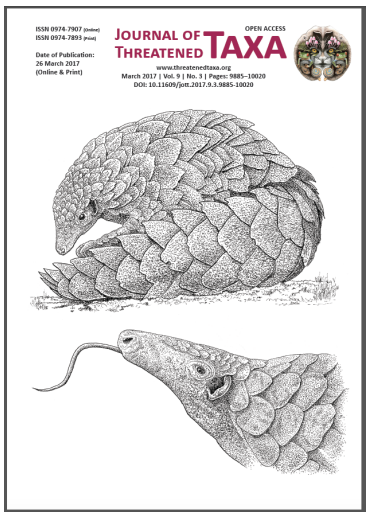

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Short Communication

A preliminary report on the impact of road kills on the herpetofauna species in Nilgiris, Tamil Nadu, India

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A preliminary report on the impact of road kills on the herpetofauna species in Nilgiris, Tamil Nadu, India

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Abstract: To know the situation of road hits of amphibians and reptile species, a survey was conducted during the period 02 June 2013 to 25 May 2014. A total of 172 incidents of road kill of different species were noticed, representing 12 species of herpetofauna, including five amphibian species of the families Bufonidae, Dicroglossidae, Microhylidae and Rhacophoridae, and seven species of reptiles of the families Scincidae, Agamidae, Uropeltidae, Colubridae, Natricidae and Xenodermatidae. Reptiles were the most affected group (60%), of which more than 79.61% of the road kills were snakes. The most affected snake species were endemic *Xylophis perroteti* (64.63%).

Keywords: Amphibians, endemic, Nilgiris, Reptiles, snakes, *Xylophis perroteti*.

Roads create a barrier to wildlife movement and change the habitat in the road verges, increasing the threat to biological communities. They also act as a physical barrier, changing animal movements and behaviors (Daveley & Stouffer 2001). The impact of roads on wildlife has been observed to affect many groups, macro invertebrate soil fauna (Haskell 2000), herpetofauna (Rosen & Lowe 1994; Fehrig et al. 1995; Gibbs & Shriver 2002; Andrews & Gibbons 2005; Glista et al. 2008; Elzanowski et al. 2009; Langen et al. 2009), birds (Mumme et al. 2000) and mammals (Laurance et al. 2006). In India very few short term studies have been conducted emphasizing the importance of road mortalities (Gokula 1997; Vijayakumar et al. 2001; Sunder 2004; Das et al. 2007; Kannan 2007; Rao & Girish, 2007; Seshadri et al. 2009; Baskaran & Boominathan 2010; Bhupathy et al. 2011; Selvan 2011; Ghadage 2013; Chittaragi & Hosetti 2014; Kumar & Srinivasulu 2015; Narayanan et al. 2016) on highway networks inside Wildlife habitats. The direct or indirect impact of these roads on wild fauna has received very little attention in the country (Sunder 2004).

Nilgiris, as the most forested district of the state signifies an important stretch of Western Ghats in Tamil Nadu and is the meeting point between the Western and Eastern Ghats. Here the forests are varied and diverse, representing a biodiversity treasure house on earth and is home to many rare, endangered and threatened species of herpetofauna. Moreover it is an important tourist center in South India; attracting a large number

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of tourists, so traffic is high throughout the year. A few studies have reported on the mortality of Reptiles due to highway traffic in the dry deciduous forests of Mudumalai Wildlife Sanctuary, Tamil Nadu (Gokula 1997; Kannan 2007; Boominathan et al. 2008; Baskaran & Boominathan 2010; Samson et al. 2014; Samson et al. 2016). Outside protected areas, a few studies have reported on the mortality of snakes (Santhoshkumar & Kannan 2016; Santhoshkumar et al. 2016). However, there is no systematic and detailed information on the effect of road traffic on the herpetofauna outside protected areas, particularly with respect to the Nilgiri District where the impact of tourist vehicles is very high throughout the year. In this situation, a study on the impact of the herpetofauna due to vehicular traffic is warranted. Hence a detailed study of this aspect needs to be conducted on a long-term basis to quantify the impact of roads on herpetofauna in the Nilgiris and to formulate action plans for the conservation of these useful creatures to our ecosystem.

Materials and Methods

Study Area

The Nilgiris is a hilly district, which is situated in the northwestern part of Tamil Nadu State. It is bordered by the states of Karnataka in the north, Kerala in the west and south and by the districts of Erode and Coimbatore, Tamil Nadu in the northeast respectively. It lies between 11–12^{0}N and 76–77^{0}E latitude. The total area of the district is 2,366.89km^2. The district has 152km of interstate highways, 142.80km of major state roads, 757.330km of district roads and 249.70km of panchayat roads. Major vegetation types of the Upper Nilgiris are montane sholas, grasslands, and plantations of exotic species such as wattle (*Acacia* spp.), blue gum (*Eucalyptus* spp.) and pine (*Pinus* spp). The elevation ranges between 300m and 2,700m. The temperature shows a wide range of variation such as 21–25 ^{0}C (summer) and 10–12 ^{0}C (winter). The present study on the impact of the road traffic on herpetofauna was conducted from Ooty to Avalanche, covering a distance of 20km (Fig. 1).

Methods

A survey was conducted during the period 02 June 2013 to 25 May 2014. Every week of the study period, during the early morning hours (07:00–09:00 hr) and evening hours (17:00–20:00 hr) of the day, the road from Ooty to Avalanche was thoroughly searched for road kills of herpetofauna, using a vehicle (Speed 10–20 km/h). Roadside habitation was divided into four categories, viz., shola (3km stretch), plantation (5km stretch), agriculture (6km road stretch) and human habitation (6km stretch). The study period was divided into three seasons, monsoon (June–September 2013, 24 days), post-monsoon (October 2013–January 2014, 24 days)

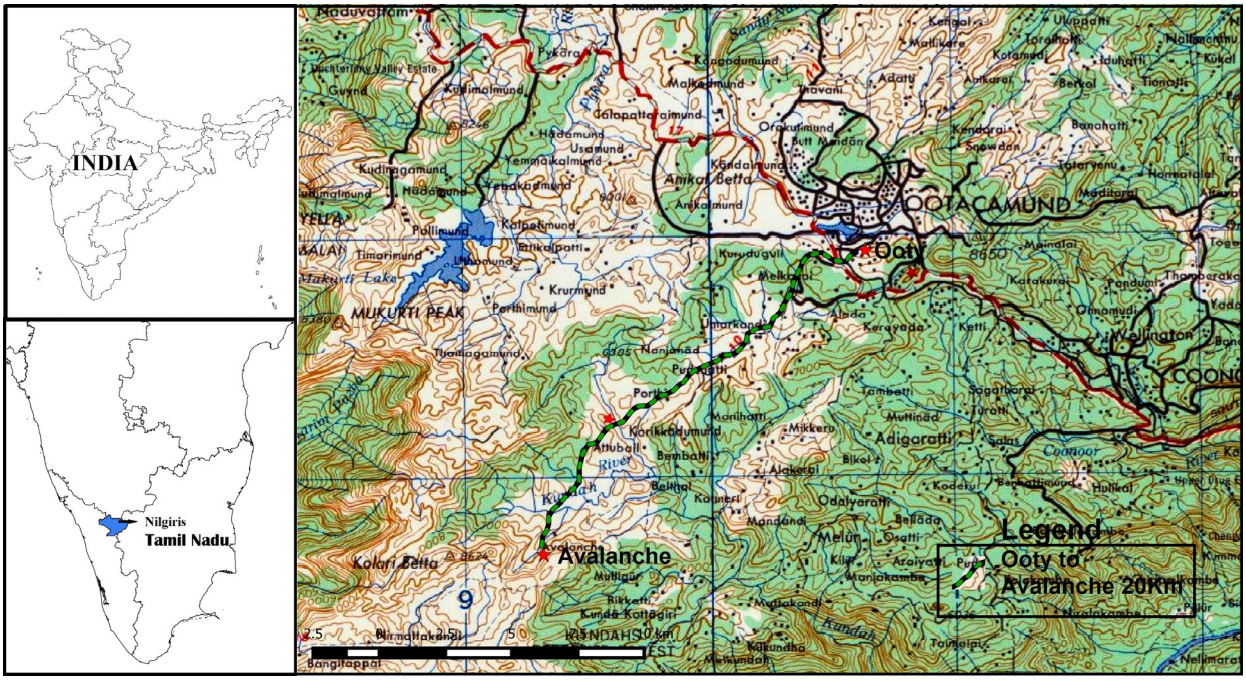

Figure 1 . The surveyed road network of Ooty to Avalanche, Nilgiris-Topo sheet (Map source: Survey of India).

and pre-monsoon (February–May 2014, 24 days). On sighting of a road kill, the reptile and amphibian species killed by vehicles was identified and photographed. The unidentified species were brought to the laboratory and identified using the keys and field guides and scale to count was done for the snakes (Whitaker & Captain 2004; Vijayaraghavan & Ganesh 2011; Kannan 2014; Nixon 2015). The amphibian species were identified by using the key (Dinesh et al. 2009; Biju & Bossuyt 2009; Gururaja 2012). Traffic intensity was monitored for two hours each time, randomly at different times of the day, every week of the study period and data was converted to per day. The habitat types were identified based on the literature (Champion & Seth 1968). PAST3 statistical software was used for analysis. The relationship between traffic intensity and the number of road kills was tested for correlation analysis. Analysis of variance (ANOVA) was tested for the difference in the number of road kills between the seasons and habitats. A T-test was performed for comparison of the number of road kills between the seasons and habitats. The carcasses were removed from the road site immediately to avoid double counting.

Results

During the survey period, a total of 172 road kills belonging to 12 species was recorded including five amphibian species representing four families (Bufonidae, Dicroglossidae, Microhylidae and Rhacophoridae), and seven species of reptiles representing six families (Scincidae, Agamidae, Uropeltidae, Colubridae, Natricidae and Xenodermatidae) (Table 1; Images 1–5). Reptiles were the most affected species (60%) followed by amphibians (40%). In reptiles, more than 79.61 % (N=82) of the road kill were snakes. The individuals of species *Xylophis perroteti* (N=53, 51%) had the highest mortality, followed by *Plectrurus perroteti* (N=20, 19%), *Ptyas mucosa* (N=5, 5%), *Oligodon venustus* (N=2, 2%) and *Xenochrophis piscator* (N=2, 2%) In the case of lizards, *Salea horsfieldii* (N=18, 18%) was the most affected species, followed by *Kaestlea bilineata* (N=3, 3%). Among the amphibian species, *Duttaphrynus melanostictus* was the most susceptible species (N=34, 49.28%) followed by *Ramanella triangularis* (N=12, 17.39%), *Zakerana nilagirica* (N=12, 17.39%), *Raorchestes signatus* (N=6, 8.70%) and *Raorchestes tinniens* (N=5, 7.25%) (Table 1). The differences in the number of road kills between the seasons (ANOVA: F= 13.4, *P*<0.1) and between the habitats (ANOVA: F= 16.44, *P*<0.1) significantly differ during the study period. Season wise data on the road kills show that almost half of the road kills were recorded during the monsoon seasons (T-test = 1.8, *P*<0.1, N=92, 53.49%) compared to other seasons (Fig. 2). Most of the road kills occurred on the road close to shola (T-test=2.1, *P*<0.1, N=90, 52%) followed by plantation (N=49, 28%), agricultural (N=21, 13%) and human habitations (N=12, 7%) (Fig. 3). The mean number of vehicles traveling on the road during this study was 2324 vehicles/day. Vehicles passing through the roads were enumerated in different seasons and showed that the traffic was higher during the pre-monsoon period (3645 vehicles/day) followed by post-monsoon (2102 vehicles/day) and monsoon season (1876 vehicle/day). Correlation analysis has shown that negative correlation was found between traffic volume and road mortality of herpetofauna (r=-0.82, P=0.5).

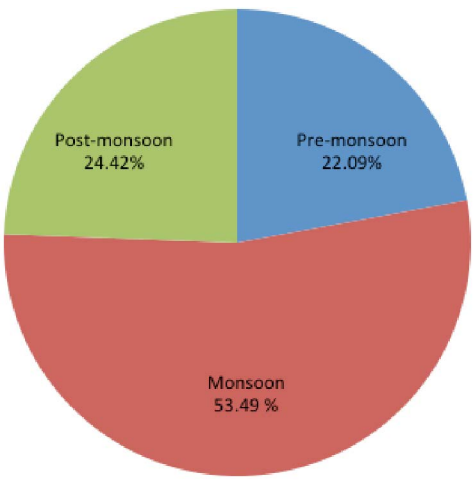

Figure 2. Percentage of kills in different seasons

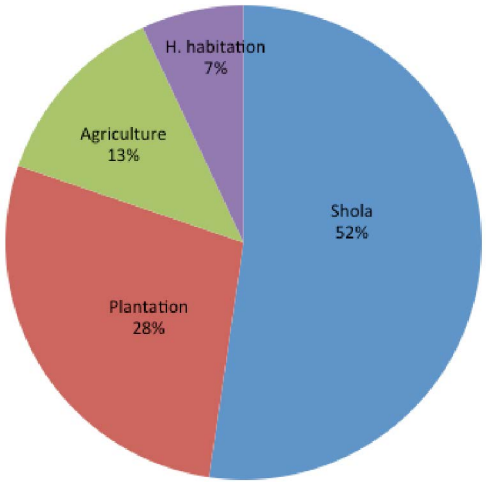

Figure 3. Percentage of kills in different habitat types

Table 1. List of herpetofauna dead on roads run over by vehicle

	Common name	Scientific name	Number of road kill animals			Total number road kills
			Pre-monsoon	Monsoon	Post-monsoon	
Amphibians						
	Bufonidae					
1	Common Indian Toad	*Duttaphrynus melanostictus*	3	22	9	34
	Dicroglossidae					
2	Nilgiri Wart Frog	*Zakerana nilagirica**	2	8	2	12
	Microhylidae					
3	Narrow-mouthed Frog	*Ramanella triangularis**		8	4	12
	Rhacophoridae					
4	Cross-backed Bush Frog	*Raorchestes signatus**		5	1	6
5	Nilgiri Bush Frog	*Raorchestes tinniens**		4	1	5
Reptiles						
	Scincidae					
6	Two-lined Ground Skink	*Kaestlea bilineata**	3			3
	Agamidae					
7	Horsfield's Spiny Lizard	*Salea horsfieldii**	5	8	5	18
	Uropeltidae					
8	Perrotet's Shieldtail	*Plectrurus perroteti**	3	10	7	20
	Colubridae					
9	Indian Rat Snake	*Ptyas mucosa*	5			5
10	Black-spotted Kukri Snake	*Oligodon venustus**	2			2
	Natricidae					
11	Checkered Keelback	*Xenochrophis piscator*	2			2
	Xenodermatidae					
12	Striped Narrow-headed Snake	*Xylophis perroteti**	17	27	9	53

* - Endemic to the Western Ghats

Discussion

The higher road mortality of reptiles and amphibians could be attributed to their slow mobility, not reacting quickly to vehicles and the fact that drivers are less likely to notice these animals because of ignorance. Among the road kills of reptiles, snakes (82 out of 103 individuals) accounted for the highest (79.61%). A similar finding has been quoted by Bhupathy et al. (2011) and Chittaragi & Hosetti (2014) who attributed the fact that snakes moved frequently, slowly and used the roads as a substrate for thermo-regulation, for the higher mortality. In our study the individuals of the species Striped Narrow-headed Snake *Xylophis perroteti* were (53 out of 82 snake road kills) the highest mortality observed. Similar to the study on road mortalities of snakes in Pench Tiger Reserve, Barred Wolf Snake (99 out of 490 snake road kills) was the most affected (Pragatheesh & Rajvanshi 2013). In some cases, lizards mostly affected were Garden Lizard *Calotes versicolor* (Narayanan et al. 2016; Samson et al. 2016). The speed of the traffic, the size of the species and its dispersal behavior are also cited as important factors when assessing the barrier effect of a road (van Langevelde & Jaarsma 1995). The Striped Narrow-headed Snake, *Xylophis perroteti* has restricted distribution in the Nilgiris and almost nothing is known about the ecology (Santhoshkumar & Kannan 2016). Santhoshkumar et al. (2016) reported that road mortality has a major impact on the endemic snake in the Nilgiris. The present study also confirms that road mortality is the major threat to endemic snake species.

In amphibians, the road kills which were recorded during the present investigation, *Duttaphrynus melanostictus* was the most affected (49.28%) species,

shows a similar result of the study from Kalakad-Mundanthurai Tiger Reserve (Narayanan et al. 2016). Because of 'relative abundance' of this species in the present study area and the foraging nature of these toads, which are very fond of gathering near street lamps and vehicle head lights to feast on insects; coupled with their highly eurytopic and human commensally traits could also be possible reasons for their higher susceptibility of becoming road kill victims (Daniel 2002; Daniels 2005). Normally road kills of herpetofauna happen during monsoon seasons. This finding is supported by a previous study conducted in Pench Tiger Reserve (Pragatheesh & Rajvanshi 2013) and Kalakad-Mundanthurai Tiger Reserve (Narayanan et al. 2016). Vijayakumar et al. (2001) stated that maybe rains trigger some kind of movement of herpetofauna species, which makes them vulnerable to road traffic. The high mortality during monsoons can be explained by the fact that herpetofauna are cold-blooded and they tend to rest on drier parts of road surfaces during cooler nights (Shine et al. 2004). Most of the literature states that herpetofauna species density is highest in shola compared to other habitats (Nixon 2015), because their biotic and abiotic factors better support this species. At the same time most of the shola patches are fragmented in the study area. During the survey period, we noticed that many times most herpetofauna species moved from one shola fragment to another across the road. Therefore, road mortality encountered was high in the roads nearest shola compared to other habitats. Several factors including specific habitats, terrain and adjacent land-use types that influence wildlife movements also play an important role in determining locations of higher probability of road mortality compared to other locations (Forman & Alexander 1998). Correlation between traffic volume and mortality of herpetofauna show clearly that there is no relation between traffic volume and monthly road kill rate. This finding agrees with previous work at Megamalai (Bhupathy et al. 2011).

During the present study period, some drivers have deliberately run their vehicles over herpetofauna, because they dislike reptiles especially, snakes. However, herpetofauna species play a vital role in our ecosystem as they are the usual predators of vermin species and agricultural pests and they are the best controllers of insects and other pests. Therefore proper awareness creation to the people especially vehicle drivers is urgently warranted to conserve the herpetofauna species in the Nilgiri landscape.

Image 1. *Salea horsfieldii*

Image 2. *Xylophis perroteti*

Image 3. *Duttaphrynus melanostictus*

Image 4. *Plectrurus perroteti*

Image 5. *Ramanella triangularis*

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