

BIOLOGY AND THE POSSIBLE

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Philosophy and biology are vastly different worlds of thinking, which have common concepts. Among these, the idea of possibility is particularly significant presently. In many fields of contemporary biology and medicine, there is a sense of an expanding possibility of modifying living beings or structures. Things which were previously considered as impossible by many observers become feasible, although there are some doubts, for instance in the field of genetical therapy. Laboratory practice in biotechnologies is changing into large-scale industrial production in medicine and agriculture. This general sense of feasibility reminds us of analogous situations in the history of science, for instance in chemistry at the end of the nineteenth century, when organic chemists became able to create new molecules almost at will.

The fact, that biological structures are modifiable without losing their overall stability raises a number of questions regarding the reasons why the biological kind of organisation makes it possible. We will have to discuss things at this level of biology itself, which corresponds roughly speaking to theoretical biology. But we will have to discuss things also at the level of philosophy in its most classical and even traditional sense. Indeed, there is a very striking and unexpected agreement between the ideas of classical philosophy regarding the possible's realisation, the idea that all possibilities are realised throughout time, and the fact that so many possibilities are envisaged and often realised by biologists today.

However, there is an additional reason why philosophy including some logic needs to be introduced in the discussion. Biologists make often use of the idea of possibility in their more popular writings. In his influential book *The Game of the Possible*, François Jacob stressed the contingent, matter-of-fact character of evolution, and developed the evolutionary tinkering idea. Other arguments are developed by Stephen Jay Gould in his book *Wonderful Life*, in which he deals with the idea of multiple possibilities and of counterfactual conditionals.

Biologists are not always sufficiently aware of the subtleties and difficulties encountered by philosophers in their attempts to clarify the most obscure idea of the possible. Biologists are surely not the only scientists who should learn more of philosophy and logic. Logic should be taken here in its broader sense, since the most sophisticated developments of modal and temporal logics are of no use in contemporary biological research. In the broader philosophical meaning of the fundamental structures of thinking, logic permeates biological reflection and might be more firmly introduced in the thinking of biologists, in the same way as the more particular disciplines which are introduced as the research tools of contemporary biology, like complexity theory, probabilities etc.

Let us begin with some general remarks on the idea of the possible. One of the most puzzling things is its relationship with reality, which takes at least two forms: 1 – the idea that all possible states or events are realised throughout time, which is named since Arthur Lovejoy the Principle of Plenitude; 2 – the very strange philosophical relationship which has been discussed by Ludwig Wittgenstein in several places of his *Nachlass* as the conception of possibility as shadow of reality or as something similar to reality or very close to it. Wittgenstein's remarks were done in the context of his philosophy of mathematics. The idea of some kind of similarity between possible and real must be kept in mind in a biological context. Indeed, in biology the so called "possible states", which are described as possible for theoretical reasons, are endowed with their own probabilities, which means that they are more or less already realised. In still another sense, the often realised possibilities are just preexisting realities arranged in a different way. This is François Jacob's basic insight of evolutionary tinkering, which means that the same structure may be reused and serve different functions. It stresses the conservative side of biological evolution. The present enquiry aims at examining more closely the logical and semantical foundations of these biological ideas.

Surely, many disciplines should be mentioned in a systematic attempt to build bridges between philosophy and biology from the timely viewpoint of the possible and its realisations. These include the history of philosophy, also linguistics and semantics of natural languages, modal logic, temporal logic, probability theory, etc. on the one hand, and on the other hand virtually all biological and biomedical disciplines, especially evolutionary theory with its strong connection to developmental biology, biophysics and biochemistry with their strong thermodynamical background, as well as medicine and biotechnologies. To this list should be added some corresponding points of interest from both the logical and the ontological points of view: the indeterminacy of the causal agent in the use and meaning of the possible; the "could have been otherwise" argument in evolution (the counterfactual conditional); the realisation of the possible (its "spontaneous" nature in a Leibnizian world); the real

plurality of the possible (with protein folding as an example); the possible as the feasible and its limits (with examples taken from medicine). The following table shows the connections between disciplines and problems, as well as the identity of problems across various disciplines:

SOME DISCIPLINES	SOME POINTS OF INTEREST
Logic and Semantics of Natural Languages:	Lack of Clarity in the Concept of Possible Compared with Impossible and Necessary Indeterminacy of the Agent Unreal Past, Counterfactual Conditionals
History of Philosophy:	Principle of Plenitude
Evolutionary Theory:	Unreal Past, Counterfactual Conditionals Indeterminacy of the Agent (Cf Logic and Semantics)
Biophysical Chemistry:	Plurality and Realisation of the Possible (Cf Plenitude)
Medicine:	Feasibility, Prediction

Some of these points will be discussed in the following way:

- I Logic, Semantics of Natural Languages: definition of possibility as absence of impossibility; indeterminate character of the cause, incompleteness of the situation; time and modality, past possibles and unreal past, counterfactual conditionals.
- II Contingency in Evolution: the "things could have been otherwise" argument (counterfactual conditional) as contingency argument in Stephen Jay Gould's *Wonderful Life*.
- III The Possible and The Real: "evolutionary tinkering"; mutagenesis as internal source of change; Eigen's hypercycle as an explanation of stabilisation.
- IV How Many Possibles and How They are Realised: the principle of plenitude; protein folding; prediction.

The first interesting point is in semantics and has consequences in logic. There are several meanings or broad categories of meanings which are associated with the idea of possibility. One can mention briefly five of these

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