'Time to eat': Videos show that toe-tapping by frogs may be a strategy to draw out prey

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It is well known that some species of frogs tap their posterior toes as they are seeking prey; this can be seen in many videos posted online. However, only a few studies to date have looked at the tapping habit

itself, and not much is known about the reason behind it.

Now a pair of researchers from the University of Illinois Urbana-Champaign has analytically investigated the behavior in Dyeing poison frogs (Dendrobates tinctorius). Their findings are posted on the *bioRxiv* preprint server.

D. tinctorius is a species of tiny poison dart frogs (measuring less than 5 cm, weighing about 3 g) typically found in rainforest areas of northern South America. These frogs protect themselves from predator threats by secreting a paralyzing and potentially fatal poison from glands within their skin. In the wild, they eat insects and non-insect arthropods such as spiders.

Owing to the speed and small size of these frogs' prey, it is essential for them to be able to detect its movement for successful capture.

Earlier studies have reported on the highly developed vibrational sensitivity of frogs and toads, though mainly while discussing their ability to evade their own predators. The researchers of this new work note that cannibalistic cane toads "vibrate their toes close to the frequency most effective at attracting conspecific prey," according to findings of a 2008 study. Furthermore, it is also known that frogs' arthropod prey are quite sensitive to vibration and will react to it.

This led the researchers to hypothesize that vibrations from the tapping toes of D. tinctorius would stimulate movement of potential prey, making it easy for the frogs to find; and that the frogs generally modulate tapping speed as needed, depending on the situation.

The team sought to learn whether the frogs tapped more slowly in situations that did not allow them vibrational contact with their prey; whether they tapped faster on surfaces that facilitated vibration; and

whether tapping helped them more successfully seize prey.

Testing tapping under various conditions

The researchers conducted their tests with D. tinctorius individuals kept in breeding pairs in terraria at their university research facility. Three times weekly, the frogs fed on fruit flies (Drosophila hydei or Drosophila melanogaster) dusted with vitamins. With these frogs, the researchers conducted three trials.

First, they took high-speed video of individual frogs during a feeding period in which they dropped a half teaspoon of fruit flies into the terrarium, then took high-speed video of the same individuals during a non-feeding period, noting the partner proximity during each recording.

In the second trial, they assessed whether the frogs adjusted their tapping behavior when prey moved about on a separate, inaccessible surface. For this, the researchers placed the fruit flies inside clear Petri dishes in the frogs' terraria, recorded high-speed video when the frogs attempted to strike the prey, and repeated the test the following day with the same individual frogs and free-moving prey.

Finally, the team tested the frogs' tap rates on four different surfaces varying in their nature and pliability:

- Leaf litter (natural, pliable)
- Soil (natural, unpliable)
- Gel (unnatural, pliable [1% agar])
- Glass (unnatural, unpliable).

They placed frogs individually into test terraria to acclimate them to each surface, then fed them and collected data during feeding and non-feeding periods as they had in the first trial, this time also noting how

many strikes the frogs made and the rates of success.

Feeding, prey accessibility and surfaces play roles in tapping rates

Feeding made a difference, the first trial confirmed. The team found that the frogs increased their tapping when prey but no partner was present (avg. 389 taps/minute), and more so when feeding while a partner frog was present (avg. 684 taps/minute). With no partner frog nearby and no prey, tapping dropped significantly (avg. 50 taps/minute), and even more with a partner nearby but an absence of prey (avg. 43 taps/minute).

The researchers observe, "We highlight that—at a maximum of almost 500 taps per toe per minute—this behavior is incredibly fast for any vertebrate muscular movement. In brief, these findings demonstrate an association between tapping and feeding and provide interesting avenues for further study."

The second trial showed that accessibility of prey mattered. When the frogs could see but not get to the flies in the Petri dishes, they tapped an average of 50 taps/minute, even as they continued making attempts to seize the flies. When the flies were moving freely, the frogs tapped noticeably faster (avg. 166 taps/minute).

Based on these results, the team notes, "When frogs could see but not capture flies, frogs tapped significantly less but still hunted. We suggest that this change in tap rate may be related to changes in vibrational stimuli and/or feedback from prey capture success. This observation suggests that frogs might alter their tapping behavior based on prey's responses."

The final trial revealed that tap rates varied according to surface type, with higher rates on pliable surfaces:

- Leaf litter (natural, pliable): avg. 255 taps/minute
- Soil (natural, unpliable): avg. 98 taps/minute
- Gel (unnatural, pliable [1% agar]): avg. 118 taps/minute
- Glass (unnatural, unpliable): avg. 64 taps/minute.

Interestingly, the frogs tapped mostly at lower average rates in the test terraria than in their home terraria. However, the researchers noted that varying surface types in the final trial did not affect the total number of prey strikes or the frogs' strike success rates. As the frogs tapped faster, they increased their strike rates, but their overall prey capture success could not be associated with their tap rates.

Commenting on these third trial results, the researchers write, "...we found that frogs tapped less on soil than leaves, despite both surfaces being familiar to frogs. Taken together, these observations demonstrate that frogs modulate tapping behavior based on substrate type and independent of prey capture attempts."

Overall, the team suggests that further research on the biomechanics of tapping and the sensitivity of both frogs and their prey to vibrations, along with measuring the surface vibrations resulting from tapping, will shed more light on this behavior in frogs.

More information: Thomas Q. Parrish et al, Tap Dancing Frogs: Posterior Toe Tapping and Feeding Behavior in Dendrobates tinctorius, *bioRxiv* (2024). DOI: 10.1101/2023.09.15.558032