UFO cross-section gives snakes a lift

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Snakes aren't usually renowned for their ability to fly, but Chrysopelea snakes from southeast Asia regularly launch themselves from trees into the air gliding for 10s of meters before touch down. In a bid to understand how these animals remain airborne, Jake Socha and colleagues from Virginia Tech and Purdue University made a model of the snake's unusual body shape and measured the forces created by the animals to discover how they glide.

If you're afraid of snakes, you're really not going to like the next bit: some snakes can fly. It sounds like a frightful nightmare, but for Jake Socha, the discovery was the start of a fascinating odyssey to learn how an animal that looks as unaerodynamic as a snake can glide as much as 30m from a tall tree. Socha describes the snakes as 'slithering' in an S-shape through the air as they descend through the Southeast Asian rainforest: 'They look like they are swimming', he adds. But what keeps the reptiles aloft? 'They turn their whole body into one aerodynamic surface', explains Socha – who has spent much of his career unpicking details of the snake's flying style, and has now turned his attention to the animal's intriguing body shape to find out how they generate the lift they require to remain airborne. Socha and his colleagues publish their discovery that the snake's body works like an aerofoil to generate lift forces to keep them airborne in *The Journal of Experimental Biology*.

According to Socha, the snakes flex their ribs as they launch to stretch and flatten the body to change their profile from a circle into an arched semi-circle: 'It looks like someone's version of a UFO', laughs Socha, adding that as aerofoils go it's an unconventional shape. To get to grips with the aerodynamic forces generated by the snake's body, Socha and his colleagues, Daniel Holden, Nicholas Cardwell and Pavlos Vlachos, used a 3D printer to produce a rod with the same UFO cross-section as the snake's body before placing it across a tank filled with water that flowed over the snake-shaped bar. Socha explains that although water is much denser and stickier than air, you can precisely recreate the air conditions experienced as the snakes fly by flowing the water over the model at a specific range of speeds.

Tilting the snake model at angles (of attack) ranging from –10 to 60deg as the water flowed over it at speeds ranging from 20 to 50cm/s, the team measured the lift and drag forces pulling on the model and saw that at most angles the animal's unusual body shape generated sufficient lift to account for some of the snake's impressive gliding performance. But when the team tilted the model at 35deg, there was a massive spike in the lift generated by water flowing at higher speeds. More surprisingly, when the model was held level with the flow, instead of generating upward lift, the fluid pushed the rod down. And when the team visualised the turbulent water flowing around the model with microscopic reflective beads, they could clearly see a spinning vortex sitting beneath the untilted snake shape, sucking it down: which may not be that crazy, according to Socha. He says, 'Maybe the snake does hold part of its body flat at some point, using it as a mechanism for control', explaining that twisting the body while airborne could allow the snakes to fine tune the forces on their bodies for precise flight control.

But Socha adds that there is much more to the snake's impressive glide than just its unusual body shape. 'If you make a rough estimate of the lift to drag ratio for the real animal, it appears to do better than what we got from this study. So even though this shape produced more lift than we were expecting, it doesn't get us the glide performance that snakes can attain, giving us a hint that there is something in what the animal is doing aerodynamically that is not captured by the cross-sectional shape alone' –

which is the next part of the problem that Socha and his team hope to crack.

More information: Holden, D., Socha, J. J., Cardwell, N. and Vlachos, P. P. (2014). Aerodynamics of the flying snake Chrysopelea paradisi: how a bluff body cross-sectional shape contributes to gliding performance. *J. Exp. Biol.* 217, 382-394. jeb.biologists.org/content/217/3/382.abstract

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