ANTS: D. FARRELL/GETTY; ILLUSTRATION: MARTIN O'NEILL

acts on groups as well as individuals. The individual is still the unit of selection, but membership of the group confers such benefit that the individual evolves to act on the group's behalf instead of its own.

Wilson argues that eusociality arises in stages: first the formation of groups, then the development of tightly knit communities built around defensible nests and then the elimination of any desire to leave the group. Dense interactions create intense advantages for group membership, allowing the development of castes in insects (some of which lose the ability to reproduce) and language and culture in humans. At this point, it makes sense to think of the group as the unit of selection — a 'superorganism' — that competes with other groups.

Wilson's theory of eusociality is an elaboration of a paper that he published in *Nature* (M. A. Nowak *et al.* *Nature* **466**, 1057–1062; 2010). When that paper came out, I was struck by how little the authors discussed one of the key results: that population structure (who interacts with whom) is extremely important in evolution. In this book, Wilson rectifies this oversight, paying particular attention to the fact that humans "are enmeshed in social networks".

For example, Wilson's elegant model of natural selection shows that two populations with an identical set of individuals can favour completely different genetic outcomes with just small changes in their network of interactions. One network may drive the population to be highly cooperative; another may drive it to be highly individualistic. And not only do networks affect genes, but genes also affect networks. In *The Social Conquest of Earth*, Wilson cites work by social scientists Nicholas Christakis, Chris Dawes and myself showing that genetic variation between individuals accounts for a sizeable part of the variation in human social networks. His model suggests that these networks and our capacity to navigate them contribute to the uniqueness of our species.

Wilson contrasts his own model of eusociality with models of inclusive fitness that build on ideas originating in work on kin selection by British evolutionary biologist W. D. Hamilton. Hamilton's key insight was that a gene can survive either by helping an individual to reproduce or by helping

BEHAVIOUR

Life interwoven

James H. Fowler applauds a master biologist's model of the evolution of sociality.

Biologist E. O. Wilson's brilliant new volume, *The Social Conquest of Earth*, could more aptly be entitled 'Biology's Conquest of Science'.

Drawing on his deep understanding of entomology and his extraordinarily broad knowledge of the natural and social sciences, Wilson makes a strong case for the synthesis of knowledge across disciplines. Understanding the biological origin of what makes us human can help us to build better theories of social and psychological interaction; in turn, understanding how other social species have evolved may help us to better understand the origin of our own.

But the main reason that Wilson's book is successful is that he also brings into biology the best of what social science has to offer. He draws on careful work in

linguistics, psychology, economics, religious studies and the arts to elaborate on differences between humans and other species. This give and take, this flow of ideas across disciplines, allows him to study an intriguing set of questions. Why did ants and humans both become social? What is it about being social that helped both species to achieve evolutionary success? And if it worked so well, why aren't all other species like us?

He answers these questions with a general theory about the origin of eusociality, the condition in which a species becomes so socially integrated that natural selection

The Social Conquest of Earth
EDWARD O. WILSON
Liveright/Norton:
2012. 352 pp.
\$27.95/£18.99

NATURE.COM

For a review of E. O. Wilson's *The Superorganism*, see: go.nature.com/pgqpjg

The Information: A History, a Theory, a Flood

James Gleick (Vintage, 2012; \$15.95)

Science writer James Gleick unpicks our fixation on information as "the driver of just about everything", said reviewer Thomas Misa. Gleick starts with African 'talking' drums, sidesteps into genetics and cryptography, and ends with the modern information overload (*Nature* **471**, 300–301; 2011).

Unnatural: The Heretical Idea of Making People

Philip Ball (Vintage, 2012; £9.99)

Creating artificial people has been a human obsession from medieval ideas of homunculi to lab-created synthetic microbes, says science writer Philip Ball. But our own myths have bred distrust of 'unnatural' forms of life. (See Chris Mason's review: *Nature* **471**, 297–298; 2011.)

other individuals with the same gene to reproduce. So, a gene that promotes an action that is costly to the individual might be able to survive if it provides a benefit for a relative. And because close relatives share more of the same genes than distant ones, interactions between kin increase the likelihood of maintaining such acts of altruism.

Wilson argues that Hamilton's model is based on overly simplistic assumptions about population structure. It does not take into account indirect fitness advantages (all the people who are helped by the people we help, for example). Inclusive fitness is a special case of Wilson's model, but he asks: "Why not simply use the general theory everywhere?"

Many of Wilson's ideas in this book will stand the test of time. However, he is perhaps a bit too assertive in the way he frames his theory. He is excessively critical of inclusive fitness theory, repeatedly claiming that it is "incorrect", and saying that the literature on it has produced "meager" results. Yet inclusive fitness theory has prompted much empirical and theoretical investigation, with more than 1,000 articles published in the past 40 years. Albert Einstein, after all, didn't disparage the numerous physics experiments showing that Isaac Newton's simple formulae work remarkably well under specific conditions.

Wilson would, I am sure, object to this characterization on the grounds that inclusive fitness theory accounts for a much smaller subset of his own theory than Newton's work does for Einstein's. In fact, Wilson continually claims that inclusive fitness theory works only "under stringently narrow conditions". But there is no empirical evidence for this.

One of Wilson's laments is that we have few examples of attempts to specifically measure fitness and interaction networks to test inclusive fitness theory — but the same is true for his own theory. So whether the special case of inclusive fitness is a reasonable simplification remains an open question.

Fortunately, Wilson's provocative and important book gives us a new way to test this theory coherently. ■

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MARTIN O'NEILL

ROBOTICS

Enter the evolvabot

Noel Sharkey is engaged by a take on the intriguing overlap between biology and robotics.

A book on robotics by a marine biologist sounds a bit fishy, but *Darwin's Devices* is anything but. John Long takes us on a journey through the wonderful, oceanic world of research on the evolution of the vertebrae of extinct species.

Long's work is innovative because of his use — and strong defence — of modelling with physically embodied robots, rather than the usual software simulations of computational biology. He is also unusual, as a biologist, for the way that he exploits artificial evolutionary methods called genetic algorithms to test evolutionary hypotheses.

Darwin's Devices: What Evolving Robots Can Teach Us About the History of Life and the Future of Technology
JOHN LONG
Basic Books: 2012.
288 pp. \$26.99, £17.99

Long's accounts of justifying his research to sceptical fellow biologists contain both triumphs and difficulties. He relates how, when a colleague asked what robots have to do with biology, he replied that they are

The Epigenetics Revolution

Nessa Carey (Icon Books, 2012; £9.99)
Epigeneticist Nessa Carey brings the emergent and controversial field of epigenetics to a wide audience. Carey's lively vision of how DNA works resembles a film script, with "plenty of room for interpretation and retakes", noted reviewer Jonathan Weitzman (*Nature* **477**, 534–535; 2011).

The Big Thirst: The Secret Life and Turbulent Future of Water

Charles Fishman (Free Press, 2012; \$16)
In what reviewer Margaret Catley-Carson called a "torrential flow of a book", journalist Charles Fishman argues that we must value water. He shames overusers, praises heroes and sets out policy challenges (*Nature* **473**, 27–28; 2011).