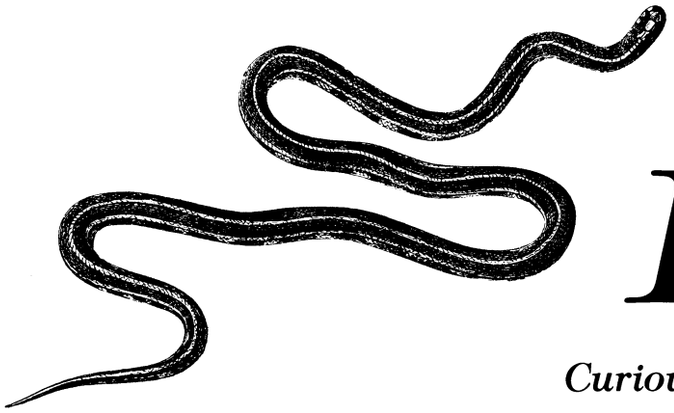

Randy Reptiles

Curious clockwork spurs sex drive in snakes

By KATHY A. FACKELMANN

Spring arrives in western Canada, and thousands of red-sided garter snakes crawl from their winter den as the May sun begins to warm the air. For several days, this all-male fraternity of reptiles remains near the hibernation den, lounging about in the sunshine. Then, the first female red-sided garter slithers out of the den.

What happens next has been termed "spectacular" by biologists who study the snakes' mating behavior. About 100 males pursue the lone female in a courtship dance that culminates in a tangled "mating ball." Only one snake actually mates with her; the rest return to the den entrance to wait for the next female to emerge.

A fascinating ritual, yet the inner clockwork that turns these snakes into such ardent suitors each spring appears even more remarkable than their frenzied nuptial display, reports zoologist David Crews of the University of Texas at Austin.

Like other male vertebrates, the red-sided garter snake, *Thamnophis sirtalis parietalis*, owes its sex drive to the hormone testosterone. Crews' research suggests, however, that the snake's testosterone level peaks in late summer — more than eight months before the breeding season. And while most vertebrate males respond to a rush of the sex hormone by rushing to find a mate, the male red-sided garter spurns sex when its testosterone level soars. Rather, the snake's summer hormonal surge seems to have a delayed action, perhaps by priming brain cells during hibernation to kick off the mating game when environmental cues finally signal the arrival of spring.

"What's unusual about this study is that one gets an effect of hormone treatment that lasts for half a year," says Arthur Arnold, a neurologist at the University of California, Los Angeles.

Crews' new study "will have quite an important impact on future research into the relationship between hormones and behavior," adds endocrinologist John C. Wingfield at the University of Washington in Seattle. With a better understanding of the powerful ways in which hormones can affect courtship, Wingfield says, scientists may eventually discover new clues to the sexual behavior of higher animals, including humans.

Crews

A lone female red-sided garter snake emerges from the den entrance to greet a multitude of male suitors eager to win her attention.

When Crews began studying the sex life of *T. s. parietalis* as a postdoctoral student 15 years ago, he assumed it would follow the standard hormonal pattern.

Support for that assumption came from a 1976 study in which he "hibernated" five male red-sided garters by placing them in cold storage in the fall. After weeks of hibernation, he warmed the snakes to arouse them from their snooze and implanted a capsule of testosterone under each one's skin. When Crews placed the snakes in a cage with a female, all five males displayed courtship behavior. Later, when he removed the implants, not one showed interest in the opposite sex. Crews interpreted these results as strongly suggesting that high blood levels of testosterone had spurred the males' sex drive.

But subsequent investigations threw a monkey wrench into that theory.

In one series of experiments, for example, Crews and his colleague Brian Camazine discovered that recently castrated garter males courted females with the same ardor exhibited by males with intact, testosterone-producing testicles.

"That was a real startling finding," he says, noting that male animals whose sexual activity is triggered by high blood levels of testosterone lose interest when castrated.

Crews went on to discover a fatal flaw in his 1976 experiment: He had implanted the testosterone at a time when the snakes would mate anyway. By the time he removed the implants, the brief mating fling had already faded of its own accord. If he had included a control group of snakes with placebo implants, he says, they would have shown similar mating behavior despite the lack of testosterone. The difficulty of obtaining large numbers of snakes, however, deterred him from including such controls.

Moreover, Crews discovered that the snakes' testosterone reaches its annual *low* in the wild as their sexuality reaches its peak. That evidence clearly pointed away from a hormonal surge as the springtime signal for sex, leaving Crews with a mystery to solve: What spurs these snakes to mate?

To find out, he embarked on a larger-scale study, traveling to Manitoba to gather enough red-sided garters for controlled experiments. Crews captured dozens of the snakes as they returned to their dens in September. He immediately castrated 45 males and gave 45 others a "sham" operation that

left their testicles intact. (Snakes with intact testicles would serve as a control group to reveal whether the surgical procedure itself could influence the experiment's results.) He took the snakes back to his laboratory and in October put them in boxes – along with 13 normal, intact males – and placed the "dens" in cold storage for 17 weeks. At the end of the simulated hibernation, Crews randomly divided the snakes into groups and put each group into a room-temperature 30-gallon terrarium. Every day for the next 12-to-21 days, he placed a ready-to-court female inside each terrarium for a 10-minute visit.

"It becomes very clear who's courting and who's not," he says of the experiment. "Males who are interested in females do a very specific behavior called chin rubbing, where they course up and down the female's body, pressing their chin against her." Crews designates the males as "courters" if they show sexual interest on at least half of the test days.

The experiment, repeated annually for a span of four years, yielded intriguing results. After their first laboratory hibernation, the 13 castrated males and their 10 intact counterparts (the snakes that survived four annual cycles) courted with equal intensity, Crews reports in the May 1 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES. However, after a summer in the lab followed by another hibernation, only four of the castrated snakes courted, compared with nine of the intact snakes. By the fourth year, there was an overall decline in courtship – a decline Crews attributes to old age. However, he says, all but two of the intact males displayed some degree of mating behavior on at least 40 percent of the test days that year. In contrast, only three of the castrated snakes showed any inclination to mate that year, and their interest surfaced on no more than 14 percent of the test days.

Castrated and intact snakes showed equivalent mating behavior during the first spring because all had experienced their normal testosterone surge while living in the wild during the previous summer, Crews explains. The following summer, the intact snakes again released the hormone, but the castrated snakes went without – and that testosterone failure showed up the second spring as a decline in courtship behavior.

Crews speculates that wintertime brain changes form the missing link between the summertime hormonal surge and springtime sexual urge. The summer testosterone rise may somehow rewire the brain during hibernation, he suggests, creating temporary changes that precipitate mating behavior when warming temperatures wake the sleeping reptiles. By the fourth year of the mating experiment, the testosterone-induced "mating memory" had faded in the castrated males, he concludes.

Crews told SCIENCE NEWS that he and his colleagues have recently turned up evidence suggesting that certain areas of the brain's limbic region – which controls sexual behavior – change seasonally, although he declined to elaborate on these preliminary findings.

Endocrinologists know that hormones, including testosterone, can induce powerful, permanent changes in the brains of fetal or newborn animals. But Crews' work and research by others hints that testosterone may induce temporary changes in the brains of adult animals – a finding that may represent a novel interaction between hormones and the fully matured brain.

"What this kind of study does," says Arnold, "is alter our basic idea about the kinds of things hormones can do to the brain." □