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Patterns shape ant cemeteries

Fifty-year-old theory explains how ants gather their dead.
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Ants arrange their dead using the same principles that are thought to produce the markings on animal skin and on tropical sea shells.

This is the first clear example of so-called Turing patterns in communities of higher organisms, say researchers Guy Theraulaz of the Universite Paul Sabatier in Toulouse, France, and co-workers[1].

Such patterns are named after the mathematician Alan Turing, who also developed some of the fundamental concepts behind computers. Fifty years ago he came up with a theory of how spots and stripes appear spontaneously in nature, while he was trying to explain how a single-celled embryo grows into a patterned organism.

Turing showed that an initially uniform distribution of reacting molecules can develop into localized blobs that differ in chemical composition. Chemicals in an embryo might behave in this way, he thought, turning a uniform cell into one with some structure - a kind of primitive body plan.

There were no computers to help Turing with the difficult and tedious mathematical calculations, so he was forced to make a lot of simplifications. As a result, the work was largely ignored by biologists for several decades.

Then, in the 1970s, Alfred Gierer and Hans Meinhardt in

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Germany showed how Turing's mechanism of pattern formation could be regarded as a specific example of a very general kind of process.

They said that all one needs for a pattern to appear are two things: activation and inhibition. Activation is some kind of feedback process that amplifies small variations in the concentration of one of the ingredients. Inhibition is the condition that, if such a concentration occurs at one point, it suppresses the appearance of similar spots nearby.

Ant cemeteries seem to be created by an activator-inhibitor process, according to Theraulaz and co-workers. Just as we bury our dead in cemeteries rather than at random places throughout our communities, so ants keep their colonies tidy by organizing the corpses of their dead into piles.

Ants do not agree in advance where to place these cemeteries. The piles emerge from the collective actions of many individuals scurrying around carrying corpses. Somehow this uncoordinated behaviour produces orderly, almost evenly spaced, piles in a few hours.

Theraulaz and colleagues think that there is a self-amplifying activation process in this activity, because ants are more likely to drop a corpse on a pile, than elsewhere. And because picking up bodies and adding them to a pile sweeps the surrounding space clear, new cemeteries are inhibited from appearing close to existing ones.

The researchers devised a mathematical model of the process, based on the activator-inhibitor mechanism, that seems to agree with experimental observations of how far apart the cemeteries are spaced.

Activator-inhibitor mechanisms have previously been proposed to explain how organisms, such as predators and their prey, distribute themselves across a landscape in an ecosystem. But this is the first time that such a system has been measured carefully enough under laboratory conditions to provide clear evidence that Turing's process can operate at the level of colonies and ecosystems.

References

1. Theraulaz, G. et al. Spatial patterns in ant colonies. ***Proceedings of the National Academy of Sciences USA*** , published online, (2002).