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First record of Wroughton's Small Spiny Mouse *Mus phillipsi* Wroughton, 1912 (Rodentia: Muridae) from Odisha, India with notes on diversity and distribution of other rodents

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Abstract: We report the occurrence of Wroughton's Small Spiny Mouse *Mus phillipsi* Wroughton, 1912 based on a specimen collected from Gajapati District, Odisha. With this species, the diversity of order Rodentia in Odisha increases to 17 species under three families and 12 genera. An updated checklist of the rodents with distribution localities and threats to various species in Odisha is also presented.

Keywords: Eastern Ghats, Mahendragiri, natural history, new locality, threats.

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Author contribution: PPM, VS and SKD carried out fieldwork; SST identified the specimen; PPM & SST wrote the manuscript; SKD & VS helped in review and editing.

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INTRODUCTION

The order Rodentia is represented by 2,335 species worldwide, comprising nearly 41% of total mammalian species (Wilson & Reeder 2011), of which Pradhan & Talmale (2011) recorded 103 species and later Sharma et al. (2015) mentioned 101 species from India. This order is represented by three suborders in Odisha, namely Sciuromorpha, Myomorpha, and Hystricomorpha (Mohapatra et al. 2019, Debata & Palai 2020). Ball (1877), Thomas (1915), Wroughton (1915, 1919a,b, 1920), Robinson & Kloss (1918), Hinton & Lindsay (1926), Ellerman (1961), Behura & Guru (1969), Das & Agrawal (1973), Agrawal & Chakraborty (1979), Das et al. (1993), and Mishra et al. (1996) mentioned about rodents of Odisha. Das et al. (1993) listed 14 species under 10 genera based on collections housed in the Zoological Survey of India at Kolkata. Although Mishra et al. (1996) listed 14 species, they excluded *M. blanfordi* but included *R. norvegicus*. Later compilations on mammals of Odisha by Mohapatra et al. (2019) recorded 17 species in order Rodentia including the present species, citing this reference and that of by Debata & Palei (2020) reported 15 species. Rodent diversity from protected areas of the state is known from the works of Chadha & Kar (1999) from Bhitarkanika (six species), Tiwari et al. (1997, 2002) from Chandaka-Dampara Wildlife Sanctuary (nine species) and Ramakrishna et al. (2006) from Similipal Tiger Reserve (11 species). Apart from these works, other studies on the nesting behaviour of the Indian Giant Squirrel *Ratufa indica* (Erxleben, 1777) in Similipal, Karlapat, Kapilas, and Kuldiha wildlife sanctuaries are also available (Rout & Swain 2006; Pradhan et al. 2012, 2017; Nayak & Patra 2015; Palei et al. 2015, 2017).

Through this contribution, we report for the first time the occurrence of *Mus phillipsi* Wroughton, 1912 from Odisha based on a specimen collected from Mahendragiri Hill in Gajapati District. An updated checklist including distribution of the rodent species from Odisha is also provided based on published literature and the observation in the present study.

METHODS

Study area

Odisha, situated along the eastern coast of India, is an amalgamation of varied physiography. With a geographical area of 155,707km^2 and a coastline of nearly 480km, the state is bestowed with high to medium peak mountain ranges, plateaus and plains. As per the classification by Rodgers et al. (2002), most parts of Odisha is covered by Deccan Peninsula (6B and 6C biogeographic provinces), a small portion towards the extreme north-east represents the southern boundary of lower Gangetic plain (7B) and the eastern coast (8B). The river Mahanadi broadly dissects the state into northern and southern parts, the northern Odisha having isolated mountains and mid-elevation hillocks in the Chotanagpur Plateau, and towards the south are the chains of broken mountain ranges named as the Eastern Ghats. Some of the important and high peak mountain ranges of the Eastern Ghats ranges in Odisha are Deomali Parbat (1,673m), Sambari Konda near Gudem Village (1,670m), Turiakonda (1,598m), Singaraju Parbat (1,516m), Mahendragiri (1,501m), Hatimali (1,391m), Devagiri (1,382m), Dharakonda (1,365m), and Chandragiri (1,269m). Broadly four forest types—semi-evergreen forests, tropical moist deciduous forests, tropical dry deciduous forests, and littoral and tidal swamp forests—are seen in Odisha (Champion & Seth 1968, Panigrahi 1983). Forests are predominantly of the mixed deciduous type with pockets of semi-evergreen, scrub forest, and shola patches offering refuge for some unique biodiversity. The moist deciduous Sal forest dominates the northern part and mixed forests are seen in the southern and western parts. A well-protected mangrove patch (Bhitarkanika Wildlife Sanctuary) is present on the northeastern side, with sporadic patches of mangroves and mangrove-associates in the deltaic regions. The coastline is almost entirely planted with *Casuarina equisetifolia* to supposedly protect from the frequently occurring cyclonic storms. There are 19 wildlife sanctuaries (WS), one national park (NP), two tiger reserves (TR), and one biosphere reserve (BR) in Odisha. Varied geography and topography of Odisha offer potential habitat for many species of flora and fauna including rodents.

The Mahendragiri Hill range encompassing around 5,000km^2 is flanked between Vamsadhara River to the west and Bay of Bengal to the east in the Gajapati District of Odisha and Srikakulam District of Andhra Pradesh (Mahalik 2010). The forest types are tropical moist and dry deciduous with patches of shola forest at the pick (Champion & Seth 1968; Dash et al. 2015). The floral diversity is well studied in this landscape (679 species comprising three species of gymnosperms and 676 species of angiosperms, under 453 genera and 115 families), among the faunal groups more than 30 species of mammals, 200 species of birds, and 69 herpetofauna species have been documented from the area (Mohapatra et al. 2010; Dash et al. 2015).

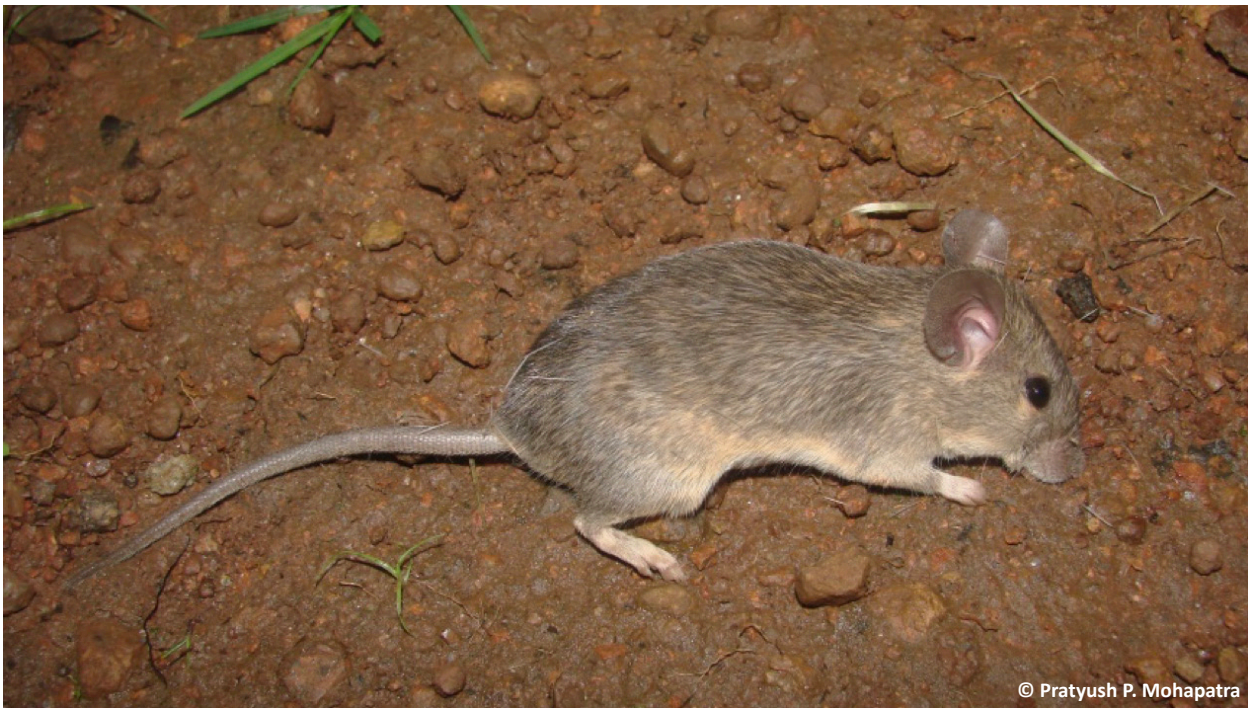

Image 1. Wroughton's Small Spiny Mouse *Mus phillipsi* Wroughton, 1912 from Mahendragiri forest, Odisha, India.

Survey and identification

During biodiversity surveys in various localities of Odisha (conducted between 2010 and 2015) information on the status and distribution of rodents was collected by the authors. For the collection of rodents, stainless steel live catch rat traps with dry-fish or bread-peanut butter bait were deployed outside protected areas and in private lands. Rodents observed in fields were photographed using a DSLR camera (Nikon-D-5100). During the survey, two of us (PPM & VS) collected a female specimen of *Mus* sp. from Mahendragiri Forest of Gajapati District in Odisha on 20 July 2013 using the rodent trap. The animal was euthanized, and the specimen was fixed by injecting 4% formaldehyde solution into the body cavities and muscles and then preserved in the 70% alcohol for further study. It was deposited in the Zoological Survey of India, Central Zone Regional Centre, Jabalpur, Madhya Pradesh. Measurements were taken using Mitutoyo absolute digimatic digital caliper and characters were observed under Leica MZ 125 stereo zoom binocular microscope. Species identification was carried out by following the key provided by Marshall (1977) and Agrawal (2000). The literature on rodent species reported from Odisha was reviewed to present an updated checklist based on records and present observations.

RESULTS AND DISCUSSION

The present study reports occurrence of Wroughton's Small Spiny Mouse *M. phillipsi* in Odisha, which extends its distribution further eastwards. With the addition of this species, the rodent diversity of Odisha now comprises 17 species under 12 genera and three families. Data on past distribution records and observation by authors are summarized in Table 1.

***Mus phillipsi* Wroughton, 1912 Wroughton's Small Spiny Mouse**

Specimen (Image 1)**:** ZSI-CZRC-V-6289, 20.vii.2013, one female, Mahendragiri Reserve Forest, in the Ashram premises (18.964^{0}N, 84.369^{0}E, 1,343m), coll. Pratyush P. Mohapatra & Vivek Sarkar.

Measurements: External—Head and body length: 77mm; tail: 72mm; hind foot: 16.3mm; ear: 8.6+ (cut); Cranial—Occipitonasal length: 24.1mm; condylobasal length: 23.9mm; nasal length: 8.6mm; length of palate: 13.1mm; maxillary tooth row: 3.7mm; tympanic bulla: 5mm; anterior palatal foramina: 5mm; length of diastema: 7.2mm; zygomatic width: 11.1mm; interorbital width: 3.8mm; cranial width: 10.2mm.

Description : A small spiny furred field mouse having the head and body length (HBL) in the range of 62.0–80.0 mm; tail bicoloured, dark above and pale below;

Table 1. Distribution and conservation status of rodent fauna of Odisha, India.

	Common & Scientific name	WL(P)A, 1972	IUCN	Distribution in Odisha	Important citations
Family: Sciuridae					
1	Five-striped Palm Squirrel *Funambulus pennantii* Wroughton, 1905	Schedule IV	LC	Throughout Odisha; distributed in forests, rural and urban areas	Das et al. 1993; Mishra et al. 1996; Mohapatra et al. 2019; Debata & Palei 2020
2	Three-striped Palm Squirrel *Funambulus palmarum* Linnaeus, 1766	Not listed	LC	Widely distributed in southern Odisha Distribution in PAs: Chandaka, Baisipalli, Satkosia, Lakhari Valley, Kotagarh, and Karlapat WS. Specific records are from Puri (Balugaon & Chilika), Ganjam (Tarasingi forest of Berhampur division, Chatrapur, Khallikote, Aska, Digapahandi, Sorada); Kalahandi (Madanpur-Rampur of Kalahani (N) division), Rayagada (Kashipur), Phulbani & Kandhamal (Daringbadi, Simonbadi, Phulbani, Kalingaghati, Baliguda and Raikia), Nayagarh (Daspalla, Banigocha, Nayagarh town, Charichaka), Khurdha (Barbara, Balugaon and Bhubaneswar) and Gajapati (Parelakhemundi, Gandahati, Mohana and Chandragiri) districts	Das et al. 1993; Mishra et al. 1996; Panda et al. 2012; Mohapatra et al. 2019; Debata & Palei 2020
3	Indian Giant Squirrel *Ratufa indica* Erxleben, 1777	Schedule II	LC	All the Protected areas except coastal PAs. Best seen at Similipal, Kuldiha, Kapilas, Satkosia, Debrigarh and Karlapat WS; also recorded from Balasore, Khurdha (Barbara and Dhuannali RF), Ganjam (Taptapani and Tarasingi forests of Berhampur division), Sundargarh (Bonai), Mayurbhanj (Rairangpur, Karanjia), Sambalpur, Nayagarh, Phulbani (Baliguda, Ghumsar North & South divisions), Rayagara (Niyamgiri, Muniguda), Koraput, Malkanagiri, and Kalahandi (North & South divisions) districts	Behura & Guru 1969; Das et al. 1993; Mishra et al. 1996; Mohapatra et al. 2019; Debata & Palei 2020
4	Giant Indian Gliding Squirrel *Petaurista philippensis* Elliot, 1839	Schedule II	LC	Mostly distributed in protected areas and primary forests. Specific records are from Similipal, Satkosia, Badrama, Karlapat, Lakhari Valley and Baisipali WS; also recorded from Sundargarh (Bonai division), Dhenkanal, Khariar, Mayurbhanj (Baripada,Thakurmunda and Karanjia divisions), Sambalpur (Rairakhol), Kalahandi (North & South divisions), Khurdha (Barbara RF) and Rayagada (Niyamgiri) districts	Ball 1877; Behura & Guru 1969; Das et al. 1993; Mishra et al. 1996; Mohapatra et al. 2019; Debata & Palei 2020
Family: Muridae					
5	Lesser Bandicoot *Bandicota bengalensis* Gray, 1835	Schedule V	LC	Throughout Odisha	Behura & Guru 1969; Das et al. 1993; Mishra et al. 1996; Mohapatra et al. 2019; Debata & Palei 2020
6	Large Bandicoot *Bandicota indica* (Bechstein, 1800)	Schedule V	LC	Throughout Odisha	Behura & Guru 1969; Das et al. 1993; Mishra et al. 1996; Mohapatra et al. 2019; Debata & Palei 2020
7	Blanford's Rat *Madromys blanfordi* (Thomas, 1881)	Schedule V	LC	Chandaka-Dampara Wildlife sanctuary, Satkosia, Baisipalli, Debrigarh WS; also recorded from Keonjhar, Mayurbhanj, Sundargarh (Khandadhar, Bonai division) and Dhenkanal (Kamakhya Nagar) districts	Tiwari et al. 1997, 2002; Agrawal 2000; Mohapatra et al. 2019; Debata & Palei 2020
8	Indian Bush Rat *Golunda ellioti* Gray, 1837	Schedule V	LC	Chandaka-Dampara Wildlife sanctuary; also recorded from Puri District; although recorded from a few areas, it might be occurring in a large distributional range in Odisha	Tiwari et al. 2002; Das et al. 1993; Agrawal 2000; Mohapatra et al. 2019; Debata & Palei 2020
9	Little Indian Field Mouse *Mus booduga* (Gray, 1837)	Schedule V	LC	Throughout Odisha	Behura & Guru 1969; Das et al. 1993; Mishra et al. 1996; Mohapatra et al. 2019; Debata & Palei 2020
10	House Mouse *Mus musculus* Linnaeus, 1758	Schedule V	LC	Throughout Odisha	Das et al. 1993; Mishra et al. 1996; Mohapatra et al. 2019; Debata & Palei 2020
11	Wroughton's Small Spiny Mouse *Mus phillipsi* Wroughton, 1912	Schedule V	LC	Gajapati (Mahendragiri hill) District	Present study

	Common & Scientific name	WL(P)A, 1972	IUCN	Distribution in Odisha	Important citations
12	Indian Gerbil *Tatera indica* (Hardwicke, 1807)	Schedule V	LC	Throughout Odisha; found near agricultural fields and scrub forests Specific records are from Chandaka-Dampara, Nandankanan, Satkosia, Baisipalli, Kapilas and Lakharivalley WS	Das et al. 1993; Mishra et al. 1996; Mohapatra et al. 2019; Debata & Palei 2020
13	Brown Rat *Rattus norvegicus* (Berkenhout, 1769)	Schedule V	LC	Throughout Odisha	Mishra et al. 1996; Mohapatra et al. 2019; Debata & Palei 2020
14	House Rat *Rattus rattus* (Linnaeus, 1758)	Schedule V	LC	Throughout Odisha	Das et al. 1993; Mishra et al. 1996; Mohapatra et al. 2019; Debata & Palei 2020
15	Indian Long-tailed Tree Mouse *Vandeleuria oleracea* (Bennett, 1832)	Schedule V	LC	Throughout Odisha in forested tracts	Mishra et al. 1996; Mohapatra et al. 2019; Debata & Palei 2020
16	Cutch Rat *Cremnomys cutchicus* Wroughton, 1912	Schedule V	LC	Khandadhar, Bonai forest division	Ellerman 1961; Alfred & Chakraborty 2002; Srinivasulu & Pradhan 2003; Mohapatra et al. 2019; present study
Family: Hystricidae					
17	Indian Crested Porcupine *Hystrix indica* Kerr, 1792	Schedule IV	LC	Throughout Odisha in suitable habitats, including mangrove forests	Das et al. 1993; Mishra et al. 1996; Chadha & Kar 1999; Mohapatra et al. 2019; Debata & Palei 2020

Abbreviations: WL(P)A, 1972—Indian Wild Life (Protection) Act, 1972 | IUCN—International Union for Conservation of Nature | LC—Lease Concern as per IUCN | PA—Protected Area.

tail shorter than HBL, about 80%; hind feet between 14.0–18.0 mm and are white; dorsal colour brown to buff and white below; mammae five pairs; occipitonasal length with an average of 22.2mm; skull with well-developed supraorbital ridges; anterior palatal foramina extending posteriorly between maxillary tooth row; upper incisors opisthodont; maxillary tooth row less than 4mm, averaging 3.7mm in length; first upper molar without an anterior accessory cusp; anterointernal cusp (t1) distorted inwards and in line with second; m^1 with eight cusps, m^2 with six cusps and m^3 very small (Agrawal 2000). Based on the morphological characters as well as cranial details, we identified the present specimen (ZSI-CZRC-V/6289) from Mahendragiri Hills as *Mus phillipsi.*

Distribution

This species is reported for the first time from Odisha from Mahendragiri Hill in Gajapati District under Parelakhemundi forest division. As it is difficult to diagnose *Mus phillipsi* from congeners such as *Mus saxicola* and *M. platythrix* in the field (the latter two species are not yet recorded from Odisha), similar-looking individuals sighted by us in Deomali (Koraput division), Gupteswar (Jeypore division) and Barbara Reserve forest (Khordha division) in Odisha are not reported. The Wroughton's Small Spiny Mouse is endemic to India and has been earlier reported from Madhya Pradesh (type locality Asirgarh, Burhanpur district, 1500 ft., Karnataka, Andhra Pradesh, Gujarat, Maharashtra, Rajasthan, and Tamil Nadu (Agrawal 2000; Molur et al. 2005; Pradhan & Talmale 2012). It is rarely encountered in its distribution range. It is terrestrial, fossorial, and nocturnal in habit and generally found in rocky outcrops, hillocks, and in forests (Agrawal 2000; Pradhan 2005). At Mt. Abu in Aravalli Hills, it was reported to be common in regions with Indian Spurge Tree *Euphorbia neriifolia* (Prakash et al. 1995).

Status: It is assessed as Least Concern by IUCN Red List (Molur & Nameer 2016) and is listed as a vermin under Schedule V of Indian Wildlife (Protection) Act, 1972.

Distribution, threats and conservation of rodents in Odisha

In Odisha, two species of palm squirrels are known to occur, of which the Five-striped Palm Squirrel *Funambulus pennantii* is widely distributed and the Three-striped Palm Squirrel *F. palmarum* is mostly distributed across southern Odisha and has patchy distribution towards northern parts. Palm squirrels are occasionally poached for bushmeat by Kela and Munda tribal communities in Odisha. During 1990s, groups of nomadic communities (Kalbeliyas and Pardhi) from central India were poaching palm squirrels on large scale to make trophies out of

stuffed animals and the meat was consumed by them (SKD and PPM pers. obs. 1990).

Indian Giant Squirrel *Ratufa indica* is a canopy dwelling arboreal species, diurnal in habit and has been recorded from various protected and reserve forests of Odisha. Rout & Swain (2006) reported 24 species of plants from seven families being used as food and 14 species of trees used for nest building by the Indian Giant Squirrel in Similipal BR, which had an estimated population of 10,660 individuals in the tiger reserve. A similar study by Palei et al. (2015) reported and estimated population density of 25.6 ± 4.6 (SE) individuals per km^2 in Similipal TR and identified 23 plant species as the food resources of the species from 17 families. Palei et al. (2017) reported 53 species of fodder plants belonging to 27 families from Kapilas WS. From Kuldiha WS, Nayak & Patra (2015) reported 23 species of plants belonging to 15 families used as food and 15 species belonging to 14 families are used for nest building. In Karlapat WS, Pradhan et al. (2012, 2017) reported 37 tree species belonging to 21 family and 31 genera were used to build nest and 18 species of food plants with a maximum preference for *Xylia xylocarpa* and *Bauhinia vahlii* in the sanctuary. Threats to the species include habitat loss, illicit timber felling, forest fire, anthropogenic disturbances, poaching for bushmeat, and use of body parts in traditional medicine (magico-religious belief) by some tribal communities. This species was occasionally found in captivity in Odisha.

The Giant Indian Gliding Squirrel *Petaurista philippensis* is a nocturnal species found in dry and moist deciduous forests, orchards, and groves. Although it has a wider range in Odisha, it is an uncommon species. Because of its nocturnal and cryptic habit, this species remains unnoticed, even if it is very much present in the village outskirts. In Baisipalli WS, three babies were seen during May 2009 near Gochhabari village (20.465^{0}N, 84.818^{0}E, 131m) inside a tree hole of *Madhuca longifolia* (Mahua tree) at a height of nearly three meters from the ground. In 2004, one animal was found incarcerated by a person in Kamakhyanagar, Dhenkanal, which died after three months in captivity.

Among the Murid rodents, species such as Large Bandicoot *Bandicota indica*, Lesser Bandicoot *B. bengalensis*, little Indian Field Mouse *Mus booduga*, House Mouse *Mus musculus*, Long-tailed Tree Mouse *Vendeleuria oleracea*, Common House Rat *Rattus rattus*, Brown Rat *R. norvegicus*, and Indian Gerbil *Tatera indica* are widely distributed in the state (Das et al. 1993; Mishra et al. 1996). The Blanford's Rat *Madromys blanfordi* and Indian Bush Rat *Golunda ellioti* are known only from a few localities in Odisha. Among these rats and mice, the Brown Rat *Rattus norvegicus* and the House Mouse *Mus musculus* are non-native/introduced species (Nameer 2000). Additionally, the Cutch Rat *Cremnomys cutchicus* is added to the checklist based on distribution locality provided by Ellerman (1961), Alfred & Chakraborty (2002), and Srinivasulu & Pradhan (2003). Although this species was earlier mentioned to be distributed in Odisha, in the subsequent literature (Das et al. 1993; Mishra et al. 1996; Molur et al. 2005; Srinivasulu & Srinivasulu 2012) the authors remained silent regarding its distribution in Odisha. The Cutch Rat was sighted by two of us (VS and PPM) from Khandadhar area of Bonai Forest Division and this locality is considered as provisional distribution locality for the species till any specimen is obtained in future.

The Indian Crested Porcupine *Hystrix indica* is the sole representative of family Hystricidae in peninsular India including Odisha. This species is found throughout Odisha including mangrove forests and lives in colonies, making their warrens by digging tunnels. They feed on roots, tubers, and barks of trees and occasionally damage crops. During the study period, a case of largescale depredation of Coconut *Cocos nucifera* L. plantation by porcupine was observed in Dakhinapur Village (19.336^{0}N, 84.740^{0}E), 10km from Berhampur Town, in Ganjam District. Within 12 days (between 4 and 15 September 2014), a total of 123 out of 132 coconut trees of 3–4 years old were damaged by the porcupines. The extent of damage was visually estimated and by the end of 12th day 46 saplings (37%) were completely damaged due to debarking and bole feeding and the rest of the trees were partially damaged at the base (debarking). The average rate of damage was 9–11 trees per day. A random survey conducted in the nearby hillock revealed the presence of a healthy population of porcupines based on secondary evidence such as droppings and quills. Similar reports of damage to the coconut plantation by porcupines have been reported elsewhere in India, with most prevailing situations in southern India (Chakravarthy & Girish 2007; Govind & Jayson 2018). In Odisha, where crop depredation by porcupine is more causing large scale damage they are poached. Porcupines are poached for bush-meat, use of quills for religious rituals, and use of intestine and bezoar in traditional medicine. It is poached by using dogs, snares and by beating the animal with a stick when sighted. The Kondh tribe in southern Odisha use to smoke the dens by sealing the entrances from all sides except one and after fanning the smoke into the den the last entrance is closed for 6–8 hours. The animals die

due to suffocation and the carcasses are collected by the poachers for further use.

Out of 17 species of rodents recorded from Odisha, two species are listed under Schedule II, two under Schedule IV, 12 in Schedule V, and one species (*Funambulus palmarum*) is not listed under any schedule of Wildlife (Protection) Act, 1972. Although all the species are assessed as Least Concern as per the assessment of International Union for Conservation of Nature (IUCN), the Indian Giant Squirrel and Giant Indian Gliding Squirrel population are declining due to poaching and habitat destruction, despite being protected under Schedule II. Hence, strict enforcement of law and awareness education may prevent these species from local extinction.

Rodents play a major role in the food chain and some species are regarded as ecological indicators. Most of them are considered as major pests for agriculture while all species are poached either for bushmeat or for use of their body parts in traditional medicine. Hence it is imperative to update knowledge on their status and distribution, which will help in developing an action plan for the species for their conservation and management. As already stated, some species of the rodents are known only from few localities, there is a need for systematic surveys to understand their distribution range, ecology, and to document additional species that are not yet recorded from this landscape. Species such as *Mus saxicola*, *M. platythrix*, *M. terricolor*, and *Rattus tanezumi* which are known from the southern and northern peninsular India (Sharma et al. 2015) are yet to be recorded from Odisha.

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