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A photograph of two people in a field of tall, golden-brown grass. The person on the left is a woman with a red backpack, wearing a light blue t-shirt and dark pants, holding a wire cage. The person on the right is wearing a dark jacket and a colorful beanie, looking through binoculars. The background shows a wide, open field with trees in the distance under a clear sky.

Science
in the
WILD



The team prepares for the day's work (left); Jenn Smith and Kay Singh seek out their study subjects (right).

TEAM SQUIRREL *takes the field*

By Susan McCarthy

ONE DAY IN KENYA, doctoral student Jenn Smith watched carefully as a lion advanced to steal food from a group of hyenas. To Smith's surprise, the hyenas turned the tables. "I actually saw spotted hyenas chase a lion up a tree. Lions *never* are seen in trees!" she exclaims.

She later saw the hyenas defeated by a similar tactic: when a hunting clan of hyenas approached grazing zebras, instead of fleeing, the zebras formed a ring, protecting the foals inside. The defense was successful enough to send the hyenas away still hungry. "The zebras were the prey animals, but they won at the end of the day," she says. "That was pretty neat."



Both of these examples demonstrate the results of individual animals working together to benefit other members of their social group. This is the primary focus of Smith's research. An assistant professor of biology at Mills since 2012, Smith examines how animals interact with their natural environment and with each other. "My work is studying how animals have evolved and why they behave the way they do," she says. Her passion is to understand social evolution in mammals, particularly the evolution of cooperation. "It's sort of uncoding the secret language they're using." Such "language," she explains, may include various behaviors, such as vocalizations and postures, as well as more obviously social actions like mutual grooming or who has priority for feeding and mating.

Secrets like these are untangled through field work, observing animals in nature. Such study allows the animal to interact with the full range of influences in its habitat and, while less tidy than lab work, provides results that simply can't be duplicated in a controlled environment. While in Kenya, Smith lived in a

tent among the Masai, where she was called Mama Fisi ("hyena woman" in Swahili).

Now, she is training students in the skills of field research, albeit a little closer to home. Under Smith's guidance, Team Squirrel, a group of Mills undergraduates, is studying ground squirrel colonies in the East Bay's Briones Park.



JENN SMITH GREW UP IN A SMALL TOWN IN MAINE, and was always drawn to observing animals. She planned to be a veterinarian, the only job with animals she knew about. In her sophomore year at Colby College she took a between-semester course in the British West Indies. Her project was to figure out what land hermit crabs did at night; to trace their journeys, she fixed the ends of tiny spools of thread to their shells. The answer? They went to the chicken coop, looking for food. In discovering the hermit crabs' path, Smith found her own.

She went on to earn an MS at the University of Illinois at Urbana-Champaign, and dual doctorates in zoology and ecology and evolutionary biology and behavior from Michigan State University while studying hyenas under the mentorship of zoologist Kay Holekamp. In her post-doctoral work, Smith joined in on a rare long-term study of yellow-bellied marmots living in the Rocky Mountain area. That project, which began in the 1960s, is now headed by Dan Blumstein, professor of ecology and evolutionary biology at UCLA. Blumstein explains a handy thing about marmots: "They have an address! It's great, they stay put and you have a place to go every day to look at your animals." (Hyenas, in contrast, can range over an area of up to a thousand square kilometers, so keeping up with your subject can be a challenge.)

Working with these scientists inspired Smith. She wanted to initiate a study of free-living wild animals, and she wanted to mentor young women scientists. Mills was the perfect place. "It's rare that people who are such good teachers are also world-class researchers," says Blumstein. "Mills is lucky to have her."



ON A FINE JUNE DAY, Smith and Team Squirrel are circling a colony of California ground squirrels in an old walnut orchard at a picnic area in Briones Regional Park. The squirrels here are protected from excessive human encroachment. There are colonies in slightly different habitats. They live much of their lives in the open, easily observed. They are relatively fearless of humans, so being watched creates minimal disturbance. Like marmots, they have addresses.

"Squirrels are abundant at Briones," says Smith. "Our research focuses on several large colonies, totalling roughly 100 squirrels each season. It's great to have so many animals involved in the soap opera!" Smith sees opportunity for a model long-term study here, and hopes the project may span decades. Collecting interlocking life stories is an important aspect of the work. "It's fascinating to build up a data set with individuals you've known since birth," she says. "You can see how they interact with others within their social network, and observe them across their whole life span."

The squirrels themselves are lovely. They are brindled with a mantle of lighter hairs over the shoulders like a silver stole, and have elegant white eye-rings. Their large dark eyes survey the landscape watchfully. With hyenas, Smith was looking at



cooperation in a predator species. With marmots and these squirrels, she's looking at a prey species. Sentinel behavior and alarm calls are an example of their cooperation. "By announcing the danger, they're putting themselves at a greater risk. But the benefit is that they're warning other individuals in their group," she says.

The plump little squirrels scampering around aren't just attractive to biologists—they're also attractive to hawks, coyotes, and rattlesnakes, against whom they have developed impressive defenses. Adult ground squirrels have some immunity to snake venom and are valiant in their actions to protect the colony's babies. When faced with a rattler, they'll call an alarm to the colony, kick dirt at the snake, and flip their tails repeatedly. They can make their tails hotter, confusing the snake's heat receptors and warning that they're ready to stand their ground. Often the snakes will exhibit defensive reactions and, having lost the element of surprise, slink away from confrontation.

Team Squirrel moves exuberantly, but seriously. Before venturing into the wilds of the park, each student researcher has studied all aspects of their mission. Students have become knowledgeable about the ethics of live trapping, and making sure squirrels don't stay in traps any longer than necessary. They have become familiar with techniques for gathering physical evidence, in the form of hair, fecal, and parasite samples. They have learned to recognize squirrel predators and to tell a gopher snake from a rattlesnake. (Students wear snake gaiters as a precaution.)

The students have also prepared an ethogram, a table of possible behaviors such as "sand kicking" or "courtship chase," that allows them to systematically record the activities of the colony. Team Squirrel pored through the literature to learn what they might expect to see. Armed with binoculars and a notebook or digital voice recorder, these observers gather an enormous amount of information about individual squirrels,

their social interactions, and their colony behavior.

Smith loves observation. "It allows for a quiet moment where you can sit and just really watch and understand what these animals are doing." Observation often reveals patterns that raise new questions about the animals' behavior.

To glimpse the team in action, I begin by watching Minnie Vo '15 set out lures for the squirrels. A biology major and pre-med

student, Vo dabs peanut butter on the treadle in the middle of each wire box trap, just enough to entice a squirrel, and places it near squirrel burrows or trails. "We tried buying the generic peanut butter, but that didn't work," Vo says. "It has to be Skippy." Vo also lays a trail of black oil sunflower seeds. On the path of deliciousness, squirrels will enter. When they touch the treadle, the door closes.

Trapped! With nothing else to do, they go ahead and eat the peanut butter.

I trail Kate Lee Newcomb '14 as she checks traps. The season's just begun, but she already knows the colony's neighborhoods. Many squirrels have already been given an identifying mark "naming" the individual. The dyed marks are a bit whimsical—Umbrella, Smiley, Peace Sign—and enable observers to recognize individuals on sight. Near a burrow under a derelict walnut tree, Newcomb murmurs, "Umbrella lives here."

When she finds a furry captive, Newcomb collects the fresh poop from underneath the cage; it will be assayed later for hormones. She notes details about the squirrel's behavior: does it chatter or try to escape? Is it bold or shy? Then she carries the squirrel to shade, where Smith fits a tapering canvas bag over the end of the trap. "This is a handling cone," Smith explains. "They're calm when they're in a narrow space."

When Smith opens the end of the trap, the squirrel bolts into the security of the dark cone, wedging itself snugly in the point as it might in a burrow. All except for Peace Sign—he's a squirrel with personality and doesn't rush into the nice dark bag. He sits up and looks around calmly. Smith blows at him. He doesn't budge. Newcomb stomps her boots. Nothing. Only the sight of a thin stick waved outside the cage gets him to step back until he's in the bag. Finally, Smith weighs the bagged squirrel, then undoes a set of Velcro straps so the squirrel's body can be examined.

Before the squirrel is released, a few hairs are pulled from its rump. The bits of cuticle on the root end contain DNA, which will be analyzed so that Team Squirrel can build a colony family tree without taking blood. The squirrel is checked for ectoparasites—fleas and ticks. Some "fleabags" have noticeably more parasites. Smith wants to find out why. "It could be an indication of being really social. We are asking whether parasites represent an evolutionary cost of living in a social group." This is a question Kay Singh '15 will explore as part of extensive research Smith plans into parasites and disease transmission, and into the relationships between sociality, stress, and levels of parasitism.

"Each student takes a part of the project," Smith explains. "The goal is to publish a paper based on our findings." Valeska Muñoz '14 is constructing the genetic tree and exploring connections between relatedness and how squirrels interact. Newcomb is



A squirrel takes the bait set by Valeska Muñoz (left); Kate Lee Newcomb and Jenn Smith comb for clues to learn about squirrel parasites (above).

studying whether squirrels use scent or hearing as their primary method of detecting predators. Vo is examining levels of a stress hormone in squirrel droppings, a baseline measurement that may later be correlated with other factors. (She predicts that mature males will have higher levels than younger males due to the pressure of having to "protect his squirrel mistresses from invaders.")

At the end of the day, Team Squirrel carries the precious data back to Smith's lab at Mills, where there are freezers for samples, chemical hoods for purifications, and microscopes for parasite identification. Here's where hormone levels are measured and DNA family trees are constructed.

Team Squirrel is supported by the Jill Barrett Biology Research Program, which was established by the parents of the late Jill Barrett '93, a keen wildlife conservationist. In addition to Team Squirrel, this summer's Barrett

program includes three other research groups: Super Fly, investigating synapse development in fruit flies; the Nematode Ninjas, identifying odor receptors in nematodes; and the Flower Children, studying rare plants on serpentine soil in Marin County.

"The students have a really sophisticated research experience," says Professor Jared Young, who directs the Barrett program at Mills. "It is more like graduate work in the sense that every student has a project that they can take ownership of."

Jenn Smith's many publications give an idea of the theoretical work that can come out of her field research. Most of her articles appear in journals about animal behavior and ecology, but she is also lead author on a paper in *Current Anthropology* about the evolution of cooperation in mammalian carnivores (like hyenas) and its similarity to early Hominin evolution.

That paper links cooperation among carnivores with such factors as large brains, reduced sexual dimorphism (males and females being more similar), increased reproductive investment (more parental care of fewer babies), and endurance hunting in open habitats. It suggests that a similar look at multiple factors, rather than relying on just one (such as tool use, hunting, or language), will be useful in analyzing the development of cooperation among humanity's ancestors.

"It's so exciting to think about something that happens in a primate and then inquire whether it also happens in something with a nervous system similar to a squirrel's. I love investigating whether you really need a human's cognitive apparatus in order to interact in complicated ways, keep track of relationships, and so forth," Smith says.

Sounds like a lifetime of inquiry for Smith and squads of Team Mills biologists. ♦