Studies in History and Philosophy of Science xxx (2018) 1–4

Contents lists available at ScienceDirect

Studies in History and Philosophy of Science

journal homepage: www.elsevier.com/locate/shpsa

Essay Review

Five chances in evolution

Carlos Mariscal*

Department of Philosophy, University of Nevada, Reno, USA
Ecology, Evolution, and Conservation Biology Program, University of Nevada, Reno, USA
Integrative Neuroscience Program, University of Nevada, Reno, USA

Alexander Lerner

Department of Philosophy, University of Nevada, Reno, USA

Chance in Evolution, Edited Grant Ramsey, Charles H. Pence (Eds.). University of Chicago Press, Chicago (2016). 359 pp., Price $45.00 cloth, ISBN: 978-0-226-40188-1

1. Chance in evolution

Among the central issues in philosophy of biology is the role of chance in evolution. Evolutionary theory relies on several chance concepts, notably 'random' genetic drift, which is where population outcomes differ by 'chance' from what is expected by natural selection. But the nature of drift is hotly debated: some have argued it is merely a place-holder for our own ignorance, others have argued it is not a force in evolution, while still others have argued it is not a distinct process in biology at all. Understanding the role of chance in evolution required the development of the field of statistics and set the stage for a conflict between scientists and those who argued that the design apparent in nature was incompatible with 'mere chance.' These authors were often impressed that camera-type eyes had evolved a half-dozen times, a phenomenon that also poses questions for practicing biologists who wrestle with whether this implies evolutionary forms are limited. From these debates, we can distinguish at least five issues raised by the concept of chance in biology:

i. whether chance in biology is objective, of the same sort as those we see in quantum theory, or whether probabilities merely reflect our own epistemic barriers (e.g., Brandon & Carson, 1996; Graves, Horan, & Rosenberg, 1999; Horan, 1994);
ii. whether evolutionary processes are forces or merely a statistical summary of underlying processes (e.g., Stephens, 2004; Walsh, Lewens, & Ariew, 2002, 2017);
iii. whether indiscriminate chancy biological processes are separate from selective processes or whether both are aspects of a single process (e.g., Beatty, 1984; Brandon, 2005; Millstein, 2002);
iv. whether chance is compatible with teleology or not (e.g., Ruse, 1996, 2003).
v. whether evolution is likely to produce repeat outcomes given radically distinct starting points or whether current features owe their occurrence to the chance events in a lineage's contingent history (e.g., Gould, 1990, Conway Morris, 1998; Powell & Mariscal, 2015);

Chance and related concepts are used in each debate in different ways, so even experts may be unclear as to how these debates intersect, if at all. Each is often posed as an exclusive dichotomy, exhaustive of all possibilities within the issue. Each question is also sometimes taken to be central to understanding biology. Debates ***ii*** and ***v***, in particular, are still actively debated in academic circles, as is ***iv*** across academia and the public sphere.

In this article, we describe each of these debates for audiences who may have a passing interest but are not actively versed in the issues. The historical roots and conceptual ordering for these debates for some of these debates is ambiguous, so we have organized our discussion in the order they arise within the new edited anthology *Chance in Evolution*, Grant Ramsey (KU-Leuven) and Charles Pence (Louisiana State University), which explores such debates side-by-side with the myriad issues raised within. Both editors are well known in these debates, especially with respect to ***ii*** and ***iii*** above (e.g., Brandon & Ramsey, 2007; Pence & Ramsey, 2013; Pence, 2015, 2017; Ramsey, 2013a, b).[1]

* Corresponding reviewer. Department of Philosophy, University of Nevada, Reno. USA.
E-mail address: carlos@unr.edu.

[1] Full disclosure, Ramsey shared academic advisors with **CM**.

https://doi.org/10.1016/j.shpsa.2018.02.004

2. Epistemic vs. ontological chanciness

In the mid-1990s, a debate raged in the philosophy of biology community as to the causes of genetic drift and other chancy biological processes. In one view, the unpredictability of such processes is due to our own epistemic limitations—the chance in biology is subjective, not objective (e.g., Graves et al., 1999; Horan, 1994; Rosenberg, 1994). In other words, populations drift because of deterministic factors we are currently unable to measure, but an ideal scientist could, in principle, perfectly predict the drift of any population. The alternative view is that drift is not an epistemic limitation, like throwing dice in a casino, but it is truly stochastic in a way similar to theories of quantum mechanics (Brandon & Carson, 1996). In the early 2000s, Leslie Graves and Barbara Horan left academic philosophy, while Alex Rosenberg abandoned the view that drift was a mere epistemic limitation (Bouchard & Rosenberg, 2004; Rosenberg & Bouchard, 2005; Rosenberg, 2001). The debate has now largely disappeared from philosophy journals.

The first chapter of this anthology takes us to the historical roots of this debate. David Depew writes a broad overview from the ancients to the Modern Synthesis. Depew covers Aristotle and Empedocles on the generation of species and their seemingly teleological natures, Immanuel Kant explicating the nature of species disposition, Charles Darwin and Asa Gray's discussions on the nature of species, and even touches on the probability revolution and ongoing research by modern thinkers. To understand their differing theories, Depew assesses the use of the term *chance* as its use varies from thinker to thinker. Sometimes chance is equivalent to *contingency,* as in Aristotle's two versions of luck, whereas other times it is closer to *stochasticity*. Darwin includes the idea of random variation in his nascent theory of natural selection, yet considers that chance may simply be the incomplete understanding of the science before us. Mutability is another avenue by which chance is examined, calling back through history to Aristotle's epigenesis, and leaning heavily on contemporary research in the field of genetics. Depew's contribution to the work explains that chance has always been present in the theory of evolution in its varied iterations. For Depew, if the Darwinian revolution was truly revolutionary, it was not revolutionary in the sense that Darwin broke with the ancients, but rather that he broke with certain beliefs that became common in the century before him. Darwin had a hard time finding a middle ground between random chance and determinism, one in which a concept of contingency might have helped (see section 4). Depew's article may be a worthwhile entry point for historically inclined scholars.

On a very different topic, Francesca Merlin pens a chapter discussing mutation and how it is observed in science. Merlin argues weak randomness is a more realistic way of viewing the randomness associated with mutation. *Weak randomness* is any stochastic process that is either a discriminate sampling process or variant over time. Research shows some pattern to changing probabilities of mutation, so mutation exhibits weak randomness (Drake, 2007; Drake, Bebenek, Kissling, & Peddada, 2005; Ninio, 1991). The author looks to future research to improve understanding of mutability biases.

3. Statisticalism vs. Causalism

Evolution is often described in causal terms: selective pressures, migration, and mutation all have an *effect* on biological populations. Some authors view these causes as biological 'forces,' analogous to forces in physics (Bouchard & Rosenberg, 2004; Brandon & Ramsey, 2007; McShea & Brandon, 2010; Pence, 2017; Ramsey, 2013b; Reisman & Forber, 2005; Shapiro & Sober, 2007; Stephens, 2004). An alternative view, 'statisticalism,' holds that the parameters in evolutionary models explain, predict, and quantify changes in population structure, but do not describe *causes*. For these authors, true causes can only be said to occur locally, among the births and deaths of particular organisms, and our evolutionary explanations are mere statistical aggregates (Ariew & Ernst, 2009; Ariew & Lewontin, 2004; Matthen & Ariew, 2002; Walsh, 2010; Walsh et al., 2017). A recent review by Otsuka (2016) does an excellent job going through this debate and we encourage readers to read that work.

An interesting new addition to this debate in *Chance in Evolution* is in the second chapter, by Jonathan Hodge. Hodge gives a thorough overview of Darwin's developing theory and Darwin's shift, over time, on his view on the force of contingency. Darwin begins with two premises: variations are due to chance and probabilities are causally related. He believed that chance variations were rare and bred out in populations, securing the place of certain fundamental traits. Chance then became simply a lack of understanding, and this would eventually lead Darwin to soft determinism. Darwin would reformulate his ideas, writing that both drift and natural selection were causal forces and causing an intellectual uproar with his acknowledgment of maladaptations, challenging the thinkers who had committed to intelligent design and theological explanations for change. Hodge weighs in on the ongoing argument between statisticalists and causalists, arguing that a historical reading favors the causalist perspective, albeit warning that the concepts of 'forces' and 'laws' have a checkered history in biology, as does linking 'fitness' with reproductive output. This serves as a specific example of a general point: philosophers should pay a keen eye to history: not only are debates shaped by their history, but so too is our conception of the issues. Hodge's chapter does well in advancing the statisticalist/causalist debate, and should be read by anybody participating in that discussion.

4. The nature of drift

One interesting consequence of the previous debate was a reconceptualization of drift. The traditional position was that drift was an unbiased sampling process or cause (Beatty, 1984; Bouchard & Rosenberg, 2004; Gildenhuys, 2009; Mills & Beatty, 1979; Millstein, 2002). The new view, in opposition to the mainstream position, is that drift is merely the byproduct of a single process (namely the births and deaths of organisms (Brandon, 2005; Walsh et al., 2002). There are alternative possibilities: Gildenhuys, 2009 accepts both, while Ramsey, 2013a views drift as an individual-level phenomenon.

In the book, several authors wrestle with how to understand drift in a way that can illuminate this debate. In one chapter, Anna Plutynski, Kenneth Vernon, Lukas Matthews, and Daniel Molter explore the myriad conceptions of chance used by each major evolutionary biologist throughout the modern synthesis. The authors argue for an appreciation of the lineage of work in the changing viewpoints in biological theory. Chance was recognized by modern synthesis authors as occurring within mutation, meiosis, small populations, and drift. Later synthesis authors would keep to a similar core of commitments, accepting that chance in mutation and recombination was inherent, although underplaying the role of drift as the synthesis 'hardened' (Gould, 1983). The authors of this chapter acknowledge that synthesis authors all held a respect for some notion of 'chance' (in the sense of unpredictable) or 'randomness' (in the sense of equiprobable outcomes) within the theory of evolution. Most would also have viewed the debate between causalists and statisticalists as a false choice. This chapter would be particularly helpful in a course when discussing the Modern Synthesis, especially leading into one of these debates.

Please cite this article in press as: Mariscal, C., & , Five chances in evolution, Studies in History and Philosophy of Science (2018), https://doi.org/10.1016/j.shpsa.2018.02.004