Is There Biological Randomness by Any Chance?

Stochastic descriptions have for a long time been part of biology. Usually a claim of biological randomness accepts two understandings, a weak but trivial and a strong but demanding. The weak says we are dealing with biological randomness when a biological description involves a random process. But it is very likely that these only two features – random and biological – would be considered far from being enough to claim biological randomness. For, it might be the case that the description can be formulated (i) within a biological non-stochastic framework or (ii) within a non-biological stochastic framework, typically one of chemistry or physics. So (i) and (ii) separately have often been considered at the base of a strong claim of biological randomness. I propose to combine those two to get a definition of epistemic biological randomness, expressed as a stochastic biological description satisfying two conditions, together necessary and sufficient: irreducibility of randomness within biology and irreducibility to non-biological randomness. I show that such a definition includes an unfortunate loophole, and that once the definition is consequently corrected, it can be argued to not be satisfiable by any biological stochastic description. I give support of the single premise of the argument, based on the probability's results known in mathematics and physics. I discuss possible impacts of the argument in debates about ontological indeterminism accessed through biology and interpretations of biological probabilities. I conclude by promoting methodological non-reductionism with respect to biological randomness.

Stochastic descriptions have for a long time been part of biology, and their usefulness for making predictions have made biologists become quite confident about their relevance in their field. Stochasticity is involved in the description of various types of phenomena: the spontaneity of genetic mutations, the randomness of the genetic drift, the unpredictable behavior of animals, stochastic gene expressions, etc. But how can be justified the claim that we are dealing with 'biological randomness'? Obviously the claim assumes that the description makes use both of a notion of randomness and of the vocabulary of biology – not necessarily of biological laws –, such as the spontaneity to be found in genetic mutations. But this might be far from being enough to support a substantive claim. For, it might be the case that the description can be formulated (i) within a biological non-stochastic framework (Sober 1981) or (ii) within a non-biological stochastic framework, typically one of chemistry or physics (Brandon 1986, Stamos 2001, Weber, 2001, Mohseni 2014). And the very fact that neither (i) nor (ii) is presently established for the stochastic description on concerned, which surely is the case for in a large proportion of the biological stochastic descriptions, is obviously not enough to ensure their in principle impossibility. Thus, this paper aims to assess the possibility to built from (i) and (ii) a double condition to be satisfy by a biological stochastic description in order to claim biological randomness. So the later requires (i) irreducibility of randomness within biology, (ii) irreducibility to non-biological randomness.

The starting point is the clarification of the notion of randomness (Earman 1986). Randomness might be directly experimentally accessed by the absence of correlations, order, patterns, etc., usually through statistical tests. It refers to different mathematical notions, which captures a lack of relations between numbers in a sequence. But it suffers a well-known limitation: its direct evidence cannot be conclusive, statistical tests for example being unable to probe all possible correlations. So the evidence of randomness surely provides some support to descriptions in terms of randomness, but will not help to prove neither (i) nor (ii). So let's turn to the description side. Here randomness enters into the dynamics usually through probabilities. Randomness characterizes the process, the different possible outcomes of which follow the probability distribution on concerned. Hence (i) and (ii) can now be rephrased as (i) irreducibility of probabilities within biology and (ii) irreducibility to physical probabilities.

I propose the two following conditions to be satisfied by a biological stochastic description: (BiR): The biological stochastic description cannot be formulated within a biological non-stochastic theory; and (RiB): The biological stochastic description cannot be formulated within a stochastic non-biological theory. I propose to address this definition with one single premise: (P1) Any stochastic description can in principle be formulated within a non-stochastic theory. This premise comes is supported by the existing proofs of the compatibility between probabilities and a deterministic framework, provided by stastistical mechanics (Aleksandr 1949, Werndl 2013) and quantum mechanics, precisely Bohmian mechanics (Dürr 2009). In both theories, an 'appearance of chance' has been proved. Yet these proofs only rely on the probabilistic nature of the theoretical framework (whether it is physical or biological does not matter) and have been obtained for the only two mathematical types of probabilities we are used to (Aaronson 2013). Thus give strong support to claim there is no irreducible randomness.

Now comes the central argument of the paper. The first step is to confront (P1) to (RiB) and (BiR). (P1) and (BiR) together do not contradict, but force to claim that the theory in (BiR) has to be non-biological. (P1) and (RiB) do not contradict neither. For, it is possible, with regards to (P1), that a stochastic biological description cannot be formulated within a stochastic non-biological theory. But (P1) imposes the description to be in principle formulated within a non-stochastic theory. The later cannot be biological without contradicting (RiB), so it is non-biological. Hence, given (P1), to claim a description satisfies (RiB) and (BiR) is to claim that the biological stochastic description can in principle be formulated within a non biological non-stochastic theory. This conclusion was obviously not expected and reveals a loophole in both conjuncts. In order to avoid the commitment to this conclusion, both conjuncts are modified, the first by removing the biological constraint, and the second by removing the stochastic constraint. Now, we have that (P1) makes impossible for any biological stochastic description to satisfy any of the modified conjuncts.

This claim of `no biological randomness' lies at an epistemic level. It have consequences on debates about indeterminism accessed through biology, particularly on the possible percolation of the alleged quantum indeterminism at the biological level (Brandon 1996, Rosenberg 2001). For, although some quantum effects might be maintained at the biological level (Mohseni 204), the absence of quantum irreducible randomness is a major objection against this idea of biological indeterminism accessed through epistemic reducibility of biology to physics. Also the defense or the attack of the realist claim on biological probabilities, the so-called propensities, might be impacted by my claim. In particular, I will joined, among others (Weber, Millstein 2003, Lyon 2011), the requirement to go beyond the dichotomy between two understandings of probabilities. Finally, as biologists are far from systematically adopting a chemical or physical perspective on biological random effects, and the heuristic usefulness of the concept of randomness in biology seems hardly to be dismissed, I will, based on my claim, promote a *methodological* non-reductionism about biological randomness (Van Regenmortel 2004).

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