

**HOW THE ENVIRONMENT CAN SIMPLIFY THE
BEHAVIORAL ALGORITHMS OF SOCIAL INSECTS**

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A key problem in the study of social insects is to establish a link between individual behavior and global structures. Of particular interest is the question of how much individual complexity is required to produce the observed global complexity. In many cases, self-organization can provide a powerful mechanism for generating collective structures. An important feature of these self-organizing systems is that natural selection often produces simple behavioral algorithms that allow social insects to exploit physical constraints in the environment. Individual behaviors modify the environment, feeding back on individual behaviors, resulting in complex global structures. This is not a new idea but today it appears that these mechanisms are more powerful than we imagined. In fact, we find similar strategies among many different social insect activities. Using examples of building by ants, involving the piling and clustering of materials, we discuss: (1) How collective decisions arise through amplification of environmental heterogeneities, (2) How physical constraints, such as available space, affect global patterns without the need to modulate individual behaviors, (3) How, in other cases, insects modulate their behaviors and communication by exploiting simple, information-rich cues. In these self-organizing systems, the interplay between positive and negative feedbacks provides the driving force for structure formation. Often, individual behaviors code for positive feedback and the environment provides negative feedback. The inverse situation is also observed, in which the environment provides positive feedback (leading to complexity) and individual behaviors code for negative feedback (leading to a simplification and regularity of the structure).