

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

Sandeep Das^{1,2,*}, Pulikunnel Syed Easa², Nithin Divakar³, Ashish Thomas⁴, and Benjamin Tapley⁵

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,

¹ EDGE of Existence programme, Conservation and Policy, Zoological Society of London, London, NW1 4RY, United Kingdom.

² Kerala Forest Research Institute, Peechi, Kerala 680653, India.

³ Krishna Kripa, Pampalil, Perinadu P.O, Kollam, Kerala 691601, India.

⁴ Department of Environmental Studies, Sri Guru Nanak Dev Khalsa College, University of Delhi, New Delhi, 110005, India.

⁵ Zoological Society of London, London, NW1 4RY, United Kingdom.

* Corresponding author. E-mail: maeri.sandeepdas@gmail.com



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 1st and 2nd 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.

Acknowledgments. We are thankful to Mr. K J Varugese IFS, Chief Wildlife Warden, Kerala Forest Department (KFD) for permission to conduct the study (WL 10-17878/2017 dated 16/9/2017). We acknowledge the Thrissur DFOs Mr. Syam Mohanlal, Mr. Suyog Patil IFS, Mr Kurra Srinivas IFS and Range Forest Officers Mr. Ranjith MK, Mr. Akhil VB and Mr. Akhil Babu for necessary permissions. We thank Rajkumar KP and Sarath R for helping with the field data collections. We thank Idea Wild for funding the wide-angle macro lens (DASINDI1117) used to capture the described events. This research work was funded by an EDGE Fellowship grant to SD.

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