist then any religio-political inclinations held by the scientific authorities. But Roll-Hansen cannot go so fair as to say that this debate, “one of the more promising places to look for external influence on important developments in science,” is a dry well for externalist historians. While the political and religious biases held by the Académie were not as determinative as Mendelsohn and others may have hoped, they were still immensely important to the course of the debate. While we may

45 Farley and Geison, p.179
46 Roll-Hansen, p.275
be confident in the ability of science to produce a true resolution to controversies, one that brings us closer to scientific truth, we cannot deny that external factors play a part in that process. The political and religious biases of the Académie certainly affected their judgment, not to the point of determining their decision, but certainly in ways that must be noted and explored in an honest evaluation of this debate.

As an afterthought, Fairley and Geason briefly assess their own biases concerning the evaluation of Pasteur, Pouchet, and the controversy over spontaneous generation. It is certainly worth noting that, however objective science may be, the discipline of history will invariably remain a subjective enterprise where a historians’ preconceptions and historiographical framework will select the evidence and shape the interpretations upon which his/her argument is based. An interesting example of this is seen in two assessments of Pasteur’s critique of the Pyrenees experiments. Roll-Hansen argued that the technique of Pouchet and his collaborators did in fact contribute to the likelihood of unwanted contamination, claiming that Pasteur’s criticisms were scientifically legitimate. Farley and Geason, however, found Pasteur’s methodological criticism to be built on “really quite desperate ground.”

The fact that two factions can examine the same piece of historical evidence with two contradictory interpretations makes one question whether or not this meta-controversy will ever be resolved. It appears as though the value of this historiographical debate is not found in a clear cut resolution or conclusion on the true nature of science, but is rather seen in the dialogue between the two camps. Both internalist and externalist perspectives are needed to accurately and fruitfully evaluate scientific controversies of the past.

47 Farley and Geison, p.191


