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CHANGE IN SCIENCE

6TH MEETING OF THE SOCIÉTÉ DE PHILOSOPHIE DES SCIENCES

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'Change in science' was the theme of the 6th meeting of the *Société de Philosophie des Sciences* (SPS), which occurred at the University of Lausanne from the 29th of June to the 1st of July 2016. The articles in this volume, which were presented at the meeting, variously take up this theme, reflecting the plurality and complexity of approaches in the philosophy of sciences.

The institution of science (and the various sciences) is undergoing changes that reflect not only different perspectives on the objects of the sciences, but also changes in the general conceptual framework within which the sciences operate. For instance, the cultural and technological backgrounds of scientists are more heterogeneous than a generation ago. The way researchers work and interact has been affected by the internet revolution in the same way other fields have been affected. New forms of knowledge are emerging, yielding new challenges (e.g. those related to 'big data', which is the theme of the 7th meeting of the SPS in Nantes in 2018). To be succinct, science is fundamentally a dynamical process.

Analogously, and for very similar reasons, the philosophy of science is also changing to capture the dynamics of science, but, moreover, a greater heterogeneity of backgrounds is starting to change philosophy of science departments. The contributions to this volume articulate various aspects of this change and are briefly introduced in what follows.

According to **Cliff Hooker**'s contribution "Re-modelling scientific change: complex systems frames innovative problem solving", the most general feature of the changes marking the contemporary state of the sciences involves the increasing use and study of complex systems. Hooker distinguishes three different but related questions pertaining to this quasi-paradigm shift. Firstly, what are the consequences, *for science*, *of science* using and studying complex systems? That question points to the impact of complex systems on science's understanding of its own practices in, for instance, constructing scientific models, choosing methods and seeking explanations. Even though there is as yet no consolidation of concepts and methods that could already be called a definite new paradigm, Hooker argues that there is an increasing number of cases suggesting a new paradigm of doing science. Secondly, what are the consequences, *for philosophy of science*, *of science* turning to study complex systems? Here, the focus is on such traditional philosophy of science subdisciplines as epistemology and methods. Some have identified a shift in the societal explanatory orientation from static structures to contingent dynamical equilibria. At the metaphysical level, identity criteria for complex systems are concerned less with the sameness of persisting components than with the sameness of dynamical landscape trajectory. Finally, what are the consequences of modelling science as a complex system for what *philosophy* of science takes itself to be doing? That last and most important question in Hooker's analysis concerns whether science itself is a complex system and how this might change our conception of science as well as of philosophy of science. For adequately modelling the dynamical process of science, Hooker distinguishes, among others, frameworks that help to identity, for instance, positive reinforcement processes between science and society, while also outlining persisting problems in modelling science itself. Hooker concludes by suggesting an account of science centred on problem solving.

The contribution of **Paul Weirich**, "Change in the decision sciences", investigates changes in science from the perspective of the generalization of scientific models. Models typically employ idealizations to control for some factors affecting the targeted phenomenon. While idealizations confessedly hold in the model but not in the actual world, general principles governing the phenomenon hold in both the world and the model. Within the framework of decision theory, Weirich then articulates the generalizing of normative models in terms of relaxing certain idealizations, such as access to complete information and other ideal cognitive assumptions about rational agents. Besides other virtues, this allows us to accommodate additional factors relevant to the phenomenon in question. Beyond this specific context, Weirich argues that this generalizing process "exemplifies a common type of change in science".

Ignace Yapi in his contribution, entitled "Le bricolage évolutif: un modèle pertinent des changements dans les sciences", argues for a model of the dynamics of science that takes into account the opportunistic recycling of old theories, which sometimes get reappreciated in novel, unexpected ways. Making a bold analogy to François Jacob's 'evolutionary tinkering' in biology, Yapi considers several historical cases, notably in astronomy and in biology, where the standard Kuhnian model of scientific revolutions, involving irreversible ruptures with the past, seems to fundamentally miss crucial, 'past-oriented' features of the dynamics at play. Yapi's contribution supports the epistemic relevance of a plurality of perspectives on the dynamics of science.

Paleontology, which began in the 19th century as a descriptive discipline subordinate to geology, underwent a paleo*biological* revolution during the 20th century by becoming a theoretical science that was integrated into evolutionary biology. Although the history of paleoanthropology reflects a similar change – the key example being its generating the evolutionary

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history of lineages that gave birth to *Homo sapiens* – the paleobiological revolution is still incomplete in this field. In her contribution "La revolution paléobiologique a-t-elle eu lieu en paléoanthropologie?", **Mathilde Lequin** explains why the change is only partial. After analysing the path that leads from paleontology to paleobiology and from human paleontology to paleoanthropology, she identifies empirical and epistemological limits to a paleobiological revolution in the field of human evolution. Such limits are notably due to a relatively fragmentary fossil record of hominids (compared to records of other taxa), as well as a result of different, conflicting understandings of paleobiology (a neo-Darwinian vs. a punctuated equilibrium understanding). Importantly, and linked to the above mentioned conflicting schools of evolutionary theory, Lequin demonstrates that there is a need to consider paleoanthropology not only as a branch of paleobiology but, as well, as one that must genuinely retain its anthropological dimension for adequately assessing paleobiological change.

The unpredictability of how science changes is regularly mentioned when it comes to defend the epistemic value of a free and curiosity-driven research against one that is primarily use-inspired. **Baptiste Bedessem** initiates a rigorous critical analysis of this "unpredictability argument" in his article, "L'imprévisibilité de la science: un argument pour la liberté de la recherche? La découverte des ARNi comme étude de cas". His model case is the "discovery" of RNA interference (RNAi), a process in which small RNA molecules inhibit gene expression. It is often referenced in the debate on fundamental research, scientific freedom and governance of science. However, Bedessem argues that it is misleading to use this episode to defend a principle of scientific autonomy. Indeed, the unpredictable part of the discovery was inspired by use- or commercial-inspired research on more colourful *petunias* (plants), whereas the fundamental research only generated predictable results *qua* following rather standard methods for identifying the underlying, unknown mechanism of an already discovered phenomenon. Hence, Bedessem concludes that the unpredictability argument is often used in a superficial and misleading way. He furthermore shows why it misses its target, namely by mixing the question of the genesis of the unexpected, which is according to him systematically neglected in the debate, with that of the management of the unexpected. One upshot of Bedessem's analysis is that the distinction of these two aspects of the problem seems categorically necessary to the evaluation of both the strength and, more importantly, the *limit* of the unpredictability argument.

In many ways, change in science is fundamentally about the evolution of scientific knowledge. **Sophie Bary** & **Anouk Barberousse** investigate the dynamics of knowledge about biodiversity, which lies at the meeting point of several fields (taxonomy, ecology, evolutionary biology, etc.) and is therefore characterized by some strong heterogeneity. Their article "Le rôle des hypothèses ininterrogées dans l'étude scientifique de la biodiversité des fonds marins" sheds some light on the role played by certain epistemically illegitimate assumptions and extrapolations in this heterogenous context. In particular, they take as a case-study the investigation of deep-sea biodiversity, where scientific knowledge is strongly influenced by technological progress and economic factors, which may lead to the emergence of unwarranted hypotheses.

The problem of clarifying the content and structure of evolutionary theory is one of the central issues in contemporary philosophy of biology. Among others, it is particularly crucial for understanding in what sense a proper "Darwinian paradigm", – insofar as *Origin of species* is commonly thought a scientific *revolution* –, can be critically discussed. In her article "Existe-t-il un paradigm darwinien? Pour une ontologie historique de la théorie de l'évolution", **Nicola Bertoldi** carefully analyses the intellectual frameworks before, at the time of, and after Darwin's most important publication. For instance, she defines the structure and content of Darwin's theory such that the problem of adaptive complexity of life can be raised and answered differently than by William Paley, without reference to a strong, non-naturalistic notion of teleology based on an intelligent designer. Besides many other results, Bertoldi also shows in what sense Darwin succeeded indeed in imposing a functionalist and purely naturalistic perspective. Importantly, she shows why that can be seen as a change somewhat *within* a *pre-existing* functionalist perspective (in opposition to a formalist perspective) such that neither "functionalism" nor "naturalism" are adequate to distinguish Darwinians from non-Darwinians. This episode leads Bertoldi to suggest a new approach called "historical ontology" as more adequate to the diachronic dimension of evolutionary theory.

Psychology has been peculiarly sensitive to changes in culture and the socius, thereby gaining new knowledge without necessarily abandoning previous insights or schemata. Still, the image of a science that increases knowledge and increasingly approximates to the truth about its object holds here as in other sciences – just as if there would be a final, finite and stable stage of truth to be discovered or to be achieved through ongoing scientific progress. Rather than challenging that picture as is done in the scientific realism debate, **Felicia Ghica** focuses in her contribution on Ignace Meyerson's very particular "historical psychology", which conceives the change of psychology as central to the mind's functioning. More precisely, in her article, entitled "De quelques questions que la psychologie historique d'Ignace Meyerson actualise en psychologie", she analyses in what sense Meyerson's psychology has the ambition to identify the specificity of the human mind by making the turn to a historic, objective and comparative psychology. By giving up the idea of a stable and immutable mind and by following the idea of a continuous change of psychological function, Meyerson's approach makes psychology a domain without any clear anchor, which, of course, gives rise to many difficult epistemological issues that Ghica discusses in a rich section of interrogations.

Following Kuhn and other anti-realist philosophers, the dynamics of science is often viewed as involving strong discontinuities, in particular in physics, and the transition from

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classical to quantum physics is widely taken as constituting a paradigmatic example of the discontinuous evolution of science. The latter lies at the heart of the infamous pessimistic meta-induction argument against scientific realism. In her contribution entitled "Scientific realism and primitive ontology or: the pessimistic induction and the nature of the wave function", **Valia Allori** discusses two main (realist) approaches in the ontology of quantum mechanics – namely the wave function ontology approach (often called wave function realism) and the primitive ontology approach – in the light of this standard argument in the debate on scientific realism. Considering a specific version of scientific realism (explanationist realism), she argues that the primitive ontology approach is in a better position with respect to the pessimistic meta-induction argument than the approach centred on the quantum wave function, since the latter irreducibly involves a radical departure from the classical picture. So, according to Allori, within the appropriate ontological framework, the transition from classical to quantum physics need not be discontinuous after all. Her contribution crucially interrelates epistemic and ontological aspects of the debate on scientific realism with that of the ontology of quantum mechanics.

In a certain sense, the contribution "Particle creation and annihilation: two bohemian approaches" of **Andrea Oldofredi** investigates to what extent the smooth transition from classical to quantum mechanics, as advocated by the proponents of the primitive ontology approach, also includes quantum field theory, which is the broader quantum theoretical framework for high energy particle physics. Oldofredi highlights the fact that the primitive ontology approach to (Bohmian) quantum field theory does not lead to a unique ontological picture. For instance, the primitive ontology of quantum field theory can either involve the stochastic evolution of (Bohmian) particles being literally created and annihilated or a fixed number of particles with deterministic dynamics. Furthermore, he argues that the primitive ontology approach does not solve the ambiguities of quantum field theory, so may rather point to an effective ontology (despite its name).

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