Antonine Nicoglou, *Plasticity in the Life Sciences* Chicago: University of Chicago Press, 2024. Pp. 320. ISBN 978-0-226-83716-1. $37.50 (paper).

In 2021 cells liberated from a frog's skin were coaxed to become different types of cells and construct hitherto unknown organisms. Organisms formed out of these liberated cells were baptised 'xenobots', with nods to the computer simulations used to assemble cells into new organisms. Michael Levin, a project lead, was reported to have said 'one of the most exciting things here is plasticity' (*New Scientist*, 31 March 2021). We might think we know what 'plasticity' means, but Nicoglou invites us to think again. To be sure, her book is not the first attempt at deepening our understanding of the plasticity concept; Maurizio Meloni attempted this in *Impressionable Biologies* (New York, 2019), albeit more historically. *Plasticity in the Life Sciences* bridges the gap between the history and the philosophy of plasticity like never before. Like Levin and Meloni, Nicoglou is motivated by the view that 'living beings are not determined by their genes'. (p. 3). She aims to show that, at a time when we use the word 'plasticity' all too frequently, we can use the same word and still mean subtly, but significantly different things.

The book's first part analyses historical uses of plasticity. Aristotle's crucial distinction was between its 'passive' and 'active' meanings. The 'active' sense is the 'ability to shape' that living entities had; the 'passive' was the 'ability to adopt a form' impelled by outside forces (p. 10). Aristotle saw them as integrated and compatible theories to understand the living world – other philosophers and embryologists not so much. But the two senses persevered, albeit in different ways for different people, inspiring a variety of conceptual and experimental methods that require historical and philosophical analysis to clarify.

The active interpretation preserved into the twentieth century, when genetics was on the rise. Unlike other biologists, who saw genes shaping organisms, the German zoologist

Richard Woltereck demonstrated that the water flea *Daphnia* developed variable traits (with the same genes) based on environmental factors. He called this the *Reakionsnorm* (norm of reaction). One might not make much of Woltereck's ideas today, without realising just how different they were from the ideas of contemporary biologists. To Woltereck, a trait was not a result of a fixed factor, like the genotype, but of dynamic interactions between heredity and environment. On the other hand, the Danish botanist Wilhelm Johannsen interpreted the variability of traits on the basis that a genotype has already predetermined possible phenotypic forms that emerge depending on environmental conditions (pp. 62–3). To Woltereck, the action of genotype was variable, rather than predetermined, depending on its reactions with other factors like development and environment.

Such debates continued in the later 1930s and 1940s, when the British biologist Lancelot Hogben and the German zoologist Richard Goldschmidt criticized their contemporaries for reasons similar to Woltereck's. Indeed, we can find examples, Nicoglou explains, of biologists who continued to pursue the active sense, combining it with the passive sense in non-incompatible ways. The British embryologist Gavin de Beer was one such figure. Like Aristotle, de Beer wanted to show the attempts to fuse different meanings of 'plasticity', rather than narrowly focusing on one alone.

Despite such efforts, the active sense of plasticity was gradually sidelined. An 'operational' sense of plasticity was used by geneticists to allow them to do genetics. The environment was to be eliminated in favour of the study of genetic mutations and recombinations to see how they determined a passive plasticity (pp. 59–60). Developments in evolutionary biology in the 1930s and 1940s such as Julian Huxley's 'modern synthesis' also sidelined the active sense in favour of analysing the plasticity of genes. Tellingly, the British ecologist and geneticist Anthony Bradshaw argued in 1965 that 'phenotypic plasticity', Nicoglou writes, was genetically determined (p. 108).

The historical analysis in the first part of the book permits a philosophical investigation in the second. While some have attempted to unify biology by reducing life to the fundamental activities of, say, genes, others have argued that no such unification under the aegis of genetics is possible, as life requires explanatory pluralism. Nicoglou tries to do neither. Fuelled by a historical survey and by fine philosophical distinctions, we should, she writes, aim to integrate those different conceptions of plasticity. For instance, based on the historical analysis of norms of reaction, Nicoglou analyses the concept of 'induction' to differentiate the active from passive senses of plasticity. A cell can be 'induced', or 'activated' at a molecular level to develop in a pre-set way in response to an environmental stimulus, or that 'induction' dynamically occurs at multiple levels and at different stages of an individual organism's life cycle. A similar point is made about biological regulation. Nicoglou also argued that natural selection, might explain the dissemination of variation at a population level, but does not itself cause variation and evolution. Variation emerges at a developmental level, actively interacting with genotype and the environment, and is then dispersed and modified further according to relative fitness requirements.

Nicoglou's point is that plasticity is better explained by integrating multiple levels of explanation and carefully distinguishing between them. For this reason, she calls plasticity a 'boundary concept'. When used thoughtfully, multiple meanings of plasticity can 'manifest themselves distinctly from one another', allowing for productive combinations rather than narrow focus on one level. It helps us 'to take account of the complexity of living phenomena without necessarily adopting a reductionistic approach but rather by considering a dynamic nesting of the different levels of explanation considered by biologists' (p. 254).

One might ask whether the thesis about the transition from an active to a passive sense of plasticity holds. After all, Julian Huxley, in *Evolution: The Modern Synthesis*, reminded his readers that the 'nature of the organism thus influences the mode of its evolution. This

applies at every level'. One should indeed look at the 'microscopic machinery of genes and chromosomes', but also examine 'the individual level, the type of reproduction, the way of life, the level of behaviour, the method of development' (London, 1942, p. 127). Did he abandon the active sense of plasticity, or was something else happening? What else must we consider socially and institutionally when we try to do any integration? Conceptually Nicoglou has got us covered in this incisive and timely analysis of what we may mean when we try to mean anything by plasticity.

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