Box 3 Ants at the edge of chaos

Most people would regard ants as relatively simple creatures but, as a series of experiments undertaken during the mid-1980s demonstrated, their behaviours, when viewed at a system level, can produce surprising and unexplainable outcomes.

The design of the experiments was simple. First take a nest of ants. Second, place two identical piles of food equidistant from the entrance to the nest. Third, replace grains of food that are removed from the piles so that they remain identical. The question is: once the ants are released, will they all go to one source of food, or divide themselves in some proportion between the two piles?

Since there was no reason for an individual ant (so far as is known) to prefer one food pile over the other, it might be expected that the colony would divide itself evenly, roughly half going to one pile and the remainder to the other. Each ant emerges from the nest, mentally tosses a coin, and makes for one pile or the other. Having been successful and the food pile remaining constant, the ant has no reason to change its behaviour.

However, it is known that an ant, having successfully found a source of food, will pass on the good news to others and try to persuade them to follow it by a chemical secretion. Successful behaviour is reinforced by this means and a positive feedback loop established.

The result should be that eventually all the foraging ants are persuaded to visit just one of the food piles or that the proportions might settle down to be different from a 50:50 split, the exact ratio being established by variations in the foraging pattern.

'In fact what was seen to take place was a completely different outcome. Even when the experiment had been running for some time, in ant terms, the proportion of the ant population visiting any one site continued to fluctuate in an apparently random fashion. The proportions averaged out at one half, but this precise outcome was hardly ever observed, and the proportion was subject to constant change. Once a large majority of ants had visited one of the sites, the outcome tended to stay reasonably stable and exhibited small variations around that proportion for some considerable time. But the majority was always eroded and the ants switched to visiting the other site. Sometimes these shifts were not only very large – from, say, an 80:20 division at one pile to the reverse outcome of 20:80 – but also rapid.'

The experiments were varied to see whether a different outcome could be induced. Different species of ants were used with no difference. To eliminate possible differences in the food sources a single pile was used. Two separate bridges were set up at identical

distances from the entrance to the nest and the numbers of ants crossing each were counted. Again, the results replicated the original experiments.

The behaviour of the ants was of interest not only to biologists, and Alan Kirman, then at the European University Institute in Florence, began to look at the problem from a different view point.

‘Kirman set up a theoretical model which gives an excellent account of the observed behaviour of the seemingly perverse ants […] An ant coming out of the nest follows one of three possibilities: it visits the food pile it previously visited; it is persuaded by a returning ant to visit the other source; or, of its own volition, it decides to try the other pile itself. And this is almost all that is required to explain the complex and seemingly baffling phenomenon of the fluctuations in the proportions of ants visiting the respective piles.’

Adapted from Ormerod (1998)