Experiments on the Reproductive Costs of a Pure Capital Breeder, the Children's Python (Antaresia childreni) (2013), by Olivier Lourdais, Sophie Lorioux, and Dale F. DeNardo

In 2013, Olivier Lourdais, Sophie Lorioux, and Dale DeNardo conducted a study on the impact of the reproductive effort on the muscle size and the constriction strength of female Children's pythons. Children's pythons are pure capital breeders, meaning that they do not eat during vitellogenesis, a process in which egg-laying or oviparous species allocate bodily resources including fat, water, and protein to follicles in the ovary that develop into eggs. In their study, the researchers aimed to identify the biological tradeoffs associated with a species that uses only stored bodily resources to allocate toward the development of embryos. The researchers found that female Children's pythons undergoing vitellogenesis experienced significant muscle loss and constriction strength loss. The researchers' findings make up an important element in assessing the fitness of a species in the wild as fitness is determined by survivability and ability to reproduce. Additionally, because Children's pythons have especially low metabolic rates, and the energy constraints associated with reproduction in Children's pythons are applicable to many other python species.

The Children's pythons (Antaresia childreni), unlike some other species, use only stored tissues to allocate toward the creation of eggs when they are reproducing. During the process of egg creation and egg laying, female Children's pythons do not eat, meaning they are capital breeders. The capital breeding method of providing the energy required to reproduce is beneficial to animals living in an environment where food is scarce and cannot be depended on. The biological cost of foraging and digesting food is high. However, there are some drawbacks to capital breeding. Energy is generally stored as fat, not protein. However, a major component of reptile eggs is the protein-rich egg yolk. Therefore, the protein content of the egg yolk must come from stored resources, typically from muscle proteins. In the wild, it can be problematic for the snake to lose muscle because while they are reproductive, they become more vulnerable to predation and are less able to escape predators. In addition, if reproductive snakes lose muscle mass, they can potentially lack the strength required to curl around their eggs. Therefore, it is important to determine the impact of breeding on structural traits like muscle mass and performance traits like contractile strength.

Researchers Olivier Lourdais, Sophie Lorioux, and Dale DeNardo conducted the experiments on the reproductive costs of the Children's python at Arizona State University in Tempe, Arizona. DeNardo, who served as director for the Department of Animal Care Technologies at Arizona State University, studied environmental physiology of certain species' ability to adapt and thrive in challenging habitats, like the desert. Lorioux, a post-doctoral researcher at Arizona State University, studied ecology, evolutionary biology, and physiology. Lourdais, a post-doctoral researcher in the DeNardo lab, studied evolutionary biology as it relates to reproductive strategies. In their investigation, Lourdais, Lorioux, and DeNardo examined the structural and performance costs of pure capital breeder behavior. The researchers predicted that vitellogenesis and the creation of eggs would induce the movement of structural proteins. They further predicted that this protein depletion would alter muscles. Lastly, the researchers predicted that protein depletion and resulting muscle loss would lead to performance changes such as weakened muscle strength.

The experiment included thirty-five female pythons and eleven males necessary for mating. The snakes used in the experiment were part of a long-term captive colony. The research team kept pythons in a cooled room from December to January to mimic the seasonal changes that they would experience in the wild. They fed the snakes every two to four weeks during the cooling period. Following the cooling period, the research team warmed the python room and made other adjustments to again mimic the change of season the pythons would experience in the wild. The members of the research team turned the lights on and off in the room where the pythons were housed, according to light and dark cycles that the snakes would experience in the wild. Snakes were also given access to a temperature gradient in their cages by way of a heat source. The researchers allowed the snakes to mate from mid-February to mid-March. The team did not feed any of the snakes after the cooling period because reproductive female Children's pythons usually refuse to eat during that period, and feeding them could have been a source of error in the experiment.

Twenty-one of the thirty-five females laid eggs. Following oviposition, or the laying of eggs, the researchers removed all but six of the females and their eggs from the cage to weigh and count the eggs. It was not possible for the researchers to collect data on all the females who laid eggs, because interrupting the female pythons during the egg-brooding period could cause them to abandon their clutch. To remedy that problem, the researchers divided the reproductive female snakes into two groups. The researchers allowed one group of six female pythons to brood their eggs until hatching, but removed the other group of fifteen from their eggs as soon as the eggs were laid. The researchers used a third group of fourteen non-reproductive female pythons as a control, to compare their beginning and ending muscle size to that of the reproductive female snakes.

During this investigation, the researchers collected data on a variety of variables including snake length, snake mass, and size of epaxial muscles, or the muscles next to the spinal column. The researchers measured the epaxial muscles because those muscles are important for movement and constriction in pythons. The researchers also measured the muscle strength of the postpartum snakes and non-pregnant snakes in ways that mimicked natural situations in which a snake would invoke body contractions. The researchers then performed statistical analysis on the data.

Following the investigation, Lourdais, Lorouix, and DeNardo found that the epaxial muscles of reproductive female snakes were 34% smaller than that of their otherwise identical non-reproductive counterparts. They also found that 64% of the total muscle loss occurred during the vitellogenic period, or when the body's protein reserves in the muscles are reallocated to the growing egg follicles and yolk protein synthesis. The remainder of muscle loss occurred during the egg brooding period. The researchers also found that muscle loss was not homogenous along the entire body. Rather, they found that most of the muscle loss in the reproductive female pythons was toward the tail (caudally), which they considered adaptive because the muscles higher up on the snake might be more important to defense and the constriction of prey than the ones close to the tail.

The researchers found that the traction force, or the measurement for the force of constriction strength, of female snakes became an additional 50% weaker after the snakes brooded their eggs. The researchers also show that egg-brooding behavior contributes to further atrophy of the constricting muscles. Lourdais, Lorioux, and DeNardo published their results in the paper "Structural and Performance Costs of Reproduction in a Pure Capital Breeder, the Children's Python."

Sources

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2. Julander, Justin, Nick Mutton, and Peter Birch, The Complete Children's Python: A Comprehensive Guide to the Natural History, Care, and Breeding of Antaresia Species. Rodeo: ECO Herpetological Publishing & Distribution, 2013.
3. Lourdais, Olivier, Sophie Lorioux, and Dale F. DeNardo. "Structural and Performance Costs of Reproduction in a Pure Capital Breeder, the Children's Python Antaresia childreni" Physiological and Biochemical Zoology 86 (2013): 176–83.