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Food habits of the Dusky-striped Squirrel *Funambulus sublineatus* (Mammalia: Rodentia: Sciuridae)

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Abstract: We report the first observations of feeding behaviour of the Dusky-striped Squirrel *Funambulus sublineatus* in the Western Ghats. It was observed feeding on eight plant species, including four non-native species. Feeding was observed in forests as well as in plantations and agricultural habitats, indicating the urgent need for studies in such human-modified landscapes.

Keywords: Feeding behaviour, modified landscape, Palani Hills, small mammal, Western Ghats.

The Dusky-striped Squirrel (*Funambulus sublineatus* Waterhouse, 1838) is a poorly studied small mammal, due to quick and cryptic behaviour that makes field observations challenging (Datta & Nandini 2014). This species of palm squirrel is endemic to the Western Ghats of southwestern India and Sri Lanka, and is listed as Vulnerable by the IUCN owing to a declining population trend (Rajamani et al. 2008). Dissanayake & Oshida (2012) propose that the Indian and Sri Lankan populations are split as distinct species, but for this note we follow the IUCN taxonomy, which is not updated. In India, it has been recorded mostly in tropical evergreen and moist deciduous forests of Karnataka, Kerala, and Tamil Nadu (Menon 2014). No targeted studies exist on the ecology and behaviour of this species, with only a couple of opportunistic published records on feeding habitats. Vivek et al. (2011) noted that this squirrel was often part of mixed-species bird flocks, gleaning on bark and flushing insects that were consumed by insectivorous birds. Ganesh & Devy (2006) record infrequent predation on flowers of *Cullenia exarillata*. An opportunistic record describes feeding on wild raspberry fruits *Rubus fairholmianus* (Datta & Nandini 2014).

The current note presents the first record of feeding habits of the Dusky-striped Squirrel in the Western Ghats. These observations are part of an ongoing study on squirrels in the Upper Palani Hills (above 1,400m contour), which is the easternmost spur of the Western Ghats biodiversity hotspot (Myers et al. 2000). The study area occurs in the Dindigul District in Tamil Nadu, between 10.000–10.333N & 77.266–77.400E. The terrain of the Upper Palanis is mountainous, comprising grasslands interspersed with forest patches, categorized as southern montane wet temperate forests or “shola

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forests" by Champion & Seth (1968). Shola forests are predominantly made up of stunted, branched, and dense crown trees which have rainforest origins (Davidar et al. 2007). The dominant tree species are *Syzygium densiflorum*, *Magnolia nilagirica*, *Gordonia obtusa*, and *Eurya japonica* (Matthew 1962). Shola-grassland habitats harbour high biodiversity (Robin & Nandini 2012), but they have undergone significant habitat loss due to timber plantations, agriculture, and other developmental activities (Arasumani et al. 2018) (Figure 1). Prominent exotic species include Acacias, conifers, and *Eucalyptus* sp. (Matthew 1962).

Opportunistic records of feeding behaviour of Dusky-striped Squirrels were noted during a systematic landscape-level study on occurrence of sympatric squirrel species on the plateau between January 2019 and July 2019. Squirrels were located both by their calls and movements. When a Dusky-striped Squirrel was seen feeding, we recorded details of behaviours until the animal moved out of sight. The part of the plant consumed and the plant species were identified. We characterised each feeding instance as a bout of activity of one or more animals feeding on the same food source. Bouts ended when the animal moved out of sight. While no data on the amount of food consumed were recorded, this method provides the diversity of food consumed (Paschoal & Galetti 1995). Unique behaviours were recorded with a video camera, when possible.

Dusky-striped Squirrels were encountered on 66 occasions at 30 distinct locations. Most sightings were of single animals, though on 12 occasions two animals were sighted together, three animals on two occasions and four were sighted together three times (1.38 ± 0.76 SD). The age and sex of animals could not be determined. Twenty-one foraging bouts were recorded over the study period (Table 1). Squirrels were seen foraging on eight plant species from seven different plant families (Table 1). Almost 40% of the foraging observations were of Dusky-striped Squirrel feeding on the nectar of *Lobelia leschenaultiana*, a native understory shrub common along habitat ecotones (Image 1a). Over a five–day period in February 2019, two to four individuals were observed feeding on nectar, and not on any other flower

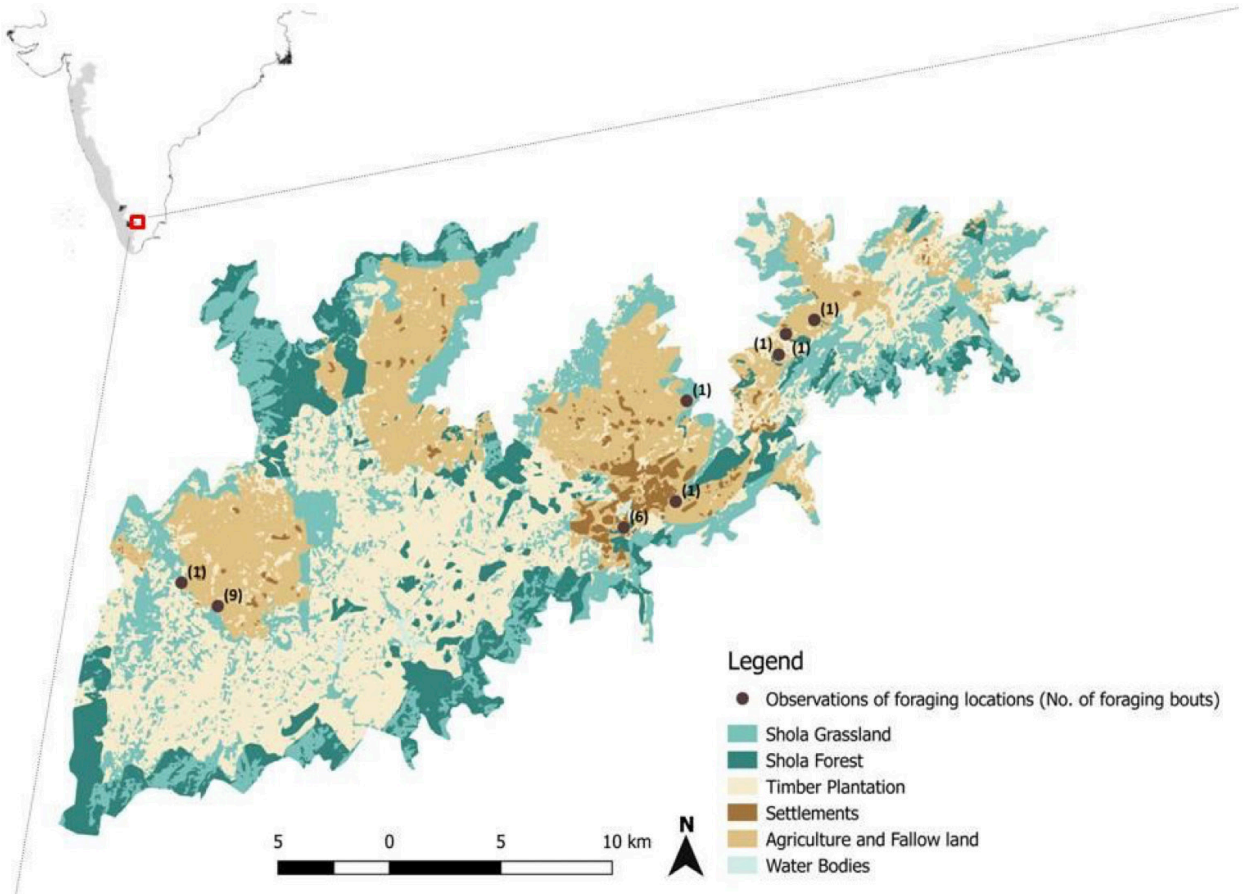

Figure 1. Land-cover of Upper Palani Hills (Arasumani et al. 2018) with locations of observed foraging bouts.

Table 1. Details of feeding behaviour of the Dusky-striped Squirrels in the Upper Palanis.

Plant species	Habitat	Parts eaten	Month eaten	Number of feeding bouts	Number of squirrels in each feeding bout
Lobelia leschenaultiana (Campanulaceae)	Timber plantation edge	Nectar	February	8	4,2,2,2,1,1,2,2
Erythrina variegata (Fabaceae)	Agriculture	Nectar	January, March	4	1,4,1,1
Memecylon randerianum (Melastomataceae)	Shola forest	Fruit	June	2	2,1
Lantana camara (Verbenaceae)	Agriculture	Fruit	July	2	1,2
Rubus ellipticus (Rosaceae)	Shola forest edge	Fruit	May	2	1,1
Acacia mearnsii (Fabaceae)	Timber plantation	Seed	February	1	1
Elaeocarpus tuberculatus (Elaeocarpaceae)	Shola forest	Bark	June	1	1
Symplocus foliosa (Symplocaceae)	Shola forest	Bark	December	1	1

parts. We confirmed that they were feeding on nectar by examining video recordings of the bouts (Video 1; using Canon EOS 700D; number of recordings= 6, mean length of recording= 57.17 ± 22.66 SD seconds). The squirrels were seen on this plant only when flowering (February), and not at any other time of the year.

On four occasions, squirrels were observed foraging on the nectar of *Erythrina variegata*, a non-native tree planted along roads and boundary walls (Image 1b). Fruits of *Memecylon randerianum* (Image 1c), *Lantana camara*, and *Rubus ellipticus*, were consumed on two occasions each. The only time we observed seeds being consumed during this study was of *Acacia mearnsii* (Image 1d). The squirrel was seen peeling the pod with its mouth and consuming the seeds (Video 2; using Nikon COOLPIX P900; number of recordings = 1, length of recording= 40 seconds). Dusky-striped Squirrels were observed on single occasions consuming bark of *Elaeocarpus tuberculatus* and *Symplocus foliosa*. We observed squirrels sniffing tree bark on eight occasions, but could not confirm if they were foraging on insects or bark. Though exact heights used by squirrels were not noted, all squirrels were seen foraging in the understory (0–8 m) and mid-canopy (8–15 m) strata only.

Overall, we observed Dusky-striped Squirrels feeding on fruit, nectar, and bark of native evergreen forest species as well as on introduced and invasive plant species, in a variety of habitats. Squirrels were observed to feed on nectar more than any other plant part (χ^2= 14.238, df= 3, p-value= 0.003), but on non-native and native plant species equally (χ^2= 0.428, df= 1, p-value= 0.513). In this note, present observations that the Dusky-striped Squirrel feeds on nectar, a behaviour similar to nectar-robbery seen in Swinhoe's Striped Squirrels (Deng et al. 2004, 2015). Other squirrel species in the Western Ghats are known to feed largely on leaves and fruit, while also feeding on other plant parts. The Indian Giant Squirrel is known as a facultative frugivore that feeds on seeds, leaves, flowers, pith, and bark (Borges 1992; Sushma & Singh 2006), while the Indian Giant Flying Squirrel is reported to feed on fruit, leaves, flower, and bark (Nandini & Parthasarathy 2008).

We report observations of feeding in shola forests (n= 6), but also in timber plantations (n= 9) and agriculture fields (n= 6) (Table 1). Our study reinforces findings from other studies, which have recorded the presence of the species outside forests. In the Western Ghats, the Dusky-striped Squirrel has been observed in coffee plantations (Bali et al. 2007; Sidhu et al. 2015), tea plantations (Sidhu et al. 2015) and in evergreen forests at the edge of tea plantations (Anamalais – Nandini Rajamani pers. obs. 2005,2006 & 2007). Sridhar et al. (2008) found the species in rainforest fragments, but detections were higher in contiguous protected rainforests.

While this note illustrates that the Dusky-striped Squirrel does use food resources outside forests, we suggest that this may not reflect the true use of modified habitats in the Upper Palanis landscape. The probability of detection of the species is likely higher in open habitats compared to the dense forest interior. We would like to state, however, that the observations of Dusky-striped Squirrel feeding on non-native plant species is a significant finding. This implies that the species shows a certain degree of flexibility regarding using resources in modified landscapes, as seen in several other small mammal species (Kellner et al. 2019). Future research

Image 1. Dusky-striped Squirrel feeding on: a—*Lobelia leschenaultiana* nectar in the edge of a timber plantation (© Aravind P.S.) | b—*Erythrina variegata* nectar in an agriculture field (© Sanjay Prasad Ganguli) | c—*Memecylon randerianum* fruit in a shola forest (© Joe George) | d—*Acacia mearnsii* seeds in a timber plantation (© Aravind P.S.).

efforts should specifically target ecotonal regions, including forest borders, to understand the distribution, population status, habitat requirements, and ecology of this cryptic lesser-known species.

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Video 1. Dusky-striped squirrel feeding on the nectar of *Lobelia leschenaultiana*

Video 2. Dusky-striped squirrel peeling the pod and consuming the seeds of *Acacia mearnsii*

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