Unended knights' tournaments

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For my generation, science has resembled the tournaments of medieval knights: fierce, but fair. Peter Mitchell started an uphill battle for his chemi-osmotic theory in the 1960s and persisted until his adversaries avowed defeat in a joint publication with him in 1977 (Boyer *et al*, 1977). He received the Nobel Prize for his work in 1978.

My generation also grew up under the doctrine of genocentrism. When Richard Dawkins presented the theory in his book, *The Selfish Gene* (1976), I agreed with the majority for whom the mystery of life appeared to be solved: living beings, including humans, function as “lumbering robots”, “blindly programmed to preserve the selfish molecules known as genes”, the preservation of which was the “ultimate rationale for our existence”. The idea also applied to society, as Edward O. Wilson argued independently in his book *Sociobiology* (1975). Dawkins and Wilson both referred to the “inclusive fitness theory” of William D. Hamilton as the foundation stone of their reasoning. The creed of selfish genes became orthodoxy in molecular and evolutionary biology for more than 40 years. Opponents were stultified by the prodigious eloquency of Dawkins, who bluntly dismissed Konrad Lorenz and other evolutionists as “totally and utterly wrong”. Dawkins' acolyts took up his emotionally charged rhetoric, labelling their adversaries as “naive” or as “heretics”.

In August 2010, Martin A. Nowak, Corina E. Tarnita and Edward O. Wilson published a paper in *Nature*, which might mark a turning point in the genocentric orthodoxy (Nowak *et al*, 2010). In it, they argue against inclusive fitness theory and its “selfish gene” basis, and essentially favour multilevel selection, which had already been proposed by others. Nowak himself (2006) had previously declared that “we might add ‘natural cooperation’ as a third fundamental principle of evolution beside mutation and natural

selection”. By March 2011, more than 100 experts in evolutionary biology had reacted to the paper, proclaiming that the arguments therein “are based upon a misunderstanding of evolutionary theory and misinterpretation of empirical literature” (Abbot *et al*, 2011).

The *Nature* paper and the reaction to it might find their place in the history of biology as a scientific parallel of Hans Christian Andersen's tale about the Emperor's new clothes, in which it takes a fresh perspective for everyone to finally agree the Emperor is naked. The current criticism of selfish gene theory has had its predecessors, but it has now resounded most powerfully. The point is that today, with our understanding of molecular biology, we have many reasons to change our way of looking at evolution. So had Wilson when contemplating empirical data that appeared to shake the very foundation of his original sociobiology, and Nowak and Tarnita when searching for a novel formalism.

Life is based on chemistry and chemistry on Earth consists of molecular association, cooperation, self-organization, the emergence of nested hierarchies and the increase of complexity. Cooperations at higher levels are grounded in this molecular level and give rise to genomes, cells, multicellular organisms and eventually human society. The genome is neither a tape nor a recipe, but a hierarchical network of interacting and context-dependent determinants. Life might not have originated in the form of “selfish replicators”: genes might have evolved later, primarily as the “bookkeepers” of an interwoven network.

It has been often pointed out that inclusive fitness and multilevel selection approaches are mathematically equivalent and simply different ways of accounting for the same evolutionary process. Mathematical theories are essentially tautologies that deduce consequences from well-defined assumptions. But the choice of the assumptions depends on the observer and on the evolutionary history

of both the observer and the observed. It is not axiologically equal, nor are we indifferent to the implications of whether we make a mathematic deduction from an axiom that humans act as selfish and independent units—like the molecules of an ideal gas—subordinated to “ruthlessly selfish” molecular dictators, or from an axiom that individual humans collaborate as parts of other, hierarchically higher individuals, which themselves constitute still other individuals, and so on up the ladder of life.

The Nowak *et al* paper gives justice to its predecessors' discordances with the ruling selfish gene theory. Its implications come as a relief: we need no longer consider ourselves and our deeds as epiphenomena, as mere shadows projected on the screen of cosmic emptiness by the Platonic substance of selfish replicators. Dawkins' book will remain a symbol for a period in biology marked by the quest for simplicity. It might be relegated to the repository of refuted scientific theories, but at the same time promoted to the treasury of immortal artistic accomplishments. Just as Winston Churchill, who we remember as a politician, not an author, received the Nobel Prize for Literature “for his mastery of historical and biographical description”, so the biologist Richard Dawkins deserves it for the magic of his persuasiveness as a superb prose stylist.

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