

Barrett only briefly mentions progress toward understanding quantum probability through the “typicality” approach in Bohmian mechanics (Dürr et al., 1992) or the “decision-theoretic” approach in many-worlds theories (Wallace, 2007). These are deep and open areas where aspiring researchers might find a foothold. I do not mean to suggest problems with Barrett’s book; rather, these are topics the same audience may wish to pursue further.

In sum, Barrett’s book is a fantastic resource within its scope. It gives a clear summary of the state of the art in the philosophy of quantum mechanics at a level appropriate for readers with no prior background. Barrett draws clear connections to issues in philosophy of science and convincingly argues for the importance of the quantum measurement problem.

BENJAMIN H. FEINTZEIG
University of Washington

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Review of Jean Gayon and Victor Petit’s *Knowledge of Life Today*

Jean Gayon, Interviewed by Victor Petit, *Knowledge of Life Today: Conversations on Biology*, London & Hoboken, NJ: ISTE/John Wiley and Sons (2019), xx + 378 pp.

At the time of his untimely death in 2018, Jean Gayon was Professor of Philosophy at Paris 1 Sorbonne and Director of the Institute for the History and Philosophy of Science and Technology (IHPST), whose earlier leaders included Gaston Bachelard and George Canguilhem. The volume makes available in English carefully edited interviews with Gayon that appeared in France not long before he passed away (Gayon &

Petit, *La connaissance de la vie aujourd'hui* [2018]; the title alludes to Canguilhem's 1952 *La connaissance de la vie*).

In his introduction, his interviewer, Victor Petit, remarks, "The development of philosophy of biology as a field . . . in France . . . is mainly the result of Jean's efforts" (xi). By philosophy of biology, Gayon and Petit mean, for the most part, philosophy of evolutionary theory. In contrast to the Lamarckian sensibility that was entrenched in French biology as recently as the 1950s, Gayon focused on eliciting the conceptual foundations of Darwinism by bringing philosophical questions to bear on its history. *Knowledge of Life Today* reviews his main conclusions.

Chapter 1 is about the concept of life and the scope of philosophy of biology. Chapter 2 gives an account of Darwin's views about the concepts of natural selection, chance variation, heredity, fitness, adaptation, lawfulness, and evolutionary progress before turning to subtle theoretical differences between Darwin and members of his circle of allies, notably Herbert Spencer and Alfred Wallace. Gayon is clear that definitive analyses of these concepts became available only with the advent of population genetics in the 1930s and the Modern Evolutionary Synthesis that soon followed, which began applying population genetics to problems in systematics, speciation, and paleontology in the 1940s and expanded to include other biological disciplines in the 1960s and 1970s.

No sooner had the Modern Synthesis begun spreading its wings than the advent of molecular genetics raised questions about the reducibility of the Mendelian gene of population genetic Darwinism to molecular biology. The bulk of Chapter 3 explores this issue. Gayon is also concerned to show that marginalized contributions by French experimental scientists were crucial to advancing the Modern Synthesis. In particular, Philippe L'Héritier and Georges Tessier invented the experimental apparatus that made it possible to test population genetics' theoretical models (211).

Chapter 4 deals with human biology and society, including such topics as eugenics, race, ideology, and genetic enhancement.

Gayon's judgments on all these topics are biologically well-informed, clearly presented, crisply argued, but too numerous to list in this review. I will content myself with sketching the perspective on Darwinism from which they spring.

The French version of this book gives useful information about Gayon's path to history and philosophy of biology omitted from the translation. In the course of qualifying to teach science in secondary school, Gayon, who had been studying history of philosophy, took a course from Canguilhem and followed his advice that if he wished to go further in history and philosophy of science, he should first take graduate-level science courses. Opting for biology, he did just that. While teaching in a lycée and starting a family, Gayon spent six years studying zoology, botany and, toward the end of this interlude, population genetics. Returning to history and philosophy of science, he submitted a thesis arguing that population-genetic Darwinism illustrates a theme in French history of science: It was neither a rupture with Darwin's own theory nor a Kuhnian revolution, but instead removed a blockage (*coupure*) that had long stood in the way of qualifying Darwinism as high-grade, empirically based, quantitatively rigorous natural science (xiii). Shifting to statistical and probability mathematics and hence population dynamics removed the blockage. But as Gayon shows in

Darwin et après Darwin (1992; expanded and translated in 1998 as *Darwinism's Struggle to Survive*) it took decades to do it.

In Summer 1984, a Fulbright grant led Gayon to visit the United States to interview respected historians of Mendelism and population genetics as well as the last surviving founder of the Modern Synthesis, Ernst Mayr, and two leading spirits of its second generation, Stephen Jay Gould and Richard Lewontin. At the time, Mayr, Gould, and Lewontin were enlisting philosophers of biology to help in their crusade against Sociobiology by analyzing how the key concepts of the Modern Synthesis work. Gayon's own approach shows receptive familiarity with the work of David Hull, Elliott Sober, Robert Brandon, Richard Burian, and others who, egged on by Mayr, "developed a new image in which physics ceased to be the only, or main, model of scientificity" (321).

Some of Gayon's claims are that: (a) The principle of natural selection is an a priori model, not an empirical law, but when applied to cases it is not viciously circular (9). Spencer was more right than Darwin on this (124–5). (b) Fitness is not a single trait like brute strength but a multi-factorial propensity to out-reproduce closely related populations (166–7). (c) While Darwin thought natural selection to be the principal cause of adaptation, speciation, and diversification, the last two require additional agencies, and adaptationist explanations of traits cannot be secure unless shifts in gene frequencies have been shown to be their etiology (37, 45, 154). For evolutionary biologists, current function is not enough. (d) Natural selection can range over genes, organisms, or groups (16–4). (e) "Because coding sequences and promotor and operator sequences overlap . . . no one with a serious understanding of theoretical reduction can consider the [Mendelian] gene concept to be reducible" to the molecular gene (228). The more we learn about DNA, the clearer it becomes that there is no single thing for the population genetic gene to be reduced to (223, 238).

In Chapter 3, Gayon also summarizes the lessons he and Burian learned from their detailed investigation of why French scientists long resisted Mendelian genes, Darwinian natural selection, and their combination. Lamarckism had something to do with it (200) as did French positivism's allergy to theoretical entities (208–9) and French resistance to eugenics. A country that worried about the disastrous effect of war on its population was unlikely to embrace eugenic enthusiasms that until the end of World War II propelled Darwinism elsewhere (210). Still, Gayon and Burian argued that the delay had an epistemically respectable cause. Until the physiological genetics of Boris Ephrussi and André Lwoff led Francois Jacob and Jacques Monod to discover the mechanism of gene regulation, neither Mendelism nor Darwinism were thought to measure up to the strict experimental standards Claude Bernard and Louis Pasteur imposed on French science (200, 207).

This belated rapprochement might easily have embraced genetic determinism and a caricatured version of Darwinism. The information transfer metaphor that took root in molecular genetics, for example, can obscure the population-genetic understanding of heritability as a measure of intergenerational similarity (17, 241, 252). Gayon and his students' nuanced reconstruction of Darwinism's history and epistemic credentials serves as a corrective. It's a good thing it does. In Chapter 4, Gayon

recounts how the Modern Synthesis undermined the eugenics and racial essentialism genetic Darwinism was originally designed to support. It may well prove useful today in suggesting why restoring normal function rather than creating a market for enhancements is the right trajectory for post-CRISPR genetic technology (322–3).

Gayon's historical approach shows that the conceptual issues of scientific theories are resolved only after multi-generational discovery and discussion. Teachers of philosophy of biology classes might press that valuable lesson by consulting or adopting this insight-laden book.

DAVID DEPEW
University of IOWA, emeritus