

RESEARCH VIEW

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BIOLOGY



Heavily Horned

Why are beetles the weaponry champs?

University of Montana Professor Doug Emlen is passionate about animal weaponry. He's not alone in a state renowned for six-point bull elk and full-curl bighorn rams. But for Emlen, an evolutionary biologist, his selected choice of study is even more awesome. He focuses on the horns, forks, shovels and spatula weapons of beetles.

Here in the hometown of the Boone and Crockett Club, the official record keeper for trophy-sized game animals, Emlen might seem a bit cheeky in his assertion that horned beetles are the weaponry champions — until you take a closer look at the staggering array of the horns' shapes and sizes. Some dung beetle horns are so massive they make up 15 percent of the beetle's body weight. By comparison, a mature bull elk may weigh 700

(Above) A rangifer dung beetle, about the size of a pencil eraser



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pounds with a set of antlers as heavy as 40 pounds. Elk antlers would have to weigh 105 pounds to live up to beetle proportions.

“My research started with figuring out what beetle horns were for,” Emlen says of his work of almost 20 years. “Today, I’m looking at the bigger question of the incredible diversity in their weapons.”

Why would male beetles evolve so many kinds of weapons simply to fight rivals, protect territories and mate with females? Why would their weapons evolve faster than any other body part in a 40-million-year-old genus?

To untangle those mysteries, Emlen is applying “evo-devo,” the nickname for the field of evolutionary developmental biology. Through his study of beetle horns, he tackles fundamental questions of science: How do you get variation in animal form? How do we get diversity?

During a Friday afternoon interview, Emlen sports a UM beetle lab T-shirt and a kid grin to match, embodying the quote from famed scientist E.O. Wilson: “Most children have a bug period, and I never grew out of mine.”

Emlen’s small office is jam-packed with beetle paraphernalia. A metal sculpture dung beetle rolls a ball with its hind feet. Mounted specimens of giant tropical beetles parade across a table. The ebony inward-sweeping horns of the *Chalcosoma atlas* are polished, sharp and formidable. Fossilized fish and trilobite-imprinted rocks add to the backdrop. Books on beetles and entomology crowd shelves. Papers and folders surround a large computer monitor, ideal for analyzing beetle horn growth at various life stages.

Within moments of my arrival, Emlen gently pulls out a Japanese rhinoceros beetle from a jar of leafy compost. The shiny black beetle with its imposing forked horn takes up his whole palm. I put out my hand — “Can I hold him?” It’s time to prove my worth as a natural history writer. As the gigantic beetle crawls up my arm, I feel those six legs clinging like grappling hooks on my bare skin.

“I latch on to really bizarre things,” Emlen tells me as I hand back the biggest beetle I’ve ever touched in my life. (The rhinoceros beetle holds the world record



UM biology Professor Doug Emlen and a Japanese rhinoceros beetle



for strength relative to size. It can carry 850 times its body weight — the equivalent of a person hefting 65 tons.)

Emlen's compelling subjects have generated a recent buzz in the national media. The New York Times ran a March 2009 Science section feature based on his recent paper in the Annual Review of Ecology, Evolution and Systematics called "The Evolution of Animal Weapons." In his article, Emlen reveals commonality within this medieval-looking arsenal. Pages of horn illustrations include the oversized claw of a fiddler crab, the pronged antlers of stag beetles, the whacky horns of rhinoceros beetles, a serrated blade on a fish's head, dinosaur horns and, of course, the antlers of the deer family.

So what is the common denominator? Emlen says that animal weapons evolve when males are able to defend a patch of territory with critical resources. A dung beetle guards a tunnel occupied by a female. A bull elk drives rivals away from his harem that he rounds up in a meadow. But what is not clear is why the weapons diverge so much in form.

"The potential for male competition to drive rapid divergence in weapon morphology remains one of the most exciting and understudied topics in sexual selection research today," he writes in the abstract. He explains that animal weaponry overall is studied far less than male ornamentation, such as peacock tails.

In Emlen's earlier dung beetle studies, he found that a big-horned male would guard a tunnel, while a small-horned male would dig a side tunnel to sneak in and mate with the prized female within. Both strategies lead to passing on genes. When you feed a beetle larva more, the horns grow larger in the pupa stage of metamorphosis. Feed him less, the resulting horns are smaller.

"It's not that hard to change these things once you have a feel for the developmental pathways," Emlen says of his nutrition investigations.

In February 2009, Emlen published an article in the esteemed journal *Science* about his co-discovery that a flashy neon-green dung beetle produces not two, but three kinds of males — large-horned, small-horned and a hornless male that resembles a female. This discovery of beetle male trimorphism

Diversity and beetles go hand in hand. Beetles — some 350,000 different kinds — make up more than a quarter of all known species of living creatures on Earth. Recent findings suggest the earliest beetles date to 300 million years ago. That's 70 million years before dinosaurs made their mark. Apparently, says British evolutionary biologist and geneticist J.B.S. Haldane, the Creator had "an inordinate fondness for beetles."

opens up new questions for study. The hornless male indicates a third mechanism at work, as well as another strategy for success in passing on genes. Does a hornless male disguise himself as a female to find yet another way into the tunnel? For now, that's pure speculation.

Opposite Emlen's office is a spacious lab with microscopes and computers attended by graduate students who research subjects such as the correlation between a rhinoceros beetle's horn size and ability to fly well. Emlen opens a door into a walk-in closet lit with infrared bulbs to simulate the nocturnal conditions of active rhinoceros beetles — a mini-tropics, thick with the aroma of decaying leaves and fruit. We watch a pair of males joust horns over a rotting pear, while another guards a bamboo shoot.

A day earlier, an elementary school class visited the lab — a chance for kids to touch the tough carapaces and check out the very cool weapons. Emlen and the graduate student studying flight joked that the only time the rhinoceros beetle adults seem to fly willingly is in the presence of kids, not for the researcher who must coax them into flight with hair dryers that mimic a warm wind.

Emlen appears to take as much joy in sharing these beetle gladiators with kids as he does in the research itself. After all, in a few years these students may join him or others in labs as scientists continue to unravel evo-devo mysteries of species that have crawled, swum and flown on this planet for millions of years.

— *By Deborah Richie Oberbillig*

Online:

- [Doug Emlen's Web site](#)

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