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# Thinking crossroads: from scientific pluralism to pluralist history of science

## Introduction<sup>1</sup>

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### 1. From unity to plurality: a brief history

It is difficult not to notice the enthusiasm that has surrounded *pluralism* in recent years. Beginning with the fields of anthropology and sociology (Despres 1968, Newman 1973, Young 1976), the word “pluralism” has taken hold as an early 21<sup>st</sup> century watchword in domains like political theory (Gatson 2002; Flathman 2005) and legal theory (Krisch 2010). The concept has also entered the philosophical arena, which now acknowledges ontological (Turner 2010), epistemic (Coliva-Pedersen 2017), ethical (Stocker 1992; Kekes 1993), and even logical (Beall-Restall 2006) forms of pluralism. Moreover, the “pluralist turn” in philosophy of science now characterizes the current paradigm of post-positivist philosophy of science, following the earlier “historical turn” (Bird 2008) and “practice turn” (Soler et al. 2014). As a variety of this larger pluralist turn in contemporary theory, this growing interest in scientific pluralism has both nourished and been influenced by other forms of pluralism originating in the philosophical and non-philosophical domains. The proliferation of pluralisms in science studies can be seen as a reaction against the prevalently monist approach of mainstream philosophy of science during the first half of the 20<sup>th</sup> century.

It has been widely noted that the philosophical program for the unification of science was at the root of the Vienna Circle’s project – its main heralds being Rudolph Carnap and Otto Neurath – and that the notion of unity became a core tenet of philosophy of science as the discipline developed in most countries during the 20<sup>th</sup> century. In its different versions, this program generally identified science with a single language – a “physicalist” language populated by spatio-temporal entities and thus believed to be purified of conceptual flaws and metaphysical temptations. Parallel to this claim was the belief that there was only one true scientific method – be it Carnap’s inductive logic and the corresponding theory of the degree of confirmation, Popper’s deductivist falsificationism, or Hempel’s hypothetico-deductive reasoning. Hempel, in particular, maintained that there should be no real division between the natural and the “mental”, cultural, social, or human sciences (Hempel 1942). Similarly, according to Carnap, “all empirical statements can be expressed in a single language, all states of affairs are of one kind and are known by the same method” (Carnap 1934, p. 32). This “unifying drift” underpinned a resolutely monist approach that assigned the natural sciences, and physics in particular, the function of serving as the exemplary and exclusive model for all scientific inquiry. Reductionism, in its various versions, implied that since there is only one world, there can only be one truth about it and one science that seeks it. There can be only one right answer to a scientific question, and “once science has answered a question definitely its verdict is final” (Chang 2012, p. 254).

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<sup>1</sup> We wish to thank the general editors of this journal for their valuable comments.

Yet this conception of science was built more upon an idea of how science should work in principle than on what science actually is or on the manifold of practices that constitute it. Logical empiricists paid poor attention to the actual functioning of the sciences and to their historical development. In response to the methodological monism implied by the unity of science project, “disunity” movements acquired visibility beginning in the 1970s. These critics emphasized the cultural and social aspects underpinning the sciences and the importance of the history of science for the construction of a more elaborate and less abstract image of scientific practice. By criticizing the unity of science project, these authors reworked some of the most central and traditional concepts such as that of “method” (Feyerabend 1975). Rather than seeing method only in terms of the analysis of validation or justification of knowledge, new emphasis was placed on method as a gateway to discovery, as it was classically for Bacon, Descartes, and Newton (Ruphy 2017, p. 21). Alternative notions, such as “styles of scientific reasoning” (Crombie 1994; Hacking 1982, 1992), ultimately highlighted the plurality of the sciences and came to replace reference to a singular concept of method. Hacking’s notion of “scientific styles”, in particular, refers to the variegated “ways of thinking and doing” science, ranging from mathematical postulation and experimentation to the statistical and probabilistic analyses, that constitute the Western sciences. These styles cut across the natural and social sciences with the aim of collaboration and integration:

Our overall interests in truth and reason may well be served by letting other styles of reason evolve in their own ways, unfettered by a more imperial kind of rationalism (Hacking 2002, p. 176)

To some extent, the existence of both unifying and diversifying trends in science can be traced back to at least the seventeenth century. It has been noted, for instance, that around that time both a tendency to search for unifying concepts and ideas “which tie the universe together” and an emphasis on details and the inexhaustible heterogeneity of nature emerged (Dyson 1988). If the former can be described as rather abstract and theoretical, the latter instead defines a more practical orientation towards scientific knowledge. While it is relatively conventional to consider Descartes the herald of the unifiers, identifying the champion of the diversifiers is more controversial. Bacon is perhaps too obvious a candidate, because of his insistence on the scientific necessity of observing and classifying a large number of, often wondrous, facts (Daston 1991), and because his impulse was not to limit scientific observation to nature but to “twist the lion’s tail” and tinker with the world in order to disclose its hidden secrets (Hacking 1983, p. 149). Yet Bacon’s status as a pluralist is contentious, to say the least, because of the equally strong (if not stronger) unifying aspects of his philosophy, such as his wide application of induction as a method of scientific inquiry and ultimate goal of searching for universal axioms and first principles (see Broad 1926; Pulte 2005).

However, it can be argued that it was only beginning in the 19<sup>th</sup> century that the debate between monism and pluralism has gained foothold by becoming entrenched in political and social discourses. Peter Galison, for instance, has remarked that modern discussions of scientific unification originated in German-speaking countries around the mid-19<sup>th</sup> century in the context of the political struggle for the unification of Germany (Galison 1996, p. 7). Among 20<sup>th</sup> century unifiers, one thinks not only of the subversive character of Neurath’s “physicalist” sociology but also of John Dewey’s idea of unification as parts of a larger cultural movement positing rationality and cooperation against fanaticism and intolerance. The Vienna Circle’s unification program also found allies in the arts and, more specifically, in the architectural modernism characterizing Bauhaus’s 1930s attempt to eschew ornamentation and decoration (Galison 1990). In the last decades of the 20<sup>th</sup> century, the meaning of unity shifted significantly from referring to a privileging of internationalism over particularism (and racism) to implying homogenization, hierarchy, and domination. The concepts of disunity and plurality have correspondingly come to signify cultural autonomy and progressive politics (Galison 1996, p. 6). Along these lines, Hasok Chang, for instance, has invited us to think of science as a liberal democracy rather than a monist authoritarian regime: pluralist science policies should be tolerant,

while at the same time remaining capable of distinguishing the level of objectivity and credibility of specific scientific claims (Chang 2012, p. 262). Such pluralist appeals produce an image of science as a quilt, stone wall, braided rope, or orchestra more than the earlier monist pyramid (Galison 2016).

## 2. Neglected pluralist traditions

If we step out of mainstream – and thus first Germanic and now prevalently anglophone – philosophy of science, we realize that the disunity of science was an idea with conceptual force long before the “pluralist turn” sketched above. This is especially the case for many of the historians and philosophers of science belonging to French historical epistemology (Braunstein-Diez-Vagelli 2019). The idea that every “region” or domain of knowledge has its own methods and standards of rationality can to some extent be traced back to Auguste Comte, who believed that each scientific domain has its own canons of investigation (Hacking 1996, pp. 37-39; Scharff 1995; Braunstein 2009, pp. 36-40). In his *Cours de philosophie positive*, Comte stressed, for instance, the irreducibility of chemistry to physics, since “in a fact rightly qualified as chemical there is always something more than in a fact which is simply physical” and “even if one day all chemical phenomena will be positively analysed as caused by purely physical actions, our fundamental distinction between physics and chemistry will essentially never be shaken” (Comte 1835, 28<sup>e</sup> leçon, p. 400-401). In this respect, we can identify one of the aims of Comte’s classification of the sciences as underscoring the diversity of reality as such and the specificity of the methods we use to investigate it. One could easily argue that, unlike neo-positivism, both French and English forms of the original 19<sup>th</sup> century positivism were inspired by pluralism. William Whewell, not dissimilarly from Comte, founded the “philosophy of the sciences” (note the plural) in the 1830s upon a pluralist conception of scientific methods:

We may best hope to make some progress towards the Philosophy of Science, by employing ourselves upon THE PHILOSOPHY OF THE SCIENCES (Whewell 1847, p. 2).

Regionalism remained a defining trait of the “French style in epistemology”, as it was later endorsed, in particular, by Bachelard and Canguilhem, among others (Braunstein 2002). Bachelard’s “regional rationalisms”, underscoring the existence of different regions in the organization of knowledge, reflected the open and plural features of the continuously evolving human mind. Against the foundationalist and fixist model defining rationality a priori and once and for all, Bachelard conceived an “integrating general rationalism” connecting different kinds of experience a posteriori. According to Canguilhem, whereas philosophy of science is a *Wissenschaftslehre* whose aim is “the unification of knowledge, at least through its method”, epistemology instead should be understood as a “special” or “regional study” consisting in “critical analysis of the principles, the methods and the results of a science”. This critical analysis entails, as such, an “assessment of the results in relation to the methods, and of the methods, in turn, in relation to the principles” (Canguilhem 2015, p. 1098). Inevitably, this more open approach to the variety of scientific forms of inquiry diversified the repertoire of philosophy of science, displacing physics as “queen of the sciences” and bringing new attention to biology, the life sciences, medicine, and the human sciences. In his works, for instance, Canguilhem defends the autonomy of a “biological rationality”, framing it as independent and irreducible to the mechanistic framework of the physical sciences (Canguilhem 1965; see Loison 2018).<sup>2</sup>

## 3. Pluralizing what?

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<sup>2</sup> It is worth noticing that the three contributions in this special issue were originally presentations made at the fourth and fifth edition of the International Workshop on Historical Epistemology held in Paris, which were dedicated to the disunity of science and to the philosophy of the life sciences (<https://episthist.hypotheses.org>).

As Hacking demonstrated, there are as many “pluralisms” or “disunities” as there are different senses or levels of “unity” (Hacking 1996). Whereas harmony can mean bringing different domains of inquiry into collaborative proximity, such unity can also mean striving for singleness, i.e. subsuming all phenomena under a single law or language. Unification moreover can be pursued at three different levels according to Hacking. One is metaphysical and is based on the belief that there is only one scientific world, only one reality, and only one truth. The second is practical and maintains that it is possible to establish a link among phenomena thanks to the interconnection among different kinds of forces. The third level of unity is methodological and is motivated by belief in the existence of one standard of reason that should be applied across time and disciplines.

In her recent work, Ruphy has distinguished between three levels of unity/plurality that only partially overlap with the ones suggested by Hacking. The first is the level of languages, objects, and methods. Pluralism on this level would mean, for instance, that more than one method can, and in many cases should, be employed to study reality. A pluralist of this kind may further claim that knowledge comes in different “styles” or “regions”, each with its own peculiar standards of rationality and ontological debates about which theoretical entities exist or do not exist. The second level is theoretical: being pluralist at the level of theories means believing that more than one theory can capture some aspects of the same segment of reality without necessarily being reducible to each other. Finally, there can be pluralism at the representational level, which simply acknowledges the diversity of the technical means and devices through which the very same phenomenon can be represented – e.g. computer simulations or taxonomic tables (Ruphy 2017, p. xiv). Pluralism at the first and the third levels, while continuously being reworked and improved from different perspectives, is now a rather uncontroversial achievement to which many philosophical and sociological traditions have contributed. Theoretical pluralism, on the other hand, entails the more controversial and ambitious claim that more than one theory can simultaneously get at the truth about one and the same portion of reality. Contrary to the idea of intertheoretical reduction (Oppenheim-Putnam 1958) and to the dreams of a “final theory” (Weinberg 1992), theoretical pluralism holds not only that the laws of one science need not be reducible to the laws of a more fundamental science but also that different, even competing laws, could and in many cases can be necessary to bring specific aspects of a given phenomenon to the fore.

It is possible to find some antecedents of theoretical pluralism for instance in Heinrich Hertz’s idea, formulated in *Principles of Mechanics* (1894), that one can develop different and even inconsistent representations of mechanics that are nevertheless equally valid in terms of prediction and explanatory power (see Hacking 1983, p. 143-144). Generalizing Hertz’s “picture theory”, Pierre Duhem and Henri Poincaré famously concluded, respectively, that scientific theories are underdetermined with respect to reality and that scientific hypotheses and principles are arbitrary conventions chosen not because they are true (they in fact can be neither true nor false) but because they are convenient.<sup>3</sup> Although he rejected the ideas that theories are underdetermined and scientific hypotheses are conventions, holding firmly to the values of truth and objectivity in science, Bachelard’s epistemological regionalism came to analogous conclusions:

It is obvious that two theories may belong to two different bodies of rationality and may oppose one another in certain points while remaining valid individually within their own body of rationality. This is an aspect of rational pluralism which must remain obscure to those philosophers who insist upon believing in an absolute and invariable system of reason (Bachelard 1968, p. 120).

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<sup>3</sup> The “pragmatic” conception of physics, according to Brenner, was rather an independent and “simultaneous discovery” by Hertz, Poincaré and Duhem, more than a case of influence of the former on the two latter (Brenner 2003, p. 126).

Bachelard applied this idea to his analysis of what he called “electric” and “mechanic” rationalisms (Bachelard 1949).<sup>4</sup> An even more strident case of theoretical pluralism is offered by cases of conflict within one and the same “body of rationality” itself. Michel Foucault called these cases “points of heresy”, by which he meant points at which two competing theories diverge in some respects, despite coexisting within the same *episteme* (Foucault 1969, pp. 110-112, 197-208). Hacking interestingly took up this idea in the framework of his scientific styles: “two parties, agreeing to the same styles of reasoning, may well totally disagree on the upshot, one party holding for true what the other party rejects” (Hacking 2002, p. 90).

Theoretical pluralism highlights the moment of choice among multiple options, and it is thus very different from what Ruphy calls “patchwork pluralism”, which merely acknowledges or juxtaposes the plurality of languages, objects, methods, or types of representation constituting the sciences (Ruphy 2017, p. xvi, 31). This kind of pluralism raises deep philosophical problems concerning the decidability of theories on an empirical basis, the contingency or inevitability of scientific results, and the correct and most fruitful way to conceive of scientific disagreement. This special issue aims to address these problems by taking a new approach to the issues raised by theoretical pluralism, one which emphasizes the pivotal role of the history of science for pluralism. Instead of reverting to abstract speculation about an idealized conception of science and of scientific knowledge, the papers presented here draw decisive insights from the ways in which science was actually conducted. These insights open up new ways not only of seeing the past of these sciences but also, and more fundamentally, of shaping present and future science. The aim of this special issue is thus to concretely show the fecundity of a pluralistic approach to science that avoids reducing science only to physics and uses evidence drawn from documented case studies. The contributions that follow consider sciences such as palaeontology, evolutionary biology, and chemistry. For each case, the author shows how pluralism leads to a better understanding of some core philosophical aspects of the science. Accordingly, our goal is not so much to refine the question of how pluralism should be articulated within the existing framework of the philosophy of science but to foreground tangible evidence of its undeniable fruitfulness in moving forward some traditional philosophical issues.

#### 4. New insights

Hasok Chang understands pluralism as an “ideology”, that is, not only as an approach acknowledging multiplicity but also an active commitment to promoting the presence and coexistence of various systems of knowledge and practice within a given research domain. Chang promotes pluralism in chemistry – and more broadly in the natural sciences – not only as a privileged way to elaborate a more appropriate philosophy of science but also to improve science itself by making less dogmatic some of its central aspects. On the one hand, his paper discusses “what good historiography should look like, *if* we accept pluralism about science – which is to say, how pluralism about science leads to pluralism in the history of science”. Chang’s presentism is, on the other hand, linked to acknowledgement of the retrospective and perspectival nature of historiography: the historian is “immersed” in the present and should not try to disguise her/his own judgment of past events, when it is based on the current status of scientific knowledge. Chang fundamentally connects pluralism with presentism, because “history of science written by monist scientists ten to downplay the plurality that existed in science”. This is why pluralist presentism often takes the form of a “loser’s history” which firstly aims to raise critical awareness of the contingency of scientific results: “once we know that there are credible alternatives to our current way of thinking, the latter will lose its appearance of invincibility and necessary truth”. Pluralist presentism moreover hopes to recover past phenomena

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<sup>4</sup> On Bachelard’s “critical inheritance” of conventionalism see Fabry 2019.

and to extend current science by showing the benefits of having multiple systems of practice operating simultaneously in a given scientific area.

Chang's treatment of pluralism leaves several important questions on the table, including *in what sense and to what extent does pluralism require presentism?* Both Thierry Hoquet's and Thomas Bonnini's papers take up this question by drawing specifically on "historical sciences", such as biology and palaeontology. Hoquet's paper applies pluralism to historical knowledge and, therefore, to the history of science. Arguing that pluralism does not require presentism, he maintains that there can be different and divergent accounts of the same event in the history of science and that reopening the question of the fertility of each historiographic view, rather than aligning with a predominant narrative, is a fundamental task for the historian. Yet references to the present and to the current status of historical knowledge may, and in many cases does, hinder our ability to "liberate" or open up a plurality of views about a past scientific event. One must rather go back in history to find the bifurcation that led us, unwittingly, down the path on which we find ourselves today. Hoquet illustrates his point by pluralizing the historiography of Darwin in order to produce a counterfactual history of science. In so doing, he counters Bowler's (*Darwin Deleted*, 2003) method of *uchrony*, which, he argues, commits a "presentist sin" by failing to deploy its potential for a better understanding of the causal processes involved in the history of the theory of evolution. Hoquet suggests that we should instead imagine "new courses for the history of biological theory by reading Darwin's 1859 masterpiece with eyes untouched by our knowledge of the Modern Synthesis". This bracketing of our contemporary knowledge begs the question of whether or to what degree a plurality of historical reconstructions can in fact contradict presentism, even in the anti-triumphalist and anti-Wiggish form developed by Chang.

By drawing on issues faced by historical theories about evolutionary problems of microbiology, Bonnini argues that the problem of the underdetermination of theory by evidence reflects monists' preoccupations that should not be worrisome if one adopts a pluralist stance. He thus makes a case for taking a plural theoretical approach to all philosophy of science, using historical sciences as a standpoint. His paper argues in favour of the possibility of embracing incommensurability among incompatible hypotheses. Bonnini's paper gets at the heart of the problem inherent in theoretical pluralism: can more than one competing theory or hypothesis about the same phenomenon or portion of reality coexist? While articulating his positive answer to this question, Bonnini decisively helps shift our attention from the mechanisms underlying the search for consensus in science to rational strategies for the management of disagreement. His paper further shows how pluralism can be heuristically useful for present-day science, as it can lead the way to new discoveries, new knowledge, and, perhaps most importantly, new methods – even if not those originally intended.

Theoretical pluralism requires the ability to "think crossroads", that is, the ability to think and possibly exploit the actual or possible paths that were or could have been taken from a given point in science. Theoretical pluralists believe that the rediscovery or recovery of at least some alternative paths is a more fruitful strategy for advancing science than sidelining all paths that are not recognized as the true one down. Chang's history of science is both pluralist and presentist, in this sense, because it unearths losing sides of scientific controversies and shows their relevance for present-day science. Hoquet's historiography is pluralist, but not presentist. He identifies in presentism the risk of sooner or later implying some form of inevitabilism that overshadows the contingency of the path that led to the idea of a Darwinian Revolution as we know it today. Bonnini's paper makes a case for philosophical pluralism by drawing on case studies in the history of science. There are more pros than cons in letting two competing and methodologically incommensurable theories concerning the role of phagocytosis in the origin of eukaryotes both exist and thrive, rather than searching for a "smoking gun" in either of the two. In conclusion, we could say that all three authors are thinking philosophical and historical crossroads in order to draw decisive insights in favour of pluralism.

More fundamentally, the three articles in this special issue share the idea that, more than purely philosophical reflections on method or the theory of knowledge, the history of the sciences is key to understanding the *plurality of the sciences*. Hoquet and Bonnini put forward this idea by

drawing directly on evolutionary biology and microbiology rather than physics – something which already pluralizes the philosophical discourse. Even Chang’s line of reasoning lies closer to the life sciences than to physics, as it is meant to exemplify the productive recovery of neglected non-mechanistic and non-reductionist systems of knowledge that were too hastily dismissed. All three cases, nevertheless, express the ambition to generalize the pluralist stance, which is not considered peculiar to biology but rather a distinctive feature of all scientific knowledge. What Chang’s, Hoquet’s and Bonnin’s articles finally demonstrate is that the most decisive arguments in support of scientific pluralism are historical in nature. They suggest that, far from simply refreshing philosophy with savory anecdotes, history of science is nothing less than indispensable for the pluralization of philosophy of science.

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