

# Predators of the Purple Frog *Nasikabatrachus sahyadrensis* Biju and Bossuyt, 2003

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*Nasikabatrachus sahyadrensis* Biju and Bossuyt, 2003 is an evolutionarily distinct and globally endangered species and is considered a global priority for species conservation (Gumbs et al. 2018). Previous studies have uncovered certain aspects of its ecology and behaviour (Dutta et al., 2004; Raj et al., 2011; Zachariah et al., 2012; Thomas et al., 2014, 2019; Senevirathne et al., 2016) and such studies on life history and ecology are recommended as they can inform subsequent conservation action (Biju, 2004). Adult frogs are fossorial (Biju and Bossuyt, 2003) and they emerge to breed for a brief period during pre-monsoon showers (Dutta et al., 2004) where male frogs call from underground burrows (Thomas et al., 2014). The brief period of surface activity and underground calling likely reduces mortality from predators (Raj et al., 2011). The tadpoles develop in seasonal fast flowing stream habitats with steep gradients, high flow velocity, and shallow water depth (~1–2 cm), factors that may facilitate predator evasion and may allow tadpoles to develop with no competition from other anuran larvae (Zachariah et al., 2012; Thomas et al., 2019). The predation on eggs by terrestrial insects and aquatic larvae (mayflies and caddisflies) has been reported (Zachariah et al., 2012). Here, for the first time we report predation events on *N.*

*sahyadrensis* adults and provide further information on the predators of its tadpoles.

Whilst undertaking a long term study (2012–2020) on the reproductive biology of *N. sahyadrensis* at a seasonal stream in the Thrissur Forest Division, Kerala, India (10.5751°N, 76.3092°E, 89 m a.s.l.) we observed many dead female frogs in a 50 m stretch of stream during the breeding season, May–June (2012, N = 6; 2013, N = 5; 2014, N = 8; 2015, N = 5; 2016, N = 6; 2017, N = 6; 2018, N = 10; 2019, N = 6; 2020, N = 2). All the dead frogs were gravid female *N. sahyadrensis*, and were usually found on rocks beside a seasonal stream. The flank of the frogs had been split open and clumps of blood-covered eggs were often scattered around. On some occasions, the carcass would disappear on the same night as it was found (Fig. 1A).

On 03 June 2016 at 20:45 h we encountered a brown fish owl *Ketupa zeylonensis* (Gmelin, 1788) perched on a rock, feeding on a single *N. sahyadrensis* within its talons. When approached, the bird flew off with the frog. Directly below the rock we found another female *N. sahyadrensis*, close to death and with its flank split open. The owl returned to the site and retrieved the frog when we turned off our head torches. It has already been established that *K. zeylonensis* feeds on frogs and toads (Vyas et al., 2013; Bindu and Balakrishnan 2015). It is likely that all the *N. sahyadrensis* carcasses that we have observed on the rocks beside the stream represent interrupted predation attempts by *K. zeylonensis*. *N. sahyadrensis* only emerges to breed after the first heavy monsoon rains and we patrolled the study site prior to and during the first rains. We only observed owls in the vicinity of the stream after the first rains when male *N. sahyadrensis* begin calling; from 2017–2020, we observed four individual *K. zeylonensis* along the same 100 m stretch of the stream actively hunting *N. sahyadrensis*. In 2017, a camera trap was installed on a sheet rock in the stream, but we were unable to obtain photographic evidence of our observations. In several instances, we also observed *K. zeylonensis* carry off amplexant *Duttaphrynus melanostictus* (Schneider,

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**Figure 1.** Predation on *Nasikabatrachus sahyadrensis*. (A) Predation on a gravid female by a brown fish owl (*Ketupa zeylonensis*). (B, C) Predation on a gravid female by the checkered keelback (*Fowlea piscator*). (D) Predation on a *Nasikabatrachus sahyadrensis* tadpole by a fishing spider (*Thalassius* sp.).

1799). We found *D. melanostictus* carcasses later, the majority of which remained uneaten and strangely, the owls did not retrieve the carcasses of this species once they had been disturbed.

Checkered keelbacks *Fowlea piscator* (Schneider, 1799) were observed inside rock crevices that are used as oviposition sites by *N. sahyadrensis*. These snakes were not seen at the site before the onset of the monsoon rains. On 10 June 2019 at 23:42 hrs we observed an amplexant pair of *N. sahyadrensis* moving towards a potential oviposition site. When the pair were at the oviposition site (a waterfilled rock crevice) the female was struck on the anterior portion by a ~1 m long *F. piscator* that came from a lower portion of the stream (Fig. 1B, C). The male remained in amplexus with the female for 2 minutes before it released its grip, moved

away and started calling from another nearby oviposition site. The female frog stopped moving after 10 minutes and the snake began to consume it, swallowing its right leg followed by the left. It took 20 minutes for the snake to consume the frog.

On 11 September 2016 we observed a spider (*Thalassius* sp.) hunting a *N. sahyadrensis* tadpole, approximately Stage 30 (Gosner, 1960), at the Thrissur Forest Division. The spider was waiting along a crevice with its 1<sup>st</sup> and 2<sup>nd</sup> pair of legs in the water. A tadpole that came out of the torrent to a slow flowing area of stream was grabbed and dragged out of the water by the spider. It rapidly moved under a dried leaf where we presume the tadpole was consumed. Another predation event on *N. sahyadrensis* tadpole by *Thalassius* sp. (Fig. 1D) was observed at Chimmony Wildlife Sanctuary (10.4602°N,

76.4638 °E, 94 m a.s.l.) by Sangeeth KR on 17 June 2018.

Blood-coated *N. sahyadrensis* eggs have been found close to oviposition sites previously and it was hypothesised that the blood on these eggs came from the female frog when expelling the last of the season's eggs (Zachariah et. al., 2012). Based on our observations, we predict that the blood-coated eggs are likely to be the remains of predation events by brown fish owls. Whilst *N. sahyadrensis* are only active above ground for a brief period, our observations demonstrate that they may be exposed to high predation pressure during the breeding season and that some predators may adjust their foraging activities so that they are present when *N. sahyadrensis* emerge at their very specific breeding time and microhabitats. Furthermore, whilst the larvae occupy habitats that are inaccessible to many predators, they are still consumed by several invertebrates.

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## References

- Biju, S.D. (2004): *Nasikabatrachus sahyadrensis*. The IUCN Red List of Threatened Species 2004: e. T58051A11722468. Available at: <https://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T58051A11722468.en>. Accessed on 03 August 2020.
- Biju, S.D., Bossuyt, F. (2003): New frog family from India reveals an ancient biogeographical link with the Seychelles. *Nature* **425**: 711–714.
- Bindu, T.N., Balakrishnan, P. (2015): Observations on the breeding of the brown fish-owl *Ketupa zeylonensis* in Kerala, Southern India. *Journal of the Bombay Natural History Society* **112**: 97–98.
- Dutta, S.K., Vasudevan, K., Chaitra, M.S., Shankar, K., Aggarwal, R.K. (2004): Jurassic frogs and the evolution of amphibian endemism in the Western Ghats. *Current Science* **86**: 211–216.
- Gosner, K.L. (1960): A simplified table for staging anuran embryos and larvae with notes on identification. *Herpetologica* **16**: 183–190.
- Gumbs, R., Gray, C.L., Wearn, O.R., Owen, N.R. (2018): Tetrapods on the EDGE: overcoming data limitations to identify phylogenetic conservation priorities. *PLoS ONE* **13**(4): e0194680.
- Raj, P., Deepak, V., Vasudevan, K. (2011): Monitoring of breeding in *Nasikabatrachus sahyadrensis* (Anura: Nasikabatrachidae) in the southern Western Ghats, India. *Herpetology Notes* **4**: 11–16.
- Senevirathne, G., Thomas, A., Kerney, R., Hanken, J., Biju, S.D., Meegaskumbura, M. (2016): From clinging to digging: the postembryonic skeletal ontogeny of the Indian Purple Frog, *Nasikabatrachus sahyadrensis* (Anura: Nasikabatrachidae). *PLoS ONE* **11**(3): p.e0151114.
- Thomas, A., Biju, S.D. (2015): Tadpole consumption is a direct threat to the endangered purple frog, *Nasikabatrachus sahyadrensis*. *Salamandra* **51**(3): 252–258.
- Thomas A., Suyesh R., Biju S.D., Bee M.A. (2014). Vocal Behavior of the Elusive Purple Frog of India (*Nasikabatrachus sahyadrensis*), a Fossorial Species Endemic to the Western Ghats. *PLoS ONE* **9**: e84809.
- Thomas, A., Das, S., Manish, K. (2019): Influence of stream habitat variables on distribution and abundance of tadpoles of the endangered Purple frog, *Nasikabatrachus sahyadrensis* (Anura: Nasikabatrachidae). *Journal of Asia-Pacific Biodiversity* **12**(2): 144–151.
- Vyas, R., Upadhyay, K., Patel, M.R., Bhatt, R.D. and Patel, P. (2013): Notes on the breeding of the brown fish owl *Ketupa zeylonensis*. *Indian Birds* **8**(6):147–153.
- Zachariah, A., Abraham, R.K., Das, S., Jayan, K.C., Altig, R. (2012): A detailed account of the reproductive strategy and developmental stages of *Nasikabatrachus sahyadrensis* (Anura: Nasikabatrachidae), the only extant member of an archaic frog lineage. *Zootaxa* **3510**(1): 53–64.