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Selfish genes and mother trees

Metaphors are excellent tools for explaining complicated concepts. But sometimes the concepts can become driven by the metaphors.

Words are powerful but slippery. However much we might wish that they had simple, defined meanings, agreed upon by everybody, they bring with them a host of associated allusions that are dependent on the culture and personal history of whoever is hearing or reading them. Poets use this to conjure images and emotions with 'the best words in the best order', as Samuel Taylor Coleridge put it in the early 19th century. For scientists this becomes a problem. Like Lewis Carrol's Humpty Dumpty, when we use a word we want it to mean "just what [we] choose it to mean — neither more nor less", but this is hard to achieve, especially when scientific words and phrases escape into general usage.

Charles Darwin did not describe his theory of evolution as 'the survival of the fittest', that term was coined by the philosopher and polymath Herbert Spencer. Alfred Russel Wallace (whose own theory of evolution was essentially the same as Darwin's and was presented at the same to the Linnaean Society in London) urged Darwin to use it instead of 'nature selection' and Darwin did include the term in a few places in later editions of his 'Origin of Species' but he preferred his own term. The problem is that when we hear the word 'fittest', we think of physical fitness and strength. It is thus almost impossible to not immediately think that those that will survive and so pass on their genes are the strongest or fastest of a population. It takes an effort of will to remember that 'fit' here relates to being adapted to an organisms environment and lifestyle. Fitting like a jigsaw puzzle piece not fit like an athlete.

A little more than a hundred years later Richard Dawkins caused a similar confusion by titling his book about a neo-Darwinist view of evolution 'The Selfish Gene'. Such a title, although not the book itself, seemed to negate or deny the possibility of altruism, collaboration, morality or culture; everything boils down to the propagation of individual genes at the expense of all others. This may have been a stroke of marketing genius, the book being as popular as it was controversial, but in the forward to the edition published in 2006 Dawkins admitted that the title might give an inadequate impression of the book's contents, and he should perhaps have followed his publisher, Tom Maschler's, suggestion: 'The Immortal Gene'.

Editors are not always so helpful. Nobel Laureate Leon Lederman's 1993 book about the history of particle physics would likely have been called "The Goddamn Particle" had not the publisher insisted on "The God Particle" instead. That title refers to the Higg's Boson an elementary particle involved in giving matter mass whose existence was hypothesized in 1964 but not confirmed until half a century later by data from the Large Hadron Collider. Peter Higgs after whom the particle is named and who died in March this year, didn't like either name preferring to call it "the scalar boson".

In plant biology we may have another prominent example. In 1997, Suzanne Simard and colleagues published a paper in *Nature* with the title 'Net transfer of carbon between ectomycorrhizal tree species in the field'[1]. The Letter does not contain the term 'wood-wide-web' and neither does the accompanying News & Views by David Read (entitled 'The ties that bind'[2]). Those were the words on the cover of the August issue of the journal, but no one can remember which member of staff came up with them. Nevertheless 'wood-wide-web' is the term that has become adopted for the idea that the roots of trees and the hyphae of mycorrhizal fungi form a network beneath the ground capable of exchanging nutrients, carbon sources and perhaps much more.

The metaphor of a wood-wide-web is almost too good. It immediately suggests that fungal hyphae are acting like the data cables that connect the servers and computers of the internet (in this analogy the trees and other plants), communicating chemically to transmit distress signals to warn of diseases or predators. The forest then appears as a super organism reminiscent of the semi-sentient 'Old Forest' in J.R.R. Tolkein's 'Lord of the Rings'. Simard herself has gone on to develop a theory of trees using the subterranean fungal networks to support their saplings growing around this central 'mother tree'.

It would be difficult to overstate the importance of the frequently symbiotic interactions between plants and fungi. However, despite the more than a quarter of a century since Simard's paper showing that carbon assimilated in one tree could be found in other trees connected by a fungal hyphae, data unequivocally supporting a fully functioning wood-wide-web can be hard to find. A recent Perspective in *Nature Ecology & Evolution*[3] concluded that the field is dogged by overinterpretation of results and biased citations, a view shared by many in the ecology community[4].

Of course, it is challenging to perform robust experiments in this area. In this issue of *Nature Plants*[5], Vincent Merckx and colleagues suggests that one approach to simplifying the system is to study mycoheterotrophic plants, which have no photosynthetic ability and instead obtain all their carbon from mycorrhizal fungi. There are many such plants from a variety of clades most notably the orchids, all of which are initially mycoheterotrophs although most develop some degree of photosynthesis as they grow.

Science demands rigorous thought and reasoning, but the language we use can be ambiguous and poorly defined. We must guard against letting our metaphors make us run ahead of our facts.

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