Seminal plugs cost red-sided garter snakes dearly

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Female red-sided garter snake with seminal plug. Credit: Christopher Friesen.

Bubbling out of their hibernation burrows as the temperature begins to rise, male red-sided garter snakes only have one thing on their mind: mating. And with females in short supply, the pressure is on. But how much effort do these males invest in reproduction? The expense is clear for females, but how costly is seminal fluid production for males? Christopher Friesen from the University of Sydney, Australia, explains that male red-sided garter snakes are clearly exerting themselves as the

seminal plugs left inside the females after copulation – to avoid sperm leakage and prevent the female from mating with other males – are massive. Also, the males' blood lactate levels soar, suggesting that seminal fluid production could be costly. Knowing that males produce and store their sperm in late summer, while the majority of the seminal fluid components are produced in spring, Friesen and his thesis advisor Robert Mason from Oregon State University, realised that they could tease apart the males' investment in seminal fluid production from the cost of sperm production to begin understanding how costly reproduction is for red-sided garter snake males.

Collecting large and small males as they emerged from their Manitoba hibernation chamber, the duo then provided the males with a continual supply of fresh females, allowing half of the males to court and mate enthusiastically, while the attempts of the other group were thwarted by tape placed over the females' cloacae. Then they measured the snakes' energy consumption over the course of 9 days and found that it was around 50% higher (7.33 kJ day^{-1}) than that of males outside of the mating season.

Next, they calculated the energy consumption (per unit mass) for each of the snakes as they courted and mated with females and although they could see that the largest males invested little energy in seminal fluid production, the smallest snakes invested up to eight times more energy. And when the team tracked the snakes' mass loss relative to the number of times that they mated – the males do not feed during the mating season – the most successful males (that mated 5 times) lost as much as 8 g, while the least successful lovers (that only mated once) lost 4–6 g. In addition, Donald Powers and Paige Copenhaver measured the metabolic rates of males that had successfully mated and the males that had just lost out and found that the metabolic rates of the largest courting males were barely raised at all. However, the metabolic rates of the smallest males rose by approximately 30% during courting and rocketed by

almost 50% when they mated successfully.

Finally, the team calculated the net cost of producing the seminal fluid's plug components, and they were impressed that the males were investing as much as 18% of their daily energy expenditure per ejaculation. They were also surprised that the resting metabolic rates of males after seminal fluid production (VO_2=0.0025 ml g^{-1} min^{-1}) were similar to the metabolic rates of pregnant female garter snakes (VO_2=0.0023 ml g^{-1} min^{-1}). However, the team were intrigued that sperm-free plugs produced by vasectomised males were 26% more energy dense than the plugs produced by fertile males, suggesting that sperm contain less energy than other seminal fluid components.

Reflecting on the smaller males' greater exertions, the team suspects that they throw everything they can into each mating opportunity as they may not survive the next harsh Manitoba winter to take advantage of the lower mating costs when older and larger.

More information: "Size dependence in non-sperm ejaculate production is reflected in daily energy expenditure and resting metabolic rate." *J. Exp. Biol.* 218, 1410-1418. DOI: 10.1242/jeb.120402

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