SuperCooperators: Altruism, Evolution, and Why We Need Each Other to Succeed

by Martin A Nowak with Roger Highfield

reviewed by EG Leigh Jr

Ecological communities are characterized by pervasive competition, and equally pervasive cooperation and interdependence. Yet evolution teaching has long emphasized competition and ignored cooperation. This view of evolution is distorted. The economist Adam Smith argued that competition promotes cooperation in human economies: competition acts likewise in natural communities (Leigh 2010). Just as teaching the first two chapters of Genesis as literal truth despite overwhelming contrary evidence created some virulent atheists, so emphasizing competition in evolution at cooperation's expense created some virulent anti-Darwinians. A new popular book on the role of cooperation in evolution—Nowak and Highfield's SuperCooperators—shows how cooperation shapes evolution. This book is a must for evolution teachers.

SuperCooperators reads rather like an autobiographical fireside chat, in which Nowak celebrates his mentors—Peter Schuster, Karl Sigmund, Robert May, and others—who helped him learn to shape mathematical questions about when cooperation evolves. The book never quite loses this character: it reminds us that science, too, is a cooperative enterprise. It begins by outlining five ways to evolve cooperation, as did Nowak (2006). The first involves a simple two-player game, Prisoner's Dilemma, that distills the essence of cooperation's benefits and risks. Each player has two options: cooperate or cheat. At each play, each partner scores three points if both cooperate, one point if both cheat. If only one cooperates, the cheater scores five, the cooperator none. In the long term, both benefit by always cooperating, but at each play, cheating always scores higher. Here, the most profitable strategy is reciprocity: cooperate at the first play, cooperate after every play where the partner cooperates, and cheat (with random exceptions) after every play that the partner cheats.

The second way of evolving cooperation involves pairwise interactions among members of a larger group where each knows the reputations of all others as cooperators. Here, individuals profit by cooperating only with those of good repute. The third involves a spatial game whose players are arranged in a square array. A player either always cooperates or always cheats; players cannot respond to the behavior or reputation of others. At each round, every individual plays a turn of Prisoner's Dilemma with each of its eight nearest neighbors. A player survives if the average of its eight scores is no lower than any neighbor's; otherwise, a clone of its highest-ranking neighbor replaces it. Cooperation persists if survivors never change their positions, whereas cooperation is doomed if survivors are randomly reassigned new positions after each round.
The last two ways to favor cooperation are best visualized in natural populations. In a population of many small groups of individuals, selection among groups favors cooperation if these groups sometimes split but almost never exchange members. Although within-group selection favors cheaters, keeping cheaters from infecting new groups allows groups of cooperators to replace groups of cheaters. Finally, kin selection favors helping close relatives reproduce if, thanks to this help, the spread of those genes of the helper also inherited by the relative from recent shared ancestors outweighs the cost helping imposes on the helper's own reproduction.

After outlining their five ways to cooperation, Nowak and Highfield show how essential cooperation was to several major transitions of evolution. They discuss how life began—emphasizing the "RNA world," how group selection transformed parasitic bacteria into mitochondria, and how metazoans and social insects evolved. Cheating endangers cooperation, so they focus more on how cheating is prevented than on how cooperation began. When discussing metazoans, for example, they provide a wonderful account of the human body's defenses against cancers, and how cancers sometimes overcome them.

Nowak and Highfield then consider cooperation among human beings. First, they discuss how language evolved, for language is one precondition for the intricate, complex, cooperative networks that allow human beings to dominate the planet. Next, they consider tragedies of the commons, failures in cooperation which gravely threaten human social and economic progress. Curiously, the book ignores how small, stable sets of neighbors often resolve such tragedies (as Nowak's theories predict), instead emphasizing artificial experiments concerning cooperation among students. In a discussion that is often illustrated by social frivolities, the book shows how cooperation thrives best at intermediate levels of connectedness (as in spatial games). *SuperCooperators* ends with a sermon on how cooperation must be maintained and its range expanded for civilization to survive.

Nowak and Highfield's five ways to cooperation have been criticized because some of them can be reformulated in terms of kin selection. For example, absence of migrants among groups promotes intragroup relative to intergroup relatedness, so group selection can be represented as kin selection. All five ways, however, have proved useful for understanding how cooperation evolves. Spatial games show why life must have begun on catalytic surfaces, not in some "warm little pond" (Lane 2009:9–24). Darwin (1871:161–166) invoked group selection, and responses to the reputation of others, to explain the evolution of cooperative morality; group selection helped Leigh (1983) understand how parasitic bacteria evolved into mitochondria.

The book varies in clarity: I had to look elsewhere to understand how spatial games worked. Another flaw is its deprecation of kin selection. The authors accuse West and others (2008) of "rebranding" group selection as kin selection. In fact, Hamilton (1975) and Crow and Aoki (1982) showed that group selection can be expressed as kin selection, without animus or attempt to rebrand. Nowak and Highfield seem to forget that relatedness r and cost of helping c are not the only variates in Hamilton's rule that helpfulness evolves if \( br > c \). They (p 167) correctly state, following the noted ant specialist EO Wilson, that even among species with identical \( r \) and \( c \), social behavior only evolves in those with a particular ecology and natural history, but they seem not to realize that the ecology and natural history that favor cooperation ensure high values of the benefit \( b \) of helping. In-
Indeed, kin selection is the easiest way to understand the maintenance of insect societies. Because a honeybee queen's workers have many fathers, a worker is more closely related to a queen's egg than to a half-sister's, so she cares for the one and eats the other. Because all the queen's workers behave thus, they create a common interest in helping the queen by making it futile for workers to lay eggs of their own (Seeley 1995:12–13).

On the whole, however, this book is clear, and it reads well. It emphasizes human cooperation more than the wonders of nature, but in today's world, that emphasis may make it a more effective teaching tool. Moreover, its message on cooperation's essential role in evolution and human affairs is right on target.

REFERENCES

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