

Serpentine Cross-Dressers.(behaviour of Manitoban garter snake)

by Richard Shine and Robert Mason

© COPYRIGHT 2001 American Museum of Natural History

Some male Manitoban garter snakes wear the alluring scent of females.

Garter snakes may be the most common snakes in North America, but the subspecies known as the red-sided garter snake provides an uncommon annual spectacle. During the severe, six- to eight-month winters in Manitoba, Canada, these small, nonvenomous snakes sequester themselves in deep crevices to avoid freezing. Since such sites are rare in the barren, rocky region between Lake Manitoba and Lake Winnipeg, snakes that have dispersed across many miles in the summer gather by the thousands to spend the winter at the few suitable spots. Some of their major dens are located about seventy-five miles north of the city of Winnipeg and are surrounded by swampland that during the warmer months provides an abundance of frogs, the snake's favorite prey. When dens near swampland empty out in early spring, some of them disgorge more than 10,000 snakes from rocky depressions as small as sixteen feet long and six feet wide.

Over the past fifteen years, one of us (Bob Mason) has been visiting these dens in an attempt to understand the snakes' behavior. Males and females mass together in the same dens, emerging from hibernation between late April and the end of May. (In dens that receive more sunlight, the exodus can take place somewhat earlier.) Males emerge first. Having reached the surface, they stay close to the den for the better part of May. It's now mating season, and they're waiting to intercept the tardy females. As soon as a female appears, a seething ball of dozens (often hundreds) of amorous suitors forms around her. This rippling clot of snakes may move en masse over rocks and vegetation until the female has mated. Some "mating balls" however, contain no females. In 1985 Bob Mason, working with David Crews, of the University of Texas, reported that frenetic males frequently attempt to mate with certain other males that they evidently mistake for females. These "she-males," they observed, are indistinguishable in size and markings from ordinary males, and they also seek female mates--yet they attract other males by the score.

Female mimicry by males, although not common, occurs throughout the animal world. Among some anole lizards, for instance, males that are too small to defend a territory of their own may manage to live within a dominant male's territory if they can avoid conflicts by passing as females. Common sunfish produce two kinds of males--a large? dominant male that builds and defends a nest and tries to

attract females to it, and a smaller male that resembles, and behaves like, a female. This female mimic swims between a mating pair just as the dominant male is about to fertilize the female's eggs and fertilizes some of them himself.

Manitoba's red-sided garter snakes, however, are the only snakes known to have males that mimic females. How does an amorous male garter snake tell a male from a female in the horde of snakes emerging in early spring from a large den? By sensing the pheromones that emanate from the animals' skin. When snakes flick their tongues in and out, they pick up chemical cues from the air, which they transfer to a sensory organ in the roof of the mouth. When a male tongue-flicks another snake, he instantly determines his neighbor's apparent gender by the scent of the lipids on its skin. Bob and David discovered the pheromone differences during their first year of collaboration, and a few years later they were able to synthesize the signaling chemical in the lab.

Why do some males smell like females? At first the researchers hypothesized that a male's release of female chemicals might benefit him by confusing his rivals: the she-male would be the only male snake within a mating ball that knows who the real females are. At this stage of the game, Bob and David also thought that individual snakes remained either she-males or he-males throughout an entire mating season, if not an entire lifetime. There the story remained until Rick Shine came from Australia in 1997 to visit Bob at the garter snake dens. Rick became so intrigued with the abundance of female mimics he saw there that he returned the following year with two research assistants from the University of Sydney, specifically to study the she-males, and our collaborative attack on this puzzle got under way.

First we attempted to quantify the attractiveness of individual snakes. Holding various "target" snakes by the tail, we crouched in the grass near a den and placed them in front of mate-searching males. We then recorded the mate-searchers' level of interest. Responses ranged from ignoring the target or rapidly flicking the tongue to aligning the body with that of the presented snake and trying to mate. With this simple method, we were able to confirm that she-males (which we had extracted from the center of mating balls) were indeed very attractive to ordinary males, though a bit less so than real females. Indeed, the she-males proved to be attractive to one another and sometimes even to themselves. (If a she-male accidentally encountered part of his own body, he might spend quite a bit of time busily courting himself!)

Serpentine Cross-Dressers. (behaviour of Manitoban garter snake)

Next we investigated how she-maleness is produced. Did she-males obtain their coating of female pheromones through physical contact with true females, perhaps by rubbing against them during courtship? We soon discovered that even if we vigorously rubbed a he-male against a female, he remained unattractive to other males. We concluded that when males were attracted to she-males, they were reacting not to rubbed-on chemicals but to those naturally produced in the skin.

To learn more about how individual snakes react to she-males, we set up several nylon enclosures about three feet square near a den. We captured a number of she-males, he-males, and females, kept them in separate cloth bags overnight, and placed various combinations of snakes in the nylon pens the next day. To our astonishment (and initial dismay), although a few of the she-males we had collected the day before continued to elicit some interest from ordinary males, most had lost their allure. In other words, we had found that a she-male could switch its sexual identity within a twelve-hour period. Needing to ascertain that stress wasn't the cause of our captive snakes' unnatural behavior, we decided to return to a den to confirm this finding in free-ranging snakes.

This time we simply collected, measured, and examined a large sample of she-males and he-males, looking for characteristics that might give us a clue to what was going on. Searching through hundreds of snakes clustered around the entrance to the den, Rick identified mating groups and examined each she-male and its ball of suitors. Eventually he spotted a pattern that had escaped prior observation. Most of the he-males were bright, glossy animals, but the she-males were often dull and dirty with grit. Once we recognized this fact, we had to account for it. The explanation, we thought, might be that she-maleness was all about the timing of reproduction in relation to hibernation. Perhaps it was a transitory phase that most--or perhaps all--male garter snakes passed through soon after they emerged from the den.

Indeed, since the same dirt can be seen on most females when they first reach the surface, the grit we observed on the she-males suggested that they, too, had just emerged from underground. And according to our measurements, the she-males were somewhat chubbier than the he-males. This was consistent with our "recent emergence" hypothesis, since we knew from studies of recaptured males that they rapidly lose weight during their frantic mate-searching and courtship activities. The hypothesis also fit in with Bob and David's original, and apparently paradoxical, finding that she-males tend to have a high testosterone level, since another recent study had shown that testosterone levels in male garter snakes are highest at emergence and fall off rapidly thereafter.

We further tested the idea by marking males as soon as they emerged. Sure enough, the marked males were she-males for a day or two and then rapidly reverted to he-maleness. So part of the puzzle was solved, but many others remained. One idea we considered was that hibernation could weaken the animals and that it might take a day or two for males to recover their strength and prepare for the frantic activity of mating. The huge numbers of emerging snakes allowed us to test the hypothesis that she-maleness is related to a recovery period. Indeed, our paint-marked she-males were weak and lethargic during the first day or two after emerging but began to move around actively at about the same time they switched off their production of female pheromones. We measured their strength by clipping their tails to a spring balance and letting them pull against it; she-males proved to be weaker than same-sized he-males. We measured their crawling speeds in a circular arena with a diameter of twelve feet and a circumference ringed with empty beer cans. After placing a snake at the center and prodding it, we recorded how long each one took to reach the edge of the circle. Again, the data confirmed the prediction: she-males moved much more slowly than he-males.

If she-males are slow and weak, how good are they at courtship and mating? Again, we used the nylon enclosures to explore this question. When we put a she-male together with a female, it took him almost twice as long to persuade her to copulate as it did for a he-male to mate with a female in an adjacent pen. Whenever we put she-males and he-males together and then added a female, it was almost always one of the he-males that succeeded in copulating with her. She-males were indeed prepared to mate with females, but they were not very good at it, because they had not yet recovered from their long winter's inactivity.

In spite of all we have learned about these snakes, we still don't really know why male garter snakes mimic females when they first emerge from hibernation. Perhaps such mimicry helps draw their rivals' attention away from newly emerged females and buys them time to recover their full strength. Mimicry would thus both prevent she-males from wasting energy on half-hearted attempts to mate and encourage other males to expend energy and sperm on fruitless courtship. In another recent study, we found that she-males seem to assess their chances of mating, and if many large and healthy he-males are wing for the same female, the she-males do not attempt vigorous courtship.

The more questions we answer about these ubiquitous little reptiles, the more new questions arise. When one first peers into a Manitoban den and sees thousands of red-sided garter snakes writhing around--looking for all the

Serpentine Cross-Dressers.(behaviour of Manitoban garter snake)

world like live spaghetti--their behavior appears chaotic. But we have come to appreciate that these animals behave with extraordinary subtlety. What we have learned about males distracting their fellows by wearing feminine perfume may be just the first step toward elucidating one of nature's more intriguing mating systems.

RELATED ARTICLE: Garter Snake Grottoes

Each spring in central Manitoba, tens of thousands of red-sided garter snakes (*Thamnophis sirtalis parietalis*) emerge from their rocky dens in the bleak countryside between Lake Winnipeg and Lake Manitoba. The mass emergence attracts busloads of schoolchildren and tourists from southern Manitoba and beyond. On Mother's Day, Winnipeg youngsters traditionally take their moms on excursions to view the springtime fertility spectacle. While many residents of the towns of Inwood, Narcisse, and Chatfield view with fascination the garter snakes' migrations, others wish the snakes would gather elsewhere. One summer, according to local residents, a young couple built a house over a rock crevice that they thought would make a perfect natural cellar. When autumn arrived, so did a few thousand garter snakes, returning to their traditional winter den. The couple soon decided they had better relocate their home to a less snaky location.

Until the early 1980s, some local collectors scooped up thousands of the snakes and sold them to pet dealers in the United States, England, and Germany. Scientists and wildlife officials became concerned, and in 1988 commercial collecting was banned, but many snakes were still being killed in traffic as they crossed a major highway near the Narcisse dens. Last year the Manitoba Department of Natural Resources (now the Manitoba Department of Conservation) installed a series of pipes under the road. But how to get the snakes to use them? Bob Mason's experiments showed that if garter snake pheromones were applied to the floor of the culverts, the snakes would follow the chemical trails. The technique is working: this fall thousands of garter snakes crossed safely under the highway.

--R. M. and R. S.

A professor of evolutionary biology at Australia's University of Sydney, Richard Shine ("Serpentine Cross-Dressers") has studied pythons in Australia and pit vipers in China. Shine (at right) earned a doctorate at the Australian National University with a dissertation on venomous snakes and a second doctorate in reptile ecology at the University of Sydney. Coauthor Robert Mason, an associate professor of zoology at the University of Oregon, discovered the "she-male" phenomenon in garter snakes while in graduate school. He met his future wife, Sarah,

when she came to Manitoba as a volunteer at the province's snake dens. "Not too many people," he writes, "can say they met their spouse in a snake pit with 25,000 mating garter snakes swarming around their feet." For more on garter snakes, Mason and Shine recommend *The Snake Scientist*, by Sy Montgomery (Houghton Mifflin, 1999), with photographs by Nic Bishop.