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Title

The Spirit of the Hive: The Mechanisms of Social Evolution . By Robert E. Page Jr. Cambridge (Massachusetts): Harvard University Press. \$39.95. xiv + 226 p.; ill.; index. ISBN: 978-0-674-07302-9. 2013.

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precisely, either by avoiding vague terms such as *information*, or by specifying which of the many definitions of *information* they are using. More fundamentally, this book will help to refine animal communication theory by prompting researchers to reconsider whether information is relevant at all.

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THE SPIRIT OF THE HIVE: THE MECHANISMS OF SOCIAL EVOLUTION.

By Robert E. Page Jr. Cambridge (Massachusetts): Harvard University Press. \$39.95. xiv + 226 p.; ill.; index. ISBN: 978-0-674-07302-9. 2013.

An enduring wonder of social insects is how individual actions are shaped by and shape the whole. Maurice Maeterlinck called this force “the spirit of the hive” and Page seeks the genetic, physiological, and behavioral mechanisms behind this spirit. Drawing from 30 years of research, he offers an elegant answer: the complex social behavior of honey bees arises from genetic and regulatory mechanisms found in their ancestors, solitary insects. Essentially, bee ovaries are a major agent in structuring their behavior and determining how they respond to environmental stimuli. The resulting behaviors provide local environmental feedback, altering the stimuli that nestmates respond to.

Page’s approach is distinguished by its emphasis on using honey bee breeding and evolutionary population genetics to explore the question of what regulates individual and colony behavior. He focuses less on the ecology and behavioral ecology of honey bees. However, Karl von Frisch would have appreciated the attention given to behavioral mechanisms. The author begins by reflecting on one of Darwin’s dilemmas: how sterile social insects castes evolved when these castes do not normally reproduce. This leads him to consider how the colony works in the absence of central control, Maeterlinck’s mysterious agent, the spirit of the hive. Page then presents a “stone soup” model of behavior and multiple case studies, all designed to show that coordinated behavior is an inescapable emergent property of bees responding to stimuli that they encounter and produce.

A major focus is how greater genetic diversity in workers has benefits and consequences. This diversity is facilitated by high honey bee recombination rates and by queen polyandry. Increased genetic diversity leads to a greater assortment of response thresholds, which in turns yields a more finely graded response to environmental changes. However, a honey bee queen can mate with more than 20 males. Why has such a high degree of polyandry evolved? The author explores three hypotheses in

detail and favors the sex determination hypothesis, that polyandry increases brood viability because homozygosity creates sterile males. He reviews evidence that multiple mating is not very costly for queens, which may also not have complete control over how many times they are mated.

Having established the benefits of genetic diversity and how honey bees increase it, Page introduces the pollen hoarding syndrome, the results of 20 years of selective breeding and the centerpiece of his research. By selecting for colonies that stored more pollen, “pollen hoarders,” the author generated bees with distinctive behavioral traits such as age of first foraging, individual foraging preferences, and altered sensitivities to multiple environmental stimuli such as nectar sugar content, pollen, light, and brood presence. Pollen hoarding is central to the theme of feedback between environmental stimuli and bee responses. From here, he returns to genetics by mapping the intricate gene network underlying the pollen hoarding syndrome. The architecture is complex and leads him to finally call for understanding the ecology of genes: how gene expression and the complex network of gene interactions can be understood at multiple levels, particularly the view from “10,000 meters” where broader patterns emerge. Likewise, this bigger picture is what I most appreciated about Page’s book, the holistic treatment of his work that is couched in language for specialists and the general audience, an understanding of how a soup stewed over 30 years has arrived at its depth of flavor.

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THE ART OF MIGRATION: BIRDS, INSECTS, AND THE CHANGING SEASONS IN CHICAGOLAND.

Paintings by Peggy Macnamara; Text by John Bates and James H. Boone; Foreword by John W. Fitzpatrick. Chicago (Illinois): University of Chicago Press. \$25.00. xx + 203 p.; ill.; no index. ISBN: 978-0-226-04629-7. 2013.

The popular appeal of observing migrating birds and insects has never been as pervasive as it is today. In her delightful book, *The Art of Migration*, Peggy Macnamara uses her talent as a watercolorist to depict, in often strikingly beautiful and vibrant colors, snapshot scenes in the seasonal passage of birds and insects in the Chicago area. Interested readers should know that the book is not, nor does it claim to be, a field guide nor does it provide a scientific treatment on the biology of migration. Her coauthors provide some scientific realism to the watercolors by giving concise and usually engaging summaries on the natural history of the