Evolution: The Extended Synthesis

edited by Massimo Pigliucci and Gerd Müller

reviewed by Anya Plutynski

In July 2008, at the Karl Lorenz Institute for Evolution and Cognitive Research in Vienna, sixteen biologists and philosophers met to discuss an “extended” evolutionary synthesis. The meeting resulted in a book: Massimo Pigliucci and Gerd Müller’s Evolution: The Extended Synthesis. This engaging volume surveys novel empirical and theoretical advances in biology since the Modern Synthesis, some of which add to, and some challenge, its central tenets.

Scientists disagree about many things, and any disagreement among evolutionary biologists, especially involving claims to the effect that “tenets” of evolutionary theory are being challenged, is all too often taken to imply that evolutionary biology is “in trouble,” and this makes for big headlines. The truth is, perhaps, rather more mundane. Pigliucci and Müller, and the contributors to this volume, do not intend to challenge the fact of common descent, or evolution by natural selection as one of several mechanisms of descent. By claiming that there is a call for an “extended” evolutionary synthesis, they explain that there is no “fundamental crisis in the structure of evolutionary theory” (p 10).

Instead, the aim of an extended synthesis is to include under the umbrella of evolutionary theory patterns and process previously considered to be at the “margins”: plasticity, accommodation, evolvability, epigenetic and niche inheritance, and multilevel selection. Essays in the volume review how and why genomics, molecular biology, and development have transformed our understanding of evolutionary pattern and process. The volume is comprehensive and almost impossible to survey in less than 1000 words; I will focus below on two key concepts that each play an important role in the “extension” of the synthesis, according to Pigliucci and Müller: plasticity and evolvability.

Plasticity of a genotype is measured by a norm of reaction (a relationship between the phenotypic expressions of a genotype over a range of environments). This notion is not new; as Pigliucci remarks, plasticity has just turned 100 years old. What’s novel is the role that plasticity plays in evolution, as Mary Jane West-Eberhard has argued. “Phenotypic accommodation” is the adaptive adjustment of an organism over the course of its lifetime, to novel internal or external environments. This idea is not new; biologists were, arguably, aware of examples of this in the 19th century and earlier. What’s more controversial is whether, and how, phenotypic accommodation “becomes” genetic accommodation—that is, whether a novel phenotype generated by phenotypic accommodation may be “stabilized” or “fixed” by natural selection through the alteration in “genetic architecture” (p 368). A central tenet of the synthesis was that germ and soma are distinct, and only genes may be passed on, not any features of the phenotype gained over the lifetime of the organism. “Lamarckian”
inheritance was thoroughly debunked by the synthesis’s architects; most took Mendelian genetics as providing a solid basis for heritable variation, a necessary condition on selection. Pigliucci argues that there are several ways that phenotypic plasticity, as well as phenotypic and genotypic accommodation, could come to play a major explanatory role in evolutionary biology; for instance, plasticity might factor in niche construction or serve as a driver for speciation. Some of these claims may be more plausible than others. As Pigliucci acknowledges, “we need further—and better characterized—examples of genetic accommodation” (p 372). While there is ample empirical data on phenotypic plasticity and accommodation, genetic accommodation is still controversial.

Another controversial idea that receives some attention in this volume is “evolvability”; roughly, this is defined as the capacity for a species to evolve. Surely, the authors of the synthesis were interested in this property, and even measured it; additive genetic variance is a measure of the ability of a population to respond to selection. Günter P Wagner and Jeremy Draghi stress that the idea of evolvability can be seen as extension of similar concepts in contemporary quantitative genetics—one might measure mutation rate or mutational variance or covariances, or, at “lineage” level, the capacity to evolve given some measure of genetic variation, variability and selection. This “integrative” approach is rather different from, for example, John Gerhart and Marc Kirschner’s notion of evolvability. They argue that there are certain developmental and molecular features of organisms—weak linkage, modularity, robustness—which make lineages “more evolvable”—that is, more likely to diversify. They appeal to this notion as an explanation for the “explosion” of diversity in eukaryotes, and call their theory “facilitated variation.” Where this notion of evolvability becomes controversial is whether, and if so, how, evolvability itself evolves. How, if at all, does selection act at the lineage level, and if it does, does it promote “evolvability” or is evolvability a byproduct of selection (or drift) at lower levels of analysis and shorter timescales? It’s not clear that this debate has been entirely resolved, and this volume does not definitively answer this question.

Advances in genomics, molecular genetics, and developmental biology have made evidence available that the synthesis’s architects of the 1940s only dreamed of discovering. The contributors to this volume correctly claim that this new evidence bears significantly on our understanding of the patterns and processes of evolution. Anyone interested in becoming aware of both what we know now and what theoretical advances may come from this new data for evolutionary theory should take a look through Pigliucci and Müller’s superb collection.

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