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COMMUNICATION

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COMMUNICATION

Small mammals in the human-dominated landscape in the northern Western Ghats of India

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Abstract: The Western Ghats biodiversity hotspot is under huge anthropogenic pressure, with unique flora and fauna facing severe threats from habitat fragmentation, loss, and degradation. The northern Western Ghats has been poorly studied for its small mammal fauna, hence we examined small mammals near Pune from 2014 to 2017. Live trapping was carried out in irrigated and rainfed agriculture fields, forests, and grasslands at low, mid, and high elevations. A total of 538 individuals were trapped, representing 17 species of rodents and one shrew. Most abundantly captured species were *Millardia kondana* (23%), *Mus saxicola* (19%), *Suncus murinus* (17%), and *Mus booduga* (13%). Species richness and abundance of small mammals varied across the habitats. High elevation grasslands were species-rich relative to low elevation grasslands and forests. Our observations indicate that human disturbances play a role in determining the richness and abundance of small mammals in the area, where populations are under threat from urbanization, tourism, agriculture, grazing, and fire. Habitat and species specific conservation measures need to be taken, coupled with in-depth species–habitat relationship studies, for the conservation of small mammal diversity of the northern Western Ghats.

Keywords: Conservation, forts, high-elevation grasslands, *Millardia kondana,* rocky outcrops, small mammals, threats.

सारांश: जगात जैवविविधतेने समृद्ध असणाऱ्या क्षेत्रांत भारतातील पश्चिमी घाटांचा समावेश होतो जे अलीकडील काळात वाढत्या मानवी हस्तक्षेपांमुळे बाधित होत आहेत. अधिवासांचं विखंडन, नाश आणि त्यात उत्तरोत्तर होणारी अधोगती यामुळे धोक्यात असणाऱ्या उत्तर-पश्चिमी घाटांतील वैशिष्ट्यपूर्ण प्राणी आणि वनस्पतींच्या प्रजातींचे संवर्धन होणे आवश्यक आहे, परंतु विशेषकरुन तिथे आढळणाऱ्या लहान सस्तन प्राण्यांचा फारच कमी अभ्यास झाला आहे. त्या अनुषंगाने सन २०१४-२०१७ च्या दरम्यान पुणे शहराजवळील पश्चिम घाटात आम्ही लहान सस्तन प्राण्यांचा अभ्यास केला. यात आम्ही मनुष्यवस्तीलगतच्या बागायती- जिरायती शेते, वने तसेच समुद्रसपाटीपासून कमी-मध्यम-अतिउंचीच्या गवताळ अशा विविध अधिवासांतून रात्रीच्या वेळी लहान सस्तन प्राणी जिवंत पकडले. या अभ्यासाअंती एकूण ५००० प्रयत्नांतून १७ प्रजातींचे ५३८ कृदन्त व एक चिचुंद्री नमुन्यादाखल जिवंत पकडले. पकडलेल्या एकूण सस्तन प्राण्यांपैकी मिलार्डिया कोंडाणा (२३.०५%), मस सॅक्सिकोला (१८.९६%), संकस मुरिनस (१६.९१%) आणि मस बुडुगा (१३.०१%) या चार प्रजातींचे प्रमाण सर्वात जास्त आढळले. विविध अधिवासांत लहान सस्तन प्राण्यांची समृद्धता आणि मुबलकतेच्या अनुषंगाने कमीअधिक फरक दिसून आला. समुद्रसपाटीपासून अतिउंचीवरील गवताळ क्षेत्रातील प्रजातींचे वैविध्यपूर्ण प्रमाण हे समुद्रसपाटीपासून तुलनेने कमी उंचीवर असणाऱ्या गवताळ तसेच झाडीच्या वनक्षेत्रांत आढळलेल्या प्रजातींपेक्षा जास्त दिसून आले. निरीक्षणाअंती मानवी घडामोडींमुळे होणाऱ्या त्रासाचा अभ्यासक्षेत्रातील लहान सस्तन प्राण्यांच्या समृद्धतेवर परिणाम झालेला दिसून आला. नागरीकरण, पर्यटन, शेतीपद्धतीतील आधुनिकीकरण, चराई व वणवे या बाबींमुळे सदर अभ्यासक्षेत्र धोक्यात आले आहे. त्यामुळे अधिवास आणि प्रजातीकेंद्रित संवर्धन होण्यासाठी योग्य ते उपाय योजले जाणे आवश्यक आहे. त्याला जोडून उत्तर-पश्चिमी घाटातील लहान सस्तन प्राण्यांच्या विविधतेचे संवर्धन करण्यासाठी प्रजाती व त्यांचा अधिवास यांतील परस्परसंबंधाचा सखोल अभ्यास करणे गरजेचे आहे.

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For **Author details, Author contribution** and **Acknowledgements** see end of this article.

INTRODUCTION

The Western Ghats (along with Sri Lanka) is a global biodiversity hotspot (Myers et al. 2000) with remarkable variations in the distribution of plant and animal communities ranging from flowering plants (7,402 species, 38% endemic) to mammals (121 species, 12% endemics) (Nayar et al. 2014; Nameer 2020). Based on the composition of the flowering plants, the Western Ghats is divided into four zones: northern, central, southern, and Nilgiri Mountains (Subramanyam & Nayar 1974). The northern Western Ghats have characteristic rocky (lateritic/basaltic) outcrops on the summit of the mountains, and sustain highly seasonal and endemic herbaceous plant communities that survive only for 2–3 months of the monsoon (Watve 2013).

Small mammals of the Western Ghats include bats (50 species) and rodents (31 species; Nameer 2020). Studies on the small mammals of India began in the early 20th century in the form of primarily descriptive and natural history surveys. Ecological and quantitative investigations were initiated in the 1970s, and became more systematic and numerous towards the end of the 20th century (Shanker 2003). Most of these studies were carried out in the southern Western Ghats and Nilgiri Mountains (Chandrasekar–Rao & Sunquist 1996; Prabhakar 1998; Shanker & Sukumar 1998, 1999; Mudappa et al. 2001; Kumar et al. 2002; Shanker 2003; Venkataraman et al. 2005; Molur & Singh 2009; Ramchandran 2013).

The Western Ghats has experienced substantial loss and degradation of natural vegetation due to changes in land-use patterns (Jha et al. 2000; Reddy et al. 2013). It is forecast that the Western Ghats will be one of the most densely populated biodiversity hotspots in the world by 2030 (Seto et al. 2012). The northern Western Ghats is the most degraded and fragmented zone in the entire region (Roy et al. 2012). Little is known about its small mammal fauna except for a few quantitative ecological studies conducted in the urban areas of Mumbai (Deoras & Gokhale 1958; Brosset 1961; Deoras et al. 1975; Pradhan 1975), and some short-term surveys and species occurrence records (Wroughton 1916; Ranade 1989; Singh & Pradhan 1992; Yazdani et al. 1992; Pradhan 1993; Pradhan & Talmale 2004, 2012; Talmale et al. 2013). Habitat loss and disturbances are taking place at an alarming rate in the Western Ghats (Gadgil 2011). It is essential to study and conserve the small mammals of this region, especially Critically Endangered and endemic species like Kondana Soft–furred Rat *Millardia kondana*. We undertook this study to examine the species richness, abundance, and natural history of small mammals in the northern Western Ghats.

MATERIALS AND METHODS

Study area

The study area is located in the mountain ranges of the northern Western Ghats (Figure 1 and Table 1) near Pune in Maharashtra State. The terrain is hilly and rugged with characteristic basaltic and lateritic rocky outcrops on summits of mountains; elevation 600–1,400 m. Climate is tropical monsoon with an average temperature range of 9.6–36.7°C and average annual rainfall of 2,500mm. The eastern slopes are less rugged with low rainfall and covered with dry deciduous forests, while the western slopes are highly rugged, receive high rainfall, and covered with moist–deciduous and semi-evergreen forests. The area is under tremendous anthropogenic pressure, especially from grazing, burning, wood extraction, agriculture, and more recently, from housing and infrastructure development as a part of expanding suburban areas of Pune metropolitan city. The urban area cover of Pune metropolis has almost doubled from 2001 to 2013 (Kantakumar et al. 2015). As a result, the natural forests are being transformed into settlements, grasslands, and agricultural fields over most of the area.

This area has a relatively large number of reservoirs. Irrigated agriculture is practiced in areas below 700m, while rain-fed agriculture is predominant at the base of hills and on gentle to moderate slopes. A large proportion of the study area is covered with grasslands and they can be categorized as low, mid- and high-elevation grasslands. Low-elevation grasslands (<900m) are situated close to human settlements and are intensively modified by burning, grazing, and fodder extraction. Mid-elevation grasslands (900–1,200 m) are less accessible and mostly found on ridges and steep slopes of the hills, and are comparatively less disturbed. High elevation grasslands (>1,200m) are relatively less disturbed due to their remoteness and also as they come under the protection of forest and archaeological departments. They, however, face threats from fire and developing/uncontrolled tourism. Forests are generally confined to the high elevation areas, gorges, and areas that are difficult to access.

Small mammal sampling

We selected 31 sites for sampling small mammals, comprising five forest sites, 12 agriculture sites, and 14 grassland sites (Figure 1, Table 1). We carried out

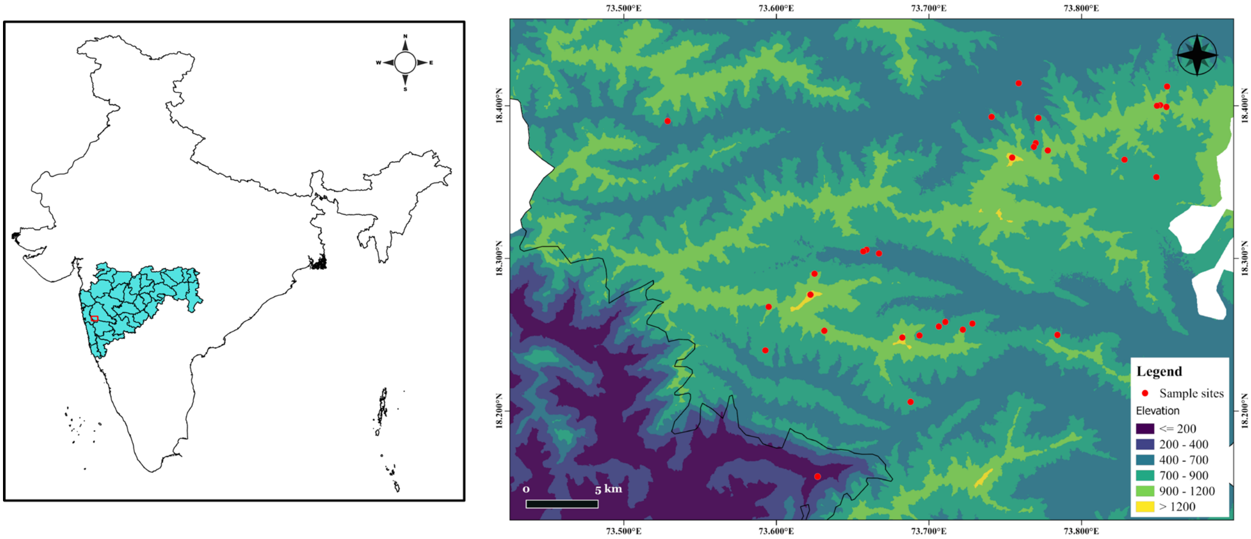

Figure 1. Study area showing elevation and sampling sites.

Table 1. Details of the trapping sites.

Locality	GPS coordinates	Elev. (m)	Habitat
Padalghar	18.389930°N, 73.528665°E	648	Rainfed agriculture field
Sambrewadi	18.392691°N, 73.741062°E	684	Rainfed agriculture field
Hirpodi_1	18.305603°N, 73.659056°E	686	Rainfed agriculture field
Hirpodi_2	18.30459441°N,73.65693911°E	685	Rainfed agriculture field
Atkarwadi_agriculture	18.37549478°N,73.76999058°E	730	Rainfed agriculture field
Kasabe-Shivtar	18.157087°N, 73.626977°E	128	Rainfed agriculture field
Gauddara	18.3646018°N,73.82818624°E	818	Rainfed agriculture field
Gunjavane_1	18.25537584°N,73.70641709°E	707	Rainfed agriculture field
Girinagar	18.41468886°N,73.75884102°E	610	Irrigated agriculture field
Khed Shivapur	18.353207°N,73.84908601°E	773	Irrigated agriculture field
Hirpodi_3	18.30318151°N,73.6672126°E	677	Irrigated agriculture field
Gunjavane_2	18.25837147°N,73.71070131°E	694	Irrigated agriculture field
Katraj Ghat_grassland_2	18.39920702°N,73.85563861°E	970	Low-elevation grassland
Kolambi_grassland	18.23974364°N,73.59274876°E	813	Low-elevation grassland
Manjai Asani_1	18.25728995°N,73.72846273°E	830	Low-elevation grassland
Sonde-Mathana	18.249864°N, 73.784194°E	747	Low-elevation grassland
Atkarwadi_grassland	18.39191865°N,73.77172104°E	734	Low-elevation grassland
Manjai Asani_2	18.2532695°N,73.72219777°E	928	Mid-elevation grassland
Katraj Ghat_grassland_3	18.40036272°N,73.85156276°E	1,083	Mid-elevation grassland
Velhe	18.28995131°N,73.62497345°E	960	Mid-elevation grassland
Katraj Ghat_grassland_1	18.399918°N, 73.849462°E	1,120	Mid-elevation grassland
Metpilaware	18.252577°N, 73.631384°E	995	Mid-elevation grassland
Avasarewadi	18.37065422°N,73.77788407°E	1,057	Mid-elevation grassland
Rajgad Fort	18.24814956°N,73.68249373°E	1,251	High-elevation grassland
Sinhgad Fort	18.36604523°N,73.75451226°E	1,312	High-elevation grassland
Torna Fort	18.27623015°N,73.62228899°E	1,376	High-elevation grassland
Gunjavane_forest	18.24949456°N,73.69378517°E	825	Forest
Bhandravali	18.205975°N, 73.687931°E	790	Forest
Kolambi_forest	18.26824283°N,73.594925°E	960	Forest
Katraj Ghat_forest	18.41256705°N,73.85606534°E	857	Forest
Atkarwadi_forest	18.37301657°N,73.76873061°E	775	Forest

trapping of small mammals during two phases: March–December 2014 and December 2016–February 2017.

In the first phase, our focus was documentation of the small mammals of the study area. Hence, we carried out trapping over a large area to cover various habitats. In each habitat, we searched for the signs of presence of small mammals such as burrows, runways, pellets and, feeding marks, and placed Sherman live traps (4"x4.5"x12"). The traps were baited with a mixture of 'pakoda' (deep-fried gram flour batter with onions) and peanut butter. We laid 40 traps in each habitat and ran for a night.

In the second phase, we undertook intensive trapping to study the abundance and habitat association of small mammals. At each site we laid five trap lines 100m in length within a buffer of radius 200m from the center of the site. We maintained a minimum distance of 50m between traplines and habitat the edges to avoid edge effects. Traps were placed at intervals of 10m in each trap line (10 trapping stations). A trap was placed within 1m of the trapping station, close to grass clumps, shrubs, trees, rocks or litter covered areas. Traps were checked once a day between 06.00 and 11.00 hours, then closed and re-opened at dusk. Each habitat was trapped for four consecutive nights between 19 December 2016–5 February 2017. Trapped individuals were measured, sexed, weighed, marked (by fur clipping), and released at the captured locations. We strictly followed animal care and use guidelines recommended by the American Society of Mammalogists (Sikes et al. 2011) during trapping and handling of the small mammals.

We calculated the abundance of species using capture rate (number of individuals trapped per 100 trap nights) and proportion (number of individuals of species/total number of individuals of all species x 100). Species richness and Shannon's diversity index were computed for each habitat using the R package 'BiodiversityR' (Kindt 2019).

RESULTS

Five-hundred-and-thirty-eight individuals of 17 species of rodents and a shrew were trapped in the 5,000 trap night effort. The overall capture rate was 10.8 individuals per 100 trap nights. The capture rate varied considerably among species; for instance, *Millardia kondana* (2.48 individuals/100 trap nights), *Mus saxicola* (2.04), *Suncus murinus* (1.82) and *Mus booduga* (1.40) had high capture rates, whereas *Funambulus palmarum* (0.02), *Vandeleuria oleracea* (0.02), *Rattus rattus* (0.04), and *Tatera indica* (0.06) had low capture rates.

Table 2. Species richness and diversity of small mammals in various habitats. Mean, standard deviation, and, minimum & maximum in parentheses.

Habitat	Richness	Diversity
Low-elevation grassland	1.80±1.30 (0–3)	0.85±0.49
Mid-elevation grassland	3.00±1.26 (1–4)	0.95±0.34
High-elevation grassland	7.00±1.00 (6–8)	1.31±0.31
Rainfed agriculture	2.75±1.75 (1–6)	1.05±0.49
Irrigated agriculture	2.75±1.25 (1–4)	1.23±0.10
Forest	1.80±1.09 (1–3)	0.72±0.55

M. kondana (23% of all animals captured), *M. saxicola* (19%), *S. murinus* (17%), and *M. booduga* (13.01%) were the most abundant species. *F. palmarum*, *V. oleracea*, *R. rattus*, *T. indica*, *Bandicota bengalensis*, and *Rattus satarae* were uncommon or rare, collectively constituting less than 4% of total animals captured (Figure 2).

Species richness was greatest in high-elevation grasslands (seven species) and lowest in low-elevation grasslands (1.80) and forests (1.80; Table 2). Shannon's diversity index was highest for high–elevation grasslands (1.31±0.31), followed by irrigated agriculture fields (1.23±0.10) and rainfed (1.05±0.49) agriculture fields, and was lowest for forests (0.72±0.55; Table 2).

DISCUSSION

The trapping success (10.8%) of small mammals recorded in our study area was higher than that reported in other sites in the Western Ghats, which ranged from 2.6% to 5.7% (Chandrasekar–Rao & Sunquist 1996; Prabhakar 1998; Venkataraman et al. 2005; Molur & Singh 2009), except for the capture success rate of 10.6% recorded by Shanker (2003) in the Nilgiris. Unlike these sites in the Western Ghats, our study area had been modified to a high degree by humans, with natural vegetation being transformed into a grassland–agriculture dominated landscape, which could be a reason for the high trapping success. It is, however, usually difficult to disentangle the influence of particular factors on trapping success, especially in short duration and small–scale studies (Venkataraman et al. 2005; Himsworth et al. 2014). Trapping success is also dependent on factors such as geographic variations in densities of small mammals (Emmons 1984; Rose 2008; Wood 2008), trapping season (Prabhakar 1998; Shanker & Sukumar 1998; Prakash & Singh 2005), habitat (Chandrasekar–Rao & Sunquist 1996; Venkataraman et

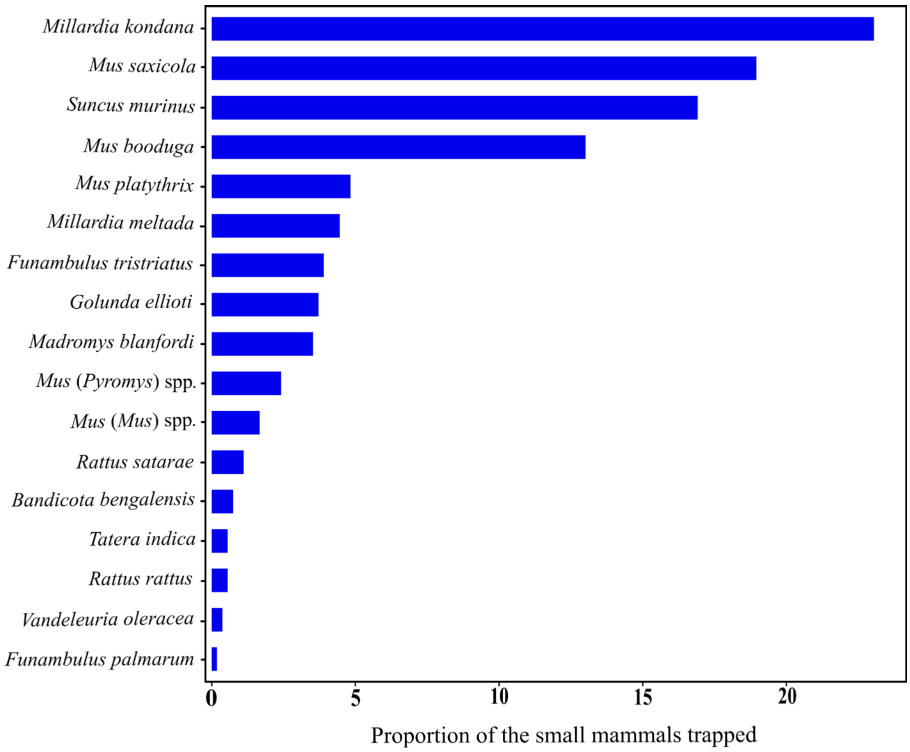

Figure 2. Proportions of the small mammals trapped in this study.

al. 2005; Prakash & Singh 2005), human disturbance (Rickart et al. 2011; Bajaru 2015) and the type of bait and trap (Patric 1970; Woodman et al. 1996).

Several studies in the Western Ghats found *Rattus rattus wroughtoni* and *Madromys blanfordii* to be dominant species (Chandrasekar–Rao & Sunquist 1996; Prabhakar 1998; Shanker 2003; Venkataraman et al. 2005; Shenoy & Madhusudan 2006; Ramchandran 2013). These species, however, had low abundance in our study area. Both these species prefer forested habitat: *R.r. wroughtoni* favors undisturbed evergreen forest, while *M. blanfordii* prefers deciduous and degraded forests. Hence their low abundance was not surprising in our study area, which primarily comprised of agriculture and grassland.

Millardia meltada, *M. booduga*, *M. platythrix*, and *S. murinus* were recorded to be the most abundant species in other sites (Prabhakar 1998; Shanker 2003; Venkataraman et al. 2005; Shenoy & Madhusudan 2006). In our study area, *M. kondana*, *M. saxicola*, *M. booduga*, and *S. murinus* were the species with high abundance. We anticipated their high abundance, as the first two species are reported to prefer grassland while the other two favor agriculture (Bajaru et al. 2019), and both habitat types were dominant in the study area. Though *S. murinus* is a generalist species (Prakash & Singh 2005), it was trapped mainly in agricultural fields in our study area.

Species richness (17 species) of small mammals was high compared to those reported in other sites in the Western Ghats, 5–9 species (Prabhakar 1998; Shanker & Sukumar 1998; Mudappa et al. 2001; Venkataraman et al. 2005; Ramchandran 2013), but was comparable with 14 species recorded from Kodagu, Karnataka (Molur & Singh 2009). The numbers of species trapped in the agriculture area in our study were comparable with that recorded by Molur & Singh (2009) in Kodagu (nine species). The species richness recorded in forests was lower (three species) than reported in other sites of the Western Ghats, i.e., 5–9 species (Shanker 2003; Venkataraman et al. 2005; Molur & Singh 2009; Ramchandran 2013). We anticipated that species richness would be poor in the forest habitat as our study area was covered with highly degraded and secondary forests, which would have impacted forest specialist species. Moreover, the northern Western Ghats is known to be poor in mammalian species richness compared to the other parts of the Western Ghats (Nameer 2020). Interestingly, we found high-elevation grasslands to be the most species-rich: the maximum richness of a site was eight species, whereas pooled richness was 13 species. The only other study on small mammals of high-

Table 3. Summary of external characters (in cm) and weights (in g) of small mammals measured in this study. Mean, standard deviation, and sample size in parentheses.

Species	HB	TL	HF	EL	Weight
Millardia kondana	13.74±1.79 (121)	14.59±1.58 (114)	3.02±0.18 (124)	2.06±0.15 (124)	85.95±29.98 (124)
Millardia meltada	12.07±1.07 (24)	11.13±1.92 (21)	2.50±0.21 (23)	1.91±0.19 (24)	56.41±16.21 (24)
Mus saxicola	8.72±1.17 (100)	6.98±0.60 (90)	1.77±0.09 (99)	1.33±0.09 (95)	20.62±7.57 (95)
Mus platythrix	8.86±1.07 (25)	7.38±0.49 (16)	1.75±0.15 (25)	1.35±0.11 (24)	23.00±7.89 (24)
Mus booduga	6.66±1.05 (62)	6.78±0.70 (61)	1.44±0.10 (64)	1.10±0.11 (64)	8.76±2.74 (63)
Golunda ellioti	11.34±1.25 (18)	10.61±1.13 (17)	2.40±0.18 (18)	1.58±0.16 (18)	50.88±13.89 (18)
Madromys blanfordii	13.72±2.29 (17)	18.71±2.87 (18)	3.38±0.20 (18)	2.30±0.20 (18)	83.88±35.65 (18)
Rattus satarae	14.58±1.11 (6)	22.70±1.52 (5)	3.20±0.08 (6)	2.21±0.11 (6)	79.33±19.21 (6)
Rattus rattus	11.95±0.07 (2)	15.35±1.20 (2)	2.95±0.07 (2)	2.00±0.00 (2)	47.00±4.24 (2)
Suncus murinus	11.61± 0.81 (17)	7.58±0.42 (18)	1.96±0.08 (18)	1.29±0.17 (18)	35.00±5.65 (16)
Bandicota bengalensis	14.62±2.20 (4)	15.17±4.96 (4)	3.25±0.23 (4)	2.12±0.05 (4)	100.00±43.81 (4)
Tatera indica	12.86±2.91 (3)	17.10±3.98 (3)	4.00±0.10 (3)	2.30±0.10 (3)	129.00±12.72 (2)
Vandeleuria oleracea	7.20±0.56 (2)	11.55±0.63 (2)	1.75±0.07 (2)	1.40±0.14 (2)	14.00±0.00 (1)
Funambulus tristriatus	14.00±0.96 (3)	14.05±0.84 (4)	3.85±0.19 (4)	1.50±0.00 (4)	82.00±55.46 (3)

elevation grassland in the Western Ghats reported three species (Shanker 2003).

The high species richness in high-elevation grasslands may be related to the low to moderate human disturbance at these sites. Disturbances such as fire, grazing, grass cutting, cultivation, and human habitation are under control in these sites (forts) because they come under the jurisdiction of Archaeological and Forest Departments of Maharashtra. This finding is consistent with the intermediate disturbance hypothesis (Connell 1978), which predicts that species diversity is highest in moderately disturbed habitats (Rickart et al. 2011). Other sites in the study area are under high human disturbances, viz., urbanization, tourism, agriculture, wood-extraction, grazing, and fire. Hence species and habitat-specific conservation actions need to be taken up without delay to conserve these habitats and species. Moreover, further investigations on species-habitat relationships of the small mammals using robust sampling and statistical analyses are needed for their effective conservation and management.

The species accounts of the small mammal trapped in this study are as follows:

Kondana Soft-furred Rat *Millardia kondana*

This species is endemic to the northern Western Ghats and only known from four forts, viz., Sinhgad, Torna, Rajgad, and Raireshwar. *M. kondana* is a large rodent (Table 3; Image 1) with reddish or grayish-brown above and grayish-white below. The tail is bicolored, sparsely haired and equal to or slightly longer than head and body length. Though *M. kondana* is superficially similar to *M. meltada,* it differs by larger body size, comparatively small ears and hind feet, and six distinct planter pads on the hind feet (Mishra & Dhanda 1975). We, however, found that some individuals of *M. meltada* had six plantar pads, and an individual had five plantar pads on one foot and six on the other foot. Hence uniqueness of the number of plantar pads as a character in differentiating the species from others is questionable.

M. kondana is much heavier than *M. meltada*. It is restricted to high-elevation grasslands (>1,200m) and not trapped in other habitats or low elevations (<1,200m). Though restricted in distribution, *M. kondana* was the most frequently trapped species (23% of total catches). We found that it favors the patches of perennial herbs and scattered shrubs in high-elevation grasslands. It mainly breeds in monsoon and post-monsoon (July–November), but a few breeding individuals were also trapped in winter (December–January). It digs burrows near trees, shrubs or perennial herbs; active burrows were recognized by the presence of pellets or remnants of seeds and fruits at burrow openings.

Soft-furred Field Rat *Millardia meltada*

This sister species of *M. kondana* is found throughout India (Agrawal 2000). It resembles *M. kondana* externally but is smaller in size and lighter in weight (Table 3; Image 2). It was only trapped below 900m in agricultural fields and low-elevation grasslands in our

Image 1. *Millardia kondana*

Image 3. *Mus saxicola*

Image 2. *Millardia meltada*

Image 4. *Mus booduga*

study area. It showed a high preference for irrigated agriculture fields, which is also reported elsewhere (Prakash & Singh 2005). This species was relatively less abundant (4.5% of total catches) than *M. kondana*. We trapped it in December–January, and some individuals were reproductively active.

Elliot's Spiny Mouse *Mus saxicola*

It is a small rodent, easily distinguished by its pure white underparts, spiny hair, and a short tail (Table 3; Image 3). The body is grayish to grayish-brown above; some individuals had a faint orange line separating the dorsal and ventral sides. The species is almost indistinguishable from *M. platythrix* morphologically, except for having an anterior accessory cusp on the first lamina of first upper molar (Agrawal 2000). It was the second most abundant species in the study area (19% of total captures). Though it appeared to be a habitat generalist (trapped in all the habitats), it was more common in low- and mid-elevation grasslands. Unlike *M. kondana,* this species was trapped frequently in degraded and open grasslands lacking shrubs and trees. Some of the individuals trapped between December–February were reproductively active. Except for three individuals with 3+2 (thoracic+abdominal) mammae, the rest had 4+2 mammae.

Brown Spiny Mouse *Mus platythrix*

This species is morphologically similar to *M. saxicola* (Table 3) but lacks an anterior accessory cusp on the first lamina of first upper molar (Agrawal 2000). It seems to be a habitat generalist, but unlike *M. saxicola*, it was not trapped in irrigated agriculture fields. It was also not abundant (4.83% of total captures). Some individuals trapped between December–February were reproductively active. Except for an individual with 4+2 mammae, the rest of the rats had 3+2 mammae.

Little Indian Field Mouse *Mus booduga*

It is the smallest rodent that was trapped in this study (Table 3; Image 4). Unlike *M. platythrix* and *M. saxicola,* it has soft hair. The body is reddish-brown above and greyish-white underneath. The tail is bicolored, thin and its length is equal to head and body length. It showed a preference for agriculture fields, but it was also trapped in low- and mid-elevation grasslands. Interestingly, it was not captured in high-elevation grasslands. This was one of the most abundant species in the study area, constituting 13.01% of total captures. Some individuals trapped between December–February were reproductively active.

Indian Bush Rat *Golunda ellioti*

This species has spiny and coarse hair, covering almost half of the ears. It is yellowish-brown above and grayish underneath. The tail is thick, shorter than head and body length, and covered with black hair having a yellowish or golden-yellow tinge (Table 3; Image 5). Though this species was trapped in all habitats, it was most often captured in low-elevation grasslands, followed by mid-elevation grasslands. It was trapped in grazed grasslands and grass patches among agriculture fields. Its abundance was low (3.71% of total captures).

Sahyadris Forest Rat *Rattus satarae*

This species is endemic to the Western Ghats. It is morphologically similar to *R. rattus* but has a very long tail (Table 3; Image 6). The body is covered with soft hair, which is reddish-brown above and white below. The species was recorded to be relatively less aggressive than that of *R. rattus* when captured. It was trapped in undisturbed semi-evergreen and moist–deciduous forest patches; similar results were found in another study (Molur & Singh 2009). Overall, its abundance was low (1.11% of total catches) in our study area. Some individuals trapped between December–February were reproductively active.

White-tailed Wood Rat *Madromys blanfordii*

A large arboreal rat with a long, white-tipped tail (Table 3; Image 7). Body covered with soft hair; grayish above and white below. It was trapped in forested habitats and was observed preferring ruined structures like forts, temples, and old houses for shelter. Its abundance was low (3.53% of total catches). Some individuals trapped between December–February were reproductively active.

Jungle Striped Squirrel *Funambulus tristriatus*

This species is endemic to the Western Ghats. It is similar in appearance to *F. palmarum* but is larger in size with a rufous forehead, flanks, and underside of the tail (Table 3). All specimens trapped were from the forested areas, and usually away from human settlements. Though we did not place traps above the ground for

Image 5. *Golunda ellioti*

Image 6. *Rattus satarae*

Image 7. *Madromys blanfordii*

Image 8. *Suncus murinus*

Image 9. *Tatera indica*

Image 10. *Vandeleuria oleracea*

trapping this highly arboreal species, the squirrels came for the bait put in the ground-laid traps. Its abundance was relatively higher (3.90% of total catches) than the other arboreal rodents, viz., *R. rattus* and *M. blanfordii*. The individuals trapped in February were found to be reproductively active.

House Shrew *Suncus murinus*

Suncus murinus, a widespread and generalist species (Prakash & Singh 2005), was the only shrew species recorded in the study area. It has a smooth, thick, and grey coat. The tail is shorter than head and body length and covered with thinly scattered, long, and white hair (Table 3; Image 8). It has a strong musky smell. It was trapped mainly in irrigated agriculture fields, followed by rainfed agriculture fields. It seems to prefer areas with moisture and the herbaceous cover as it was frequently trapped on bunds in agriculture fields covered with green grasses and forbs. It was a third-most abundant species (16.91% of total captures).

Image 11. *Bandicota bengalensis*

Other Species

In addition to frequently trapped species, some species were captured rarely (less than five individuals or less than 1% of total captures; Table 3). For instance, only three individuals of *Rattus rattus* were trapped near human settlements, and three individuals of *Tatera* *indica* (Image 9) were captured in high and mid-elevation grasslands. The absence of *T. indica* in agriculture fields is intriguing, as it is associated with agroecosystems and considered an important crop pest (Prakash & Singh 2005). We trapped two individuals of *V. oleracea* (Image 10)*;* one by hand from the ruined walls of the fort, the other in a rainfed agriculture field in a trap placed on a grass-covered bund under a *Ficus racemosa* tree. Four individuals of *B. bengalensis* (Image 11) were trapped from both rainfed and irrigated agriculture fields, and in a high-elevation grassland. All capture locations of *B. bengalensis* were close to the human settlements which was not surprising as this is a synanthropic species, thrives in human habitation areas. We also captured a squirrel, *F. palmarum,* in a rainfed agriculture field. This study was not particularly focused on squirrels, hence trapping time and trap placement was not ideal for capturing squirrel, which would explain the low capture rate of this otherwise common Indian rodent species. *Ratufa indica*, an arboreal and large (too large for our trap size) squirrel species, was not captured during the study but was seen and heard in undisturbed semi-evergreen and moist deciduous forest patches.

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