



Bellyache?

Alligators have a complex circulatory system that helps them make more stomach acid after a big meal.

Credit: Stan Osolinski/Corbis

How to Give a Gator Heartburn

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The way to an alligator's stomach is through its heart--via the left aorta, to be precise. That's the upshot of a new study that may have finally explained the enigmatic crocodylian circulatory system. Crocs are able to send deoxygenated blood directly to their stomach, and researchers show that strategy comes in handy when the reptiles need to quickly digest enormous helpings of meat and bone.

Like birds and mammals, crocodylians--the group that includes alligators, caimans, and crocodiles--have a four-chambered heart. They can completely divide their blood flow in the same way we do:

Deoxygenated blood returns to the heart from the body, heads straight to the lungs to pick up oxygen, returns to the heart, and then gets pumped to the rest of the body. Although the four-chambered system is considered more efficient, crocs still sometimes engage an alternative primitive flow pattern characteristic of other reptiles. They can bypass the pulmonary artery that carries blood to the lungs, sending spent blood straight back to the digestive system through the left aorta. Since the early 1800s, scientists have

envisioned many functional explanations for this shunting architecture--from keeping CO₂ out of the lungs during dives to speeding digestion--but experimental data have remained scarce.

To test the digestion hypothesis, zoologist C. G. Farmer of the University of Utah in Salt Lake City and colleagues performed a series of experiments on young American alligators. First, they implanted probes around the left aortas of five gators and found that the animals shunted more deoxygenated blood to their stomachs after eating. Then, the researchers operated on a group of nine gators, closing off the left aorta. The surgery prevented shunting and forced the animals' circulation to run in the fully divided mammalian pattern. (The gators appeared healthy despite the change.) A control group underwent only sham surgeries.

After they recovered, the 2-kilogram alligators feasted on chopped steak, and the researchers measured their gastric acid secretion. As the team reports in the March/April issue of *Physiological and Biochemical Zoology*, the animals with intact shunting abilities produced more stomach acid than did the altered reptiles, especially when it was warm. In fact, they produced 10 times more than the greatest amount recorded in any animal, apparently using the CO₂-rich blood to supply stomach glands that use CO₂ to make gastric acid. The "acid secretion seemed ludicrous it was so high," Farmer says. All that stomach acid should be good for digesting large, bony meals. Indeed, x-rays showed that shunting gators with more acidic tummies finished digesting a bony ox tail days ahead of their nonshunting counterparts. Because alligators rely on external heat to warm their bodies, they can't always maintain the ideal temperature for digestion--so processing huge meals as quickly as possible is "like making hay while the sun shines," Farmer says.

Gordon Grigg, a zoologist at the University of Queensland in Brisbane, Australia, calls the study "fantastic" and says he is "in awe" of the technical challenges the researchers overcame. But he won't be completely convinced, he says, until researchers can show that blocking the left aorta doesn't decrease overall blood supply to the stomach, which might also slow digestion.