SHORT COMMUNICATION

A THREAT ASSESSMENT OF THREE-STRIPED PALM SQUIRREL

Funambulus palmarum (Mammalia: Rodentia: Sciuridae)
FROM ROADKILLS IN SIGUR PLATEAU, MUDUMALAI TIGER RESERVE, TAMIL NADU, INDIA

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A threat assessment of Three-striped Palm Squirrel *Funambulus palmarum* (Mammalia: Rodentia: Sciuridae) from roadkills in Sigur Plateau, Mudumalai Tiger Reserve, Tamil Nadu, India

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Abstract: This study was undertaken to assess the threat from road kills for three-striped palm squirrels in the tropical forest of Sigur plateau, Mudumalai Tiger Reserve, Tamil Nadu, and Southern India from January 2014 to December 2016. Road kills were recorded along the Udhagamandalam to Masinagudi state highway passing through Mudumalai Tiger Reserve (40 km). Four visits per month were carried out mostly on weekends (Saturday or Sunday). A total of 497 three-striped palm squirrel kills were recorded, with an overall rate of 0.09/ km of the roadway. Habitat wise 387 kills were observed in the thorn forest and 110 in dry deciduous forest habitats. Season wise 176 kills were recorded in winter, 156 in summer, 83 post-monsoon, and 82 during the monsoon. The study distinguished the ongoing major threat on the three-striped palm squirrel in the present scenario.

Keywords: Deciduous forest, ecology, habitat loss, mortality, vehicle movements.

The Three-striped Palm Squirrel *Funambulus palmarum* is a small rodent of the Sciuridae family, with four subspecies native to India and Sri Lanka. *F. palmarum* is endemic to southern India and Sri Lanka (Thorington & Hoffmann 2005; Nameer & Molur 2008), where it is widely distributed from sea level to 2,000m (Nameer & Molur 2014). Squirrels can reach head-body length of 12–15 cm and tail length of 14–15 cm (Menon 2014), and they have short fur that is yellowish-brown or brown on the back and creamy white on the belly (Menon 2014). Three white stripes on the back stretch from the head to tail. *F. palmarum* has dark round eyes, small triangular ears, long front teeth, and a bushy tail (Figure 1a; Prater 1971; Menon 2014; Pradhan & Talmale 2012). It is an omnivore with a diet based largely on fruit and nuts that also includes...
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eggs, small birds, larvae, and insects (Prasad et al. 1966; Malhi & Kaur 1994; Malhi & Khushrupinder 1995). Squirrels mate throughout the year and build nests in treetops using grass and branches. Pregnancy lasts 34 to 45 days and produces 1–5 offspring; young are fully weaned at 10 weeks and reach sexual maturity at nine months. Animals can survive up to four years in the wild and >5 years in captivity (Weigl 2005). This study was undertaken to assess the threat to Three-striped Palm Squirrels from roadkills in the tropical forest of Sigur Plateau, Tamil Nadu in southern India.

STUDY AREA

Sigur Plateau is located in Mudumalai Tiger Reserve. It is a connective junction of Western and Eastern Ghats and harbors a diverse range of wildlife that includes Asian Elephant *Elephas maximus*, Tiger *Panthera tigris*, Leopard *Panthera pardus*, Gaur *Bos gaurus*, Chital *Axis axis*, Sambar *Rusa unicolor*, and other mammals (Ramakrishnan & Saravanamuthu 2012), as well as birds such as Endangered and Critically Endangered vultures including the Long-billed Vulture *Gyps indicus*, White-rumped Vulture *Gyps bengalensis*, Red-headed Vulture *Sacrogyps calvus*, and Egyptian Vulture *Neophron percnopterus* (Ramakrishnan et al. 2014; Samson et al. 2014, 2015). The corridor between the Western and Eastern Ghats is used by elephants, tiger, gaur, and other herbivores for seasonal migrations influenced by the southwest and northeast monsoons. The major streams of Sigur Plateau are the Moyar River, the Sigur River, the Avarahalla River, the Kedarhalla River, and the Gundattihalla River, which crisscross the Moyar Valley and drain into the Bhavanisagar Reservoir. Villages located within the Sigur Plateau are home to local communities and more recently to several tourist facilities that subsist mainly on the attractions of the diverse wildlife in the area surrounding Mudumalai Tiger Reserve.

Methods

Roadkills were recorded along the Udhagamandalam–Masinagudi state highway passing through Mudumalai Tiger Reserve (40km) (Figure 1). The local habitats are classified as dry thorn forest and dry deciduous forest (Gokula & Vijayan 1996; Ramakrishnan & Saravanamuthu 2012). Four visits per month were carried out between January 2014 and December 2016, mostly on weekends (Saturday or Sunday) by an observer and driver on a motorbike traveling at 10–15 km/h; observation times alternated between morning (06.00–08.00 h) and evening (16.00–18.00 h). Intermittent roadkills were also observed by forest officials and drivers, which when verified were included in the totals. For each kill the information recorded included the location, surrounding area (forest, human habitation, plantation), habitat type,
and state & sex of dead animals, which when possible were removed from the road to avoid recounting.

**RESULTS**

A total of 497 individual Three-striped Palm Squirrels (Figure 1; Image 1) were recorded as roadkill victims in 144 visits covering 5,760km, for an encounter rate (ER) of 0.09 individuals/km/month. Most kills were recorded as fresh (n=307). Males (n=220) were more frequently observed than females (n=145), although many were unidentified (n=132; Figure 1). Three-hundred-and-eighty-seven kills were observed over 33km of road in thorn forest habitats (ER=0.08 individuals/km/month), and 110 in dry deciduous forest (7km; ER=0.11 individuals/km/month) (Table 2). More roadkills were recorded in forest habitats (n=354; ER=0.078 individuals/km/month) followed by human habitation (n=89; ER=0.08 individuals/km/month), and plantations (n=54; ER=0.57 individuals/km/month). The roadkill results show significant variation $R^2=0.995$ year by year 2014 (n=148; 12.33±1.25; ER=0.08 individuals/km/month), 2015 (n=165; 13.75±1.55; ER=0.08 individuals/km/month), and 2016 (n=184; 15.33±1.58; ER=0.10 individuals/km/month) (Figure 2). Month-wise analyses of the roadkills show that May (n=75; 25±1.15) had more number of roadkills followed by December (n=61; 20.33±1.76), April (n=48; 16±1.15), November (n=47; 15.66±1.45) March (n=42; 14±1.15), and January (n=41; 13.66±1.45) (Figure 2); and significant variations were observed between month-wise data and the year-wise data (F=11.12 p= 0.005). The season-wise data revealed that winter (December–March) (n=176; 14.66±1.19; ER= 0.09 individuals/km/month) and summer (pre-monsoon) (April–June) (n=156; 17.33±2.12; ER= 0.11 individuals/km/month) seasons recorded more kills compared to post-monsoon (October–November) (n=83; 9.11 ± 0.78; ER= 0.09 individuals/km/month) and monsoon seasons (July–September) (n=82; 13.83±1.07; ER= 0.06 individuals/km/month) (Figure 3; Table 1).
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Road surface for sunbathing, it seemed to be the reason study indicating that Three-striped Palm Squirrel use the dusk in the present study also corroborate the previous of Three-striped Palm Squirrel are observed at dawn and dusk (Mendez-Carvajal et al. 2016). Samson et al. (2016) recorded that most fresh roadkills are easily tamed by humans and easily adapt to human habitation, plantations, and gardens (Molur et al. 2005). Three-striped Palm Squirrel live in diverse habitats but mainly occur in tropical forests and around human habitation (Molur et al. 2005). The present study was carried out in two different vegetation structures in Sigur Plateau. Thorn forest had more roadkills compared to dry deciduous forest which indicated that Three-striped Palm Squirrels utilized thorn forest vegetation more. A considerable amount of roadkills was observed in human habitation as well as plantations. Three-striped Palm Squirrels are easily tamed by humans and easily adapt to human habitation, plantations, and gardens (Molur et al. 2005).

Sunbathing is one of the key activities for striped squirrel at dawn and dusk (Mendez-Carvajal et al. 2016). Samson et al. (2016) recorded that most fresh roadkills of Three-striped Palm Squirrel are observed at dawn and dusk in the present study also corroborate the previous study indicating that Three-striped Palm Squirrel use the road surface for sunbathing, it seemed to be the reason for the high death rate. Some incidences may have occurred related to eating the insect on the roads. The road and road allowances attract prey populations, in particular, small mammals and carrion, but also insects and worms that are washed out of the soil onto roads (Tabor 1974). According to the literature, individuals from this genus prefer insects as protein sources more than fruits and nuts when fruits and vegetation are in the same proportions (Prater 1971; Barnett & Prakash 1975; Tiwari 1990; Balasubramanian 1995; Parasara et al. 1997).

Winter and summer seasons recorded Three-striped Palm Squirrel roadkills because of very high traffic on the state highway passing through the Nilgiri North Forest Division at one end connected to the Interstate highway NH 67 at Theppakadu and Ooty on other end. Generally, winter and summer are the best seasons to visit Udhaagamandalam and that is a reason for high vehicular traffic intensity resulting in the high number of roadkills. Similarly, significant number of roadkills were also found in Mudumalai Tiger Reserve due to local vehicular movement as well as wildlife safaris (Samson et al. 2016).

Discussion

This study targeted a single species affected by linear construction like road networks. In fragmented habitats, linking route ways enhance the movements of small mammals (Coffman et al. 2001). Medium and large-sized mammals are particularly at risk, especially when the emergence of young coincides with high traffic volumes (Oxley et al. 1974). The present study shows that males are frequently killed rather than females. Linear construction appears to affect the movement of males and females (Davis-Born & Wolff 2000). Various species show seasonal peaks in accident rates often with a higher percentage of males being killed (Davies et al. 1987; Rotar & Adamic 1997; van Langevelde & Jaarsma 1997; Mead 1997; Reeve & Huijser 1999). This suggests that breeding or dispersal behavior may be partly responsible (Moshe & Mayer 1998). Three-striped Palm Squirrel roadkills because of very high traffic on the state highway passing through the Nilgiri North Forest Division at one end connected to the Interstate highway NH 67 at Theppakadu and Ooty on other end. Generally, winter and summer are the best seasons to visit Udhaagamandalam and that is a reason for high vehicular traffic intensity resulting in the high number of roadkills. Similarly, significant number of roadkills were also found in Mudumalai Tiger Reserve due to local vehicular movement as well as wildlife safaris (Samson et al. 2016).

According to the literature, habitat loss and degradation due to agro-industry farming, small-scale logging, human encroachments, invasive alien species, and hunting for local consumption purposes are minor threats to the Three-striped Palm Squirrel population (IUCN Red List Data 2016). The present study explored the current major threat in the present scenario. An urgent long-term study is needed to better understand the impact of roads on the ecology of the Three-striped Palm Squirrel.

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