Book review

Philosophy, who needs it?

W. Ford Doolittle

Philosophy of Biology
Peter Godfrey-Smith
(Princeton University Press, Princeton, New Jersey; 2013)
ISBN: 9780691140018

In September, I was privileged to be one of a very few card-carrying scientists at an event grandly called the "Calgary Summit of Philosophers of Science: Future Approaches for Philosophy of Biology." Grand it was, with many of the field's luminaries in attendance to discuss the condition of the discipline. Some thought this to be precarious. Philosophy departments (in the US at least) often regard the subject as problematically impure — dangerously close to the actual science. Biologists, on the other hand, may think it too far removed, not infrequently harbouring the opinion, famously that of Richard Feynman, that "philosophy of science is as useful to scientists as ornithology is to birds." We know what we know, and too much attention to conceptual frameworks and terminological precision just leads to 'analysis paralysis'.

Both views are misguided, as Peter Godfrey-Smith's refreshingly short (187 pages) new book, *Philosophy of Biology,* and recent brouhahas in genomic biology make abundantly clear. Biology is beset with deep conceptual puzzles, and biologists *do* need to take them seriously, even — or especially — when they admit to no clearly best solution.

Concerning the brouhahas, that over ENCODE two years ago comes first to mind. Claiming to have driven the final nail in the coffin of 'junk DNA', the proponents of this richly-funded megaproject then did not (and still only grudgingly) acknowledge that the fraction of the human or any genome regarded as functional depends on what one means by 'function', and that this is not a given. In other vigorous debates of particular personal interest, such as those concerning the 'Tree of Life' or 'species', there are also no facts of the matter. Everything depends on what one wants those terms to mean, so disputes about them are semantic: but not *merely* so. Unpacking words and concepts is essential to understanding the natural phenomena to which they are meant to refer.

As to Godfrey-Smith's little book, it provides an authoritative but easy starting place for readers of *Current Biology* who want to root out tacit philosophical commitments in their disciplines, and/or appreciate how thinking more deeply about how we think about what we do would benefit us all as scientists. Written for both "philosophy students and biologists interested in philosophical issues surrounding their work", all but the first of its nine chapters explore currently active areas in philosophy of biology, most of which relate to types of active empirical research embraced by this journal.

The first chapter succinctly recounts the history of biology, reminding us of the integrative power of the theory of evolution, especially as it has expanded to more enthusiastically embrace molecular and developmental biology and eliminate the last traces of teleological and vitalist thinking. The next chapter goes on to address 'laws', which biology is often disparaged (*vis-à-vis* physics) for lacking. "So what?" is one rejoinder: the astounding success of 20th century biology indicates that we are doing something right. But Godfrey-Smith digs deeper into the distinction between necessarily true but abstract conditional statements (the laws of physics or the principle of natural selection), and historically contingent ('accidental') exception-prone regularities (for instance Mendel's so-called laws or molecular biology's 'Central Dogma'). That distinction may be one of degree not kind, and some regularities may be both — Mendel's laws are necessary for organisms with the reproductive machinery of contemporary sexual eukaryotes, but there did not have to be such organisms. And if one believes — as some do — that our universe and its mix of laws and constants are also contingent, comprising only one of many possible or actual realities, biology is not so different from physics after all.

Perhaps to avoid such metatheory, many biologists deal in 'mechanisms' or 'models', the differences between which Godfrey-Smith parses delicately. It is the pursuit of such explanatory schemes, even if they are not laws, that makes biology more than simple 'stamp collecting'.

The next chapter, on natural selection, might best be read after the author's justly popular 2009 book *Darwinian Populations and Natural Selection.* The latter freed many of us from the need to shoehorn every situation in which we are sure in our hearts that selection *must* be at play into rigid (for instance, replicator–interactor) formal models. Godfrey-Smith in this new book highlights other issues, such as whether or not selection can be 'creative' (it can), and how best to formulate a 'universal Darwinism' (undogmatically but in a principled fashion). Practicing biologists may be surprised that there is still debate about what kind of a force, principle or process 'natural selection' actually is, on what sort of entities it might act and the meaning of 'fitness'. We readily invoke, but often cannot easily explicate, these concepts. Godfrey-Smith explains why.

Chapter Four, "Adaptation, Construction and Function", should be assigned reading for the ENCODE team. Surely the attitudinal divide between 'adaptationists', who think of organisms and their genomes as exquisitely tuned machines, and those of us who see biological systems as barely able to cope with their own ineradicable noisiness is one of the deepest in the discipline. 'Empirical adaptationism' as defined by Godfrey-Smith seems to be ENCODE's default mode, and may explain its conflation of the different meanings of 'function', which Godfrey-Smith succinctly compares and contrasts in the broader context. Perhaps there is no single true definition, but inferences embracing one cannot be used to refute claims based on another, which is what happened in the junk DNA debates of 2013.

In just six pages Godfrey-Smith deftly traces two millennia of ideas about function and their imperfect mappings one to another. Of course, since Darwin frank purposiveness has been replaced by evolutionary 'just so stories' (teleology by teleonomy), but there remains a mysterious backward-looking character to both. In fact, adaptation is "a kind of feedback process, operating over a long time scale." Such processes were coming into intellectual focus in the 19th

century and Wallace, if not Darwin, drew a connection to selection.

Individuality, the subject of the following chapter, is a key issue in contemporary 'microbiomics'. The belief that we and our microbiota comprise holobionts with shared evolutionary trajectories underlies the popular distinction between 'dysbiosis' (as in inflammatory bowel disease) and 'eubiosis' (good gut health), at least connotatively. Godfrey-Smith does not address this hot new science directly, but provides a framework with which to do so. In his previous book, he introduced very useful three-dimensional cube diagrams, with axes corresponding to various tuneable (coming in degrees) biological parameters. For reproductive individuality of collective entities (made up of lower-level reproducers), these parameters could be bottlenecking (periodic reduction to a few individuals or cells), germ/soma separation and integration. By their positions in the cubical space so defined we can distinguish tightly conforming 'paradigm cases' of reproductive individuals on which selection can obviously act (such as fruit flies or humans, with high values in all three axes) from more complex potential 'collective reproducers', such as aspen groves, slime molds, or buffalo herds.

To the extent that selection can act on any population of such entities, the latter are 'Darwinian individuals'. Not all are also 'organisms' according to Godfrey-Smith (viruses and memes aren't, for instance) nor, conversely, are all organisms necessarily Darwinian individuals. If we define organisms metabolically or physiologically, as "systems comprising diverse parts that work together", then holobionts such as bobtail squid (which must acquire fresh vibrios as luminescent symbionts from the ocean each generation), humans together with their gut microbes, and even Gaia might be such. But none of these would be Darwinian individuals, reproducing as units or comprising unitary targets on which selection might act. Darwinian individuality and organismality are tightly coupled in most organisms chosen by biochemists and geneticists as models; indeed, one might argue that the choices were made on that basis. Much of the living world is not like that.

Chapter Six is about "Genes". Thankfully Godfrey-Smith does not get bogged down in the definitional problematics (What are the boundaries of genes? Do untranscribed regulatory regions count?) that often seem to trouble philosophers more than biologists. He does tackle another hoary issue which can still put geneticists at loggerheads with developmental biologists and humanists: to what extent do genes *cause* phenotype? Causation is not as simple as many biologists might naively think: is it a defective phenyalanine hydroxylase, that amino acid itself, the enzymes that convert it to phenylpyruvate, or for that matter the ribosomes that make the enzymes, that causes phenylketonuria? More contentiously, is religiosity caused by some 'God gene'? Much of the rhetoric indulged in by genomicists gives causal primacy to genes and much of the pushback (often from social scientists) privileges epigenetics and environmentally-driven developmental systems, broadly defined.

Godfrey-Smith wants to avoid what many of us have settled for in order to get past these recurring nature-nurture debates — 'bland interactionism'. By this he means "a view saying merely that every feature of every organism is due both to its genes and environment and there is no way to distinguish their importance" (p. 86). There *is* a way he argues, and that is through focusing on *difference making* (being sufficient for an effect) and *specificity* (variation in the effect matching that in the cause). Whether DNA comes out on top causally in the everyday biology of cells depends on the circumstances and scale of the analysis, though "at least one significant difference between genetic and non-genetic causes is that a gene can have an effect on phenotype that explains why the gene is there — why it has been selected for" (p. 91).

As to the evolutionary centrality of individual genes Godfrey-Smith demurs, seeing such models as tracking "just a few features of a complex set of processes." This seems to be partly (and regrettably, in my view) because he buys into ENCODE's claim that pretty much all of our genome (and presumably of the much larger ones of lungfish and lilies) has some subtle regulatory function. Although indeed, as he notes, "Genomes are more organized objects, and their partition into genes more artificial, than the classic models suppose" (p. 98), the magnitude of each 'more' remains hotly contested. Philosophy and science *must* work together on this.

The chapter on "Species and the Tree of Life" reminds us that 'typological thinking' (or essentialism) has not been eradicated from systematics, or at least from some of the ways in which it is practiced and promoted. A widely-publicized paper three years ago asserted that there are "~8.7 million (±1.3 million SE) eukaryotic species globally", reinforcing the notion that species are countable things, but proposing no definition of what was being counted. Godfrey-Smith rings the changes on popular species definitions, none universally applicable, and then expresses sympathy with the very sensible position "that 'species-talk' can be useful in biology even though species are not real units in the natural world" (p. 107). Useful, yes, but how do we count the unreal?

A deeper question, surely philosophical enough to satisfy the purest metaphysician, is what sorts of things species, if they *were* real units of the natural world, might be. Godfrey-Smith considers sets, sums and properties (intrinsic or extrinsic) as possibilities and seems to settle on a robustly practical pluralist species ontology: "Different kinds of structure in the world make different grouping criteria useful, and different grouping criteria often work naturally with one ontological framework or another" (p. 113). One would presumably not have such a deep exegesis on unicorns or snarks, so maybe there *are* some ways that 'species' engage reality. But anyone who thinks she knows there is only one true way, and that she knows what that is, should read this chapter. In the end, Godfrey-Smith notes that different species notions apply in different parts of the Tree of Life, itself possibly a *metaphor* (not a *discovery*) that may in future come to be seen as "a rough representation that has been superseded by something else". He concludes that "There is no point in trying to legislate about the use of the word ["species"]. A term surrounded by a long history of debate and diverse applications, as "species" is, will take its own undirected evolutionary path" (p. 119).

Chapter Eight, about "Evolution and Social Behavior", is my favorite. Godfrey-Smith's treatment of *group selection*, *kin selection* and

reciprocity is brief but admirably clear in explicating these processes as they might foster altruism (defined nonpsychologically, as net reproductive sacrifice). He appears to endorse the common belief that selection between groups for altruism is a weak force because it "seems likely to be a slow process, while the subversion of groups from within seems likely to be a fast one" (p. 121). True, but if group benefit is conferred as a pleiotropic effect of an individually beneficial trait, such selection could be *very* strong. And one of the scenarios Godfrey-Smith entertains for an easily demonstrated 'basic human prosociality' (an evolved altruistic bias) indeed is multilevel. His exploration of the possibilities in this very active area of psychosocial research and evolutionary speculation is refreshingly noncommittal. Similarly his treatment of meme theory and cultural evolution, which allows that under some conditions ideas can be 'Darwinian individuals'. Under other conditions what happens is more like *learning*, in which, though "adaptation can arise by retention and refinement of useful variants, this is not in general because these variants make more of themselves" (p. 138).

Most brilliant is how Godfrey-Smith handles 'human nature', which many of my politically liberal humanist colleagues vehemently dismiss as a pernicious myth. But of course there is such a thing — even liberal humanists have different expectations for their children than their dogs! Godfrey-Smith writes: "*Homo sapiens* is an easily recognized species, and once you know that someone is a human you can make predictions about him or her. The observable features are caused in large part by a genetic profile that is common across humans. If you want to know why humans look so unlike chimps and sturgeons, DNA is not the whole story but it is the most important difference maker" (p. 139, harkening back to Chapter Six). But he goes on to insist that we are not stuck with the nature we have: "As evolution is open-ended, this talk about our nature has a *post hoc* character. A new characteristic that is 'abnormal' now might be the basis for a new nature in the future. That much is true of all species, not just humans." (p. 142). This balanced and hopeful view Godfrey-Smith aligns with those of 20th Century existentialists, like Jean-Paul Sartre.

The last, and perhaps the most 'ornithological', chapter is on "Information". One knee-jerk reaction is to think we know what this is: what else could it be that is transcribed into RNA and translated (like a poem) into protein if not *information*? But the idea is riddled with contradiction. We can describe in exquisite detail just how a particular gene produces a particular protein without ever using the I-word. Of course how and why a gene makes a protein *is* recorded in its structure. But similarly a tree's age and climatic experience is recorded in its pattern of rings, and a geological formation's history is recorded in its strata. Godfrey-Smith concludes that "evolution is not an information-using or information-involving process in a way that marks it off from other processes of change" (p. 152). Instead, he prefers *communication* as a unifying concept for biology, quite unlike standard accounts of information or coding. "Communication-like behaviors are ubiquitous, and communication is also a manifestation of something more basic. A combination of receptivity and activity, with those behaviors stabilized by selection, by feedback, is a distinctive feature of the living world" (p. 156).

The philosophy and practices of biology connect more or less strongly in the various chapters of this book. Although doubtless too much attention paid to the meaning of words would slow progress, too little promotes fruitless debates and opens windows for hype — encouraging the public (and our funders) to believe that results mean more or other than they do. Some areas of research importantly engage social issues (genetic determinism, human empathy, species conservation) and to pretend that there are only facts at play is disingenuous. In others it may be that all we birds might gain from ornithology is a deeper understanding of ourselves. This book touches all these bases, and although it is too brief to be the only text for any course, it would be a perfect addition to or foundation for the reading list for many. And no practicing biologist who reads it is likely to think her time was wasted.

Department of Biochemistry and Molecular Biology, Dalhousie University, Halifax, Nova Scotia, Canada.
E-mail: ford@dal.ca

Q & A

John K. Tsotsos

John Tsotsos is Distinguished Research Professor of Vision Science at York University and Fellow of the Royal Society of Canada, with Adjunct Professorships in Computer Science and in Ophthalmology and Vision Sciences at the University of Toronto. He received his doctorate in Computer Science from the University of Toronto, developing the first computer system to interpret visual motion depicted in digital image sequences, with application to heart motion analysis. After a postdoctoral fellowship in Cardiology at Toronto General Hospital, he joined the University of Toronto on faculty in Computer Science and in Medicine. In 1980, he founded the Computer Vision Group at the University of Toronto. He was recruited to move to York University in 2000 as Director of the Centre for Vision Research. He has been a Canadian Heart Foundation Research Scholar (1981–1983), a Fellow of the Canadian Institute for Advanced Research (1985–1995), and currently holds the Canada Research Chair in Computational Vision (2003–2017). He has held visiting positions at: the University of Hamburg, Germany; Polytechnical University of Crete, Greece; Center for Advanced Studies at IBM Canada; INRIA Sophia-Antipolis, France; and, the Massachusetts Institute of Technology, USA. His current research focuses on a comprehensive theory of visual attention in humans. A practical outlet for this theory forms a second focus, embodying elements of the theory into the vision systems of mobile robots.

What turned you on to science — and vision science in particular — in the first place? The earliest relevant memory I have is learning about the accomplishments of Albert Einstein; he passed away when I was three years old, but I do recall telling my friends at a young age that I was going to be a scientist like Einstein, so I must have heard about him and his accomplishments, likely from my parents, and was inspired. The space race of the 1960s was also a major inspiration, and I went through most of my younger years alternating between wanting to be a physicist, an