

BOOK REVIEW

The medium is the message: a review of *Ant Encounters: Interaction Networks and Colony Behavior*, by Deborah M. Gordon

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In a culture like ours, long accustomed to splitting and dividing all things as a means of control, it is sometimes a bit of a shock to be reminded that, in operational and practical fact, the medium is the message.

Marshall McLuhan 1964, p.7

When the cultural media critic Marshall McLuhan wrote these famous words in 1964, he may not have realized they might also apply to the organization of ants as Deborah Gordon has come to understand them. Ten years ago, Gordon wrote *Ants At Work: How an Insect Society is Organized* (2000), a short book that gave general readers a rich, first-hand account of her work on the behavior and ecology of the red harvester ant, *Pogonomyrmex barbatus*, which she has studied in the Arizona desert for over 25 years. Her new book, *Ant Encounters: Interactions Networks and Colony Behavior* (2010), is of similar length and format, and picks up the trail of the previous one, exploring ant colonies as complex systems whose behavior as a unified whole emerges from the self-organizing activity of its parts. *Ant Encounters* is both a reiteration and extension of Gordon's thesis that the key to understanding the behavior of an ant colony as a collective entity lies in the particular pattern of local interactions among individuals and the tasks they are performing at a given time. The hypothesis seeks to explain behavior of ant colonies in a generalized sense, with red harvester ants (affectionately known as "Pogos" to ant biologists) as the model system. Gordon's detailed research on task allocation within Pogo colonies and the behavioral dynamics between them is unique in the field because of her

many years of continuous observation tracking the same colonies. Given this empirical depth, her research program has contributed novel insights into our understanding of colony growth, lifecycle, and the means by which ants manage to coordinate on the level of the "superorganism," despite a lack of any centralized control.

A key conclusion that Gordon draws from both empirical observations and computer models is that change in the size of a colony (in terms of the number of individual workers) is essentially a change in the size of an adaptive *network*, with each worker ant functioning as a participatory and interactive node. Changes in colony size bring about changes to the rate and pattern of local interactions, and this in turn fundamentally alters the behavior of an ant colony and its responsiveness to its environment. The particular focus on rate and pattern of interaction is a fundamental and crucial aspect of Gordon's hypothesis: "The pattern of interaction itself, rather than any signal transferred, acts as the message. What matters is not what one ant tells another when they meet, but simply *that they meet*" (pp. 47–48). The medium, alas, is the message. Ants may "tell" each other something via pheromones, but the idea is that these act as auxiliary cues for contextualizing the fundamental message that is embedded within the rate and pattern of the ant-ant interaction itself as well as the configuration of connectivity these collective interactions subsequently generate colony-wide. It is this quality of networked interactions that Gordon believes links ant colony behavior to a range of other complex and self organizing systems like brains, immune systems, and the internet—all of which are distributed, noisy, and highly responsive wholes composed of relatively simple parts.

Gordon makes clear that she believes this perspective on ant organization contrasts sharply with the extensive body of research that employs the concept of specialized "castes" that

manifest a “division of labor” within a colony, a theoretical framework whose development owes much to the work of Wilson and colleagues (Oster and Wilson 1979; Hölldobler and Wilson 1990). McLuhan’s commentary on, “a culture like ours, long accustomed to splitting and dividing all things as a means of control,” could just as well describe Gordon’s conceptual critique of division of labor theory, which she believes implies, “that each individual is genetically programmed to do a certain task” (p. 25). Her epistemic claim is that a caste and division of labor approach to studying ants favors reductionistic and gene-centric accounts that look for deterministic solutions, and in turn neglect the central roles that interactive, stochastic, and emergent processes play in generating behavior of whole colonies. For anyone familiar with the social insect literature, however, it may be hard not to feel like Gordon’s characterization of caste and division of labor theory—as well as Wilson’s conception of them—tend toward caricature in the book. As a consequence, readers may at times have the uncomfortable feeling of being asked to make a biologically false choice between the role of “genes” versus “the environment” as causes of an ant’s behavior; between being loyal to a narrowly deterministic and reductionist approach on the one hand, or open-mindedly embracing holistic complexity on the other. Such oversimplifying dichotomies early on are frustrating, and perhaps a little ironic given that *Ant Encounters* is part of the Santa Fe Institute’s series “Primer in Complex Systems” intended for a general readership seeking to engage the inescapably layered complexity of biological systems.

As for making sense of the differences between Gordon and Wilson raised in the book, it is useful to consider the philosophical distinction between “methodological reductionism” as a matter of scientific practice, and “ontological reductionism” as a matter of belief about the causal basis of a biological phenomenon (Fehr 2004). As methodological reductionists, both Wilson and Gordon have been committed to analyzing the dynamics of individual ants as a means to study a colony’s collective ends, with neither ever assuming the whole is simply the sums of its parts. The fact that Wilson spent the majority of his career focusing on ant species with polymorphic workers while Gordon has devoted herself to those with monomorphic workers has profoundly affected the kinds of models and approaches they prefer. This in turn has contributed to internecine disputes over how “the quint-essential” ant colony supposedly works, which is of course tricky terrain. As Gordon points out, “Because ants are so diverse, it is misleading to generalize about ants” (p. 15). Of course, avoiding generalizations is much easier said than done. After all, seeking generalities is a hallmark of science, and models are its method.

Gordon’s preferred model for analyzing the dynamics of biological systems of various types at various scales is the interaction network: “An interaction network is a set of re-

lations among the participants. We all participate in such networks: within families and at work, on the Internet, among users of cell phones. Networks differ in what happens at each node and by whether information or some substance is transferred” (p. 47). What the concept of an interaction network achieves in its broad scope, it trades off for specifics in the book. Gordon asks us in the first chapter, “What exactly is the similarity between an ant colony and a computer program, or an artificial brain?” (p. 8). To the extent that this larger question is an important one, its resolution remains elusive. Similarities to other biological systems like multicellular coordination are briefly discussed, although with little explicit reference to the concepts of redundancy, exploratory behavior, linkage, or robust feedback that readers of an EvoDevo inclination might expect when considering the mechanisms that underlie self-organizing biological phenomena.

As for the role of analogical models in social insect studies historically, the first two chapters of *Ant Encounters* gives a short and compelling introduction to how our beliefs about ant behavior have been influenced by our anthropocentric conceptions of social order, from the Old Testament to contemporary Disney movies. Gordon shows how social models have given way to the mathematical models, computer simulations, and biomimetic engineering analogies of today. The models function as both tools of study as well as their own forms of metaphor in shaping our thinking about complex collective behavior. The powerful and widely applicable models that complex systems research employs have suggested a deep unity between computational systems and biological systems. Given Gordon’s caution for us to consider the assumptions that lurk within metaphors and models, it leads one to wonder the degree to which shared properties discovered across diverse systems are revealing fundamental patterns in nature, or rather revealing the shared structure of the models that are used to study these complex systems. If division of labor theory in ant research is a little too cozy with Adam Smith, will we ask similar questions about the use of the computer network paradigm in biology a hundred years from now?

Ant Encounters provides a broad treatment of recent empirical findings across a wide diversity of species, especially in comparison to her earlier book. Gordon’s discussion of invasive species biology as well as ant-plant mutualisms in later chapters of give a nice level of detail with aptly chosen cases that illustrate the networks of interaction that are significant in the broader ecological context of the colony. As biology as well as natural history, these sections are evocative and enjoyable. While there is little visual or diagrammatic explanation made use of in the book, Gordon’s descriptive clarity is vivid. The writing is skillful in describing task groups as they undertake the work of foraging, nest maintenance, and defense under natural conditions, as well as elegant

experimental ones that Gordon sets to her small and numerous study subjects.

In the end, *Ant Encounters* nicely conveys a sense of the myriad of dynamics at work under every unassuming anthill, as complicated as they are complex. In terms of connecting the dots, a full synthesis of how simple interaction networks within a colony self-orchestrate to create a full-fledged super-organism is left open, but this is inevitably so given all that remains to be understood. Biologists need only follow the sound research advice of *Proverbs 6:6* and, “Go to the ant, thou sluggard; consider her ways,” for there is plenty of work still to be done in exploring the complex developmental & evolutionary networks that make social insect colonies such compelling—and indeed “super”—organisms.

REFERENCES

- Fehr, C. 2004. Feminism and science: mechanism without reductionism. *NWSA J.* 16: 136–156.
- Gordon, D. M. 2000. *Ants at Work: How an Insect Society is Organized*. W. W. Norton & Company, New York, NY.
- Hölldobler, B., and Wilson, E. O. 1990. *The Ants*. Belknap Press of Harvard University Press, Cambridge, MA.
- McLuhan, M. 1964. *Understanding Media: The Extensions of Man*. McGraw Hill, New York, NY.
- Oster, G. F., and Wilson, E. O. 1979. *Caste and Ecology in the Social Insects*. Princeton University Press, Princeton, NJ.