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A survey on the mammal species from a peri-urban coal mining plateau of Eastern India

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Abstract

The present study was conducted to determine the diversity of mammalian species from a peri-urban coal mining region of West Bengal for almost three years from September 2017 to August 2020. The survey was done on the basis of direct sightings, extensive searches, detection and identification of indirect mammalian signs such as pug marks and droppings, opportunistic sightings and road-kill incidents. Secondary information from previous literature and information from local people, citizen scientists and Forest Department were also included in the study. A total of 20 mammals belonging to 9 orders, 15 families and 20 genera were observed from 31 locations during the present study and 6 species belonging to two orders, three families and four genera which were previously reported from the present study location but not observed during this study were also included in the list. Two endangered species, Asian Elephant *Elephas maximus* and Indian Pangolin *Manis crassicaudata*, were observed from the present study location within the study period. Based on the habitat types, the maximum number of species was observed from the Human Habitation (HH) areas whereas the least number of species was noted from the Riverside Zones (RS). Proportion of the different habitat types for each mammalian species found in the present study and also obtained from literature depicted that Asian House Shrew *Suncus murinus*, Asian Palm Squirrel *Funambulus pennantii* and Indian Pygmy Pipistrelle *Pipistrellus mimus* were among the most abundant mammals in the study area. Golden Jackal *Canis aureus* was observed from a wide variety of habitat types whereas the two varieties of civets were only observed from the riverside areas. Principle Component Analysis between species and habitat type indicated that the Bengal Fox *Vulpes bengalensis* and the Black-naped Hare *Lepus nigricollis* were only associated with the grasslands. The Hanuman Langur *Semnopithecus entellus* and other small rodent species were generally found in the human habitation areas. Various threats like habitat destruction, habitat degradation and hunting posed the major problems in the present study location.

Key words: Asansol, citizen science, Durgapur, Paschim Bardhaman, West Bengal

Introduction

Asansol-Durgapur division harbours a vast area of open cast coal mining projects in the upper catchment of the Damodar River basin of India with 25 million human dependents in that particular region (Choudhury et al., 2012). Mining in these areas dates back to British colonial era (1815) and since then a majority of the

landscape has been utilized for its natural resources. Several excavated locations are left abandoned after the completion of mining activities while a number of casts are still operated for mining purpose in the region (Ghosh and Mukherjee, 2018). Mining for the development of industries is considered as one of the backbones of modern civilizations but the concerns regarding the local human health and impact on the regional biodiversity due to these mining activities are not of minor concern (Mandal and Ray, 2015). Asansol-Durgapur division has gone through several changes over the decades in its land use patterns from forested areas to mining and reforestation and plantations. These changes have resulted in the vanishing of smaller forest patches and elevated complexity of existing larger fragmented forest areas (Dutta et al., 2020) simultaneously increasing agricultural lands and human residential areas and industrial regions (Choudhury et al., 2019) in the landscape. Evidence suggests these modifications have been known to degenerate biological diversity (Hingtgen and Clark, 1984; Larkin et al., 2008) and hamper genetic constituency of the local populations (Matzenbacher et al., 2019). Industrial pollutions, especially coal mining, are known to be inversely correlated to the shortening of telomere length and increased DNA damages, altering local population structure and hampering demography and sex-ratios (Matzenbacher et al., 2019). These threats and their impacts are assessed generally through the estimation of mammal species diversity in the landscape. Presence of diverse adaptive animals in the retrospect provides a rapid quantification on the wildlife health of the landscape (Agarwal et al., 1992). Apart from their adaptive capabilities, they are easy to locate, identify and contains a majority of the historical data in comparison to other taxa in the present landscape (Agarwal et al., 1992). However, in order to scientifically evaluate the impact of mining on the local faunal elements, it is necessary to have compact data on which species resides in the concerned region of the study (Chatterjee et al., 2020).

India has 427 extant mammal species in 199 genera which represents 52 families of 14 orders (Debata and Palei, 2020). There are 234 mammal species reported from the state of West Bengal (Mallick, 2019), however, consecutive account on the mammal composition and their distribution in the Asansol-Durgapur division is unconsolidated. We recorded few scattered records of past surveys conducted in the present study area. The oldest record of the reported mammal species from the region dates back to 1910, by Peterson mentioning the flora and fauna of Bardhaman district. Later, B. Nath (1948) passed down records of collected mammal species from the Chotanagpur Plateau, including the present study area. P.K. Das and his team (1988) collected various mammal specimens from the district of Bardhhaman which included parts of the present study area (Agarwal et al., 1992). It is almost 30 years since the last documented mammal diversity was reported from the region. So the current study was undertaken to acquire and document the mammal species residing in the region at present as well as their distribution and relation to the available habitat types in the landscape.

Material and Methods

Study Area

Paschim Bardhaman is an industrial mining district of West Bengal which was bifurcated from Purba Bardhhaman in 2017 (previously under Bardhaman District). Lying in the transitional zone between Chotanagpur Plateau and Gangetic Plains, it is home to various flora and fauna having species from both the eco-regions. Only a few studies on the fauna of this region were documented in the recent times (Adhurya et al., 2015; Nayak and Roy, 2016; Gayen et al., 2017; Adhurya and Bhandary, 2019; Nayak, 2020; Gayen et al., 2021; Roy and Mukherjee, 2021). Paschim Bardhhaman is separated from the district of Bankura on one side by the Damodar River and from the district of Birbhum on the other side by the Ajay River. The rocky undulated topography of this region is the extension of the Chotanagpur Plateau whereas the eastern part of the district slopes down to the Gangetic Plain region. This district covers an area of about 1600 km^2 and has two subdivisions, Asansol (covering an area of about 830 km^2) and Durgapur (covering an area of about 770 km^2). The average temperature of the study area ranges between 26.9 ^oC (January) and 37.4 ^oC (May) (Climate of West Bengal, 2008) whereas the mean annual rainfall of this area is about 1359 mm (Guhathakurta et al., 2020). The present study area exhibits a great variety of habitats starting from the grasslands to forested areas, river banks to urban habitations and agricultural fields to scrub forest and degraded coal mine areas. The study area was divided into six different habitat types: i. Forested Areas (FA), ii. Scattered Forests (SF), iii. Human Habitation (HH), iv. Grasslands and agricultural fields (GR), v. Riverside Areas (RA) and vi. Degraded Coalmine Areas (DC). Soils present here are mainly of three types: laterite soil with gravel, silty clay soil and sandy clay soil whereas the primary vegetation of the study area is represented by tropical dry deciduous plants dominated by *Shorea robusta*. The image of the study site and the details of the six different habitat types are provided in Figure 1 and Table 1 respectively.

Methodology

The present study was carried out from September 2017 to August 2020 in the two subdivisions of Paschim Bardhaman District, Asansol and Durgapur. Surveys were systematically performed twice a month in the morning (05.30 AM- 10.00 AM), noon (11.30 AM- 02.00 PM), afternoon (03.00 PM-04.00 PM)

and night (08.30 PM- 10 PM) during the study period. In the present study multiple methods were used to detect or infer the diversity of mammals in Paschim Bardhaman District. These include direct sightings, extensive searches, detection and identification of indirect mammal signs such as pug marks and droppings in the six aforementioned habitats (GR, FA, RS, HH, SF and DC), opportunistic sightings and the road-kill incidents were also regularly followed. Secondary information was collected by reviewing the online/offline literature and anecdotal reports for mammal studies conducted in the study area or at nearby areas. Reports on previous mammalian studies from Bardhaman and Asansol were searched in Google Scholar and archives of Records of Zoological Survey of India. The reports were downloaded and studied to get a clear picture of the diversity of the mammals from the present study location and nearby locations. Additional information from local people and forest staff and rescue records of the Forest department and wildlife related Non-Government Organisations (NGOs) were also compiled and included in the present study.

We also included the Citizen Science initiative to extend our secondary information source in the region, which is becoming a major tool for biodiversity monitoring. (Cohn, 2008; Theobald et al., 2015). Several web-based programmes like Indian Biodiversity Portal and iNaturalist were mined for information in the present study. A NGO, named Durgapur Wildlife Information and Nature Guide Society (WINGS) started a citizen science programme, "Biodiversity of Paschim Bardhhaman" in 2017 to document various flora and fauna of this district with the help of citizen scientists. Photographers and nature lovers post their observations of mammals with date and place in the website "Biodiversity of West Bengal" and Facebook group "Biodiversity of Paschim Bardhaman" which are verified by the relevant experts before approval for confirmation. These approved records were transferred and analyzed using MS Excel to prepare the database of the present study.

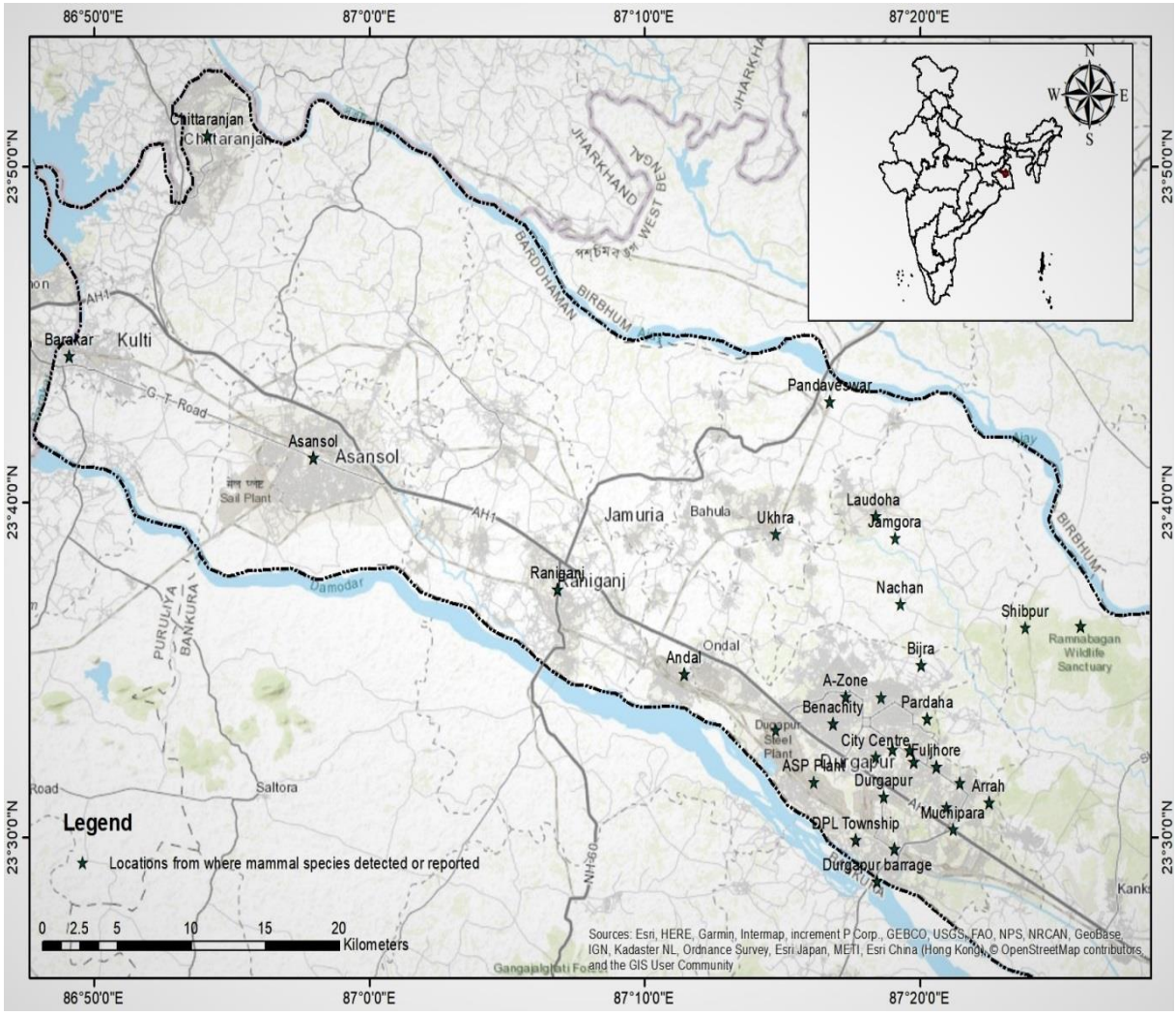

Figure 1: Image of the present study area with the locations from where mammal species are reported or observed.

Table 1: Showing the different areas under different habitat types and the important plant species in those areas.

Habitat types	Areas	Important plant species
Forested Areas (FA)	Arrah (23.52ºN, 87.38ºE) Garh Jugle (23.60ºN, 87.43ºE) Pardaha (23.56ºN, 87.34ºE) Pandaveswar (23.72ºN, 87.28ºE)	*Shorea robusta* (Sal), *Tectona grandis* (Segun), *Butea monosperma* (Palash), *Terminalia* spp.
Scattered Forests (SF)	MAMC Township (23.54ºN, 87.33ºE) Bijra (23.59ºN, 87.33ºE) Pardaha (23.56ºN, 87.34ºE) Laudoha (23.66ºN, 87.31ºE) Nachan (23.62ºN, 87.32ºE) Ukhra (23.65ºN, 87.25ºE) Shibpur (23.60ºN, 87.40ºE) Andal (23.58ºN, 87.19ºE) Raniganj (23.62ºN, 87.11ºE) Asansol (23.69ºN, 86.97ºE) Chittaranjan (23.85ºN, 86.90ºE)	*Acacia auriculaeformis* (Sonajhuri), *Eucalyptus* spp., *Shorea robusta* (Sal), *Tectona grandis* (Segun)
Human Habitations (HH)	MAMC Township (23.54ºN, 87.33ºE) Durgapur Government College Campus (23.54ºN, 87.33ºE) DPL Township (23.50ºN, 87.29ºE) Muchipara (23.50ºN, 87.35ºE) City Centre (23.54ºN, 87.31ºE) Benachity (23.56ºN, 87.28ºE) Bidhannagar (23.52ºN, 87.35ºE) A-Zone (23.57ºN, 87.29ºE) Fuljhore (23.54ºN, 87.34ºE) Durgapur Railway Station (23.49ºN, 87.32ºE) ASP Plant (23.53ºN, 87.27ºE) DSP Plant (23.55ºN, 87.25ºE) Ukhra (23.65ºN, 87.25ºE) Andal (23.58ºN, 87.19ºE) Raniganj (23.62ºN, 87.11ºE) Asansol (23.69ºN, 86.97ºE) Chittaranjan (23.85ºN, 86.90ºE) Barakar (23.74ºN, 86.82ºE)	*Azadirachta indica* (Neem), *Ficus bengalensis* (Banyan), *Ficus religiosa* (Peepul), *Mangifera indica* (Mango), *Shorea robusta* (Sal)
Grasslands and agricultural lands (GR)	Fuljhore (23.54ºN, 87.34ºE) Heemsheela School Ground (23.54ºN, 87.32ºE) Bijra (23.59ºN, 87.33ºE) Pardaha (23.56ºN, 87.34ºE) Jamgora (23.65ºN, 87.32ºE) Ukhra (23.65ºN, 87.25ºE) Andal (23.58ºN, 87.19ºE) Raniganj (23.62ºN, 87.11ºE) Asansol (23.69ºN, 86.97ºE) Chittaranjan (23.85ºN, 86.90ºE)	*Saccharum spontaneum*, *Saccharum munja*, *Pennysetum* sp., *Hemidesmus indicus*, *Solanum xanthocarpum*
Riverside Zones (RS)	Durgapur Barrage (23.48ºN, 87.30ºE) Asansol (23.69ºN, 86.97ºE)	*Bombyx* sp., *Saccharum* spp., *Typha augustifolia* (Hogla), *Lemna minor*, *Lemna major*, *Fragmites* sp., *Valisneria* sp.
Degraded Coalmine Areas (DC)	Ukhra (23.65ºN, 87.25ºE) Pandaveswar (23.72ºN, 87.28ºE) Raniganj (23.62ºN, 87.11ºE) Asansol (23.69ºN, 86.97ºE) Chittaranjan (23.85ºN, 86.90ºE)	*Butea monosperma* (Palash), *Eucalyptus* spp., *Saccharum* spp., *Acacia auriculaeformis*, *Phoenix* spp.

Observations of the field sampling were identified using suitable field guides (Bahuguna and Mallick, 2010; Menon, 2014) and online databases (Indian Biodiversity Portal 2016). Statistical analysis and charts were prepared using MS Excel. To demonstrate the distribution of different mammals in relation to the six different habitat types, Principal Component Analysis (PCA) was performed on the species and habitat types using PAST 4.0 Software. Before doing the PCA, a normality test was done for all the variables. PCA factor scores for Principal Components (PC) with eigen values >1.0 were reported. Factor scores of the first two components were visualized on scatterplots to assess the distribution of species in different habitat types. The locations from where the mammal species presence were reported were plotted over the study area using Arc-GIS version 10.2.2 and the photographs were taken using digital cameras Nikon Coolpix B700 and Nikon D3500.

Results

A total of 20 mammals belonging to nine orders, 15 families and 20 genera were observed from 31 locations during the present study and six species belonging to two orders, three families and four genera which were previously reported from the present location are also incorporated in the species list (Table 2). In total, 26 species were recorded during the present study on the basis of direct sightings (11 species or 42.3%), rescue by Forest Department, NGOs and information from local people (4 species or 15.4%), information gathered from citizen scientists (1 species or 3.8%) and from past literature (6 species or 23.1%) whereas some species had information from multiple sources like information of two species (7.7%) were gathered both by direct sightings and through citizen scientists, for one species (3.8%) it is from direct sightings and reports from Forest, NGOs and local people and for another single species (3.9%) from citizen scientists and local people (Table 3).

Table 2: Mammalian Species Diversity recorded from Paschim Bardhaman District, West Bengal along with IUCN Status, WPA Status and their Sighting Frequency in the study area. Abbreviations used- Sl. No- Serial Number, IUCN Status: LC- Least Concern, EN- Endangered, WPA Schedule: I- Schedule I, II- Schedule II, III- Schedule III, IV- Schedule IV, V- Schedule V, NA- Not listed in WPA Schedules, Sighting Frequency: VC- Very Common (>75%), C- Common (>50% and <75%), R- Rare (>25% and less than 50%) and VR- Very Rare (<25%), NR- Not Reported during the present study and cited from previous literatures.

Order	Family	Sl. No	Species Name	Local name	IUCN Status	Status as per Indian Wildlife Protection Act, 1972	Sighting Frequency in the study area
Eulipotyphla	Soricidae (Shrews)	1	*Suncus murinus* Linnaeus, 1766	Chuccho	LC	V	VC
Chiroptera	Pteropodidae (Fruit Bats)	2	*Pteropus giganteus* (Brünnich, 1782)	Boro Badur	LC	V	C
		3	*Cynopterus sphinx* (Vahl, 1797)	Kala Badur	LC	V	NR
	Megadermatidae (False Vampire Bats)	4	*Lyroderma lyra* E. Geoffroy, 1810	-	LC	NA	NR
	Vespertilionidae (Evening Bats)	5	*Scotophilus heathii* (Horsfield, 1831)	-	LC	NA	NR
		6	*Scotophilus kuhlii* Leach, 1821	-	LC	NA	NR
		7	*Pipistrellus mimus* Wroughton, 1899	Chamchike	LC	NA	VC
		8	*Scotozous dormer* Dobson, 1875	-	LC	NA	NR
Primates	Cercopithecidae (Old world monkeys)	9	*Macaca mulatta* (Zimmermann, 1780)	Bandor	LC	II	NR
		10	*Semnopithecus entellus* (Dufresne, 1797)	Honuman	LC	II	C
Carnivora	Canidae (Dogs)	11	*Canis lupus* Linnaeus, 1758	Nekre/ Hural	LC	I	R
		12	*Canis aureus* Linnaeus, 1758	Siyal	LC	II	C
		13	*Vulpes bengalensis* (Shaw, 1800)	Khek-siyal	LC	II	R
	Felidae (Cats)	14	*Felis chaus* Schreber,1777	Bon-biral / Khotash	LC	II	VR
	Herpestidae (Mongooses)	15	*Herpestes edwardsi* (E.Geoffroy Saint-Hilaire, 1818)	Boro Beji	LC	II	C
	Viverridae (Civets and Palm Civets)	16	*Paradoxurus hermaphrodites* (Pallas, 1777)	Bham	LC	II	R
		17	*Viverricula indica* (E.Geoffroy Saint-Hilaire, 1803)	Gondhogoku	LC	II	VR
Proboscidea	Elephantidae (Elephants)	18	*Elephas maximus* Linnaeus, 1758	Hathi	EN	I	R
Cetartiodactyla	Suidae (Wild Pigs)	19	*Sus scrofa* Linnaeus, 1758	Buno Sukor	LC	III	R
Pholidota	Manidae (Pangolins)	20	*Manis crassicaudata* E.Geoffroy,1803	Bonrui	EN	I	R
Rodentia	Sciuridae (Squirrels)	21	*Funambulus pennantii* Wroughton, 1905	Kathberali	LC	IV	VC
	Muridae (Rats and Mice)	22	*Mus musculus* Linnaeus, 1758	Nengti Indur	LC	V	VC
		23	*Rattus rattus* (Linnaeus, 1758)	Indur	LC	V	C
		24	*Bandicota bengalensis* (Gray 1835)	Indur	LC	IV	C
	Hystricidae (Porcupines)	25	*Hystrix indica* Kerr, 1792	Shojaru	LC	IV	R
Lagomorpha	Leporidae (Hares)	26	*Lepus nigricollis* F. Cuvier,1823	Buno-khorgosh	LC	IV	C

Table 3: Showing the different mammalian species and their information source (Symbols used: "✓"- Information source used, "×"- Information source not used).

Name of the Species	Information Source			
	Sighted during the present study	Information from Local people, NGOs and Forest Department	Reports from Citizen Scientists	Previous Literatures
Suncus murinus	✓	×	×	×
Pteropus giganteus	✓	×	×	×
Cynopterus sphinx	×	×	×	✓
Megaderma lyra	×	×	×	✓
Scotophilus heathii	×	×	×	✓
Scotophilus kuhlii	×	×	×	✓
Pipistrellus mimus	✓	×	×	×
Scotozous dormer	×	×	×	✓
Macaca mulatta	×	×	×	✓
Semnopithecus entellus	✓	×	×	×
Canis lupus	✓	×	✓	×
Canis aureus	✓	×		×
Vulpes bengalensis	✓	×	✓	×
Felis chaus	×	✓	✓	×
Herpestes edwardsi	✓		✓	×
Paradoxurus hermaphrodites	✓	✓	×	×
Viverricula indica	✓	×	×	×
Elephas maximus	×	✓	×	×
Sus scrofa	×	✓	×	×
Manis crassicaudata	×	✓	×	×
Funambulus pennanti	✓	×	×	×
Mus musculus	✓	×	×	×
Rattus rattus	✓	×	×	×
Bandicota bengalensis	×	×	✓	×
Hystrix indica	×	✓	×	×
Lepus nigricollis	✓	×	×	×

Among the nine orders observed during the present study, excluding the species included from historical records, Carnivora was found to be most diverse (7 Species), followed by Rodentia (6 Species), Chiroptera (2 species) and the rest of the encountered orders with one species each. In the present study, presence of two endangered species, the Asian Elephant *Elephas maximus* and Indian Pangolin *Manis crassicaudata*, were reported. The rest of the species belong to the Least Concern category according to the IUCN Red List of Threatened Species. The status of these animals according to the Wildlife Protection Act, 1972 was Schedule I- 3 species (11.54%), Schedule II- 8 species (30.77%), Schedule III- 1 species (3.84%), Schedule IV- 4 species (15.38%), Schedule V- 5 species (19.23%), Not Listed- 5 species (19.23%). Based on the habitat types, maximum species richness was observed in Human Habitation (HH) areas with 16 species, followed by Forested Areas (FA) with 13 species. Minimum species richness was observed in the Riverside Zones (RS) with only two species. The proportion of the different habitat types for each mammalian species found in the present study and also reported from the literature, depicted that Asian House Shrew *Suncus murinus*, Asian Palm Squirrel *Funambulus pennanti* and Indian Pygmy Pipistrelle *Pipistrellus mimus* were among the most abundant mammals in the study area. The Indian Pangolin *Manis crassicaudata*, was reported only by the local people in the study area.. Golden Jackal *Canis aureus* was observed from a wide variety of habitat types whereas Indian Grey Wolf *Canis lupus* and Jungle Cat *Felis chaus* were observed mostly from the scattered forests. The two varieties of civets, Asian Palm Civet *Paradoxurus hermaphrodites* and small Indian Civet *Viverricula indica* were only observed from the riverside areas and Indian Crested Porcupine was mainly observed and rescued from the scattered forest zones

surrounded by human habitation in various parts of the district. Asian House Shrew *Suncus murinus*, Asian Palm Squirrel *Funambulus pennanti*, Indian Pygmy Pipistrelle *Pipistrellus mimus*, House Mice *Mus musculus*, House Rat *Rattus rattus* and Indian mole-rat *Bandicota bengalensis* were mostly observed from the human habitation areas (Fig. 2). Principal Component Analysis (PCA) for the mammalian species and habitat types recovered three Principal Components (PC) with eigen values > 1.0 that accounted for 97.9% of the total variance. PC1 explained 83.5% variance with highest loading for Human Habitation, PC2 explained 9.7% variance with highest loading for Grassland and agricultural field, PC3 explained 4.7% variance and the remaining factors explained 2.1% of the variations. Species and habitat types' biplot showing the distribution of different mammal species is given in Figure 3.

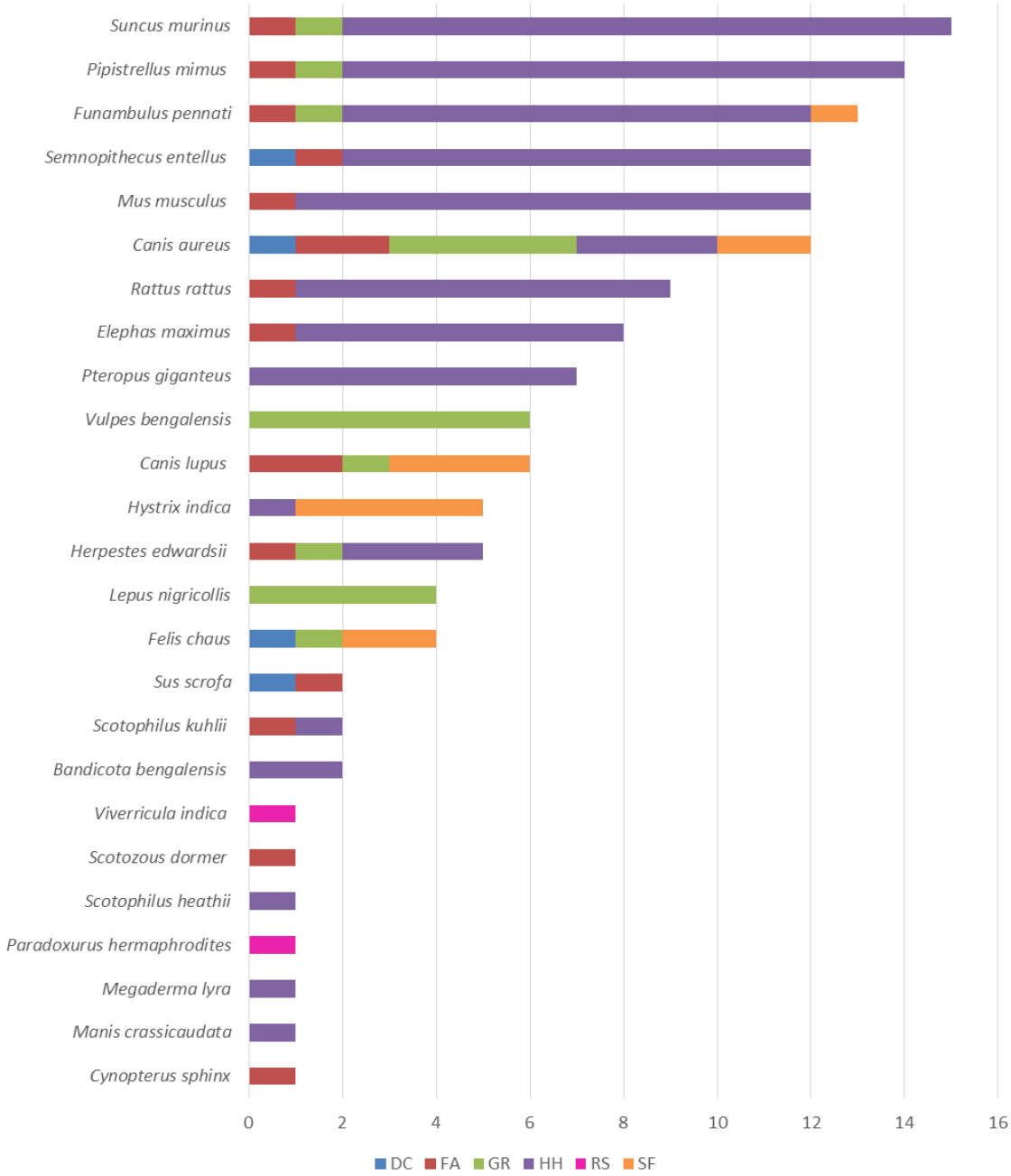

Figure 2: Stacked bars representing proportion of different habitat types (Abbreviations used- DC-Degraded Coal Mines, FA-Forested Area, GR- Grassland, HH- Human Habitation, RS- Riverside, SF-Scattered Forest) reported for each mammal species found in the study.

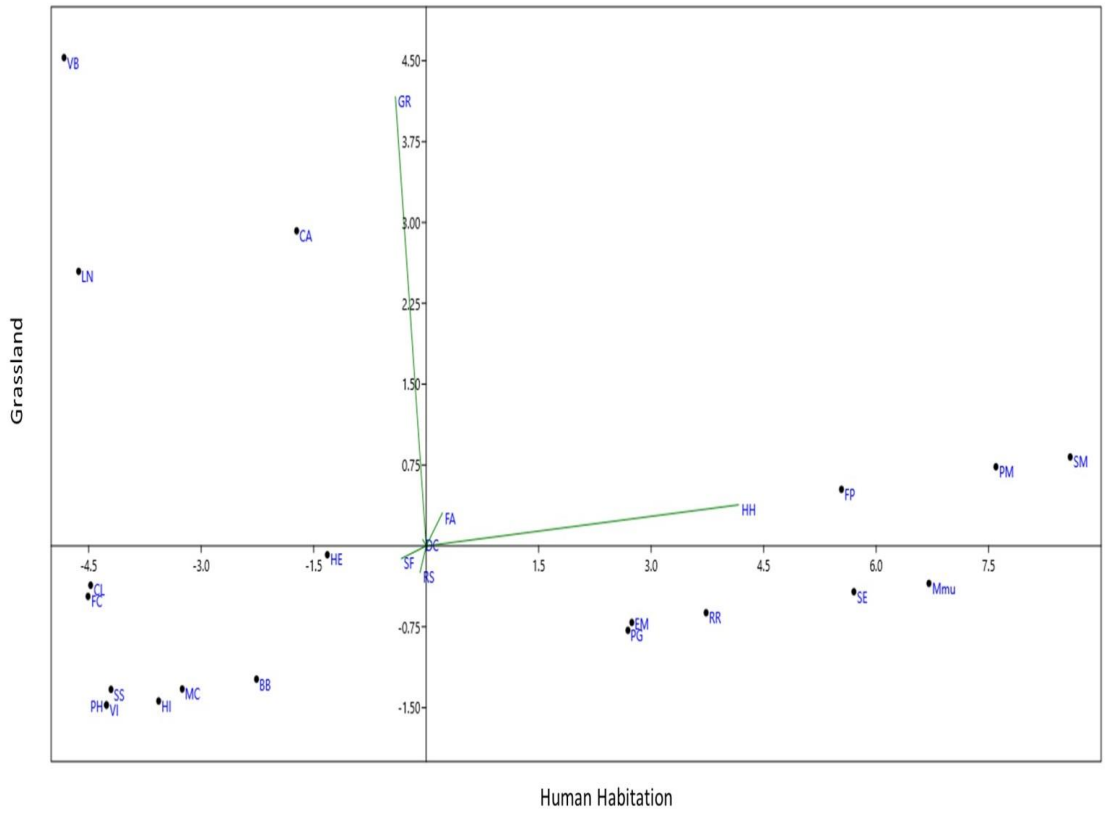

Figure 3: Species and habitat type's biplot showing the distribution of different mammal species along the Principal Component 1 (human habitation) and PC 2 (grassland). 20 species observed during this study were only included and the six species included from the historical evidences were excluded from the PCA. Abbreviations used: FA- Forested Areas, SF- Scattered Forest, DC- Degraded Coalmine Areas, RS- Riverside Zones, HH- Human Habitations, GR- Grasslands and agricultural fields, VB- *Vulpes bengalensis*, CA- *Canis aureus*, LN- *Lepus nigricollis*, CL- *Canis lupus*, FC- *Felis chaus*, HE- *Herpestes edwardsi*, SS- *Sus scrofa*, PH- *Paradoxurus hermaphrodites*, VI- *Vivvericula indica*, HI- *Hystrix indica*, MC- *Manis crassicaudata* , BB- *Bandicota bengalensis*, PG- *Pteropus giganteus*, EM- *Elephas maximus* , RR- *Rattus rattus*, SE- *Semnopithecus entellus*, Mmu- *Mus musculus*, FP- *Funambulus pennanti*, PM- *Pipistrellus mimus*, SM- *Suncus murinus*.

Very interestingly, more than five reports of elephant occurrence were recorded in the human habitations rather than the forested areas. The images of various mammals recorded during the present study are given in Figure 4-15. The details of each species reports are listed below according to their taxonomic order: -

Order: Soricomorpha
Family: Soricidae
Subfamily: Crocidurinae

1. *Suncus murinus* (Linnaeus, 1766)
Common name: House Shrew
This nocturnal variety of shrew is commonly found both in forests and human habitation. B. Nath collected 1 male and 2 females from Barakar (23.7393ºN, 86.8181ºE) and a single female specimen from Durgapur in 1948. P.K. Das also collected two females from Arrah (23.5178ºN, 87.3756ºE) in 1988. In the present study it is quite commonly encountered from various parts of Durgapur and Asansol. In the current study, one adult individual and one road killed individual from Durgapur Government College (23.5436ºN, 87.3275ºE) area and Heemsheela grasslands (23.5439ºN, 87.3169ºE) of Durgapur subdivision respectively are photographed.

Order: Chiroptera
Family: Pteropodidae
Subfamily: Pteropodinae

2. *Pteropus giganteus* (Brünnich, 1782)
Common name: Indian Flying Fox
In the past these bats were seen in large numbers in the study area but with growing rate of urbanisation and deforestation their population is largely affected. In 1949, B. Nath collected 2 females from Barakar (23.7393ºN, 86.8181ºE). In the present study too, they were seen quite frequently during the evening time from various places in Durgapur like Muchipara (23.5044ºN, 87.3536ºE), Fuljhore (23.5356ºN, 87.3436ºE), Durgapur Government College area (23.5436ºN, 87.3275ºE), MAMC Township (23.5378ºN, 87.33ºE) and from Asansol (23.6889ºN, 86.9661ºE) when they are out flying. They are also being observed to roost in open branches of trees near some water bodies from the human habitation areas of the study site.

Subfamily: Cynopterinae

3. *Cynopterus sphinx* (Vahl, 1797)
Common name: Greater Short-nosed Fruit Bat
P.K. Das collected one male from Arrah (23.5178ºN, 87.3756ºE) in 1988 and another collection of a female from Raniganj (23.6234ºN, 87.1143ºE) was done with no Collector's name and collection date. Though earlier recorded, this nocturnal bat was not observed during the present surveys.

Family: Megadermatidae

4. *Megaderma lyra* (E. Geoffroy, 1810)
Common name: Greater False Vampire Bat
This variety of false vampire bat was collected from the Raniganj area (23.6234ºN, 87.1143ºE) in 1875 by Stoliczka (1 male, 1 female and 1 foetus). This species was not seen during the recent survey.

Family: Vespertilionidae
Subfamily: Vespertilionniae

5. *Scotophilus heathii* (Horsfield, 1831)
Common name: Greater Asiatic Yellow House Bat
5 females were collected in 1988 by P.K. Das from Arrah (23.5178ºN, 87.3756ºE). This species was not seen or reported from secondary sources during the recent survey.

6. *Scotophilus kuhlii* (Leach, 1821)
Common name: Lesser Asiatic Yellow House Bat
One male and one female were purchased from Raniganj (23.6234ºN, 87.1143ºE) in 1869. There is also mention of this species from the district by Dobson in 1875. P.K. Das also collected 2 male specimens from Arrah (23.5178ºN, 87.3756ºE) in 1988. This species was not seen or reported from secondary sources during the recent survey.

7. *Pipistrellus mimus* (Wroughton, 1899)
Common name: Indian Pygmy Pipistrelle
P.K. Das collected 2 males and 1 female specimens of these species from Arrah (23.5178ºN, 87.3756ºE) in 1988. It is very common throughout the study area where it enters into homes frequently. This species of bat is common in and around human habitations and also around grassland areas. Reports of the occurrence of this species were noted throughout the study area.

8. *Scotozous dormeri* (Dobson, 1875)
Common name: Dormer's Pipistrelle
3 male and 2 female individuals were collected in 1988 by P.K. Das from Arrah (23.5178ºN, 87.3756ºE). This species was not seen or reported from secondary sources during the recent survey.

Order: Primates
Family: Cercopithecidae
Subfamily: Cercopithecinae

9. *Macaca mulatta* (Zimmermann, 1780)
Common name: Rhesus Macaque
Peterson in 1910 mentioned that this variety of primate is very common throughout the district of Bardhaman (presently Paschim Bardhaman and Purba Bardhaman) where it mostly inhabits the human habitations and the forested areas (Agarwal et al., 1992). It has not been observed in the present survey.

Subfamily: Colobinae

10. *Semnopithecus entellus* (Dufresne, 1797)
Common name: Northern Plains Grey Langur/ Hanuman Langur
This diurnal species is quite common throughout the study area. It is present in all types of major habitats including the forest areas, human habitations and grasslands. They prefer to live in large groups. During the present study they were observed throughout the study area.

Order: Carnivora
Family: Canidae
Subfamily: Caninae

11. *Canis lupus* (Linnaeus, 1758)
Common name: Grey Wolf
Peterson in 1910 mentioned the presence of this species from Bardhaman District in his report. Local people and forest officials also confirmed the presence of this elusive animal. In the present study period it is quite rarely seen. But owing to the citizen science project, more sighting of this animal were made by the citizen scientist and photographers. It is known from Ukhra Range (23.6508ºN, 87.2461ºE), Shibpur Forest (23.6047ºN, 87.3975ºE), Pandabeswar (23.7169ºN, 87.2789ºE), Laudoha (23.66ºN, 87.3069ºE) (citizen science observation reports) and the first author have observed it from the Garh Jungle region (23.6053ºN, 87.4311ºE) of Durgapur Subdivison.

12. *Canis aureus* (Linnaeus, 1758)
Common name: Golden Jackal/ Asiatic Jackal
This canid is very commonly found in semi-arid environments, dry deciduous forests and also in rural and urban regions. Smaller in size than the Indian grey wolf, it is one of the most common and widely distributed canid species of Paschim Bardhaman. In the present study, it is encountered from almost all parts of the study area. The present study site harbours a stable population of this animal. The jackals are known to attack the dogs sometimes according to the local people.

13. *Vulpes bengalensis* (Shaw, 1800)
Common name: Bengal Fox
This small variety of canid is very rare in the present study area. It generally prefers open habitats and grasslands but its actual distribution in Paschim Bardhaman is still unknown to a greater extent. Because of its shy nature and nocturnal activity, this species is observed only once from Pardaha (23.5591ºN, 87.3380ºE) during the present study. However owing to the citizen science project launched by WINGS, more sighting records of this animal were made by the citizen scientist and photographers and is reported

from various parts of Durgapur like Durgapur Barrage area (23.4783ºN, 87.3075ºE), Bijra (23.5858ºN, 87.3344ºE), Jamgora (23.6491ºN, 87.3186ºE), Andal (23.5815ºN, 87.191ºE) and Raniganj (23.6234ºN, 87.1143ºE).

Family: Felidae
Subfamily: Felinae

14. *Felis chaus* (Schreber,1777)
Common name: Jungle Cat
The Jungle Cat is a common carnivore found in the study area. It is generally found in the drier and open parts of forested area and also in scrubland and grasslands. During this study it was recorded only three times from the district. It has been reported from Nachan (23.6163ºN, 87.3216ºE), Shankarpur (23.5272ºN, 87.3578ºE) and Laudoha (23.66ºN, 87.3069ºE). Locals and forest officials have confirmed its presence from other parts of the district.

Family: Herpestidae
Subfamily: Herpestinae

15. *Urva edwardsi* (I. Geoffroy S- H, 1818)
Common name: Grey Mongoose
This diurnal species is recorded from various parts of the district. The preferred habitats of the Grey Mongoose are the open areas, scrublands and agricultural fields It also had been observed from human habitations and forested areas. It is quite widely distributed in the study area.

Family: Viverridae
Subfamily: Paradoxurinae

16. *Paradoxurus hermaphrodites* (Pallas, 1777)
Common name: Asian Palm Civet
It can be commonly found near human habitation. They generally prefer fruits as food. Two juveniles were rescued from Durgapur Subdivision by forest officials and members of a non-government organisation. They had accidentally entered into a house. Local peoples have also confirmed its presence from the areas near the Damodar River in Durgapur Subdivision (23.4783ºN, 87.3075ºE).

Subfamily: Prionodontinae

17. *Viverricula indica* (E.Geoffroy Saint- Hilaire, 1803)
Common name: Small Indian Civet
The Small Indian Civet is recorded only twice as opportunistic sighting in the present study. This nocturnal species was seen crossing the road near the Damodar River (areas with long grasses) (23.4783ºN, 87.3075ºE). No other information is known about this animal from the district.

Order: Proboscidae
Family: Elephantidae
Subfamily: Elephantinae

18. *Elephas maximus* (Linnaeus, 1758)
Common name: Asian Elephant
There is no residing elephant population in the district. Anon in 1990 mentioned that the elephants enter Bardhaman (previously) periodically. In the present study from 2017 to 2020 we found periodic visits of these animals in the district. Every year these elephants occasionally enter the various parts of the district.

Order: Cetartiodactyla
Family: Suidae
Subfamily: Suinae

19. *Sus scrofa* (Linnaeus, 1758)
Common name: Wild Boar
Peterson in 1910 mentioned that the Wild Boar is common in the forested areas of the present study site (Agarwal et al., 1992). Local people and forest officials had also mentioned about their presence in various parts. However, this species was not seen during the present survey.

Order: Pholidota
Family: Manidae
Subfamily: Maninae

20. *Manis crassicaudata* (E. Geoffroy,1803)
Common name: Indian Pangolin
The Indian pangolin generally prefers the plains living inside tree hollows or inside burrows. Locals have mentioned the presence of this species from the study area but no other sighting records are available from this region. The population is greatly reduced due to poaching for its scales and flesh.

Order: Rodentia
Family: Sciuridae
Subfamily: Sciurinae

21. *Funambulus pennantii* (Wroughton, 1905)
Common name: Asian Palm Squirrel/ Five-Striped Palm Squirrel
This species of squirrel is very commonly found around human habitation, forested areas, rural gardens, urban areas and introduced vegetation. This species had been recorded throughout the district.

Family: Muridae
Subfamily: Murinae

22. *Mus musculus* (Linnaeus, 1758)
Common name: House Mouse
A very common variety of mouse found in abundance in the study area. According to the historical literature, two sub-species were known from the present study area *Mus musculus castaneus* and *Mus musculus urbanus*. B. Nath collected 1 female of *Mus musculus castaneus* from Barakar (23.7393ºN, 86.8181ºE) in 1948, whereas P. K. Das collected 1 male of *Mus musculus urbanus* from Arrah (23.5178ºN, 87.3756ºE) in 1988. In the present study, as there are no collected specimens, we cannot identify the subspecies of the observed individuals. This species can be found throughout the district and generally prefers to live in human habitations.

23. *Rattus rattus* (Linnaeus, 1758)
Common name: House Rat
B. Nath collected 9 males and 6 females from Begunia near Barakar (23.7393ºN, 86.8181ºE) in 1948. P.K. Das also collected 1 male and 1 female from Arrah (23.5178ºN, 87.3756ºE) in 1988. The House Rat is generally found around human habitations where they live inside homes, food storage facilities throughout the study area

***24. Bandicota bengalensis* (Gray and Hardwicke, 1833)**
Common name: Indian Mole-rat/ Bandicot Rat
A single individual is photographed by Mr. Amar Kumar Nayak from Andal (23.5815ºN, 87.191ºE) and some individuals were seen at Durgapur Railway Station (23.4947ºN, 87.3180ºE) during the present study. Information from local people shows that it is quite widely distributed in and around the study area. More study is required to comment on its distribution and status from the present study location.

Family: Hystricidae
Subfamily: Atherurinae

25. *Hystrix indica* (Kerr, 1792)
Common name: Indian Crested Porcupine
The crested porcupine is a nocturnal animal and very hard to find. This animal was not directly sighted in the present study. Two rescued individuals from DPL Township, Durgapur Subdivision (23.4988ºN, 87.2947ºE) by Forest Department and a local NGO reported its presence in this district. Moreover, local people and citizen scientists have confirmed its presence in Chittaranjan also (23.8492ºN, 86.902ºE).

Order: Lagomorpha
Family: Leporidae

26. *Lepus nigricollis* (F. Cuvier,1823)
Common name: Indian Hare/ Black-naped Hare
This species is fairly common in the study area. It generally prefers the grassland area. Sighting of this diurnal hare was recorded during the present survey in Andal (23.5815ºN, 87.191ºE) and Laudoha (23.66ºN, 87.3069ºE) of Durgapur Subdivision and also in Asansol Subdivision (23.6889ºN, 86.9661ºE). Its population is decreasing due to the regular hunting of this species.

Figure 4: Asian House Shrew *Suncus murinus*
(Photo Credit: Subhajit Roy)

Figure 5: Indian Flying Fox *Pteropus giganteus*
(Photo Credit: Sagar Adhurya)

Figure 6: Grey Mongoose *Herpestes edwardsi*
(Photo Credit: Sagar Adhurya)

Figure 7: Black-naped Hare *Lepus nigricollis*
(Photo Credit: Arnish Bose)

Figure 8: Golden Jackal *Canis aureus*

Figure 9: Grey langur/ Hanuman langur *Semnopithecus entellus*

Figure 10: Bengal fox *Vulpes bengalensis*
(Photo Credit: Koushik Roy)

Figure 11: Jungle Cat *Felis chaus*
(Photo Credit: Milan Mandal)

Figure 12: Indian mole-rat *Bandicota bengalensis*
(Photo Credit: Amar Nayak)

Figure 13: Indian Grey Wolf *Canis lupus*
(Photo Credit: Arnish Bose)

Figure 14: Rescued Indian Crested Porcupine
(Photo Credit: Arindam Chakraborty)

Figure 15: Road killed Golden Jackal *Canis lupus*

Discussion

Various similar kinds of studies on the mammals of a particular region were done in the other parts of the state as well as in the country in the previous years. Gajera and Dharaiya (2011) observed 28 species of mammals excluding the chiropterans and the rodents from the northern region of Gujrat. Phejen et al. (2018) observed 16 species of mammals belonging to 16 families in their study from the tribal district of Dimapur in Nagaland. Subramanyam and Khan (2017) reported 34 species from their two years long study in the Anantapuramu District of Andhra Pradesh. There were also some previous works on the mammalian fauna from the adjoining areas of Paschim Bardhaman District in the Damodar Valley Corporation (DVC) Project area and in the district of Purulia. Biswas et al. (2008) documented 28 species from selected areas of Purulia District during their study and Chakraborty (2011) had worked on the mammals of DVC Project area where she reported 55 species of mammals belonging to 25 families. Mallick (2011; 2012) in his two studies from Kalimpong Hills and Sundarban Tiger Reserve reported 99 species and 40 species respectively. Previously B. Nath in 1948 and P.K. Das in 1988 had also collected specimens of 29 species from undivided Bardhaman which includes the present study region (Agarwal, 1992). As evident from our study, Carnivora is observed to be the most diverse group in the Paschim Bardhaman District of West Bengal which corroborates well with the other studies of mammals in different states of India (Gajera and Dharaiya, 2011; Subramanyam and Khan, 2017). Although there was less historical information available in the region, five of the species like Greater False Vampire Bat *Megaderma lyra*, Greater Asiatic Yellow Bat *Scotophilus heathii*, Lesser Asiatic Yellow Bat *Scotophilus kuhlii*, Dormer's Bat *Scotozous dormeri* and Greater Short-nosed Fruit Bat *Cynopterus sphinx* which were recorded previously by Agarwal (1992) were not encountered any more in any part of this region despite of this sufficiently long survey with multiple implemented methods. This may be due to the fact that either we have overlooked these species (as we have no specimen collection permission) or these species might have been affected by habitat destruction and wiped out from this present study location. Peterson (1910) mentioned the presence of Rhesus Macaque *Macaca mulatta* was very common in these areas (Agarwal et al., 1992), of which we have not observed a single individual during our study period which confirms the fact that this particular species had faced local extinction from this area owing to the increasing anthropogenic interventions in the recent times. These six species which we have failed to document in our study (previously documented from the present location) were reported by various workers from the adjoining regions. Greater Short-nosed Fruit Bat and Lesser Asiatic Yellow Bat were documented by Biswas et al. (2008) in their study from Purulia district whereas Chakraborty (2011) had recorded five of the species we have failed to encounter during our study except Dormer's Bat from the Damodar Valley area. However, few of the species like Indian Pangolin *Manis crassicaudata*, Indian Crested Porcupine *Hystrix indica* and Small Indian Civet *Viverricula indica* have no mentions in the previous literatures and are probably the first reports from the district. This study reinstates a very pertinent fact that heavy urbanization and consequent alteration of habitats may insert significant impact on the native mammalian fauna. In case of Paschim Bardhaman District, rapid urbanization had taken place in some points whereas constant mining operations had left many of the wildlife habitats as degraded. However, in spite of all anthropogenic pressures, many mammal species (at least 20 as according to the present study), both anthropo-commensals and wild ones, survived. The present study is therefore, first of its kind from this area after almost 40 years. The present study also carries more comprehensive information than previous studies with additional information on their distribution in this region.

During the present study it is observed that maximum number of species was observed from the Human Habitation (HH) areas whereas least number of species was noted from the Riverside Zones (RS). Paschim Bardhaman is experiencing major alterations in habitat due to the growing urbanisation and most of the forests, scattered forests and grasslands are converted into human habitation or agricultural fields with suitable anthropogenic activities which is resulting in shift in species composition from the study sites. The species observed from the habitations are mostly rodents, shrews and primates. They are generalist species and have broad dietary spectrum and are very well adapted to human habitations. All the species we recorded are consistent with several past studies where these species are reported from the human habitations across the world. For the other species we cannot state conclusively whether they are becoming more dependent on the novel resources in human habitations and thus venturing into these habitats, which has been noticed quite commonly in case of birds of prey and lesser cats (Mazumdar et al., 2018; Roy et al., 2020; Chakraborty et al., 2020 a,b). Moreover, the Riverside Zones (RS) are threatened by habitat destruction, urbanisation and anthropogenic interventions and these three may act as a primary cause for the presence of least number of mammals from this particular zone. Only four species of mammals were also noted from the degraded coal mine areas and needs special concern. Thus the degraded coal mine areas attracted neither the generalist species nor any other wildlife, asserting these regions as completely unsuitable for the animal life.

From the observed species it is seen that two species, Bengal Fox *Vulpes bengalensis* and Black-naped Hare *Lepus nigricollis* were only found in the grassland habitats whereas two species of civets, Small Indian Civet *Viverricula indica* and Asian Palm Civet *Paradoxurus hermaphrodites* were observed only from the riverside zones of the district during the present study period. With increasing urbanisation, these two habitats are experiencing major alternations and habitat destruction which in turn is dangerous for these species. Moreover, Paschim Bardhaman has no residing population of Asian Elephant *Elephas maximus* in the present time. According to the reports of the Forest Department, two major Elephant movement pathway are there in the district. With the growing population and expansion of urban areas, most parts of these two areas are now turned into human habitation. This is the main reason for the eight encounters of elephants in the human habitation zones of Paschim Bardhaman.

Reports of Gangetic Dolphin *Platanista gangetica*, and Fishing Cat *Prionailurus viverrinus* were also received from the local people of Paschim Bardhaman but due to the absence of information about their presence in the previous literatures, lack of photographs or other evidences like scat and pugmarks, these two species have not been included in the list. Striped Hyena *Hyaena hyaena* and Nilgai *Boselaphus tragocamelus* were documented with photographic evidence from the present study area in the recent years (2021 and 2022) from Durgapur and Asansol area but as this study covers the species we have found till 2020, so we have excluded these two species from our list. More details regarding from where this Nilgai or Blue Bull came is needed as this species is not a commoner in this areas and has no past records from the present study site or its adjoining areas. Moreover, Chinese Pangolin *Manis pentadactyla* was also rescued from the Asansol area during the study period. But as Chinese Pangolin cannot be found in the present area and that rescued individual might have ended up here due to illegal trade, so we have also excluded it from our list.

Various threats were also recorded in the present study (Table 4). With the increasing development and industrial growth, forested areas are being cleared for residential purposes, mining purposes and for agriculture which in turn is causing habitat destruction, alterations and fragmentations. These changes in the landscape are driving the mammals more vulnerable and less distant to anthropogenic disturbances through frequent conflicts and environmental pollutions in the region. Hunting of mammals by the tribal and local people in the name of festivals and road kills are growing concerns in the recent times in this region as we have encountered several in the present study first hand. Concerns from all corner of the society are the prime need of the hour to conserve this diverse eco-region and the animals living inside it. It is of the first importance in order to maintain the natural balance that has been tampered with for over two centuries in the region. Restoration of these degraded coal mining sites and riverside side zones with high anthropogenic pressure should be done by the concerned authorities. There is further scope of research on the site-specific occurrence and abundance of the mammals from the present study giving special emphasis to the chiropterans and rodents. More detailed study will surely provide some more insights on the status of mammals from this region.

Table 4: Reports of the various threats to the mammalian species observed or reported during the study period

Species Name	Threat perceived	Information Source	Location name
Canis aureus	Habitat degradation and Habitat loss due to construction of building in grasslands	Observation during the study	Pardaha, Durgapur
Canis aureus	Roadkill	Observation during the study	Durgapur Barrage, Durgapur
Canis lupus	Killing by local people	Citizen scientist	Laudoha, Durgapur
Suncus murinus	Road kill	Citizen scientist	Durgapur
Funambulus pennanti	Road kill	Observation during the study and citizen scientist	Durgapur and Asansol
Vulpes bengalensis	Habitat degradation and Habitat loss due to construction of building in grasslands	Citizen scientist	Durgapur
Lepus nigricollis	Habitat degradation and Habitat loss due to construction of building in grasslands	Observation during the study	Durgapur
Lepus nigricollis	Hunting by local people and tribals	Citizen scientist	Durgapur

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Conflict of interest

All authors declare that there are no conflicting issues related to this research article.

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