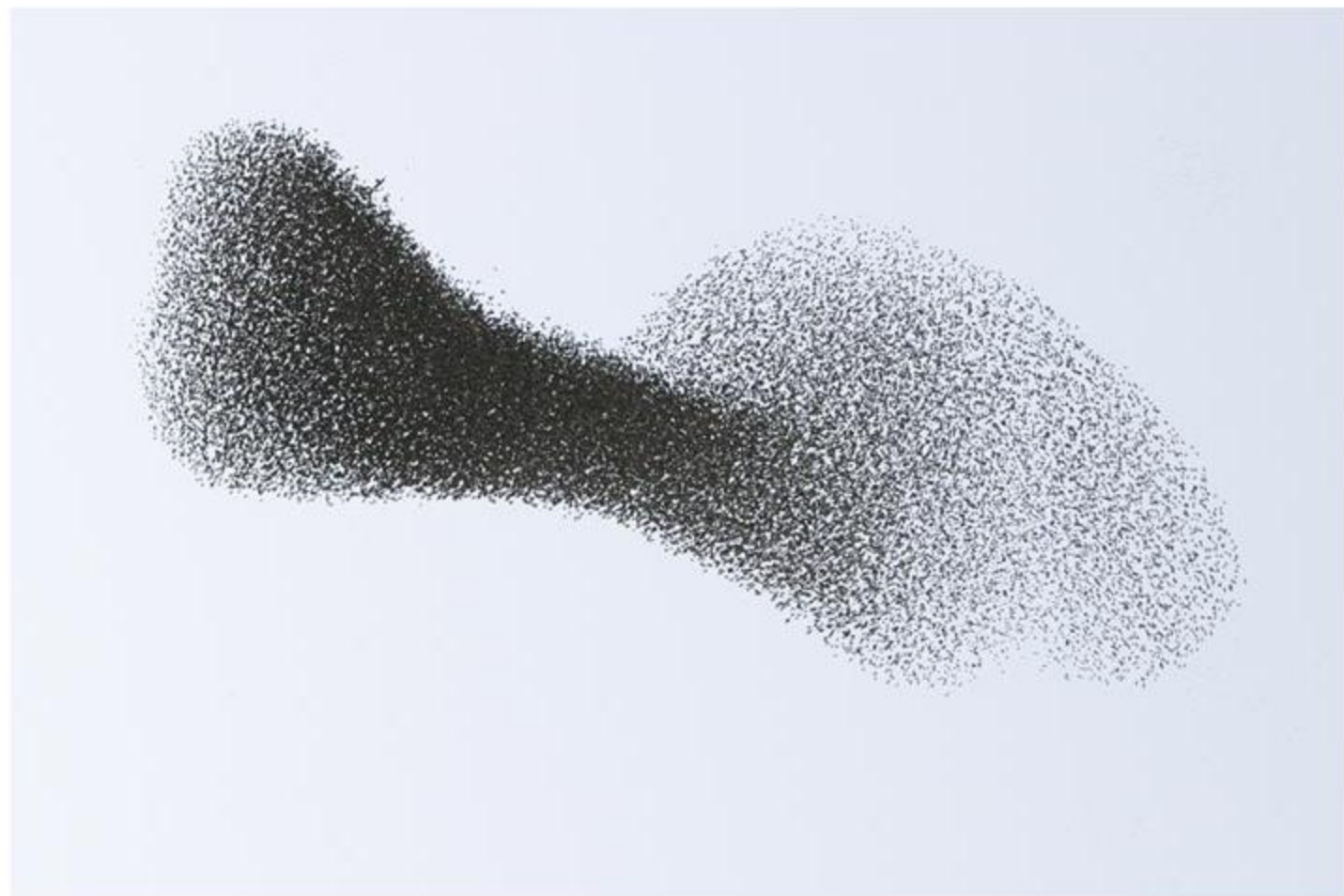


Swarm Behavior

A single ant or bee isn't smart, but their colonies are. The study of swarm intelligence is providing insights that can help humans manage complex systems.



Harmonious Flight

The ability of animal groups—such as this flock of starlings—to shift shape as one, even when they have no leader, reflects the genius of collective behavior—something scientists are now tapping to solve human problems.

Photograph by Manuel Presti

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Mass Escape

A peregrine falcon on the attack forces a flock of starlings to take evasive action, moving together as one.

Photograph by Manuel Presti

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Instant Messaging

Because each individual is paying close attention to its neighbors, news travels fast through a school of bigeye jack near Cocos Island in the Pacific. The fish follow simple rules that keep the group alert: stick together, avoid collisions, and swim in the same direction.

Photograph by David Hall

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On the Move

Wildebeests crossing the Mara River in Kenya may be able to follow a migration route even if only a few of them know the way, say researchers using a computer model of herd behavior. Never mind that the informed animals aren't trying to lead. The rest follow anyway.

Photograph by Winfried Wisniewski, Foto Natura

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Modern-day Plague

Locusts beyond number rise in a single black cloud in Mauritania, devouring every crop in their path and leaving hunger or starvation in their wake. Finding ways to prevent such plagues depends on a deeper understanding of swarm theory and the surprising ways it affects our lives.

Photograph by Jean-François Hellio and Nicolas Van Ingen

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Conveyer-belt Behavior

Leafcutter ants (*Atta colombica*) in Panama carry bits of vegetation to their nest, where collaborating teams of ants transport, clean, cut up, crush, mold, and pack the material into compost piles. Still other ants tend the piles to grow fungi, the main food source for the colony's young. Because a colony of several million leafcutters relies upon cooperation to survive, biologists sometimes describe it as a superorganism.

Photograph by Christian Ziegler

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Arboreal Light Show

A tree ablaze with fireflies in Indonesia blinks on and off as each insect adjusts its flashes to match the others. Such self-organized behavior resembles the synchronized firing of heart muscle cells or the rhythmic applause of a crowd—but seems more mysterious.

Photograph by Mitsuhiko Imamori, Minden Pictures

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Color-coordinated

A red color ring means "grab me," a blue one "stay away," as robots in a Brussels lab converge to form a single unit. Their goal: to accomplish something together they can't do alone, such as moving a heavy object.

Photograph by Mark Thiessen, National Geographic Photographer

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High-tech Teamwork

A team of inch-long (three centimeters) robots spreads out through a mock-up of a turbine engine in a Swiss lab. To speed the task of inspecting each blade, these experimental units can signal neighbors through infrared sensors.

Photograph by Peter Essick

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Communal Breadwinners

Army ants work together to find food to haul back to the group.

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From Ant Trails to Truck Routes

Tanker trucks with cargoes of liquid nitrogen, oxygen, and argon in Pasadena, Texas, are assigned delivery routes by dispatchers using a computer program inspired by the foraging behavior of ants.

Photograph by Peter Essick

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Working Smarter

When Southwest Airlines wanted to expand its package delivery business, but ramp workers complained that they were already doing a lot of extra handling of packages, the airline asked a consulting firm to look into it. Using a computer simulation based on the foraging behavior of ants, the consultants advised the workers to change their rules of thumb for routing packages. Instead of using the "hot potato" strategy—putting a package on the next flight heading in the general direction of the final destination—they recommended waiting for the next plane going to that destination, even if it meant a delay of several hours. The result: a 50 to 85 percent reduction in the number of packages transferred by ramp workers at their six busiest locations.

Photograph by Peter Essick

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Democratic Decisions

Even though swarming honeybees frequently differ about where to establish a new nest, the group usually chooses the best site. Bees reach this decision by gathering information, conducting independent evaluations, and holding a kind of vote.

Photograph by Peter Essick

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Driving Force

Chicago traders swarm on the stock exchange floor, driving the price of soybean futures with the same practices—fact-finding, independent study, and voting—used by swarming honeybees in search of a new site to nest.

Photograph by Peter Essick

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Mob Mentality

In high spirits, a well-dressed crowd at Ascot Racecourse near London celebrates a day of horse races with singing and patriotic flag waving. Individuals in a densely packed group tend to act differently from the way they would on their own, scientists say, not unlike a herd of animals. So event organizers need to take special care to keep participants from panicking as they exit such events.

Photograph by Peter Essick

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Water Ballet

Kids from a summer day camp watch a school of golden trevally swim by at the Georgia Aquarium in Atlanta. The ability of schools to stick together as they move through the water, which is beautiful to observe, still holds mysteries for biologists trying to understand the principles of collective motion.

Photograph by Peter Essick

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Gathering Storm

Biologists in an Oxford lab show that when otherwise harmless juvenile locusts get too crowded, they will suddenly align themselves and march in the same direction, triggering a potentially devastating swarm.

Photograph by Peter Essick

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Aerial Art

Flocks of starlings in Rome, Italy, twist and turn into curious shapes. The birds are not following leaders as they perform such maneuvers, biologists say, but rather acting as a group in which individual birds constantly change their position.

Photograph by Manuel Presti