REPTILES & AMPHIBIANS

Mortality of Freshwater Turtles on a Railway Track in Puducherry, India

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Linear infrastructure such as roads and railway tracks are renowned for their negative impacts on wildlife (Trombulak and Frissell 2000; Coffin 2007; Popp and Boyle 2017; Barrientos et al. 2019). Vehicular collision on roads disrupts vertebrate population dynamics (Taylor and Goldingay 2010; Barbosa et al. 2020), species migration (Brehme et al. 2021), ethology (Passoni et al. 2021), and genetic factors affecting viable populations (Westemeier et al. 1998; Saccheri et al. 1998; Reed et al. 2007; Balkenhol and Waits 2009; Holderegger and Di Giulio 2010; Ascensão et al. 2016). As a persistent threat to wildlife, road ecology has garnered research attention, whereas studies on railway ecology are far less common (Popp and Boyle 2017; Barrientos et al. 2019). Nevertheless, railway tracks have been recognized as threats to major wildlife taxa (Popp and Boyle 2017).

For reptiles, thermoregulatory behavior is a crucial mechanism for maintaining body temperature (Meek 1995; Bansal 2020). Black heat-radiating surfaces help maintain temperature during nighttime hours but may lead to road mortality (Bernardino and Dalrymple 1992; Bambaradeniya et al. 2001; Selvan et al. 2011; Karunarathna et al. 2013; Bansal 2020; Das and Vishnu 2021).

Likewise, suboptimal weather conditions can induce overheating and dehydration to poikilotherms in unfavorable habitats, leading to mortality (Berry et al. 2002; Dayananda et al. 2021). Mortality events due to overheating can lead to localized extinctions in reptiles (Munguia-Vega et al. 2013). Although reptiles rely on external temperatures, optimal values fluctuate between thermal maximum and minimum thresholds according to their varied physiological needs (Gatten 1974; Obbard and Brooks 1979). Suboptimal thermal values reaching either maximum or minimum thresholds could attain or exceed physiological critical points leading to animal death and possibly to regional extirpation (Meek 1995; Gilman et al. 2010).

Fig. 1. Dead Indian Flapshell Turtles (*Lissemys punctata*) apparently trying to climb the railway track (left) and with apparent burns attributable to overheating on the ballast stones (center); a dead Indian Black Turtle (*Melanochelys trijuga*) on ballast stones associated with railway tracks (right). Photographs by Anbazhagan Abinesh.

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The Indian Flapshell Turtle (*Lissemys punctata*) is a soft-shelled turtle that is widely distributed across the Indian Subcontinent, where it inhabits habitats that include metropolitan, agricultural, and natural aquatic systems (Das 1991; Moll and Moll 2004; Hossain et al. 2008; Krishnakumar et al. 2009). *Lissemys punctata* is known to move through terrestrial areas during drought conditions and monsoons due to sub-optimal water levels (Bhupathy et al. 2014). They are listed as Vulnerable on the IUCN Red List of Threatened Species (Rahman et al. 2021). The Indian Black Turtle (*Melanochelys trijuga*) is known to inhabit similar lotic and lentic freshwater systems and are listed as being of Least Concern on the IUCN Red List (Ahmed et al. 2020).

At 0825 h on 16 October 2021, we observed mortality of *L. punctata* and *M. trijuga* along a railway track in Puducherry, Tamil Nadu, India (11.91967°N; 79.75089°E). The temperature was 33 °C and weather was clear and sunny. Heavy rainfall during the prior week had flooded nearby habitat. The railway is surrounded by barren land dominated by invasive Mesquite (*Prosopis juliflora*) on one side and human habitation on the other.

A total of seven *L. punctata* and three *M. trijuga* were found dead in a 50-meter stretch of track. The tracks were embedded with crushed angular ballast stones that serve to maintain rail track infrastructure. These ballast stones also have high heat transfer potential, making them attractive for thermoregulation (Clark et al. 2002). The dead turtles of both species were between the tracks on top of the ballast stones (Fig. 1).

All observed individuals were smaller than rail height (*L. punctata* mean carapace length 9.63 ± 2.53 cm; *M. trijuga* mean carapace length 16.5 ± 2.29 cm). Of the ten dead turtles, two *M. trijuga* and two *L. punctata* were inverted whereas others were in typical dorsal-side-up position. No turtles had any obvious external injuries or abnormalities other than what appeared to be burn marks from heat exposure (Fig. 1). Turtles likely moved from the submerged barren land habitat based on the direction the animals were facing and the lack of individuals on the opposite side of the tracks.

Prior studies on road and railway ecology indicate a number of impacts on wildlife. Specifically, linear infrastructure near water bodies corresponds to mortality in reptiles (Aresco 2005). Additionally, alteration of habitats for roads and railways may negatively impact reptile thermoregulatory behavior. However, the attainment of optimal thermal temperatures depends upon the availability of basking substrates, which usually demand spatial heterogeneity induced by physiological needs (Avery and Bond 1987). Natural habitats would provide spatially heterogeneous thermal substrates and retreat sites that serve as heat insulators and shades to attain ecological optima. The lack of natural substrates in fragmented or urban habitats during unfavorable environmental scenarios may direct reptiles towards anthropogenic substrates that are less optimal (railway tracks in this case). This observation suggests railway tracks may serve as a barrier leading to overheating in poikilothermic animals like turtles, and indicates a need for further study and mitigation tactics such as passages under the tracks and provision of safe substrates to meet the migratory and thermoregulatory requirements of turtles and other species.

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