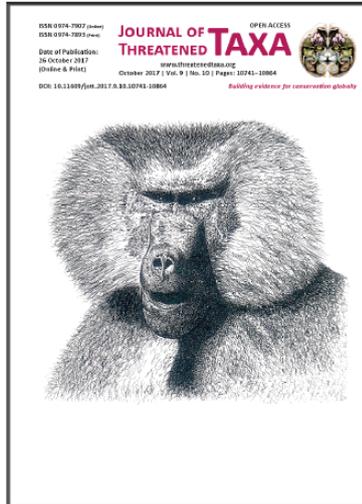


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Journal of Threatened Taxa

Building evidence for conservation globally

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ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

SHORT COMMUNICATION

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26 October 2017 | Vol. 9 | No. 10 | Pp. 10823–10830
10.11609/jott.3021.9.10.10823-10830



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ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

MAMMALS OF PAPIKONDA HILLS, NORTHERN EASTERN GHATS, INDIA

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Abstract: Papikonda National Park covering an area of 1,012km² holds high conservation value as the only national park in the geographically vast northern Eastern Ghats. The tropical moist deciduous forests support species assemblages characteristic of the Eastern Ghats. We conducted the first comprehensive assessment of the mammal diversity in Papikonda National Park using camera traps, sign surveys and community interviews between October 2014 and March 2015, combined with a comprehensive literature review of research articles, field guides and IUCN species range reports. A total of 55 species from 46 genera belonging to 24 families were enumerated. There was a high diversity of carnivores (15 species), followed by chiropterans (13 species) and rodents (11 species).

Keywords: Diversity, mammals, Papikonda National Park.

Abbreviations: CT - camera trap; EN - Endangered; ETM - Enhanced Thematic Mapper; IN - interviews; IUCN - International Union for Conservation of Nature; LC - Least Concern; LR - literature review; NGO - Non Governmental Organization; NP - National Park; NT - Near Threatened; RF - Reserve Forest; SS - sign survey; VU - Vulnerable.

The Eastern Ghats hill ranges (77.36–85.33 E & 11.50–21.00 N) stretch from the Mahanadi River valley in Odisha in the north to the Sirumalai Hills in Tamil Nadu in the south. The hills extend roughly parallel to India's east coast stretching over 1,600km, and are spread over an area in excess of 75,000km² (Mahapatra et al. 2013; Pragasan 2014). The Eastern Ghats are characterized by their division into a number of distinct hill regions

by several large rivers such as the Godavari (1,465km), Krishna (1,400km) and Cauvery (800km) flowing east into the Bay of Bengal (Mani 2012). The Eastern Ghats landscape is a treasure trove of biodiversity where several species endemic to the landscape such as the Golden Gecko *Calodactyloides aureus* (Daniel et al. 1986; Javed et al. 2007), the Jeypore Ground Gecko *Geckoella jeyporensis* (Agarwal et al. 2012), the Slender Loris (Singh et al. 2000) and the Critically Endangered Jerdon's Courser *Rhinoptilus bitorquatus* (Jeganathan et al. 2002) have been reported. The northern section of the Eastern Ghats in particular contains extensive stretches of moist deciduous and semi-evergreen forests harboring high biodiversity and several rare species (Javed et al. 2007; Seetharamaraju et al. 2009; Sreekar & Srinivasulu 2010); however, there is no published baseline information on the mammal diversity of the northern Eastern Ghats, and there are currently no updated lists of mammals for the landscape.

Mammal populations in tropical forests of South Asia are amidst a global extinction crisis with some of the most serious population declines (Corlett 2013). Enumerating the mammal diversity of the region would provide baseline information on mammals for the landscape that would help in future monitoring of the population and

DOI: <http://doi.org/10.11609/jott.3021.9.10.10823-10830> | **ZooBank:** urn:lsid:zoobank.org:pub:03365529-1623-442E-B7AA-C2ED6F9046B2

Editor: H.N. Kumara, Salim Ali Centre for Ornithology and Natural History, Anaikatty, India.

Date of publication: 26 October 2017 (online & print)

Manuscript details: Ms # 3021 | Received 09 January 2017 | Final received 24 August 2017 | Finally accepted 04 October 2017

Citation: Aditya, V. & T. Ganesh (2017). Mammals of Papikonda Hills, northern Eastern Ghats, India. *Journal of Threatened Taxa* 9(10): 10823–10830; <http://doi.org/10.11609/jott.3021.9.10.10823-10830>

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Funding: Conservation Leadership Programme (CLP).

Competing interests: The authors declare no competing interests.

Acknowledgements: We would like to thank the Conservation Leadership Programme (CLP) for providing financial support for this project, Idea Wild for equipment support, and the Andhra Pradesh Forest Department for providing field permits. We are grateful to Babu Rao, Prasad, Rama Krishna and Kunda Rajulu for their field support.



management of the larger landscape. The conservation measures are critical, as rapid land cover changes across the northern Eastern Ghats are occurring in recent decades through deforestation and infrastructure development resulting in forest conversion. This has a massive impact on habitats, vegetation and plant community structure, associated species, competitors and their prey-predator relationships. Our objective therefore is to build an updated enumeration of the mammalian fauna of Papikonda National Park (PNP), the only national park in the northern Eastern Ghats.

Papikonda National Park has historically experienced varying levels of protection, beginning as a reserved forest in 1882, a wildlife sanctuary in 1978, and as a national park from 2008. The long history of protection and management has afforded PNP with better protection than most of the Eastern Ghats. Consequently, PNP holds some of the last contiguous forests in the landscape and supports a good population of many mammals. We provide the first comprehensive and updated checklist of mammals for the PNP.

MATERIALS AND METHODS

Study area

Papikonda National Park (Fig. 1) is spread over 1,012km² in the East and West Godavari districts of the northern Eastern Ghats of the present Andhra Pradesh state, and is located between 18.491944–19.181389 N & 79.541111–83.233333 E. The Godavari River bisects PNP into northern and southern halves with an elevation gradient from 20–850 m at Bison Hill. The river acts as an important biogeographic divider. PNP consists predominantly of southern tropical mixed moist deciduous, along with some semi-evergreen and dry deciduous forest patches (Champion & Seth 1968; Rao 2000; Reddy et al. 2010).

Methods

The study was conducted in PNP and its adjoining forests in a five-kilometre buffer from October 2014 to March 2015. The 2014 satellite image (LANDSAT 8 ETM) of the PNP and the northern Eastern Ghats was downloaded from the United States Geological Survey (<https://glovis.usgs.gov/>). The image was classified into habitat types (moist deciduous forest, dry deciduous forest and scrub forest/grassland) through a supervised classification using GIS software (Fig. 2). This classified habitat map was overlaid with 2km² grids, and sampling grids were selected randomly within each forest type for intensive surveys using a stratified sampling framework, to assess the mammal richness across different habitats

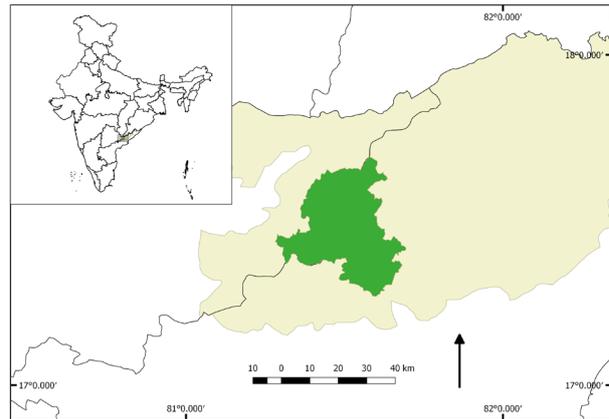


Figure 1. Location of Papikonda National Park in the northern Eastern Ghats of Andhra Pradesh State, India

in Papikonda. Field surveys involved camera traps and sign surveys (Karanth & Nichols 1998; Buckland et al. 2001; Yoccoz et al. 2001; O'Brien 2008; Tobler et al. 2008; Ahumada et al. 2011). Five camera traps each were placed in a total of 58 grids, covering different microhabitats in each grid. Cameras were fixed between 50 to 100 cm, with a minimum separation of 300m for three nights (72 hours). We also conducted sign surveys for secondary evidence of mammals through pugmarks, hoofprints, scat, pellets, scrape and rake in these grids. Camera trap images of mammals and direct sightings were identified following Menon (2003).

We conducted 138 interviews with local community members (belonging to the Konda Reddi and Koya tribes) in 33 villages located in and around the park, as well as 10 interviews with local forest department officials and forest guides. The interview questions were focused on species of mammals encountered around villages, changes in frequency of sightings of animals over the past three decades, hunting and livestock depredation. Common local Telugu names for all mammal species were compiled from discussions during community interviews, following existing literature and field guides.

We carried out a literature review to collect information on mammals of PNP from available literature that included management plans for PNP and the working plans of four territorial divisions covering the buffer forests of the national park, and existing research publications accessed through online sources, and species ranges and their population status on the IUCN Red List of Threatened Species. Habitats in the study area for species enumerated through the literature review were not categorised.

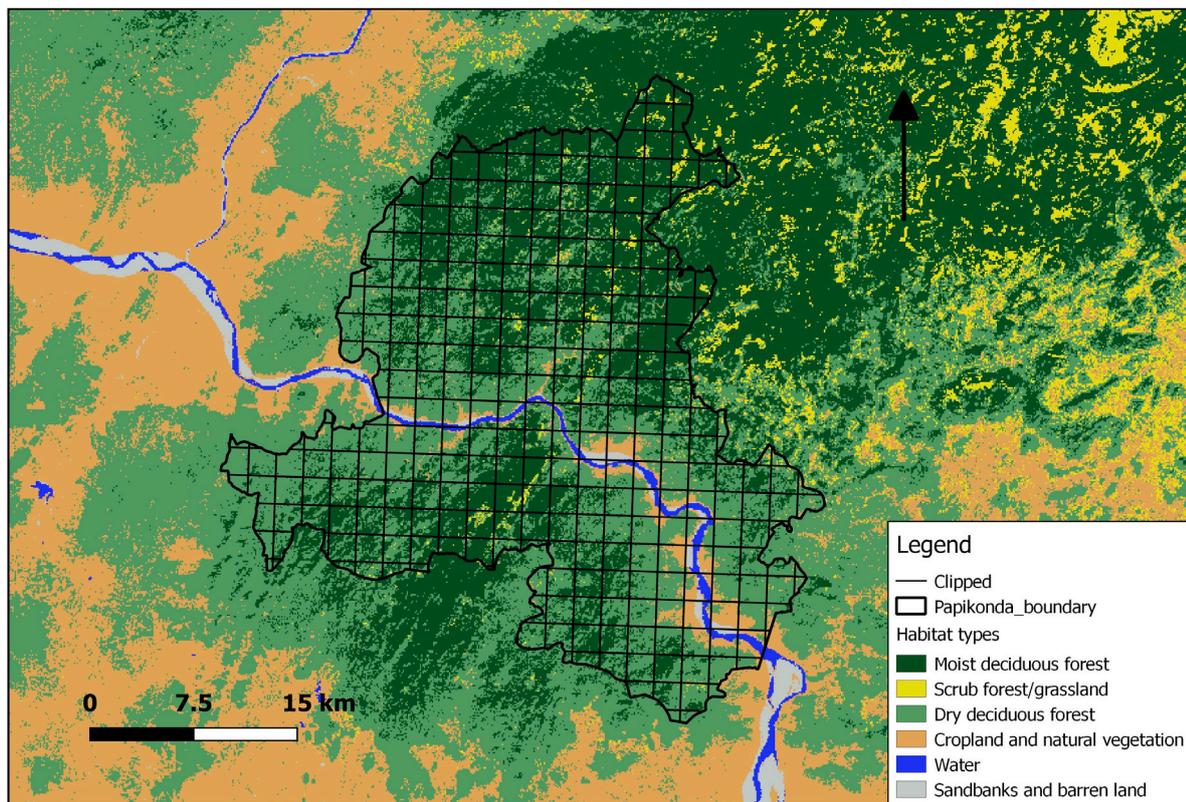


Figure 2. Habitat classification and survey grids across Papikonda National Park

RESULTS

A total of 118km² of forests in PNP was surveyed through 271 camera trap locations resulting in a survey effort of 19,512 trap hours. We recorded 23 species of mammals from 21 genera which were captured in 400 camera trap captures and through sign surveys (Images 1–21). The literature review and community interviews added 33 more species. Altogether, we enumerated a total of 55 species of mammals from 46 genera belonging to 24 families and nine orders in PNP (Table 1). Order Carnivora had the highest richness with 14 species, followed by Chiroptera with 13 species and presumably 11 species of Rodentia were recorded from literature surveys and sighting. Family Muridae had the highest mammal richness with eight species.

DISCUSSION

Few earlier studies have been conducted on the mammal diversity occurring in the northern Eastern Ghats). Mammal diversity in PNP includes the Tiger *Panthera tigris* and the first records of Leopard Cat *Prionailurus bengalensis*, the Rusty-spotted Cat *Prionailurus rubiginosus* and the Stripe-necked Mongoose that were reported recently (Aditya & Ganesh 2016; Balaji & Satyanarayana 2016). The

northern Eastern Ghats supports good populations of forest mammals such as the Indian Muntjac (Barking Deer) *Muntiacus muntjak*, Four-horned Antelope *Tetracerus quadricornis*, Gaur *Bos gaurus* and Sambar *Rusa unicolor*. The Asian Elephant *Elephas maximus* despite being widely distributed in other parts of Odisha and Jharkhand, missing from this section of the Eastern Ghats (Sukumar 1992). Although the exact factors responsible for the absence of elephants here are unknown, the steep and hilly terrain and high levels of human activity could be a factor (Ganesh et al. 2015). Further research into historic elephant distribution and population connectivity across eastern India could throw light on the absence of elephants from much of the Eastern Ghats.

Our study indicates that mammal species in the study area are found in well-forested patches, with dry-deciduous habitats in particular supporting the highest species richness particularly of primates and small carnivores (Aditya & Ganesh 2016). Rapid forest conversion has been occurring around PNP and this has particularly affected the dry deciduous forests spread across lower elevations below 200m, especially along the Godavari River. Several landscape studies have shown that non-volant, terrestrial mammals are

Table 1. Checklist of species recorded in, or with probable range, in Papikonda National Park

	Family	Scientific name	English name	Common Telugu (local) name	IUCN status	Habitat in PNP	Source
Order: Carnivora							
1	Felidae	<i>Panthera tigris</i> Linnaeus, 1758	Tiger	Pedda Puli	EN	MDF	CT, IN
2	Felidae	<i>Panthera pardus</i> Linnaeus, 1758	Leopard	Chiruta Puli	VU	MDF, DDF	SS, LR, IN (Menon 2003)
3	Felidae	<i>Prionailurus bengalensis</i> (Kerr, 1792)	Leopard Cat	Chiruta Gurtulu Gala Pilli	LC	MDF, DDF	CT, IN
4	Felidae	<i>Prionailurus rubiginosus</i> (l. Geoffroy Saint-Hilaire, 1831)	Rusty-spotted Cat	-	NT	MDF, DDF	CT
5	Felidae	<i>Felis chaus</i> Schreber, 1777	Jungle Cat	Jangu Pilli, Adavi Pilli	LC	DDF	CT, IN
6	Hyaenidae	<i>Hyaena hyaena</i> (Linnaeus, 1758)	Striped Hyaena	Dummulgondi	NT	Unknown	LR, IN (Menon 2003)
7	Canidae	<i>Cuon alpinus</i> (Pallas, 1811)	Asiatic Wild Dog	Rechukukka	EN	MDF, DDF	SS, LR, IN (Menon 2003)
8	Canidae	<i>Canis aureus</i> Linnaeus, 1758	Golden Jackal	Nakka	LC	DDF, Scrub	Sighting, IN
9	Canidae	<i>Vulpes bengalensis</i> (Shaw, 1800)	Indian Fox	Gunta Nakka	LC	Unknown	LR (Menon 2003)
10	Ursidae	<i>Melursus ursinus</i> (Shaw, 1791)	Sloth Bear	Elugubanti/ Goddelugu	VU	MDF, DDF	Sighting, CT, SS, IN
11	Viverridae	<i>Paradoxurus hermaphroditus</i> (Pallas, 1777)	Common Palm Civet	Chinna Punugu Pilli	LC	MDF, DDF	CT, IN
12	Viverridae	<i>Viverricula indica</i> (É. Geoffroy Saint-Hilaire, 1803)	Small Indian Civet	Punugu Pilli	LC	MDF, DDF	CT, IN
13	Herpestidae	<i>Herpestes edwardsii</i> (É. Geoffroy Saint-Hilaire, 1818)	Indian Grey Mongoose	Mungeesa	LC	MDF, DDF	CT, IN
14	Herpestidae	<i>Herpestes smithii</i> Gray, 1837	Ruddy Mongoose	Mungeesa	LC	MDF, DDF	CT, IN
15	Herpestidae	<i>Herpestes vitticollis</i> Bennett, 1835	Stripe-necked Mongoose	Mungeesa	LC	MDF	LR, SS (Menon 2003)
16	Mustelidae	<i>Mellivora capensis</i> (Schreber, 1776)	Honey Badger	Vedinchu	LC	DDF	LR, IN (Menon 2003)
Order: Artiodactyla							
17	Cervidae	<i>Axis axis</i> (Erxleben, 1777)	Spotted Deer	Chukkala Jinka	LC	MDF, DDF	CT, SS, IN
18	Cervidae	<i>Rusa unicolor</i> (Kerr, 1792)	Sambar	Duppi	VU	MDF	CT, SS, IN
19	Cervidae	<i>Muntiacus muntjak</i> (Zimmermann, 1780)	Indian Muntjac	Konda Gorre	LC	MDF, DDF	CT, SS, Sighting, IN
20	Tragulidae	<i>Moschiola indica</i> (Gray, 1852)	Indian Chevrotain	Eluka Jinka	LC	MDF	CT, IN
21	Bovidae	<i>Bos gaurus</i> C.H. Smith, 1827	Gaur	Adavi Dunna/ Gorre Geda/ Manubothu	VU	MDF	CT, SS, Sighting, IN
22	Bovidae	<i>Boselaphus tragocamelus</i> (Pallas, 1766)	Blue Bull	Nilgai/ Manubothu	LC	Unknown	LR (Menon 2003)
23	Bovidae	<i>Tetracerus quadricornis</i> (de Blainville, 1816)	Four-horned Antelope	Nalugu Kommula Jinka	VU	DDF, MDF	CT, SS, IN
24	Suidae	<i>Sus scrofa</i> Linnaeus, 1758	Indian Wild Pig	Adavi Pandi	LC	MDF, DDF	CT, SS, Sighting, IN
Order: Lagomorpha							
25	Leporidae	<i>Lepus nigricollis</i> F. Cuvier, 1823	Indian Hare	Kundelu	LC	DDF, MDF, Scrub	CT, SS, Sighting, IN
Order: Primates							
26	Cercopithecidae	<i>Macaca mulatta</i> (Zimmermann, 1780)	Rhesus Macaque	Kothi	LC	DDF, MDF, Scrub	CT, SS, Sighting, IN
27	Cercopithecidae	<i>Macaca radiata</i> (E. Geoffroy, 1812)	Bonnet Macaque	Kothi	LC	DDF	LR (Menon 2003)
28	Cercopithecidae	<i>Semnopithecus entellus</i> (Dufresne, 1797)	Northern Plains Gray Langur	Kondamucchu	LC	DDF, MDF	CT, Sighting, IN
Order: Pholidota							
29	Manidae	<i>Manis crassicaudata</i> É. Geoffroy, 1803	Indian Pangolin	Alugu	EN	MDF	SS, LR, IN
Order: Insectivora							
30	Soricidae	<i>Suncus murinus</i> Linnaeus, 1766	House Shrew	Gayyaali	LC	DDF, Scrub	LR (Menon 2003)

	Family	Scientific name	English name	Common Telugu (local) name	IUCN status	Habitat in PNP	Source
Order: Scandentia							
31	Tupaiaidae	<i>Anathana ellioti</i> (Waterhouse, 1850)	Madras Tree Shrew	Chettu Gayyaali	LC	DDF, MDF, Scrub	Sighting, CT, LR (Menon 2003)
Order: Chiroptera							
32	Pteropodidae	<i>Rousettus leschenaultii</i> (Desmarest, 1820)	Fulvous Fruit Bat	Pandla Gabbilamu	LC	Unknown	LR (Menon 2003)
33	Pteropodidae	<i>Pteropus giganteus</i> (Brünnich, 1782)	Indian Flying Fox	Pandla Gabbilamu	LC	DDF, MDF, Scrub	LR, Sighting, IN (Menon 2003)
34	Pteropodidae	<i>Cynopterus sphinx</i> (Vahl, 1797)	Greater Short-nosed Fruit Bat	Pandla Gabbilamu	LC	Unknown	LR (Menon 2003)
35	Rhinopomatidae	<i>Rhinopoma hardwickii</i> Gray, 1831	Lesser Mouse-tailed Bat	Gabbilamu	LC	Unknown	LR (Menon 2003)
36	Emballonuridae	<i>Taphozous longimanus</i> Hardwicke, 1825	Long-winged Tomb Bat	Gabbilamu	LC	Unknown	LR (Menon 2003)
37	Megadermatidae	<i>Megaderma lyra</i> É. Geoffroy, 1810	Greater False Vampire	Gabbilamu	LC	Unknown	LR (Menon 2003)
38	Rhinolophidae	<i>Rhinolophus rouxii</i> Temminck, 1835	Rufous Horseshoe Bat	Gabbilamu	LC	Unknown	LR (Menon 2003)
39	Rhinolophidae	<i>Hipposideros speoris</i> (Schneider, 1800)	Schneider's Leaf-nosed Bat	Gabbilamu	LC	Unknown	LR (Menon 2003)
40	Rhinolophidae	<i>Hipposideros fulvus</i> Gray, 1838	Fulvus Leaf-nosed Bat	Gabbilamu	LC	Unknown	LR (Menon 2003)
41	Vespertilionidae	<i>Pipistrellus ceylanicus</i> (Kelaart, 1852)	Kelaart's Pipistrelle	Gabbilamu	LC	Unknown	LR (Menon 2003)
42	Vespertilionidae	<i>Pipistrellus tenuis</i> (Temminck, 1840)	Least Pipistrelle	Gabbilamu	LC	Unknown	LR (Menon 2003)
43	Vespertilionidae	<i>Scotozous dormeri</i> Dobson, 1875	Dormer's Bat	Gabbilamu	LC	Unknown	LR (Menon 2003)
44	Vespertilionidae	<i>Hesperoptenus tickelli</i> (Blyth, 1851)	Tickell's Bat	Gabbilamu	LC	Unknown	LR (Menon 2003)
Order: Rodentia							
45	Squiridae	<i>Funambulus palmarum</i> (Linnaeus, 1766)	Three-striped Palm Squirrel	Udata	LC	Scrub, DDF	LR (Menon 2003)
46	Squiridae	<i>Ratufa indica</i> (Erxleben, 1777)	Giant Squirrel	Raachiluka	LC	MDF	Sighting, IN
47	Muridae	<i>Tatera indica</i> (Hardwicke, 1807)	Indian Gerbil	-	LC	Unknown	LR (Menon 2003)
48	Muridae	<i>Golunda ellioti</i> Gray, 1837	Indian Bush Rat	Podala Eluka	LC	Unknown	LR (Menon 2003)
49	Muridae	<i>Millardia meltada</i> (Gray, 1837)	Soft Furred Field Rat	Chinna Eluka	LC	Unknown	LR (Menon 2003)
50	Muridae	<i>Rattus rattus</i> (Linnaeus, 1758)	House Rat	Eluka	LC	Scrub	LR (Menon 2003)
51	Muridae	<i>Mus musculus</i> Linnaeus, 1758	House Mouse	Eluka	LC	Scrub	LR (Menon 2003)
52	Muridae	<i>Mus booduga</i> (Gray, 1837)	Little Indian Field Mouse	Eluka	LC	Scrub, DDF	LR (Menon 2003)
53	Muridae	<i>Bandicota bengalensis</i> (Gray, 1835)	Lesser Bandicoot Rat	Chinna Pandikokku	LC	Scrub, DDF	LR (Menon 2003)
54	Muridae	<i>Bandicota indica</i> (Bechstein, 1800)	Greater Bandicoot Rat	Pedda Pandikokku	LC	Scrub, DDF	LR, Sighting (Menon 2003)
55	Hystricidae	<i>Hystrix indica</i> Kerr, 1792	Indian Crested Porcupine	Mulla Pandi	LC	DDF, MDF	CT, IN, Sighting

IUCN Categories: LC - Least Concern, NT - Near Threatened, VU - Vulnerable, EN - Endangered
Method of observation: CT - camera trap, IN - interviews, SS - sign survey, LR - literature review
Habitat in PNP: DDF - Dry deciduous forest; MDF - Moist deciduous forest

highly vulnerable to the effects of forest conversion (Wilcox 1980; Soule & Wilcox 1980; Malcolm 1988; Turner 1996) and therefore the rapid forest conversion occurring in the northern Eastern Ghats is a major threat to mammal populations in the region. Our community interactions revealed that the primary drivers of this forest conversion were podu cultivation (a form of long

fallows shifting cultivation practiced throughout the northern Eastern Ghats), logging for domestic use, over-extraction of forest produce, increasing penetration of roads, bamboo cutting and monoculture plantations of timber yielding species. Traditional forms of hunting using bows and arrows, traps and snares practiced by local forest dependent communities such as the Konda

Reddis and Koyas, which despite occurring at low intensities, has combined with decreasing forest cover to severely affect the populations of several mammal species in PNP (Ganesh et al. 2015). Likewise, most roads around Papikonda pass through the low elevation dry deciduous forests, and facilitate easier access to forests for hunting and tree felling, resulting in these forests becoming more fragmented and thereby further affecting mammal populations.

The pressure on these low elevation forests around PNP has been exacerbated manifold through the ongoing construction of the Polavaram Project (officially Indira Sagar Multi Purpose Project) across the Godavari in the southeastern portion of the NP, immediately abutting its boundary. When completed, the project will submerge an estimated 3,267ha of dry deciduous forest in PNP and its forested buffers (Gujja et al. 2006; Mohan 2006). This is expected to further reduce habitat availability and severely affect forest connectivity for mammal movement. Large mammals such as Gaur, Sambar, Four Horned Antelope, Barking Deer and Tiger which mostly occur in moist deciduous forests at higher elevations are also at threat from shifting cultivation and plantations, which cause loss of moist deciduous forests. Mitigating the impacts of shifting cultivation, dams and other development projects in and around PNP, particularly in the easily accessible low elevation dry deciduous forests, would help in conserving mammal populations in PNP. As the forests of the northern Eastern Ghats directly connect to the central Indian forest landscape along the Bastar Plateau of southern Chhattisgarh and the forested regions of the lower Godavari River valley, monitoring wildlife movement between these two landscapes would help in identifying critical wildlife corridors and movement patterns.

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Images 1–12 Camera trap pictures: 1 - Barking Deer; 2 - Chital; 3 - Four-horned Antelope; 4 - Gaur; 5 - Grey Mongoose; 6 - Hare; 7 - Jungle Cat; 8 - Leopard Cat; 9 - Mouse Deer; 10 - Palm Civet; 11 - Porcupine; 12 - Wild Boar



Images 13–19 Camera trap pictures: 13 - Ruddy Mongoose; 14 - Rusty-spotted Cat; 15 - Sambar; 16 - Small Indian Civet; 17 - Tiger; 18 - Rhesus Macaque; 19 - Northern Plains Grey Langur

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ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

October 2017 | Vol. 9 | No. 10 | Pages: 10741–10864

Date of Publication: 26 October 2017 (Online & Print)

DOI: 10.11609/jott.2017.9.10.10741-10864

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