WALK SOFTLY & CARRY A BIG NET

Armadillos have the most compelling genetic reason on Earth to behave altruistically toward one another, and yet they apparently don't. Earthwatch volunteers are helping Drs. Jim Loughry and Colleen McDonough catch a few of these enigmatic mammals to find out why.

Story and photos by Philip Johansson

"I can't believe a bunch of grown adults would let a two-foot-long, beady-eyed mammal with a brain the size of a snail's whip you like this!" said Dr. Jim Loughry with a wry smile. "You should be ashamed!" It was Loughry's droll version of a half-time pep talk. His team of five Earthwatch volunteers was seriously behind: one armadillo caught vs. nine missed. It was eight o'clock in the evening and our clothes were plastered to us with sweat. Nobody said catching armadillos would be easy, but none of us reckoned exactly how challenging it would be.

Loughry and Dr. Colleen McDonough, researchers at Valdosta State University and principal investigators for the Earthwatch-supported *Florida's Armadillos* project, are studying armadillos in the wild to explore the limits of "kin selection." This central theory in evolution has been used to interpret altruistic behaviors ranging from the tireless labors of worker bees to predator defense in prairie dogs (see "Kin Selection Exposed"). Kin selection predicts that one of the pinnacles of altruism should be found in the armadillo because of how they have babies.

In the course of embryonic development, the armadillo egg splits in two, then those two split again, so that each female produces four embryos from the same fertilized egg. These embryos will result in identical quadruplets. They are clones. Many other mammals will occasionally have twins or other multiples of identical embryos. But the genus *Dasypus*, composed of six species of "banded" armadillos, is the only vertebrate group where this pattern is the norm.

Volunteers Tannys Laughren (top) of Ontario and Shashi Menon (middle) of California rose to the challenge of netting the fast-footed armadillo (bottom).

Biologists call this unusual arrangement "obligate polyembryony."

Loughry and McDonough are working to reveal the implications of polyembryony and kin selection on the behavior of nine-banded armadillos (*Dasypus novemcinctus*), the best-known member of the genus (see "Closer Look"). McDonough has been working with armadillos since 1987, when she began the first long-term field study of their basic ecology in Texas. Since 1992, the two scientists have been collaborating on field research at Tall Timbers Research Station, north of Tallahassee, Florida.

Soon we were back to stalking armadillos on Hall's Island, a peninsula sticking out into Lake Iamonia (the locals call it "Lake Ammonia") on the Tall Timbers property. We skulked in pairs along the lake's edge through a lush forest of live oak and magnolia, hanging with Spanish moss and epiphytic ferns. I walked 5 meters to the left of my partner Shashi Menon, a 16-year old from San Diego with very sharp eyes. Each of us carried a large and ungainly net with a 3-meter handle. We looked like dog-catchers lost in the woods.

Finally, it emerged like an apparition in the dim light: a giant sowbug; a football with ears; an anteater from the Age of Chivalry, snuffling blithely among the leaf litter. All stealth was forgotten as we attempted to surround the armadillo, shouting to each other like we were rounding up a herd of wild horses.

"He's going toward the lake!"

"He's making for the brush!"

"Head him off!"

"He's..."

"Get him!"

CLOSER LOOK: ANATOMY OF A SURVIVOR

Nine-banded armadillos (*Dasypus novemcinctus*) represent the last wave of a migration of South American mammals that began 3 million years ago. Since they crossed into Texas in 1820, they have extended their range throughout the southeastern United States.

- Armadillos are covered with an outlandish carapace of some 2,500 bony plates, and precious little fur.
- They have the lowest metabolism of any mammal, and sleep an enviable 18 to 20 hours a day.
- They have disproportionate claws that would make any manicurist envious, with which they burrow and root for their invertebrate prey.
- A tiny mouth with simple peg-like teeth and a long tongue is adapted for eating small invertebrates.
- They possess among the smallest brains, proportional to body size, of any mammal in North America.
- They have a penchant for jumping a meter into the air when they are alarmed, which is a liability when they are startled by a speeding vehicle.
- They are able swimmers, holding their breath for up to six minutes.
- By some strange twist of fate armadillos are the only vertebrates, besides humans, that can be affected by leprosy.

With all the coordination and speed I could muster, I brought my net down on a large cypress "knee." The armadillo had been there, and then it was not. I reacted with lightning speed, and next netted a clump of blackberries; the armadillo ran through the brush and into the lake. We crashed through

It emerged like an apparition in the dim light: a giant sowbug; a football with ears; an anteater from the Age of Chivalry.

the cattails and rushes for a few minutes, before calling Loughry on the walkie-talkie to report our location. It was our third miss in a row that night.

"You're breaking my heart," he replied dryly.

Field Assistant Mike Wilson and volunteer Wil Morris, a psychologist from Michigan, had better luck that night, catching a juvenile armadillo on the western shore of the island. When we got there Wil was helping measure the animal,

front carapace, back carapace, tail length, tail base, taking care to avoid the scimitar-like claws. Loughry took two notches out of the armadillo's ear for DNA samples, attached an ear tag with a distinctive four-digit number, and injected a passive transponder (PIT) tag under the skin at the base of the animal's neck for further identification. The last bit of marking was reflective tape, glued to the animal's carapace for identification from a distance.

Later, our team would pinpoint the location of the young armadillo using a global positioning system (GPS), basically using satellite positions to triangulate its location within a few meters. Over the past ten years, Loughry and McDonough have caught more than 725 individuals and logged more than 1,800 locations, primarily in the bottomland hardwoods along Lake Iamonia. Last summer, Earthwatch teams helped catch 125 individuals, a fair year. Among the variables responsible for a lower catch was the fact that Lake Iamonia was down 1.3 meters after three years of drought, giving armadillos additional refuge in the dense, reedy margins of the lake. Another variable, speaking for myself at least, is that Earthwatch volunteers tend to trip a lot. McDonough asserts that she and Loughry alone had a success rate of about 33 percent, while Earthwatch teams managed more like 25 percent.

"While having more people in the field is good in terms of coverage, they are less experienced and tend to be more timid," McDonough said. Faced with the perils of rattlesnakes, biting insects, flesh-ripping brambles, and prehistoric mammals that jump in the air and spray feces at the least provocation, I had to agree with her.

Despite years of research, Loughry and McDonough have been unable to find clear evidence of altruistic behavior between armadillo littermates (see "He Ain't Heavy, He's My Clone"). Their study animal is apparently a singular example of self-absorption, clones or no clones, suggesting significant limits on kin selection.

"Our findings with armadillos don't contradict the theory, but what they do show is that just because you have a high degree of relatedness doesn't mean you have kin selection," said Loughry. "There have to be other considerations."

In the case of armadillos, Loughry and McDonough

KIN SELECTION EXPOSED

J.B.S. Haldane, one of the founders of modern evolutionary theory, reportedly claimed that he would lay down his life for two brothers, or eight cousins. This is the essence of kin selection theory, which explains altruistic behaviors in animals based on their degree of relatedness.

In evolutionary terms, success is measured in genes passed onto the next generation. The most direct way to do this is by reproducing. But according to kin selection, another way is by helping relatives, who share some fraction of your genes, to survive and reproduce. For instance, Haldane's brothers shared one-half of his genes, while his cousins shared one-eighth, prompting his hypothetical heroism.

The textbook case of kin selection is found in honeybees and ants, where sterile workers slave to provide for and raise the offspring of the queen, without any benefit to their own reproduction. By a quirk of genetics, workers are related to the queen's offspring by three-quarters, so they gain more by raising them than they would by raising their own offspring, with which they would only share half their genes.

"If you can get altruistic behaviors in other species where relatedness is one half or three quarters, you'd expect to find all kinds of altruism in armadillos," said Loughry. "In the case of sibling armadillos, which are clones of each other, relatedness is one. You can't go any higher."

Volunteer Michelle Measel (right) mentally prepared herself for an evening of stalking and high speed chases through the rich hardwood hammocks (far right) on the shores of Lake Iamonia.

suggest a couple of constraints are at work. First of all there is the ecological consideration of high predation, especially on unwary juvenile armadillos, which eliminates the likely presence of littermates and all opportunity for kin selection. A preliminary analysis of DNA samples from armadillos in the field shows that out of a total of 215 adults, there were only 7 cases of adult littermates in the same area. Even when adults have siblings present in the population, that sibling is typically more than half a kilometer away, further than resident armadillos usually range.

Another possible reason why armadillos aren't tripping over each other in an effort to be helpful has to do with the evolutionary history of this unusual animal. Armadillos sleep about 18 hours a day and have a very low metabolic rate. Their food, invertebrates that they dig for in the soil, is widely dispersed and relatively low volume—not a meal you can sink your teeth into—and they require about 100 kilograms of these invertebrates every year. Just about every animal we observed in the field was caught in the act of one thing—foraging.

"If you've only got six to eight hours a day to find the food you need, you may have to spend all your time feeding," said Loughry. "If you don't have time to be social, because of energetic limitations, then there's no opportunity for kin selection." But if there is no social advantage to the armadillo's curious cloning birth pattern, why do they go to the trouble? One possibility, supported by some evolutionary models, is that armadillos take advantage of having clones to disperse, in hopes of finding at least one spot where they can thrive: sort of a four-for-one deal. Ironically, this may help explain why armadillos have been so successful in extending their range throughout the southeast U.S. in recent years.

"There is no behavioral discrimination between kin and non-kin. We know they can tell the difference. They don't seem to care."

The ancient Aztec name for the armadillo was *azotochtli*, meaning a hybrid between tortoise and hare. Although our taxonomic understanding of the armadillo has come a long way since Aztec times, scientists like Loughry and McDonough are still puzzling over the patent lack of social behavior in this odd animal. Unlike the fabled tortoise or hare, the armadillo is neither fast nor slow, patient nor quick-witted, but rather wins the race by being single-mindedly self-reliant.

Philip Johansson is senior editor of *Earthwatch*. Robert Stringer, a 7th Grade science teacher from Kickemuit Middle School, Warren, Rhode Island, was "Teaching Live from the Field" from Florida's Armadillos, last month. For details, go to http://www.earthwatch.org/ed/roster.html. See page 8 for more information on "Teaching Live from the Field."

AMIABLE ARMADILLOS

In the first of two experiments, Loughry and McDonough determined if armadillo siblings could discriminate each other from non-siblings, a necessary condition for kin selection. Individual baby armadillos were placed in a round arena, with a pad bearing a littermate's scent stuck on one side and a stranger-scented pad on the opposite side. The subjects spent significantly more time near the littermate-scented pads, and stood on their hind legs to sniff them more often (technically known as a "bipedal sniff"). Based on these results, baby armadillos can tell who their littermates are.

Next, Loughry and McDonough devised an experiment to find out if siblings treat each other differently than non-siblings, another prerequisite for kin selection. They put paired baby armadillos, either siblings or non-siblings, in an arena, and recorded their interactions. They found overwhelming evidence that juvenile armadillos were just plain friendly.

"Baby armadillos treat every other baby armadillo exactly the same way, whether they're related or not," said Loughry. "There is no behavioral discrimination between kin and non-kin. We know they can tell the difference. They don't seem to care."

Earthwatch volunteers are helping to find out if there is more room for altruism among juvenile armadillos in the wild, or if there is any reason for adults to discriminate kin from non-kin.