The Indomitable Dung Beetle Plays Key Role in Parasite Regulation

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Research on dung beetles is uncovering surprising insights into both the history of this ancient family of insects and the value of the ecological services many species provide.

For one, some dung beetles are far older than scientists realized. An Australian and Czech research team found molecular evidence that the scarab beetle subfamily Scarabaeinae evolved 115 million to 120 million years ago in the mid-Cretaceous, roughly 30 million years earlier than previously thought. Through DNA sequencing of 540 scarab beetles, a reconstructed evolutionary family tree isolates the timing, which coincides with the introduction of angiosperms into dinosaur diets. The study, published in PLOS ONE in May 2016, also confirms a significant loss of dung-beetle species diversity concurrent with the extinction of dinosaurs at the Cretaceous–Paleogene boundary.

Surviving dung-beetle species experienced a subsequent increase in species evolution, mirroring the evolution of mammals in the postdinosaur world. Many of these beetles survive today, continuing to feed on wildlife and livestock dung. Through manure disposal, dung beetles provide an array of environmental services: nutrient cycling, soil aeration, reduced pasture fouling from manure, improved forage palatability, and parasite control. “Dung beetles are especially important in agricultural ecosystems with a high density of animals,” explains Bryony Sands, a University of Bristol PhD student.

Sands and her UK colleague Richard Wall conducted the first temperate climate field study to evaluate endocoprid, or dung-dwelling, beetle impacts on cattle intestinal parasites during the summer grazing season. The findings, reported in the Journal of Applied Ecology in November 2016, mirror the results of previous studies conducted in South Africa and Australia that indicate paracoprid, or dung-burying, beetles significantly reduce intestinal-parasite survival on pastures in arid climates.

Anthelmintics administered to cattle for intestinal-parasite control do not degrade during digestion and prove toxic to dung beetles on the landscape. “If dung-beetle populations are allowed to thrive and recover, they can help naturally control the very parasites farmers are treating,” suggests Sands. An average of 200 insects colonized the cow pats analyzed in Sands’s study, including 20 Aphodius beetles who permanently reside in dung. “Overtreating with insecticides potentially makes the problem worse by selecting for drug resistance in parasites,” she says.

Farmers could potentially realize significant cost savings through reduced insecticide treatment. A 2015 UK study valued the total ecosystem services provided by dung beetles to the cattle industry at £367 million ($445 million), with the elimination of gastrointestinal anthelmintics equaling £196 million ($238 million) alone. Sands suggests that sustainable livestock management follows a combined natural and artificial approach based on her observations that wet conditions promote high parasite counts, even in beetle-churned cow pats. “Management should be herd and environment specific,” explains Sands. “This strategy may require more targeted effort, but provides sustainable economic benefits, as well as benefiting the environment and the livestock. Repeated blanket treatment of whole herds is counterproductive in the long run.”

Recognition of the beetles’ effects on dung parasites began roughly a century ago, with introductions of Onthophagus gazella to Hawaii for control of the invasive horn fly (Haematobia irritans irritans). Then, in 1967, Australia began importing 55 beetle species to target multiple fly and midge species thriving in undegraded cow pats. Twenty-three of these species successfully colonized Australia, alongside native species who feed exclusively on wildlife dung.

Today, Australia’s Commonwealth Scientific and Industrial Research Organization continues to evaluate and introduce additional dung beetles—such as Onthophagus vacca and Bubas bubalus in 2014—targeting remaining geographic, seasonal, and habitat gaps not filled by the previous introductions. In neighboring New Zealand, a similar program introduced 11 beetle species to reduce fouling, soil compaction, and waterway contamination from intensive cattle, sheep, and horse pasturing. “We have also found that [beetles] significantly reduce reinfection rates of parasitic nematodes by over 70 percent,” says Shaun Forgie, cofounder of Dung Beetle Innovations.

Endocoprid and paracoprid dung beetles disrupt parasites in several ways: The beetles manipulate manure piles, which aerates and desiccates parasite eggs. The movement of manure also damages and destroys eggs. In addition, the adult beetles accidentally imbibe and digest parasite eggs. And paracoprid dung beetles may bury the eggs to 15 centimeters or more, thereby reducing the probability that hatching larvae migrate back to the surface. “These things significantly reduce the nematodes available to re-infect livestock,” says Forgie. Not all dung...
beetles are so helpful for livestock, he adds. In New Zealand, native dung-beetle species cannot complete these manure maneuvers. “They’re flightless, small ball rollers (telocoprids that roll dung into balls). They all live in very restricted habitats and very rarely, if ever, venture out from the margins of their forest habitat into pastures,” says Forgie.

As beneficial as dung beetles are today, they probably had little impact on dinosaurs. “The fossil record doesn’t show dung beetles were any bigger than they are today, so unless there were large volumes of beetles, I can’t see them significantly controlling gut parasites,” suggests Forgie. Sands notes that even with an adequate beetle population, “in a nonagricultural setting where wild animals are widely dispersed, the overall effect may be negligible.”

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