Self-organized processes in social insects

Guy Theraulaz

Laboratoire d'Ethologie et Cognition Animale, CNRS - ERS 2382, Université Paul Sabatier, 118 route de Narbonne, 31062 Toulouse Cédex, France.
Tel: (033) 5.61.55.67.82, Fax: (033) 5.61.55.61.54, E-Mail: theraula@cict.fr

Social insects are capable of building complex structures, such as termite mounds resembling 'skyscrapers with air conditioning'. However, unlike human builders, they generate these structures without the help of an architect or a blueprint. This is similar to the process of morphogenesis by which cells of a developing organism produce features on a scale much larger than their own size. The cells do not possess an internal representation of these features, be it the pattern on a sea shell or the basic segmentation of a fruit fly. Since the pioneering work by Turing on the chemical basis of morphogenesis (Turing, 1952), local activation and long range inhibition mechanisms have traditionally been regarded as important characteristics of pattern formation. They have been identified in physical and chemical systems but their relevance in biology remains controversial. So far, no conclusive experiments have confirmed this conjecture due to the lack of a clear identification of the microscopic processes at work. I will present a simple experimental set-up involving colonies of the ant species *Messor sancta* which displays a well defined phenomenon of collective clustering of corpses. This process is shown to follow the characteristic features of local activation long-range inhibition mechanisms and Turing instabilities, i.e. competition between modes, symmetry breaking and a well-defined characteristic wave length. All relevant properties have been measured experimentally allowing to construct a theoretical model which fully agree with experimental data. These results give support to previous theoretical work suggesting that social insects might use these type of instabilities to construct their nests and a wide variety of spatio-temporal structures. Furthermore, these results have parallels in other processes of pattern formation. In morphogenesis, decisions are made by cells that are hard to cast in the roles of architects. Organisms and 'superorganisms' of social insects thus share a problem, so that ants might teach us valuable lessons about morphogenesis.

Turing, A. On the chemical basis of morphogenesis. *Phil. Trans. Roy. Soc. London B* 237, 37-72 (1952).

Keywords**:** *Messor sancta*, Reaction-difusion models, Turing structures, self-organization, pattern formation.