

Diet of the Malabar pitviper *Trimeresurus malabaricus*

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The Malabar pitviper *Trimeresurus malabaricus* (Jerdon, 1854) is endemic to India, distributed in the tropical rainforests of the Western Ghats from Mahabaleshwar to Kanyakumari (Whitaker & Captain, 2004). This polymorphic species is active nocturnally on rocks, trees, bushes and occasionally on the ground (Whitaker & Captain, 2004; Sawant et al., 2010), often inhabiting riparian habitats (Whitaker & Captain, 2004; Ganesh et al., 2010). Its diet is known to include small mammals, frogs, toads, lizards, birds and their eggs, moreover cannibalism has been observed (Whitaker & Captain, 2004; Khaire, 2006). Sagar (2016) highlighted variation in the dietary preference among the life stages of *T. malabaricus* with adults and sub-adults eating rodents, birds and bird eggs, whereas the young and juveniles feed on small frogs and lizards, and sometimes on insect larvae and the eggs of birds and lizards.

Analyzing the diets of snake species provides a basis to understand their natural history and provides a broader ecological and evolutionary context (Greene, 1983; Mushinsky, 1987). Furthermore, it gives an understanding of both resource partitioning (Schoener, 1965) and competition within an ecosystem (Toft, 1985) that pave the way for the development of species-specific conservation approaches (Greene, 1994). No detailed study on the diet of *T. malabaricus* has been published previously, consequently we have prepared an inventory of the recorded prey items of *T. malabaricus* from the following information sources:

1. Social media records

We searched Facebook using the keywords- "*Trimeresurus malabaricus*", "Malabar pit viper", "*Trimeresurus malabaricus* eating", "Malabar pit viper eating", "*Trimeresurus malabaricus* feeding", "Malabar pit viper feeding", "*Trimeresurus malabaricus* kill" and "Malabar pit viper kill" and Instagram using the hashtags- "#trimeresurusmalabaricus" and "#malabarpitviper" and compiled all records along with photographic evidence of *T. malabaricus* feeding only in the wild. The observations were verified through their captions and photographs. Information including identity of the prey, the observer's name, location of sighting, direction of ingestion and the colour morph of *T. malabaricus* were recorded. Additionally, we searched YouTube and Flickr using the same keywords and compiled records that met the above criteria.

2. Citizen science records

Records of *T. malabaricus* feeding were collected from various citizen science websites such as Reptiles of India (Kamdar et al., 2021) and iNaturalist (2020).

3. Records from literature

Records of *T. malabaricus* feeding were reviewed in published literature and were added to the list. These were compiled from Google Scholar and ResearchGate.

All the above-mentioned records were collected and arranged in a Numbers v.11.1 spreadsheet. Before finalising the data, records of the same observation posted across multiple platforms by the same observer were deleted (literature and citizen science websites taking priority over the duplicate social media records) as were multiple records of the same observation posted by different observers (which were identified based on the images). From the records collected, we first created separate data frames, i.e. type source of records and type of prey consumed. We then broke down the prey by morph to reveal trends/ patterns (if any) and tested the statistical significance of the relationship between the morph of *T. malabaricus* and its prey items using the Chi-Square test. Data obtained from crowdsourcing is accurate but has some obvious biases that have been listed by Kalki & Weiss (2020). These included observers naturally photographing events of personal interest and photographs being restricted to easily accessible spaces, closer to the ground, on or near forest trails etc. that have a higher probability of catching the observer's eye.

A total of 51 observations of *T. malabaricus* feeding in the wild were compiled (Table 1). Of these, most were social media records (88.2 %), followed by citizen science (9.8 %) and then published literature (2 %). Of the total social media records, Facebook contributed 51.1 %, Instagram 33.3% and the rest came from YouTube and Flickr. According to the data collected, *T. malabaricus* primarily feeds on anurans (74.5 %), occasionally on lizards (13.7 %) or mammals (7.8 %) and quite rarely on other prey types (3.9 %; there was one instance each of feeding on a land snail and an eel) (Fig. 1). The direction of ingestion was determined for 78.4 % of the total records, out of which 75 % prey were consumed head-first and only 25 % were consumed feet-first.

Out of all the feeding observations, most were recorded for the brown-green (olive) morph of *T. malabaricus* (45.1 %), followed by the green morph (35.3 %) and then by the other

Table 1. List of prey items* recorded for *Trimeresurus malabaricus* along with their source type

	Social media	Citizen Science	Literature
Anura			
<i>Clinotarsus curtipes</i>	1		
<i>Euphlyctis</i> sp.	1		
<i>Hoplobatrachus tigerinus</i>	1		
<i>Indirana</i> sp.	1	1	
<i>Indosylvirana intermedia</i>	4	1	
<i>Minervarya</i> cf. <i>rufescens</i>	1		
<i>Nyctibatrachus</i> sp.	5		
<i>Polypedates</i> sp.	1		
<i>Pseudophilautus</i> sp.	1		
<i>Rhacophorus malabaricus</i>	16	2	
<i>Uperodon marmorata</i>	1		
Unidentified anuran	1		
Fish			
<i>Monopterus</i> sp.	1		
Lizards			
<i>Cnemaspis</i> sp.	2		
<i>Hemidactylus</i> sp.	4	1	
Mammals			
<i>Vandeleuria oleracea</i>	2		
Unidentified rodent	2		
Invertebrates			
Land snail			1**
% Total observations	88.2	9.8	2.0

*Identifications were visual and based on the images examined by us. None of the prey items were keyed out ** from Lele & Chuneekar (2014)

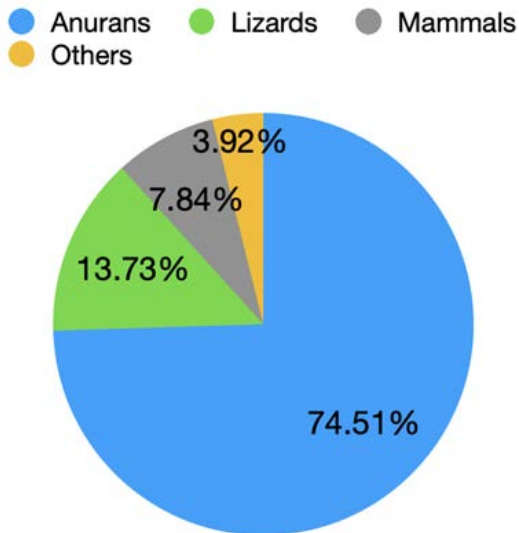


Figure 1. Types of prey eaten by *Trimeresurus malabaricus* as observed in the study

morphs (19.6 %) (Fig. 2). There was also an interesting pattern in the relationship between the morph of the *T. malabaricus* and the prey items consumed; only the green morphs were recorded consuming mammals (n=4) and the two unusual prey items (land snail and eel) while the orange and the yellow morphs were only observed feeding on anurans. However, the apparent differences between morphs were not statistically significant ($\chi^2=15.151$, $p=0.233$).

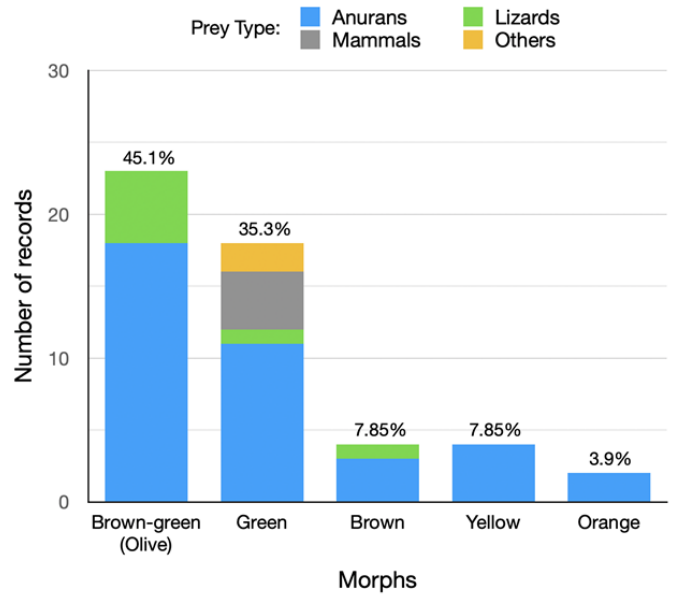


Figure 2. Types of prey eaten by different colour morphs of *Trimeresurus malabaricus* as observed in the study

Of all the listed trophic interactions, 16 have not yet appeared in scientific reports and 12 have been sourced solely through social media, demonstrating social media to be a significant repository for such natural history data (Maritz & Maritz, 2020). The collected data suggest that *T. malabaricus* feeds primarily on frogs, occasionally on lizards and mammals, and rarely other taxa. Its diet is also said to include small birds but examples of avian predation were not collected in this study; perhaps the result of the aforementioned observer bias. There has only been one record of *T. malabaricus* attempting to feed on a land snail. This might be a more common prey item but as feeding events involving small sized prey, such as land snails, involve shorter feeding times, the probability of them being observed is relatively low. An adult *T. malabaricus* in captivity was recorded eating a juvenile conspecific on two occasions (Whitaker & Captain, 2004) but no observations of cannibalism or even ophiophagy have yet been reported in the wild. It is clear that *T. malabaricus* can be an opportunistic predator, as illustrated by the two observations of predation on unusual prey. The captive scenario, unlike the natural one, may have provided the right conditions for *T. malabaricus* to indulge in ophiophagy.

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