The great escape: earthworm survives the digestive tract of Indian bull-frog (*Hoplobatrachus tigerinus*)

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Introduction

The Indian bullfrog (*Hoplobatrachus tigerinus*) (Daudin, 1802) is a large dicroglossid frog distributed amongst the Indian subcontinent, and has established invasive populations on the Andaman Islands and Madagascar (Mohanty *et al*., 2020). It is one of the largest species of anuran in South and Southeast Asia, reaching a snout to vent length of 170 mm, and classified as "Least Concern" on the IUCN Red List (Padhye *et al*., 2008).

The tadpoles of the Indian bullfrog are obligate carnivores, feeding on sympatric tadpoles and scavenging animal matter (Khan, 1996). As adults they are generalists, feeding mostly on invertebrates, but only limited by what can fit in their mouth, including vertebrates (Khan, 1973; Corlett, 2011; Rahman *et al*., 2012), with some notable predation notes on other large frog species (Datta & Khaledin, 2017; Tripathi, 2018).

There are few records of prey items escaping through the digestive tract of a predator, most unpalatable or indigestable prey items are regurgitated instead of swallowed. Snails have been demonstrated to consistently survive the digestive system of birds (Wada *et al*., 2012), and other molluscs have been identified to survive the digestive tracts of fish both in situ and ex situ (Brown, 2007). These are hypothesised to be advantageous dispersal mechanisms, by surviving the digestion process and excreted with faeces.

Some more examples exist from anuran predators. Sugiura (2020) reports the escape of the aquatic beetle *Regimbartia attenuata* (Coleoptera: Hydrophilidae) from the vents of five frog species via the digestive tract, and experimentally demonstrates they actively use their legs to hasten their escape. O'Shea *et al*., (2013) observed the defecation of a live blind snake (*Ramphotyphlops braminus*) from a Common Asian Toad (*Duttaphrynus melanostictus*), which despite being small and slender, is still a remarkable feat for a

vertebrate to survive. The blindsnake did, however, die shortly after expulsion, presumably from exposure to digestive chemicals or anoxia (Pizatto *et al*., 2012).

Observation

Here we report the excretion of a live earthworm (*Opisthopora*) by an Indian bullfrog, by Dehra, Himachal Pradesh, India. On the 31st of August, 2019, at approximately 2230, during a night-time herpetofaunal survey, we encountered a sub-adult Indian bullfrog (*H. tigerinus*) on a concrete path. The surrounding surfaces and vegetation were wet from recent light rain, and invertebrate and amphibian activity appeared to be elevated. Upon closer inspection, we identified a live, moving annelid worm emerging from the cloaca of the frog. The frog was approximately 40 mm snout to vent length, and approximately 55 mm of the worm was visible (Figure1). The presence of the clitellum and the direction of locomotion demonstrated the worm was emerging anterior first, with the posterior part still within the frog. By appearance of its rectilinear locomotion, the worm appeared to be actively "escaping" from the frog's cloaca, however it is impossible to discount any potential effect of muscular contractions from the frog. The frog remained motionless during the encounter, with

Figure 1. Sub-adult Indian Bullfrog (*Hoplobatrachus tigerinus*) nearing the end of its excretion of a live earthworm (*Opisthopora*).

no behaviour inferring discomfort. The remaining excretion continued for approximately three minutes, until the worm had fully escaped. Both the worm and the frog appeared unharmed. The entire length of the worm was estimated at 65 mm. Although both predator and prey were alive once we had finished observing, it is possible the worm died after the event. A full video of the encounter is available at https://figshare.com/articles/media/VID_20190831_210833_mp4/14673756.

Conclusion

Given the voracious nature of the Indian bullfrog, the likely scenario included the predation and ingestion of the worm without much jaw pressure, allowing it to survive entry to the digestive tract. The worm than either actively, or passively, or likely a combination of both, navigated through the digestive tract to the cloaca, of which we observed. Despite annelid worms respiring through their skin, they are notable for their regenerative properties, and given previous literature regarding the excretion of live animals from anurans, perhaps the digestive system of frogs are not particularly strong, or some live prey items may be more tolerant of the conditions. These factors combined may have worked synergistically to explain our observation.

References

Brown, R. J. (2007). Freshwater mollusks survive fish gut passage. *Arctic*, 124-128.

Corlett, R. T. (2011). Vertebrate Carnivores And Predation In The Oriental (Indomalayan) Region. *Raffles Bulletin of Zoology*, 59(2).

Datta, A. K., & Khaledin, S. (2017). Observations on an Indian Bull Frog swallowing an Asian Common Toad, and a Checkered Keelback on a Skipper Frog. *ZOO'S PRINT*, 32(6), 28-29.

Khan, M. S. (1996). The Oropharyngeal Morphology and Feeding Habits of Tadpole of Tiger Frog Rana tigerina Daudin. *Russian Journal of Herpetology,* 3(2), 163-171.

Khan, M.S. (1973). Food of the Tiger Frog Rana tigerina Daudin. *Biologia*, 93–107.

Mohanty, N. P., Crottini, A., Garcia, R. A., & Measey, J. (2020). Non-native populations and global invasion potential of the Indian bullfrog *Hoplobatrachus tigerinus*: a synthesis for risk-analysis. *Biological Invasions*, 1-13.

O'Shea, M., Kathriner, A., Mecke, S., Sanchez, C., & Kaiser, H. (2013). 'Fantastic Voyage': a live blindsnake (*Ramphotyphlops braminus*) journeys through the gastrointestinal system of a toad

(*Duttaphrynus melanostictus*). *Herpetology Notes*, 6, 467-470.

Padhye A, Manamendra-Arachchi K, deSilva A, Dutta S, Kumar Shrestha T, Bordoloi S, Papenfuss T, Anderson S, Kuzmin S, Khan MS, Nussbaum R (2008) *Hoplobatrachus tigerinus*: The IUCN Red List of Threatened Species. http://dx.doi.org/10.2305/ IUCN.UK.2008.RLTS. T58301A11760496.en

Pizzatto, L. Somaweera, R., Kelehaer, C., Brown, G.P. (2012): *Rhinella marina* (cane toad). Diet. *Herpetological Review*, 43: 469-470.

Rahman, S.C., W.I. Opu & K.R. Das (2012). *Lycodon aulicus* (Common Wolf Snake): predation. *Herpetological Review*, 43(2): 346.

Sugiura, S. (2020). Active escape of prey from predator vent via the digestive tract. *Current Biology*, 30(15), R867-R868.

Tripathi, R. (2018). Indian Bullfrog: Predation record on *Duttaphrynus* species by *Hoplobatrachus tigerinus* (Daudin 1802). *ZOO'S PRINT*, 33(4), 10-11.

Wada, S., Kawakami, K., & Chiba, S. (2012). Snails can survive passage through a bird's digestive system. *Journal of Biogeography*, 39(1), 69-73.