Trimeresurus malabaricus (Malabar pit viper): Diving behaviour and underwater apnoea duration

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Pit vipers belong to the sub-family Crotalinae which includes about 231 species (The Reptile Database 2015). They are either arboreal or terrestrial with the exception of the Cottonmouth (*Agkistrodon piscivorus*), which is semi-aquatic in nature. Diving behaviour and apnoea (suspension of external breathing) have been well studied in aquatic elapids (Heatwole & Seymour 1975; Heatwole 1999; Ineich & Laboute 2002; Aubret et. al. 2007; Brischoux et. al. 2007), however, little is known about viperids occupying aquatic niches and their apnoea abilities.

Malabar pit vipers (*Trimeresurus malabaricus*) are often found in riparian habitat (Whitaker and Captain 2002; Ganesh et. al. 2010), however, diving behaviour has never previously been reported in this species. This note is based on two observations made on free ranging *T. malabaricus* diving voluntarily. Observations were made in the tropical moist evergreen forest of Agumbe, which is located in the central Western Ghats of Karnataka State in India (13° 31' 21" N, 75° 5' 17" E, elevation 650 - 850 m a.s.l.). This region receives heavy annual rainfall (7,500 to 10,000 mm) during the monsoon season (June to September). *T. malabaricus* is one of the most common venomous snake species found in this region.

On 10 April 2011 at 11 am, while following a King cobra (*Ophiophagus hannah*) during a telemetry project, which was moving along a shallow, slow flowing stream, an adult *T. malabaricus* (total length approximately 35 – 40cm) was seen on the same bank (13°31'24.68"N, 75° 6'18.57"E). After the *O. hannah* had passed through the area in which the *T. malabaricus* was sat unnoticed, the *T. malabaricus* proceeded to move into the stream. Swimming at a slow pace, the snake was observed to halt in the middle of the stream (approximate depth 35 – 45cm). The stoppage was followed by a short backward jolt of the leading half of the body, causing the snake to completely submerge 8 – 10 cm below the surface. After the backward jolt, the snake remained underwater for 5 - 6 seconds, of which approximately 3 - 4 seconds it was completely motionless. Resurfacing involved a slight forward progression during which only the head broke the surface for approximately 1 - 2 seconds, before repeating the backward jolt action. The snake repeated this action three more times, remaining submerged for 5 - 6 seconds each time. After surfacing for a fourth time, the snake swam a further 3 m downstream to a submerged horizontal branch. It then wrapped its tail around the branch and coiled its body in a typical ambush position, fully submerged approximately 5cm under the surface, with its head facing upwards (Fig. 1). Underwater tongue flicks with occasional slow sideward movement of the head were observed. The snake remained in this position without any attempt of surfacing to breath for approximately 20 minutes and then surfaced in a slow and controlled manner with tongue flicking, leaving the body still submerged and coiled. The snake was not visibly gasping or heavily breathing on surfacing. At this point the observation ceased due to the necessity of following the studied *O. hannah*.

Figure 1. *T. malabaricus* coiled on a branch underwater with its body completely submerged.

In a further incident on 22 July 2015 at 10:20 pm, another adult *T. malabaricus* (total length approximately 35 – 40cm) was observed in an open concrete tank (80 cm wide, 250 cm long and 45 cm deep) at Agumbe Rainforest Research Station (13°31'3.76"N, 75° 5'21.39"E). This tank is a regular breeding site for Malabar gliding frogs (*Rhacophorus malabaricus*) during the monsoon season, which are common prey for *T. malabaricus*. The snake was initially observed floating, partially submerged, at the surface of the 30 cm deep water. The snake remained motionless with its head under the surface pointing downwards and floating in unusual sideward position due to an inflated body (Fig. 2). After approximately 1 minute the snake surfaced and swam a little distance. Once

Figure 2. The second *T. malabaricus* floating in a water tank with its head submerged. Notice the unusual sideward position due to inflated lung.

stopped, the snake retracted its body, with its head, once again, in a submerged downward position and kept floating. The snake repeated this action of partial submergence for four more times, remaining apnoeic for approximately 1 minute during each submergence event within 15 minutes of observation before it ceased due to heavy rain.

Aubret (2004) has shown that snakes may develop apnoea relative to the usage of an aquatic habitat. His study, along with our observations, raise questions about the diving and apnoea capabilities of all non-aquatic snake species. Furthermore, Heatwole (1977) suggests that all reptiles already possess advantageous fundamental physiology to allow survival in an aquatic environment if required. Further studies on the diving behaviour of *T. malabaricus* would shed more light on this topic.

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