Convergent con artists: How rove beetles keep evolving into army ant parasites

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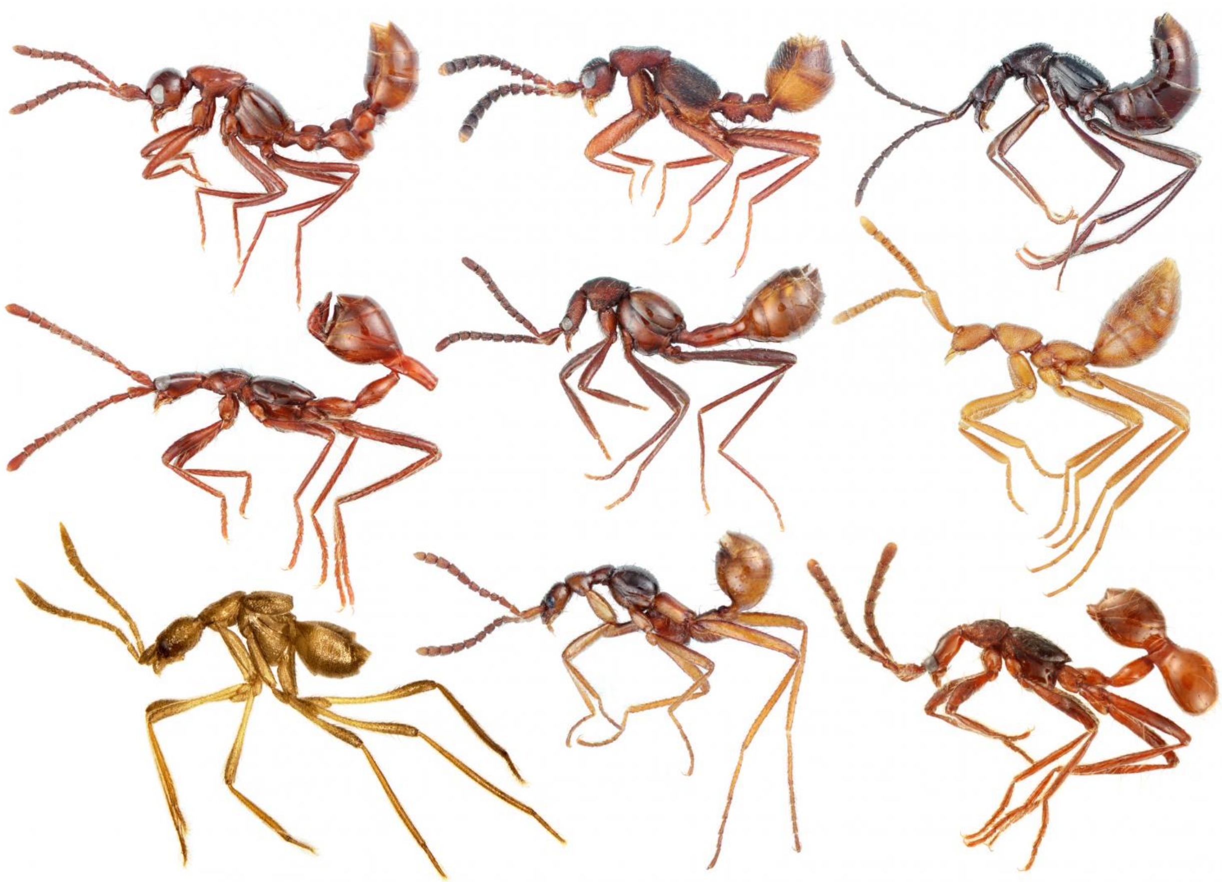
Symbiotic *Ecitophya simulans* rove beetle (foreground) walking alongside its lookalike army host ant, *Eciton burchellii* (left). The ant has a large round head, whereas the beetle has a flatter head. Credit: Taku Shimada

Marauding across the tropical forest floor, aggressive army ant colonies harbor hidden enemies within their ranks. The impostors look and smell like army ants, march with the ants, and even groom the ants. But far from being altruistic nest-mates, these creatures are parasitic beetles, engaged in a game of deception. Through dramatic changes in body shape, behavior, and pheromone chemistry, the beetles gain their hostile hosts' acceptance, duping the ants so they can feast on the colony brood.

This phenomenon did not evolve just once. Instead, these beetles arose at least a dozen separate times from non-ant-like ancestors. This discovery, published March 9 in *Current Biology*, provides evidence that evolution has the capacity to repeat itself in an astonishingly predictable way.

"These beetles represent a new and really stunning system of convergent evolution," says study co-author and evolutionary biologist Joseph Parker (@pselaphinae) of Columbia University and the American Museum of Natural History. "It's an elaborate symbiosis, which has evolved in a stereotyped way, multiple times from free-living ancestors."

The ant-mimicking beetles all belong to the Staphylinidae, or rove beetles, but don't mistake them for close relatives: the last common ancestor of the beetles in the study lived 105 million years ago, at about the time that humans split from mice. "What's exceptional is that this convergent system is evolutionarily ancient," says Parker. Although most other convergent systems, such as Darwin's finches, three-spined stickleback, and African lake cichlid fish, are a few million years old at most, this newly discovered example extends back into the Early Cretaceous.



Nine convergent rove beetle genera that have evolved to look like different army ant species. Top row, left to right: Weissfloggia, Ecitocryptus, Ecitoglossa. Middle row: Aenictoteras, Giraffaenictus, Pseudomimeciton. Bottom row: Dorylogaster, Diploeciton, Aenictolixa. Credit: Munetoshi Maruyama and Joseph Parker

Given this great age, Parker and his co-author Munetoshi Maruyama of the Kyushu University Museum argue that their finding challenges Stephen J. Gould's hypothesis that if time could be rewound and evolution allowed to replay again, very different forms of life would emerge. "The tape of life has been extremely predictable whenever rove beetles and army ants have come together," says Parker. "It begs the question: why has evolution followed this path so many times?"

Parker and Maruyama propose that although it's impossible that the beetles' most recent common ancestor was an army ant doppelganger, it probably possessed traits that would allow its descendants to readily evolve into army ant parasites. Free-living rove beetles are armed with glands that secrete defensive chemicals, so a beetle encountering an ant troop stands a much better chance of surviving than most insects do. And since rove beetles are predators, the brood of an army ant colony is an attractive food source. These traits, along with the rove beetle's body plan—flexible and able to readily evolve into an ant-like shape to deceive hosts—enabled the beetles to repeatedly infiltrate army ant societies.

"There's been this explosion of ants over the past 50-60 million years that must have radically changed terrestrial ecosystems," says Parker. "Army ants were part of that. They presented this huge niche for exploitation that these beetles were equipped to exploit, and they did so multiple times in parallel."

Two *Pseudomimeciton* rove beetles walking alongside the *Labidus* ant they've evolved to resemble. Note the difference in color: the ant is darker, whereas the beetle is redder. Credit: Taku Shimada

The paper itself focuses on DNA sequencing and reconstructing evolutionary history, but a decade of fieldwork went into collecting the beetle specimens for the study. Maruyama and Parker spent many hours in tropical forests, searching for beetles. "If you watch one of these army ant colonies for long enough, maybe one in every five thousand ants that wander past will be one of these beetles," says Parker. "You've got to have eagle eyes to pick them out."

The study opens up many questions about how this convergent system arose, some of which the researchers are starting to address by sequencing whole genomes of the rove beetles. "How predictable has molecular evolution been in each of these convergent beetle lineages? That's an obvious next step that could reveal genes involved in the ant-beetle symbiosis," says Parker.

Parker argues that discoveries like this compel us to study "underappreciated groups of organisms," he says. "If we want to understand life on Earth, we have to study groups like rove beetles. These tiny insects comprise the largest family of animals. We need to know how they live, how they evolved, and what role they play in the environment. Amazing things come from doing that."

More information: Maruyama and Parker, "Deep-time convergence in rove beetle symbionts of army ants," *Current Biology*. DOI: 10.1016/j.cub.2017.02.030

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