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EDITORIAL

Cooperation, Conflict and Competition

'Survival of the fittest' is a phrase that is most often used as a succinct, but misleading, summary of the essence of modern ideas on biological evolution. A decade before Darwin's *Origins*, Tennyson wrote these famous lines in 1849:

*'Who trusted God was love indeed
And love Creation's final law-
Tho' Nature, red in tooth and claw
With ravine, shrieked against his creed.'*

In later years, Tennyson's image of 'Nature, red in tooth and claw' has been used as a poet's view of the struggle for survival in the natural world, most often in discussions of Darwinian ideas. Tennyson's verse may have been inspired by an 1849 pamphlet entitled 'Vestiges of the Natural History of Creation', which was published anonymously at that time. The idea of competition and conflict as drivers of evolution seems implicit in the phrase 'survival of the fittest'. Selection and adaptation are less often perceived as important in the common view of evolution. Extrapolation from biology and nature to human affairs has made the phrase 'survival of the fittest' an apt descriptor of a ruthlessly competitive world, in which the 'fittest' move ahead, while the less endowed fall by the wayside. While conflict and competition seem to be commonplace, it is surprising that biology abounds with examples of cooperation and altruism. Human civilizations have also developed over centuries by evolving models for cooperation and conflict resolution, albeit imperfect models which often breakdown. As a science administrator, I have often wondered at the reluctance of scientists to collaborate and cooperate and the difficulty of generating a passion for shared visions and goals. The individual always seems to take precedence over the collective. I was therefore immediately drawn to a recent essay entitled 'On the origin of cooperation', written to commemorate the 'Year of Darwin' (Pennisi, E., *Science*, 2009, **325**, 1196).

The social insects, organisms where 'workers' display remarkable discipline in working in orderly fashion 'for the good of the colony', attracted Darwin's attention, posing as Pennisi notes, 'one special difficulty which first

appeared to me insuperable and actually fatal to my theory'. In the century and a half that has followed, Darwinian ideas and the existence of cooperation and altruism have been reconciled. Organization of multicellular forms of life requires synchrony and cooperation between individual cells; flocks of birds, swarms of bees, herds of elephants, groups of monkeys and schools of fish are examples of cooperation in nature. Dissimilar organisms can cooperate forming unique ecosystems; 'nitrogen fixing bacteria team up with plants', an example that Pennisi cites. There are others that are evident in our environment; the termite mounds, that sometimes tower in silence on our campuses, are the product of cooperation between the termites and a specific soil microorganism that enter into a symbiotic relationship. E. O. Wilson termed the fungus-farming termites, 'One of evolution's master clockworks, tireless, repetitive, and precise, more complicated than any human invention and unimaginably old'. In her essay, Pennisi advances the compelling view that cooperation, so pervasive in biology, may be considered as 'the third pillar of evolution, alongside of mutation and natural selection'. From Darwin's day, kinship has been advanced as a major element in cooperation. Pennisi highlights a key issue that must strike a chord in most readers, who wonder about the benefits to individuals of cooperating with larger entities: 'But cheaters – those who benefit without making sacrifices – are likely to evolve because they will have an edge over individuals who spend energy on helping others, thus threatening the stability of any cooperative venture'. In emphasizing the importance of genetic relatedness as a basis for cooperative behaviour, Pennisi quotes Haldane who is reported to have, famously, said: 'Would I lay down my life to save my brother? No, but I would to save two brothers or eight cousins'. In human societies cooperation appears to transcend genetics. Trivers' concept of 'reciprocal altruism', in his own words quoted by Pennisi, is summarized in readily understood terms: 'You scratch my back, and I'll scratch yours'. Large scale cooperation in humans is driven by complex factors and is a subject that has fascinated both sociologists and game theorists. The fact that human societies may be anomalies in the animal world and the mounting evidence that genes and kinship may be

overwhelmed by other factors has attracted researchers from diverse fields. 'Culture', a term that is harder to define than 'gene', is often invoked to rationalize human behaviour. Cooperation is important in the progress of fields as distant as science and commerce.

The 'nature of human altruism' has been analysed in many different studies. Ernst Fehr and Urs Fischbacher argue that 'there is much individual heterogeneity and the interaction between altruists and selfish individuals is vital to human cooperation. Depending on the environment, a minority of altruists can force a majority of selfish individuals to cooperate or, conversely, a few egoists can induce a large number of altruists to defect' (*Nature*, 2003, **425**, 785). The literature of sociobiology and human behaviour abounds with terms that are widely used in everyday life; cooperation, punishment, reputation and reward. Game theorists describe individuals with 'heritable strategies' as 'defectors', 'cooperators' and 'shunners', although the last descriptor is used in a manner that needs some explanation (Panchanathan, K. and Boyd, R., *Nature*, 2004, **432**, 499). A recent study authored by groups with interests in evolutionary dynamics and economics has a title that is immediately attractive: 'Positive interactions promote public cooperation' (Rand, D. G. *et al.*, *Science*, 2009, **325**, 1272). These authors use the device of the 'public goods game', which all of us engage in during the course of daily life. The authors note that 'reducing CO₂ emissions by driving fuel efficient cars and minimizing waste is a global public goods game'. So too is 'cleaning your dishes at home and doing your share of work at the office'. In contrast to many previous studies, Rand *et al.* conclude 'reward is as effective as punishment for maintaining public cooperation and leads to higher total earnings'. These authors suggest that 'reward outperforms punishment in repeated public goods games and that human cooperation in such settings is best supported by positive interactions with others'. The game theory literature is full of everyday terms and problems; the analyses and conclusions, based on mathematical models and simulation, are often equivocal. Nevertheless, the factors that govern large scale behaviour are beginning to be slowly understood. There are some lessons that might even be learned from the titles of papers in this area. I particularly liked the title 'Winners don't punish', a conclusion that seems statesmanlike (Dreber, A. *et al.*, *Nature*, 2008, **452**, 348). These authors note that within the 'framework of direct reciprocity, winners do not use costly punishment, whereas losers punish and perish'. Biologists and game theorists have been attracted by the possibility that 'defectors' and 'cheaters' can be distinguished from 'cooperators'. Similarity appears to pro-

mote sympathy. Recognition, in a biological sense, may be rooted in genetics and chemistry. Even physical similarity appears to be important in evoking trust in a game. A flurry of studies in this area point to the great interest that is focused on understanding the determinants of human cooperation (Sigmund, K., Sympathy and similarity: The evolutionary dynamics of cooperation. *Proc. Natl. Acad. Sci. USA*, 2009, **106**, 8405; Antal, T. *et al.*, Evolution of cooperation by phenotypic similarity. *ibid*, 2009, **106**, 8597; Krupp, D. B. *et al.*, A cue of kinship promotes cooperation for the public good. *Human Behaviour*, 2008, **29**, 49).

Cooperation within groups and conflict between groups are common features in the animal kingdom and rampant in human societies. In a provocatively titled essay, 'Conflict: Altruism's midwife', Samuel Bowles argues that the 'grisly evidence of a warlike past may help explain our distinctly cooperative nature'. He suggests that this distasteful idea is based on the evolution of 'parochial altruism', but notes that this 'is puzzling from an evolutionary perspective because both altruism and parochialism reduce fitness or material well-being compared with what a person would gain were he or she to eschew these behaviours'. Ethnic, racial and caste conflicts are rationalized by the idea of 'parochial altruism', but Bowles looks forward to a better future when he suggests 'that a parochial form of altruism is part of the human legacy, it need not be our fate' (Bowles, S., *Nature*, 2008, **456**, 326).

In science and in academic institutions the advantages of cooperation and collaboration are obvious. The rise of the multi-authored paper, the growing importance of interdisciplinary research and the need for large, collegial and cohesive teams in many areas of cutting edge research have resulted in a dramatic increase in scientific collaboration. Paradoxically as the global scientific environment becomes even more intensely competitive, alliances are forged between individuals, groups, institutions and even countries in an effort to survive and move ahead in the face of competitive pressures. The reward system in science has always promoted individuals over groups; credit sharing has been a potent inhibitor of cooperation. Curiously, in the globalized environment of higher education and research, 'survival of the fittest' may be a term that may soon apply to disciplines, departments and institutions. 'Fitness' may indeed be enhanced by cooperation and collaboration. Indian institutions must begin to think of a future where collective endeavour creates an environment which encourages both cooperative success and individual achievement. 'Cooperators' must eventually overwhelm 'cheaters'.

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