Tongue-Sticking: Tongue Behavior of Arboreal Colubrids During Gap Crossing

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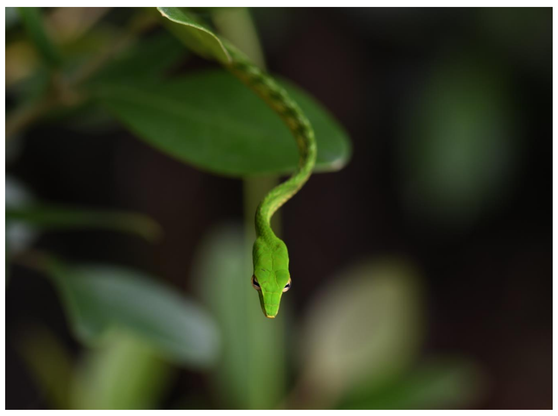
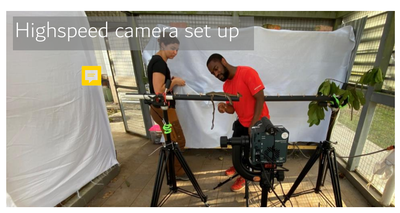
Do close relatives of flying snakes also exhibit this behavior?

Tongue movement in snakes has been previously attributed to chemo- and mechanosensation characterized as a sweeping, vertical oscillation of the tongue, followed by the tongue being pulled back into the mouth to allow particle transfer to sensory organs. In previous studies, flying snakes (*Chrysopelea*) have been observed to protrude their tongue without oscillation in the context of locomotion.



Recorded the behavior of snakes crossing gaps of different sizes

To investigate this question, we recorded the tongue behavior in close relatives (*Ahaetulla prasina*, *Dendrelaphis pictus*, *caudolineatus*, and *formosis*) as well as less related species (*Dryocalamus subannulatus*, *Boiga cynodon*, *drapiezii*, *and nigriceps*, *Lycodon capucinus*) as they traversed gaps.

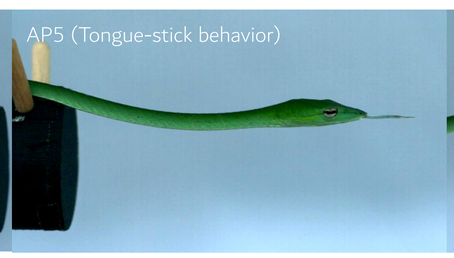


The setup consists of two artificial branches oriented horizontally and suspended 118 cm off the ground. Each snake completed four trials, recorded on four GoPro Hero4 cameras, crossing gaps of 0%, 15%, 30%, and 45% of the snake's snout to vent length.

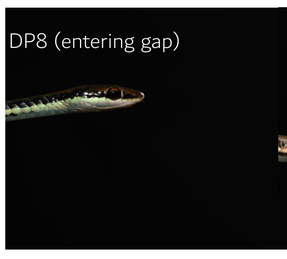
Only the close relatives of flying snakes exhibited tongue stick

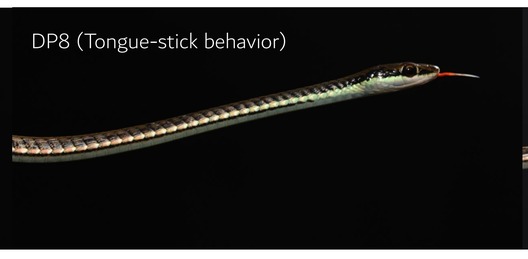
Ahaetulla and *Dendrelaphis* spp. exhibited the presence of a tongue protrusion variant when crossing a gap. This behavior followed an oscillation, stick, oscillation (OSO) pattern. Generally, the tongue stick could be characterized by a rigid proximal half of the tongue while the tines show variable motion.

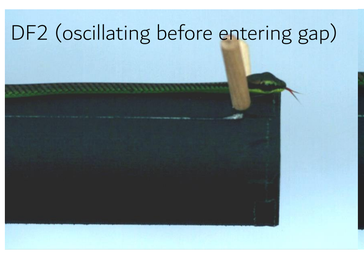
Ahaetulla prasina performs a few tongue oscillations when leaving the origin and quickly morph into full stick behavior, where the tines of the tongue are stuck together, stiff, and in line with the posterior half of the tongue. When approaching the target, *Ahaetulla* may oscillate slightly before or after reaching the target branch.

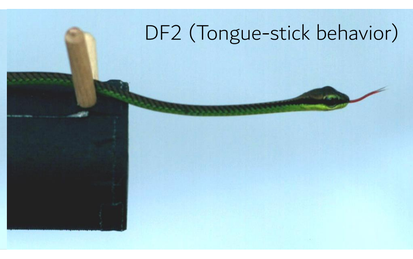


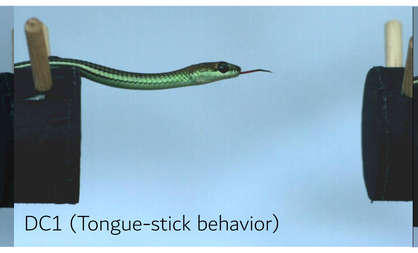
Dendrelaphis, when entering the gap, perform full tongue oscillations. Once in some percent of the gap, the tongue will switch from oscillations to a tongue stick with spread tines. The tines during this phase are not stationary but perform a kind of vertical flick or flutter motion.





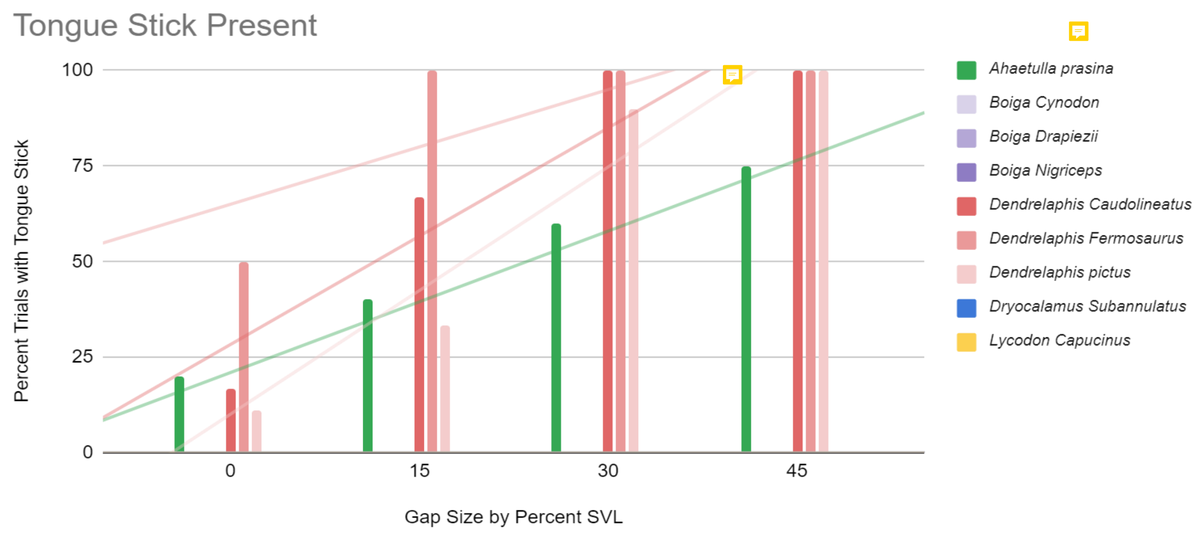




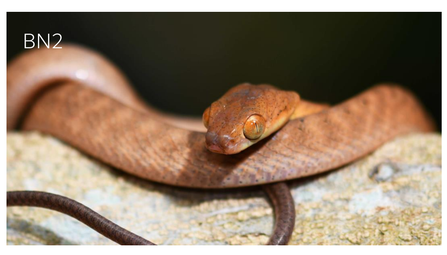


There is variability in tine movement between the *Dendrelaphis* species. As the snake approaches the target stick, the tines switch from a vertical motion to an inward and outward fluctuation on the midline with an increase in separation the closer the snake gets to the target or a scissor flick. Once on or close to the target, *Dendrelaphis* switch to full or half upward oscillations. Tines are always separated when the tongue is out of the mouth for the *Dendrelaphis* genius.

The presence or absence of the tongue stick, for snakes that showed the behavior, varied slightly based on gap distance. The longer the gap distance, the more likely the snake was to perform the tongue-sticking behavior(figure below).



Dryocalamus Subannulatus, *Boiga cynodon*, *drapiezii*, *and nigriceps*, and *Lycodon capucinus* did not show signs of rigid tongue stick behavior.



Why do they do it?

While the reason for the tongue stick behavior remains relatively a mystery there are some ideas for what the purpose may be. The rigid stick of the tongue might be being used as a sort of blind spot tester, protruding in front of the snake where its eyes might have a more difficult time discerning the depth and spacing of the objects in front of its snout. To test this hypothesis further, a more detailed analysis of the snakes' eyes' field of view. Another idea is that the tongue is used to test the conditions(such as wind) of the cross. However, when hanging stationary off a branch, none of the snakes exhibited any sort of tongue protrusion.

It is important to note that the snakes do not seem to need the tongue to cross. When running trials with the *Ahaetulla prasine* AP3, due to a misaligned jaw, the snake was unable to protrude its tongue at all and still successfully crossed all three gaps. Further analysis needs to be done on AP3's trial comparing the snake's efficiency to the other snakes in the study to see if the loss of tongue causes lower effectiveness

Acknowledgments

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