Why locusts abandon a solitary life for the swarm

December 18 2008

By applying an old theory that has been used to explain water flow through soil and the spread of forest fires, researchers may have an answer to a perplexing ecological and evolutionary problem: why locusts switch from an innocuous, solitary lifestyle to form massive swarms that can devastate crops and strip fields bare. Their report, published online on December 18th in *Current Biology*, a Cell Press publication, concludes that once the insects' ranks grow to a certain threshold size, banding together prevents predators from moving from one patch of insects to the next and easily picking the bugs off one by one.

"A predator can only move continually across a landscape, consuming locusts as it goes, if there is a landscape-spanning pathway of connected, high-yielding patches containing locusts in abundance," said Andy Reynolds of Rothamsted Research. "If the locusts were to remain dispersed when their numbers become sufficiently high, then such predator-sustaining pathways would always exist. By grouping together, locusts can reduce the number of connections between patches, and there is a significant probability that the predator will locate too few locusts to sustain itself."

Locusts are a notorious outbreak pest, with the ability to increase sharply in abundance when conditions are right. They've also been of interest because of their remarkable ability to shift from a cryptic, solitary state to form migratory bands when their numbers grow. At such times, the insects not only behave differently, but the two "phases" also differ from each other in their physiology, color, shape, and many other traits—so much so that the phases were sometimes thought to be completely different species.

Despite the interest, scientists had no satisfactory explanation for the evolution of this behavior. Until now, that is.

In the new study, the researchers applied percolation theory—the study of how randomly generated clusters connect and behave—to the problem. The theory, so named from the way in which coffee flows through a percolator, is known to play a fundamental role in a diverse range of disorderly physical phenomena, but it had received rather little attention in ecological quarters, Reynolds said. Using the theory, they now show that it would be highly disadvantageous for individual locusts to continue indefinitely in a dispersed distribution as their population explodes. That's because the switch to a swarm disrupts the connections in the predators' network of tempting food patches.

The finding suggests that selection pressure from predators has been a key factor in driving the evolution of the insects' gregarious tendencies. And, they said, the theory will no doubt apply to other species and circumstances as well.

"We suspect that for any natural enemy that exploits patches of hosts, percolation theory warrants consideration as a generally applicable model underlying the ecology and evolution of aggregative behavior," Reynolds said. "For example, aggregation behaviors may have evolved in insects as an anti-parasite defense mechanism because by aggregating in groups, there is a greater probability that a parasite or pathogen will fail to breach the gap between infectious hosts."

Source: Cell Press