TAPROBANICA, ISSN 1800–427X. November, 2021. Vol. 10, No. 02: pp. 135–137.

http://www.taprobanica.org
https://doi.org/10.47605/tapro.v10i2.267

Gliding behaviour of Indian giant flying squirrel (*Petaurista philippensis*)

The Indian giant flying squirrel or large brown flying squirrel, *Petaurista philippensis* (Elliot, 1839) is one of 13 gliding squirrel species found in India (Koli 2016, Walston *et al*. 2016). Nocturnal by nature, they have ability to glide up to 150 m (McLean 2017). We studied its gliding habit in the human-modified landscape of the Kevdi ecotourism site (22.5198ºN, 73.9356ºE; Fig. 1), Panchmahal District, between two protected areas in Gujarat: Ratanmahal Sloth Bear Sanctuary and Jambughoda Wildlife Sanctuary. The Kevdi ecotourism site is a known locality of this species (Singh *et al*. 2016). Here, we present basic information on the gliding ecology of the species in the dry deciduous forests of central Gujarat.

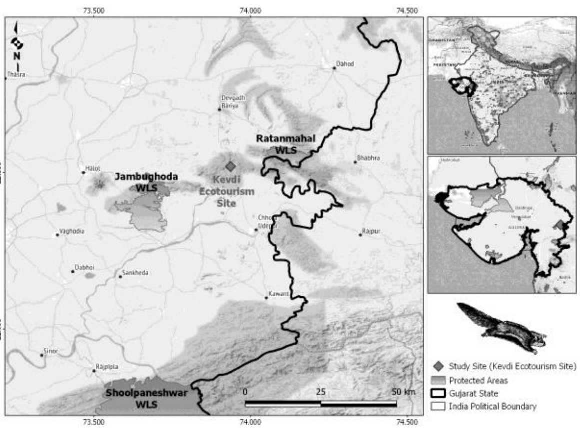

Figure 1. Study Area Kevdi Ecotourism Site, located between Ratanmahal and Jambughoda Wildlife Sanctuaries in Gujarat State, India

We located two flying squirrel nests on a Mahua (*Madhuca latifolia*, Family Sapotaceae) tree, surrounded by many other dense canopy Mahua trees. The methods used for observations followed Koli *et al*. (2011). The squirrels typically came out of the tree cavity (nest) at dusk and climbed up further before gliding. Before taking a glide, they moved from one branch to another as if trying to find a perfect place to take off from. The squirrels were detected by eye shine and observed for half an hour using a spotlight between 1900 and 1930 h. The sexes of the two individuals could not be differentiated. For each glide (n=8), we recorded seven variables related to the gliding activity (Koli *et al*. 2011; Fig. 2): height of launch on the launch tree (H1), height of landing on the destination tree (H2), vertical drop (H3), horizontal distance (L), glide angle (θ), GBH of launch tree (G1), and GBH of destination tree (G2). We also calculated the glide ratio using the horizontal distance (L) and vertical drop (H3) (Koli *et al*. 2011).

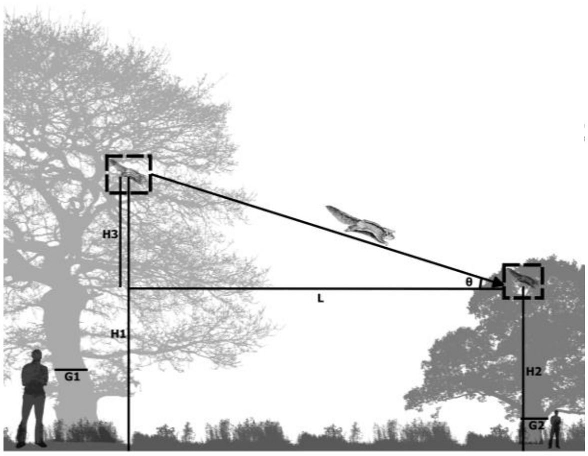

Figure 2. Observed tree variables related to gliding activities of Indian giant flying squirrel

We found an average glide ratio of 3.92, which is higher than that recorded in Sitamata Wildlife Sanctuary, Rajasthan (2.32). Further, it is also higher than other species of flying squirrels: *Petaurista leucogenys* (1.87 in Japan—Andō & Shiraishi 1993, Stafford *et al*. 2002), *Glaucomys sabrinus* (1.98 in Canada—Vernes 2001), *Pteromys volans orii* (1.70 in Japan—Asari *et al*. 2007), *Petaurus gracilis* (1.91 in Australia—Jackson 2002), *Petaurus breviceps* (1.82 in Australia—Jackson 2002), *Glaucomys volans* (2.8 in North America—

Nowak 1991), and lower than *Petaurista petaurista* (3.1 in eastern Himalaya, India—Krishna *et al*. 2016). The higher glide ratio is an indicator of the absence of environmental barriers in their habitat (Koli *et al*. 2011). In contrast, lower glide ratios help squirrels to avoid risks such as strong winds, aerial predation, etc (Koli *et al*. 2011). The mean height of launch from the Mahua tree was 21.9 m with an aerial glide of 49.5 m to the destination trees and landing height of 5.75 m on average. The mean horizontal distance between launching and destination trees was 45 m. The mean glide angle was 20 degrees. Average GBH of launching and destination trees were 10.1 m and 7.15 m, respectively. These results were close to the results of Koli *et al*. (2011), but in some cases, greater distances were observed in our study, which can be attributed to the low sample size. A previous study by Koli *et al*. (2011) described the functions of glide ratio (L/H3) for Indian giant flying squirrels in Sitamata Wildlife Sanctuary of southern Rajasthan. A robust study using the characteristics mentioned above could significantly improve knowledge of the gliding ecology of this species.

The gliding mode of locomotion has proven to be an efficient approach as it restricts energy usage required for dispersal in arboreal gliders (Krishna *et al*. 2016). This mode also reduces predation risk (Krishna *et al*. 2016). Studies on the gliding ecology of flying squirrels can provide insights for forest management since glide ratio is a good indicator of tree density and forest health (Asari *et al*. 2007). Activities such as expanding agriculture and settlements cause forest fragmentation and degradation, which adversely affect gliding ecology and population structures of flying squirrels (Asari *et al*. 2007, Krishna *et al*. 2016). Local environmental factors such as canopy cover, vegetation type, and density, and topography also have significant effects on gliding patterns (Koli *et al*. 2011). More studies on the gliding ecology of *P. philippensis* are required to implement conservation efforts for this species locally and globally.

Although the IUCN Red list status is Least Concern (LC) (Walston *et al*. 2016), the status at local levels in India can be different as various threats are leading the species to high risks of local extinction. Threats include human disturbances, habitat destruction and fragmentation, forest fires, increased human settlements, shifting cultivation, collisions with vehicles, myths and hunting for local consumption, medicinal use and socio-cultural traditions, etc (Molur *et al*. 2005, Koli *et al*. 2013, Koli 2016). There is a need to study this species with respect to their ecology and distribution in India, as little is known about its patchy distribution and behavioural ecology in India. Nevertheless, local authorities should not wait for more information before conserving forest patches that are important for gliding squirrels and other forest-dependent wildlife. This short study on gliding behaviour might be helpful for conservation and future studies.

Acknowledgments
We thank Lee Harding (Canada) and Vijay K. Koli for their valuable comments, and Nisha Singh and Prasad Patil for their contribution during the field activities.

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Submitted: 24 May 2021, *Accepted*: 9 Sep. 2021
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