Pythons Grow Bigger Hearts at Mealtimes

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Burmese pythons like a meal they can really get their fangs around, especially since the snakes are known to go half a year or more between meals. That gustatory pause is merely one of pythons' more remarkable adaptations.

New research shows that when the reptiles swallow whole rats, birds, and other prey, the pythons' hearts temporarily grow bigger.

Scientists in California say the snakes experience a 40 percent increase in heart muscle mass within 48 hours of feeding. The change enables the pythons to meet the metabolic demands of digesting a meal.

What's more, the process is fully reversible, with the snakes' hearts shrinking back to their original size once feeding ends.

Pythons can offer new insights to understanding heart growth in other species, including humans, according to researchers behind the discovery, which is reported in the current issue of the science journal *Nature.*

One of the world's largest snakes, the Burmese python can grow as long as 25 feet (7.6 meters) and weigh as much as 200 pounds (90 kilograms). Native to Southeast Asia, it preys on mammals, birds, and other animals, which the reptile swallows whole. But python meals are few and far between.

"These animals have a remarkable ability to shut down their metabolism between meals," said James Hicks, a professor of ecology and evolutionary biology at the University of California, Irvine.

"We currently have 1.5-kilogram [3.3-pound] pythons in the lab that have not eaten for three months and have only lost one to ten grams [four to thirty-five hundredths of an ounce] of weight," noted Hicks, who is also the study's lead author.

But when these reptiles do feed, Hicks added, they often tackle prey that is 50 to 100 percent the size of their own body mass. Such meals require a considerable digestive effort.

"Some investigators have reported as much as a 44-fold increase in metabolism during digestion," Hicks said.

Metabolic Demands

Hicks and his colleagues investigated how Burmese pythons meet the metabolic demands of digestion.

They found that oxygen consumption rose sevenfold in lab pythons after feeding. This was accompanied by an extraordinarily rapid growth in heart size. The snakes' heart ventricle muscle mass (ventricles are the heart's pumping chambers) increased 40 percent in just two days.

The study team was able to link this sudden growth to increased production of a cardiac protein. The protein is associated with cells that enlarge the heart and boost its pumping capacity, a condition known as cardiac hypertrophy.

The researchers say feeding-induced cardiac hypertrophy likely explains why Burmese pythons pump 50 percent more blood per heartbeat while quietly digesting a meal than when slithering at full speed.

Previous studies point to why python hearts need to go into overdrive when these animals digest food. Researchers report livers growing to three times their normal size, intestines doubling in mass, and pancreatic enzyme activity increasing threefold. Such changes within the snake significantly raise the demand for oxygenated blood.

Stephen Secor, a biologist at the University of Alabama in Birmingham, is among those to have studied digestion in pythons. While most carnivores are able chew, tear up, or crush their prey first, snakes "swallow only intact prey

One of the world's largest snakes, Burmes
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pounds (90 kilograms).

*Photograph courtesy Bryan Rourke, Depar
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and must delegate to the stomach the whole job of breaking [it] down," Secor said.

Yet once a python has finished its meal, its heart quickly returns to its usual size.

Heart Remodeling

Hicks, the University of California ecologist and evolutionary biologist, said that by quickly remodeling their hearts depending on whether they are feeding or fasting, Burmese pythons are able to match their metabolism to their bodily needs.

Hicks said he is unaware of any other animal that is able to do this with such speed.

His lab is currently investigating other reptiles that feed intermittently, including lizards and crocodiles. American alligators, for instance, exhibited a two- to threefold increase in metabolism during digestion. But, Hicks added, "So far, we haven't seen cardiovascular remodeling."

Nevertheless, hearts are known for their ability to adapt to the physiological demands of their owners. Human athletes, for example, often develop cardiac hypertrophy in response to vigorous training routines. Benefits of the condition include lowered heart rates and improved blood circulation.

The difficulty, Hicks said, is in understanding the mechanisms that lead to heart remodeling in humans and other mammals. Such investigations involve complex and highly invasive surgical procedures that could easily result in death.

Hicks and his colleagues propose the Burmese python as an ideal investigative model instead.

August Krogh, the 20th-century Danish physiologist, once wrote, "For a large number of problems there will be some animal of choice, or a few such animals, on which it can be most conveniently studied."

Krogh's approach has been a guiding principle for comparative physiology ever since.

Hicks said if we want to better understand how the human heart is able to remodel itself, we should look no further than the Burmese python.

After all, the reptile can grow its heart in the time it takes to eat its lunch.

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