BOOKS & ARTS

Does diversity always grow?

Samir Okasha is intrigued by a proposed universal law of biology: that complexity inevitably increases in the absence of other evolutionary forces.

Biology's First Law: The Tendency for Diversity and Complexity to Increase in Evolutionary Systems
by Daniel W. McShea and Robert N. Brandon
University of Chicago Press: 2010.
184 pp. $20, £13

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The eyes of cavefish vary between individuals despite never being used.

The nineteenth-century astronomer John Herschel is said to have dismissed Charles Darwin's theory of evolution as "the law of higgledy-piggledy". Whether he was referring to the role of chance in natural selection or the lack of definite predictions due to it, Herschel's criticism was misplaced: the selective preservation of the fittest variants makes a population more homogeneous, not less. Herschel's epithet does apply neatly to the 'zero-force evolutionary law' that palaeobiologist Daniel McShea and philosopher of science Robert Brandon propose in *Biology's First Law*.

McShea and Brandon state that diversity and complexity tend to increase over time in biological systems. It is, the authors argue, a universal law, applicable to all taxa, at all hierarchical levels and at all times. They use the analogy of Newton's law of inertia — just as it tells us that a body will move with a constant velocity if no forces act on it, this zero-force evolutionary law seeks to capture how a biological system will behave in the absence of other influences. Although the trend they describe may not manifest itself in cases when it is counteracted by constraints, it provides the background against which other evolutionary pressures should be understood, the authors contend.

McShea and Brandon use a standard definition of diversity: the amount of variation in a biological system. A taxon that contains many species, or a species that has many forms, is more diverse than one that has few. But the authors adopt a simplified measure of complexity that considers only the degree of differentiation among the parts of a biological system, not the various functions of those parts. Complexity thus becomes a matter of having many part types, irrespective of what the parts do or how they are organized. The authors argue persuasively that their simpler definition of complexity is more scientifically useful than the traditional one, because function is hard to quantify.

Diversity and complexity can be assessed at any level of the biological hierarchy — in clades, species, subspecies, populations and between and within organisms. But diversity and complexity are the same thing, the authors say, when viewed from adjacent levels. For example, an organism with a great diversity of cell types is also a complex organism. Thus, diversity at one level of the hierarchy equates to complexity one level higher. Both diversity and complexity will increase over time through the accumulation of mutations, they suggest.

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McShea and Brandon do not claim that their law represents a wholly new evolutionary principle, rather that it is a unifying one. The tendency for increasing diversity has been recognized previously in specific situations. For example, molecular geneticists know that, in the absence of selection, populations will diverge genetically as neutral mutations accumulate. And evolutionary biologists have noticed that tissues and organs that are not subject to selection, such as the eyes of cave-dwelling fish, often show more variation between individuals. The authors aim to encompass these various findings in a single theory that covers all of the fields in which the principle has been seen — in molecular biology, population genetics, phylogenetics, palaeobiology and elsewhere. They make a good case for their argument that a single principle is at work.

Their theory suggests new research questions, such as whether the tendency for diversity to increase will usually be overcome by natural selection, and it advances our philosophical understanding of evolution. The law also makes testable predictions: for example, that diversity and complexity will increase fastest in ecological circumstances and taxa where selection is weak.

Biology's First Law is an original and unusual book. A hybrid of theoretical biology and philosophy of science, it addresses both conceptual and empirical problems. If there is a lacuna, it is that the authors do not attempt a mathematical formulation of their law, claiming only that it is reducible to probability theory. Such a formulation is essential if we are to investigate and integrate the law with other theories of evolutionary dynamics. Nevertheless, it is a thought-provoking study. ■

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