Biol Theory (2015) 10:176–181
DOI 10.1007/s13752-015-0207-1

MEETING REPORT

Ontological Issues in the Life Sciences

Third European Advanced Seminar in the Philosophy of the Life Sciences, Klosterneuburg, Austria, 1–5 September 2014

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Received: 26 January 2015 / Accepted: 25 March 2015 / Published online: 17 April 2015

Introduction

In September 2014, the third European Advanced Seminar in the Philosophy of the Life Sciences (EASPLS) took place at The KLI Institute in Klosterneuburg, outside Vienna. The EASPLS meetings are biennial conferences coordinated by a number of major European institutions involved in the philosophy of the life sciences: Egenis, the Centre for the Study of Life Sciences (Exeter); the European School for Molecular Medicine (SEMM, Milan); Department of Health Sciences, University of Milan; the Institut d'Histoire et de Philosophie des Sciences et des Techniques, Université Paris 1 Panthéon-Sorbonne (IHPST, Paris); the KLI (Klosterneuburg); the Institut Universitaire de Formation des Enseignants (IUFE) and Department of Philosophy, University of Geneva; and the Department of Logic and Philosophy of Science, University of the Basque Country (San Sebastián). This year's meeting was directed principally by Werner Callebaut (KLI) and Giovanni Boniolo (European Institute of Oncology (IEO), Milan).

The seminar focused on "ontological issues in the life sciences," a theme that deserves some general comment. For much of the twentieth century, and perhaps still to some extent today, the notion that there would be ontological issues in the life sciences might have sounded strange. Ontology has traditionally been conceived as an area of pure philosophy far removed from the concerns and the possible contributions of the empirical sciences. Conversely, it would seem that any issues that might arise in the life sciences should be resolvable from within, rather than calling for philosophical or ontological intervention. This methodological division partly reflects the strict partition between philosophy and science that was embedded in the old positivistic philosophy of science of Carnap, Neurath, and others belonging to the Vienna Circle. Several developments have contributed to the erosion of this

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disciplinary partition, however, such that there is important work to be done on something like "ontological issues in the life sciences."

The decline of positivism meant, among other things, that it was impossible to completely eliminate metaphysics from science by reducing scientific knowledge through whatever indirect paths to propositions that are just observation reports. Most philosophers of science now recognize that observation is theory-laden, and that theory is laden with philosophical presuppositions. Developments within biology itself have also given it an increasingly theoretical and not only observational or experimental character, such as the rise of model-based representations, computational techniques and simulations, as well as efforts to find unifying principles among the specialized subdisciplines of the life sciences. The more theoretical questions posed from within biology—questions about what life is, how core concepts in evolutionary theory like fitness or inheritance are to be defined, how biological individuals are demarcated, how the biological hierarchy should be conceptualized, and so on—are appearing more and more to be continuous with philosophy of biology. In the other direction, since branching off from general philosophy of science as a discipline, philosophy of biology has become increasingly integrated with biology and less and less a distinct enterprise of conceptual analysis by and for philosophers. The resulting situation is one in which not only has the science expanded to encounter ontological issues requiring a measure of philosophical subtlety, but also the philosophy has adapted to address these very problems by becoming more continuous with theoretical biology.

The growth and diversification of research on ontology in the life sciences was exhibited in the diversity of topics covered by this year's meeting. The presenters mostly came from philosophy of biology, but there were others from biology and sociology as well. Presentations followed a format of two junior presentations followed by a commentary prepared in advance by a conference participant, with a commentary allotted for each senior presentation. Although the topics addressed in the presentations were heterogeneous—perhaps more so than in previous EASPLS meetings—three broad themes stood out.

Guiding Themes

Ontologies in Contemporary Biological Research

Searching for "ontology" on Google, one might be surprised to find that the first entries mainly refer to a domain of computer science called "applied ontology." "Ontology" in the more traditional philosophical sense is to be found on Wikipedia and just a few other websites.

Whereas *philosophical* ontology is devoted to theoretical speculation, engineers and computer scientists revitalized the notion in the light of other applications. In modern computational jargon, a *computational* ontology is a way to model and represent a domain of interest or a particular area of knowledge so that a computer can process it. As Gruber (2009, p. 1964) writes, "An ontology specifies a vocabulary with which to make assertions, which may be inputs or outputs of knowledge agents (such as a software program)." Whereas philosophical ontology has traditionally been pursued as a way to establish via reason alone "what there is," or the fundamental entities of the world, applied ontology pertains to informational and computational approaches to knowledge representation and data integration.

From "ontology" we come to "ontologies," tools allowing for comparison among data that were originally produced and stored in different ways. Ontologies are also conceived as modes of translating specific knowledge at a certain level of description to other levels. This is why ontologies are also said to be at the "semantic level" of scientific modeling. The growing area of *applied ontology* has recently acquired increasing relevance in the context of biomedical research. "Bio-ontologies," as they are called, are now proliferating in the management of many biological databases. Among them, Gene Ontology, developed by the Gene Ontology Consortium, represents a leading project rapidly influencing several areas of biological research. The semantic dimension of this enterprise is clear in its own mission. The aim of the Gene Ontology project is to provide a representation of features of gene products across different species and databases through a controlled vocabulary of different "biological categories."

Federico Boem argued that bio-ontologies constitute a novelty within the epistemological repertoire. Neither entirely models nor precisely theories, ontologies are more like a map and compass for biomedical research. As they graphically provide a map of models and for modeling purposes, they form an orienting tool, useful to scientists for both familiar and unfamiliar territories of knowledge.

Eric Garnier showed that the use of applied ontology in ecology is pursued in a bottom-up way, rather than through a classificatory framework based on specific philosophical commitments. Bio-ontologies are still just tools in search of a theory. However, by highlighting relations and connections between different areas of research with their integrative approach, ontologies are able to provide structured information about phenomena that would otherwise be inaccessible. They also function as maps in that they situate specific knowledge coming from a defined, localized, experimental condition into the big picture, or the whole fabric of biological knowledge.

The rapid success of bio-ontologies might suggest a change in epistemic strategies within the life sciences. *Emanuele Ratti* analyzed this issue in terms of the debate on discovery and justification in philosophy of science. Against the claim that contemporary molecular biology, which heavily relies also on sequencing technologies, is just the direct consequence of the tradition of "experimentalism" within biology, Ratti, following the "hybridization thesis" (Strasser 2011), suggested that contemporary biology is the hybridization of natural history practices of collecting and classifying data and experimentalism.

Finally, *Isabella Sarto-Jackson* analyzed the other side of the coin by examining how hidden ontological commitments can shape experimental research. She discussed several examples of protein–protein or protein–ligand interactions models, highlighting how different approaches reveal different ontological assumptions. Thus, distinct models privilege different features (e.g., the focus on structures rather than on processes and vice versa) which channel research efforts towards either one methodology or the other.

DST and Extended Inheritance

A few talks were dedicated to the connected issues of development, evolution, and inheritance, often taking Developmental Systems Theory (DST) as a starting point. DST has gained attention in recent decades as an alternative conceptual approach to both development and evolution (see, e.g., Oyama et al. 2001). One of its main postulates is that the dichotomous partitioning of causes of phenotypic characters into genetic and nongenetic (environmental) causes is to be rejected in favor of an integrated, system-level view of the developmental process. Given such a view of development, together with the recognition of the importance of developmental processes for evolution, accounts of evolution and inheritance have undergone a major reconceptualization. However, DST has also met with critique, in particular for allegedly not offering any viable research program that can lend itself to empirical investigations.

Gerd B. Müller took up these critiques in his keynote address. He argued that some of them might be seen as misplaced once it is acknowledged that DST is not—despite its name—a *theory* in the typical, hypothetico-deductive sense of the term, but is rather a metaphysical framework. In this context, DST should be better conceived as a *critique* that originated in opposition to the reigning gene-centered account of development and evolution. Müller suggested that EvoDevo, by contrast, *can* be regarded as providing a more empirically oriented research program—with more specific operational theories.

Gaëlle Pontarotti and Francesca Merlin shared Müller's concern about the theoretical value of DST with respect to the topic of extended inheritance. While there is an increasing recognition in contemporary biology of the need to broaden the concept of inheritance beyond genetic processes and to include other inheritance mechanisms in more inclusive models (epigenetic, behavioral, cultural, and ecological), both Pontarotti and Merlin expressed skepticism about overly broad notions of inheritance that would not be well suited to empirical research. Invoking a "dilution risk," *Gaëlle Pontarotti* asserted that a conceptual clarification is needed, especially where the definition of "inherited factors" is concerned. Dissatisfied with the description of inherited factors as stable developmental resources (the solution propagated by DST advocates), she argued for an organizational framework in which inherited factors only include heterogeneous persisting "constraints," whose specific role is to harness flows of matter and energy across generations of extended organized systems.

Francesca Merlin similarly asked how far extending the notion of inheritance should go. What Merlin found problematic in the recent proposals for the redefinition of inheritance is the idea that every form of transmission is a form of inheritance. She suggested conceiving of inheritance as a cause in an evolutionary sense, that is, as a process allowing transgenerational functional and morphological continuity (which is one of the conditions of evolution by natural selection). As a result, Merlin proposed that a new, theoretically coherent definition of inheritance should be restricted to what is transmitted via reproduction from one generation to the next. Inheritance would thus be defined as the transmission of the capacity to reproduce, or to develop that capacity.

Individuality and Hierarchy

Issues relating to biological individuality and hierarchy also attracted a significant amount of attention in the seminar's presentations. These issues have come to occupy a central place in current philosophy of biology following the debates on the units and levels of selection. Work in this area ranges from contributions to evolutionary biology on how to count individuals for fitness measurements to more metaphysical questions about which ontological category living systems belong to (i.e., are they objects, processes, 4-dimensional events, or something else?).

On individuality, *Marcel Weber* argued that evolutionary conceptions of individuality in which individuals are just units of selection identify individuals having a certain biological significance, but do not tell us what these individuals are. For the latter, he suggested posing Van Inwagen's Special Composition Question, modified for specifically cellular components: namely, under what conditions does some collection of cells compose a biological individual? He tentatively suggested functional integration as such a condition. In a similar vein, *Matteo Mossio* argued that biological individuality is to be grounded in the system property of organizational closure rather than in selection, drawing on a tradition of theories of organization from Kant to Herbert Simon, Stuart Kauffman, and Robert Rosen. The question was posed whether organizational closure should be considered necessary and sufficient or only necessary for individuation, and how it ought to be re-integrated with evolutionary individuation. Following up on the theme of organization in an origins of life context, *Eva Fernández-Labandera* discussed the conflict between increasing structural complexity and stability against perturbations. She defended the idea that negotiating this conflict requires control mechanisms of regulation at a distinct level of functional architecture than metabolic processes.

John Dupré urged a thoroughgoing process ontology for biology in which stable individuals are treated as explananda of underlying process acting at different timescales, as a further departure from biological essentialism. The consequences of such a radical ontological shift were explored for the biological structure–function relation and the issue of biological identity. An interesting exchange followed between Mossio and Dupré as to whether process ontology is capable of accounting for the phenomenon of organization and the qualitative difference between constraints and dynamics. There seemed to be loose agreement that it can do so in a hierarchical context, where constraints are seen as processes with a longer timescale than their constrained dynamics. Along these same lines, *James DiFrisco* argued that the biological hierarchy should be reconceptualized as a hierarchy of processes ordered by timescale, rather than as a hierarchy of objects ordered by standard compositional and typological criteria.

Seeing a residue of essentialism in perspectives focused on individuals, *Jörg Räwel* proposed thinking of species or populations as fundamental autopoietic units of biology, such that individuals as normally conceived are operative moments "within the evolutionary dynamics of populations or species as autopoietic systems." Instead of talking about "units" of selection, then, he recommended that we think of positive or negative selection in terms of the persistence of populations.

Varia

The breadth of the conference theme was reflected in the wide variety of topics addressed, enumerated here in brief.

The notion of mechanism as developed by the new mechanists has been an influential ontological characterization of biological phenomena, particularly in the contexts of neuroscience and molecular biology. *Dan Nicholson* challenged the ontic status of mechanisms, however, arguing that they are not "real and local" but rather idealized cross sections of organisms that heuristically select certain causal features over others.

Vidyanand Nanjundiah developed the idea that the autonomy of biology from physics and chemistry is to be found in the arbitrariness of information transfer, exemplified in the genetic code, by contrast to the nonarbitrary chemical and mechanical interactions which are deducible from physicochemical principles.

Eric Rogers discussed species selection in the context of the debate about whether selection is to be understood dynamically as a force or statistically as a pattern, arguing that only a dynamical conception of species selection can distinguish it conceptually from sorting, drift, and effect macroevolution (i.e., differential speciation and extinction due to organismic rather than species-level properties).

Thibault Racovski addressed the problem of defining novelty in evolutionary biology. According to him, no current definition succeeds in distinguishing novelty from the mechanism that produces it. This observation does not threaten novelty as an explanandum but does threaten its status as an evolutionary event.

James Lowe's talk focused on the changing status of variation in developmental biology. Recalling that new methods allow biologists to study an increasing number of organisms and to better observe variations between them, Lowe argued for the need to take variation seriously and to assess its effects on well-established ontological categories related to the biology of development.

Kepa Ruiz-Mirazo emphasized the special role of philosophy within science to develop new research avenues and detect blind spots, whereas scientific practices can generate new ontological constructs (for example, protocells) that extend the evaluation domain for models and theories. To this end, both scientifically trained philosophers and philosophically trained scientists are needed. This was illustrated with examples from synthetic biology and systems chemistry for research on the origins of life.

Marco Tamborini spoke about the development of paleobiological data that has fostered theoretical improvements in paleobiology and that conveys general lessons for the constitution and utilization of scientific databases. Tamborini gave a historical survey of paleontology in the mid-19th and early 20th centuries and of the conceptualization of the fossil record between the 1940s and the 1970s, providing insights in the nature and limits of paleobiological data.

Marco Nathan presented his work on the semantics, pragmatics, and epistemology of counterfactuals in the sciences. Although counterfactuals are of critical importance for science, they have received surprisingly little attention. Instead of the traditional metaphysical view in which counterfactuals are statements about possible worlds, Nathan proposed a view in which the semantics of counterfactuals relies on their adequacy with abstract *models*, whereas the pragmatic question of their assertibility depends on the similarity of the model to the world.

Maria Kronfeldner addressed how behavioral scientists deal with the complexity of their subject matter. Contra Longino (2013), who argues that the diversity of approaches leads to a diversity of incommensurable causal spaces, Kronfeldner admits a pluralism in the resulting explanations but considers it an integrative, kaleidoscopic pluralism.

Vanessa Triviño questioned the possibility of reducing biology to physics or biochemistry. To this end, she considered the evolutionary concepts of fitness and evolvability in order to evaluate whether they could be reduced to lower-level properties. The result of her analysis is that these concepts refer to emergent properties rather than supervenient ones, such that they depend on the constituents of their bearers but nonetheless constitute novel, level-specific, and irreducible properties.

Zdenka Brzović argued against a recent view of natural kinds (Ereshefsky and Reydon 2015), according to which a functional account fits better with the epistemic role of natural kinds in scientific practice than the homeostatic properties cluster (HPC) view. Brzović considers that the multiple realizability of functions can lead to shallow explanation and that common properties among members of natural kinds should be a requirement.

Conclusions

Trans-thematic Issues

Among the trans-thematic issues raised during the seminar were two of particular relevance: the recurrent question of dialogue between philosophers and biologists, and the connected issue of the links between conceptual philosophical work and scientific practice.

Several participants raised questions about the dialogue between philosophers of biology and biologists. In the wake of David Hull's early hopes for philosophy of biology (1969), Kepa Ruiz-Mirazo (San Sebastián) insisted on the need to share a common language with the scientific community as well as common theoretical interests. This requires, according to him, "scientifically well-trained philosophers and philosophically well-trained scientists working together." In fact, most of the participants of the third EASPLS were philosophers. Even if the biennial meeting is designed for the community of European philosophers of biology, the relative absence of biologists might reveal a persistent lack of dialogue between specialists from both disciplines.

The links between conceptual work done by philosophers and scientific practice was abundantly discussed, beyond the exchanges on the polysemic notion of ontology. For example, Marcel Weber (Geneva) suggested that an adequate concept of individuality, and more particularly a relevant definition of the conditions that an element must fulfill to compose an individual, might depend on the context of inquiry, namely on scientists' interests and practice. *Russell Winslow* (Santa Fe), for his part, insisted on the difference between the biological and philosophical concepts of *biological space*. Referring to Canguilhem's philosophy, he claimed that the "laboratory milieu" built by biologists in their current practice radically differs from an environment allowing biological entities to have a "life of relations," a characteristic trait of the ontological situation of every living being.

Axis for Improvement

Before concluding the meeting, Werner Callebaut (KLI) and Giovanni Boniolo (IEO, Milan) invited the participants to engage in an open forum regarding possible improvements to the seminar. Some suggested that the next meeting could last three or four days instead of five. While there was a wide agreement on the value of the presentation commentaries, it was suggested that they should be shortened and that the commentators should systematically be related to the field of the speakers. A few people raised the question of the participation of graduate students: attending the meeting could be part of their training and could potentially be worth academic credit. All in all, participants were very satisfied with the seminar, and happy with the intellectual and social exchanges they had.

It is important to highlight that the third EASPLS would not have been so successful without the work of the organizers, and the great sense of hospitality of the KLI members. A special tribute is owed to Giovanni Boniolo, Isabella Sarto-Jackson, and especially to Werner Callebaut, whose recent passing came as a shock to the philosophical community in which he was deeply involved. We take the opportunity of this report to remember Werner, a source of inspiration for all young scholars and for the discipline as a whole.

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