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FrogLog

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Salamanders Lost, Salamanders Found, Salamanders Saved

Do All Threatened Amphibians Belong on the Ark?

Mapping the Malabar Tree Toad

And Much More!

A calling male Malabar Tree Toad. Photo: Gururaja KV.

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Frog eat Frog

By [1]Giovanni Vimercati & [2]John Measey

Cannibalism in the African Bullfrog *Pyxicephalus adspersus* in Polokwane, Limpopo Province, S. Africa. Photo: Les Minter.

Frogs can be voracious predators, and we usually think of their prey as insects and other small invertebrates. Generations of herpetologists have extracted stomach contents to see what frogs eat. The results are not what we might have expected however, as their capacity to feed on relatively large items such as reptiles, birds or mammals is surprising (*1*). Not least among these larger prey items are other frogs. Some species are notorious frog eaters, such as the South American Horned Frogs (genus *Ceratophrys*), the African Bullfrogs (genus *Pyxicephalus*) and the North American Bull Frog (*Lithobates catesbianus)*. But are these the only frogs eating frogs? What variables are influencing this behavior?

A common hypothesis is that bigger frogs are more likely to consume other frogs. However, this has yet to be tested across taxa and maybe there are other characteristics that are strongly associated with frogs that eat other frogs. We decided to investigate the extent of anurophagy (literally "feeding on frogs"; from Latin prefix an,- "not" + Ancient Greek ourá, "tail" and from Ancient Greek-phagia, from phagein,"eat") at the population level to ask how widespread it is in frogs. In addition, we wanted to determine the influence of some key variables: habitat, diversity and invasiveness. To accomplish this we conducted a literature review of post-metamorphic diet in Anura (*2*). The ease of stomach content analyses through dissection or stomach flushing has produced an extensive literature on frog diet. From each paper we extracted the species name, total prey items, total anurans eaten (eggs, larvae and post-metamorphics), location and mean body size. Moreover, we also considered for each record: species taxonomic position at family and superfamily level, anuran species diversity at the study site, habitat, cannibalism occurrence and if the studied population was native or invasive. In total we analyzed data from 355 cases in 323 papers representing 228 species. Our results show that anurophagy is not uncommon, with the predation on eggs, tadpoles or post-metamorphic frogs reported in more than 20% of cases. Ranoidea and Pipoidea were observed feeding on other frogs more frequently than other superfamilies, showing how the phylogenetic position is correlated with anurophagy. Correcting for this taxonomic effect, we confirmed the size hypothesis, with large frogs more likely to feed on other frogs. For every additional millimetre in the body size, the likelihood of observing frogs in the diet increased 2.8%. We also found that habitat and anuran diversity play a role in determining whether a frog species showed anurophagy. More specifically, generalist species consume significantly more frogs than forest, shrubland and grassland species, and frogs from sites with high anuran species diversity were more likely to consume frogs. On the other hand, cannibalistic species (*i.e.*, species that had conspecifics among their prey items) were not observed to have more frogs in their diet if compared with non-cannibalistic species. Last but not least, invasive anurans were 40% more likely to consume frogs than non-invasive ones.

While the positive effect of body size on the capacity to prey on other frogs is fairly straightforward to interpret, other factors such as habitat or anuran diversity are more difficult to put into context. Generalist species should have the capacity to use a larger spectrum of microhabitats and show a more flexible behavior, having a higher possibility to come across other frogs to feed on. For analogous reasons, anuran diversity could act as a proxy of higher frog abundance in the ecosystem or determine a more diversified niche partitioning—both elements that should cause higher encounter rate of one anuran with another (especially when one is generalist). These areas seem ripe for further investigation. Our finding that invasive species were more likely to be predators of other frogs, even after accounting for the effect of body size, is an important result. However, dietary data for invasive species was limited and we encourage more research on this topic. From a conservation perspective, it has to be noted that native frog populations are currently declining across the globe (*3*) and introduced amphibians are at least partially driving this decline (*4*). Since the amphibian trade is potentially causing new frog introductions (*5*) and some countries are currently compiling list of species that should not be traded, we suggest that large generalist species, and especially ranids and pipids, should be of particular concern because of their tendency to feed on other frogs, especially in areas characterized by high anuran diversity.

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References:

1. L. F. Toledo, R. S. Ribeiro, C. F. Haddad, *J. Zool.* **271**, 170–177 (2007).
2. G. J. Measey *et al.*, *PeerJ* 3:e1204 https://dx.doi.org/10.7717/peerj.1204 (2015).
3. J. P. Collins, M. L. Crump, T. E. Lovejoy III, Extinction in Our Times: Global Amphibian Decline (Oxford Univ. Press, Oxford, UK, 2009).
4. G. M. Bucciarelli, A. R. Blaustein, T. S. Garcia, L. B. Kats, *Copeia* **4**, 611–632 (2014).
5. M. A. Schlaepfer, C. Hoover, C. K. Dodd, *BioScience* **55**, 256–264 (2005).

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An adult African Clawed Frog *Xenopus laevis* regurgitates a Clicking Stream Frog *Strongylopus grayii*. Photo: John Measey.