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Research Article

Diversity and ecology of mammals of Bahawalnagar, South Punjab, Pakistan

Jawad Ahmad[1], Adil Riaz[2], Ghulam Rasool[3], Sana Ashraf[4], Muhammad Haroon Hamed[5], Muhammad Ameen[6], Sundas Asghar[7], Muhammad Zohaib[4], Ayesha Ishaq[8], Muhammad Waris[9], Muhammad Tariq[10], Muhammad Junaid[4], Naseem Mukhtar[4], Mubashir Mumtaz[4], Muhammad Qasim[4], Abdul Majid Khan[11], Muhammad Imran[11], Noushin Irshad[12], Muhammad Altaf[13*]

[1]Department of Zoology, The Islamia University of Bahawalpur, Bahawalnagar Campus, Pakistan
[2]Department of Zoology, University of Kotli, Azad Jammu and Kashmir, Pakistan
[3]Deputy Director, Wildlife, Punjab Wildlife and Parks Department, Pakistan
[4]Department of Zoology, University of Lahore, Sargodha campus, Pakistan
[5]Department of Zoology, Wildlife and Fisheries, University of Agriculture, Faisalabad, Pakistan
[6]Department of Zoology, University of Sialkot, Pakistan
[7]Department of Biological Sciences, The Superior University, Lahore
[8]Department of Zoology, University of Okara, Pakistan
[9]Department of Zoology, University of Veterinary and Animal Sciences, Lahore, Pakistan
[10]Department of Livestock Management, University of Agriculture Faisalabad, Sub-Campus Toba Tek Singh, Pakistan
[11]Institute of Zoology, University of the Punjab, Lahore, Pakistan
[12]Department of Zoology, University of Poonch Rawalakot, Azad Jammu and Kashmir, Pakistan
[13]Insitute of Forest Sciences, The Islamia University of Bahawalpur, Bahawalpur, Pakistan
***Email:** altafweco@gmail.com

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Abstract

Pakistan has 195 species of mammals and diverse habitats, with three zoogeographical realms: Palearctic, Oriental, and Ethiopian. Approximately two-thirds of the area is mountainous, and abrupt altitude changes result in variations in diversity over short distances. The key objectives of this study are to examine the diversity, distribution, and ecological status of mammalian species in Bahawalnagar, Punjab, Pakistan. Data collection was done twice every month throughout the day and night for one year using the Linear Count Method. The research identified 21 mammalian species from district Bahawalpur. The diversity indices show that the area has a high and rich diversity, as the Dominance Index is 0.1605, Simpson Index is 0.8395, Shannon-Wiener diversity index (H') is 2.124, the evenness (E) is 0.3982 and the richness index (R) is 2.648, and in the study area. During the survey, the highest relative abundance (abbreviated as RA = 0.26261) of *Mus musculus* is documented from Bahawalnagar. The lowest relative abundance (RA = 0.00105) is noted in three species (i.e. *Vulpes bengalensis, Viverricula indica* and *Antilope cervicapra*) in the natural habitats of Bahawalnagar. These three species are rarely seen in the study area. It is documented that *Rattus rattus, Herpestes edwardsii, Millardia meltada* and *Canis aureus* also have high relative abundances as 0.21008, 0.15756, 0.10504 and 0.07773 respectively.

Keywords: Bahawalnagar, abundance, ecology, mammals, diversity

Introduction

Pakistan is a key country for faunal diversity (Sial, 2024), home to at least 195 recorded mammalian species (Roberts, 1997). Conservation efforts have been initiated to protect this diversity through the establishment of various conservation areas, such as national parks, wildlife reserves, and sanctuaries (Bolaane, 2004; Green et al., 2024). But managing such environments

can have a negative influence on animals in a number of methods including degradation of habitat, enhanced human-wildlife relations, and decreased fertility rates. As a result, knowing the differences in mammalian diversity (Altaf et al., 2014), distribution, and abundance is important for handling environmentally friendly land-management approaches.

Mammalian populations are vital to the proper function and structure of ecosystems and can modify nutrient routes, change the structure of plants, and ultimately effect the species composition of the ecosystem (Hantak et al., 2021). They are essential seed dispersers for various tree species (García-Rodríguez et al., 2022), participating in food networks at multiple trophic levels and assisting in herbivore control (Tourani et al., 2023). Despite this, mammals provide many economic benefits to people, including food (Alves et al., 2021), pets, (Bashir et al., 2024; Shivambu et al., 2021), medicine (Faiz et al., 2022), ornamental (Shivambu et al., 2021), and tourism (Barcelos et al., 2022). Recent increases in both anthropogenic and natural factors have put the survival of mammals at risk (Pérez-Irineo et al., 2021). Key contributors to the decline of mammal species include overexploitation (Vuorinen et al., 2021), fragmentation (Kuipers et al., 2021), global climate change, and various other human-induced pressures threatening mammals in the worldwide (Riddell et al., 2021). Mammals serve as key indicators for evaluating human impact on biodiversity and play a vital role in maintaining ecological functions (Jacob et al., 2024). The continuous disappearance of species across the globe is decreasing the variety of ecological roles organisms perform in communities, as well as the number of evolutionary lineages present (Altaf et al., 2022). Understanding which anthropogenic factors have the most severe impacts on functional and evolutionary diversity is challenging, as is discerning whether the loss of these aspects of diversity is outpacing, or lagging behind, the reduction in species numbers (Brodie et al., 2021). In this case, we demonstrate that unique mammals which perform critical functions within their ecosystems are especially

vulnerable to overhunting, species dislike (Ejaz & Rasheed, 2024) and habitat destruction in the most species-rich regions (Bennett, 2023). There is an immediate and grave need to enhance protective measures, particularly concerning the sustainability of harvesting, to avert the decline of biodiversity and ecosystem functions (Sharma & Birman, 2024).

Bahawalnagar, situated in South Punjab, Pakistan, features a diverse ecological landscape that includes a mix of habitats such as arid plains, agricultural fields, river areas, and scattered native flora. This ecological diversity supports a wide range of mammal species, many of which are poorly documented due to limited scientific research and increasing human influence. The area's proximity to the Sutlej River and its transitional between desert as well as agricultural land make it ideal for investigating mammal diversity and environmental relationships. But challenges like as fragmentation of habitat, development of agriculture, and conflict between humans and mammals pose serious threats to the indigenous species of mammals (Jahangeer & Awan, 2024). As a consequence, an in-depth knowledge of the richness, distribution, and ecological roles of mammals in this overlooked area is essential in developing effective conservation efforts to sustain the balance of nature. The key objectives of this study are to examine the diversity, distribution, and ecological status of mammalian species in Bahawalnagar, Punjab, Pakistan.

Material and methods

Study area

Bahawalnagar is also known as a district of the Punjab province in Pakistan (Fig. 1). Before the independence of Pakistan, Bahawalnagar was included within the Bahawalpur state, which was ruled by the Nawab of Bahawalpur. The district capital is located in the city of Bahawalnagar. The eastern and southern boundaries of Bahawalnagar border the Indian district of Bikaner, while

the Firozpur and Bahawalpur districts are to its west, and the River Sutlej flows to its north. District Bahawalnagar extends over a cross-section of 8,878 square kilometers. According to the census of 2023, there are 557,616 households and a population of 3,550,342 in the Bahawalnagar district. The sex ratio of the district is 108.27 males to 100 females, and the literacy rate is 57.01 percent: 63.55 percent male and 49.95 percent female. A total of 971,921 individuals (27.42 percent of the surveyed population) are below ten years of age. Additionally, 974,118 individuals (27.44 percent) reside in urban areas (Hussain & Shaikh, 2025; Iqbal et al., 2023).

Data collection

From July 2024 to June 2025, data was gathered in Bahawalnagar by a team of two field members using both direct and indirect approaches to study mammalian species. The two-person team employed these methods to collect data, and field guides were utilized for accurate species identification (Roberts, 2005a,b).

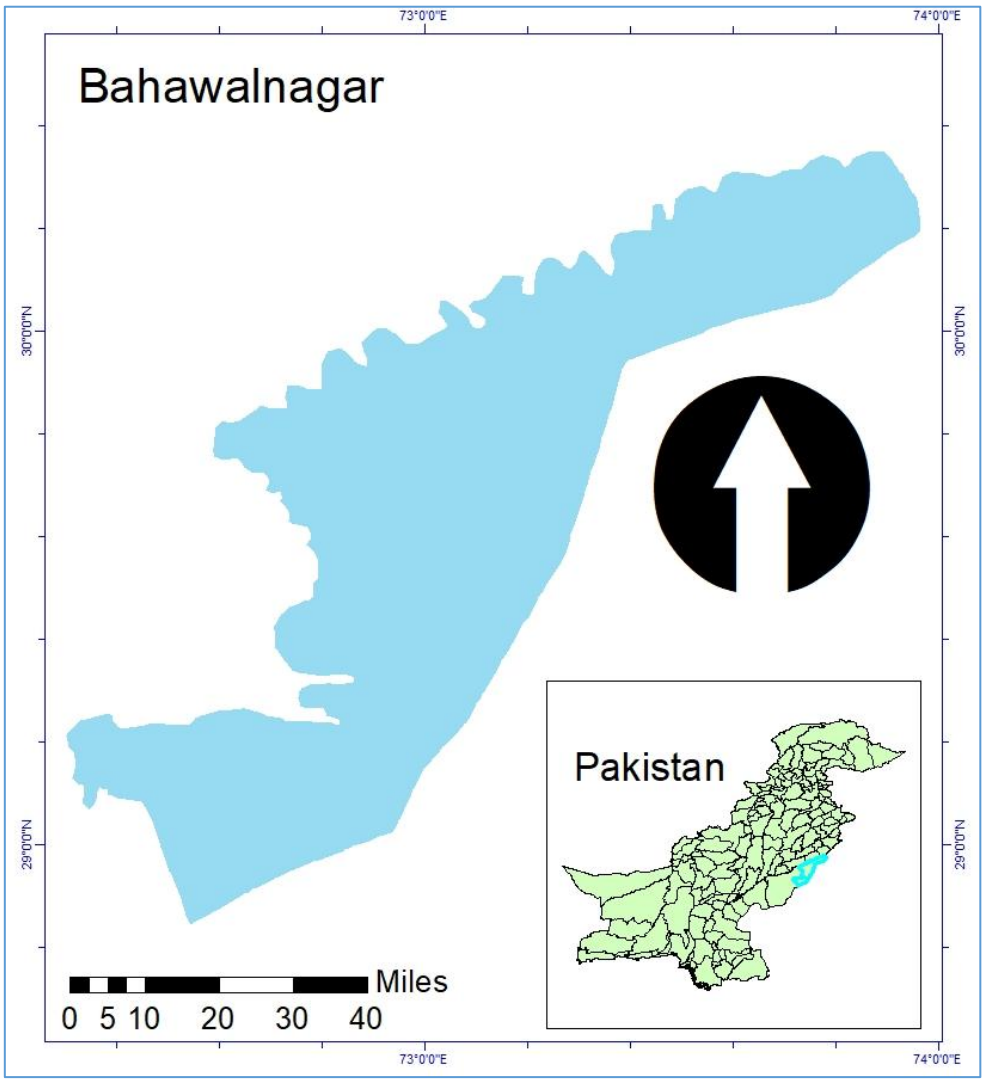

Figure 1. Map of the study area.

The research group spends an excessive amount of time studying the study area and conducting numbers to identify the mammalian species present. The researchers recorded noises and identified the species; voice counts from the same species were combined. Data collection was done twice every month throughout the day and night for one year using the Linear Count Method. In the designated study area, the researchers collected fecal pellets from wild mammalian species for observational identification purposes. They also examined mammal

pugmarks and footprints to determine species identification. The researchers identified the species of animal carcasses reported in the study region. The researchers also gathered photographs of mammalian species from residents and wildlife photographers in Bahawalnagar. Hair mounting procedures were used to evaluate species hair samples collected in the study region. Furthermore, the researchers acquired data through the use of standardized questionnaires delivered to the local populace.

Statistical analysis

The parameters of diversity, such as Dominance Index, Simpson Diversity Index, Shannon Diversity Index, Evenness Index, and Richness Index, were analyzed with the help of PAST Statistical Software (Version 5.1). Graphs are compiled using the assistance of the OriginPro (2023b) statistical software and the R Program (4.5.1).

Results

Data was collected from 75 Muslim male (n=74) and female (n=1) informants, who work in various professions such as teachers (n=6), students (n=20), housewives (n=5), shopkeepers (n=2), farmers (n=31), shepherds (n=4), hunters (n=3), and wildlife experts (n=4). Most respondents are educated (58.7%), with only a few holding higher education degrees (14.7%); the majority have completed secondary education (26.7%) (Fig. 2). The ages of the selected informants range from 18 to 78 (Fig. 3).

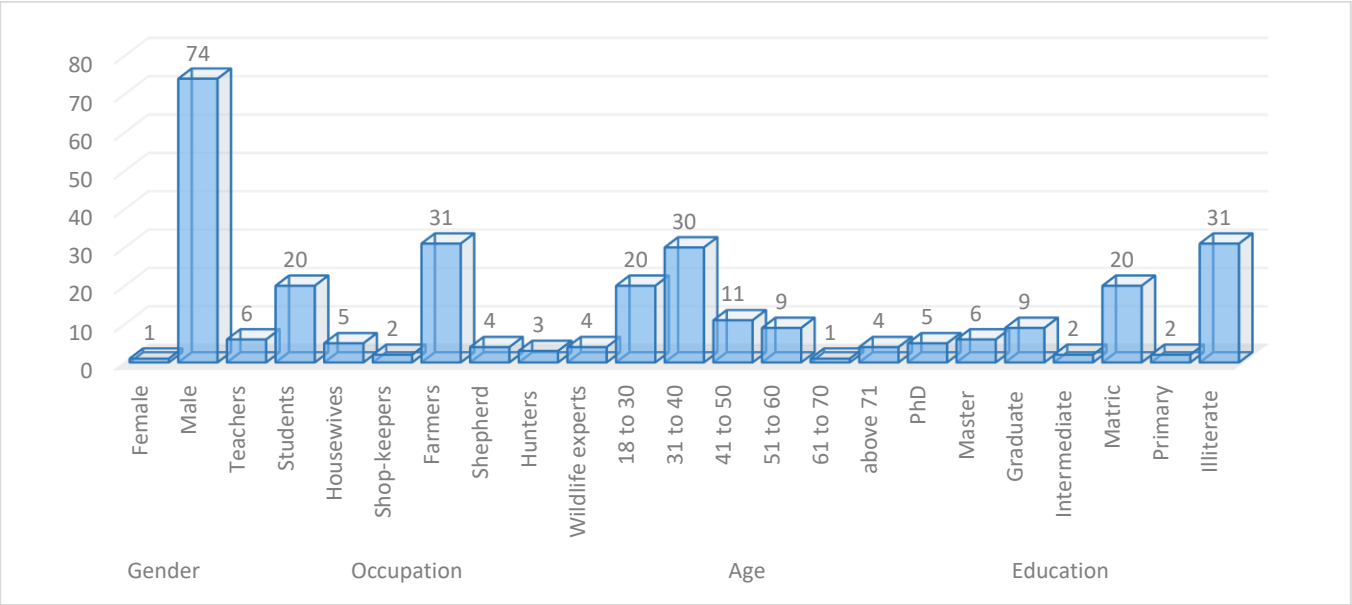

Figure 2. Respondents' profile of the study area

Figure 3. Respondents of the study area

Mammalian diversity

During the research, 21 species (i.e. *Antilope cervicapra, Boselaphus tragocamelus, Gazella bennettii, Sus scrofa, Canis aureus, Canis lupus, Herpestes edwardsii, Herpestes javanicus, Viverricula indica, Vulpes bengalensis, V. v. pusillus, Felis chaus, Hemiechinus collaris, Suncus murinus, Lepus nigricollis, Funambulus pennantii, Hystrix indica, Meriones persicus, Millardia meltada, Mus* musculus and Rattus *rattus*) of mammals (Fig. 4 and 5), belongs to 12 families (i.e. Erinaceidae, Felidae, Hystricidae, Bovidae, Herpestidae, Sciuridae, Leporidae, Muridae, Soricidae, Canidae, Viverridae and Suidae) (Fig. 6) and 6 orders (i.e. Erinaceomorpha, Artiodactyla, Carnivora, Lagomorpha, Rodentia and Insectivora) (Fig. 7 and Table 1). M Altaf et al. (2014) observed 15 species of mammals from the Chenab River in Punjab, Pakistan, belonging to 10 families and 6 orders. Roberts (1997) identified 23 mammalian species from the Chenab River, belonging to 11 families, and 6 orders. Sial (2024) noted 12 different species of mammals, belonging to 7 families and 4 orders.

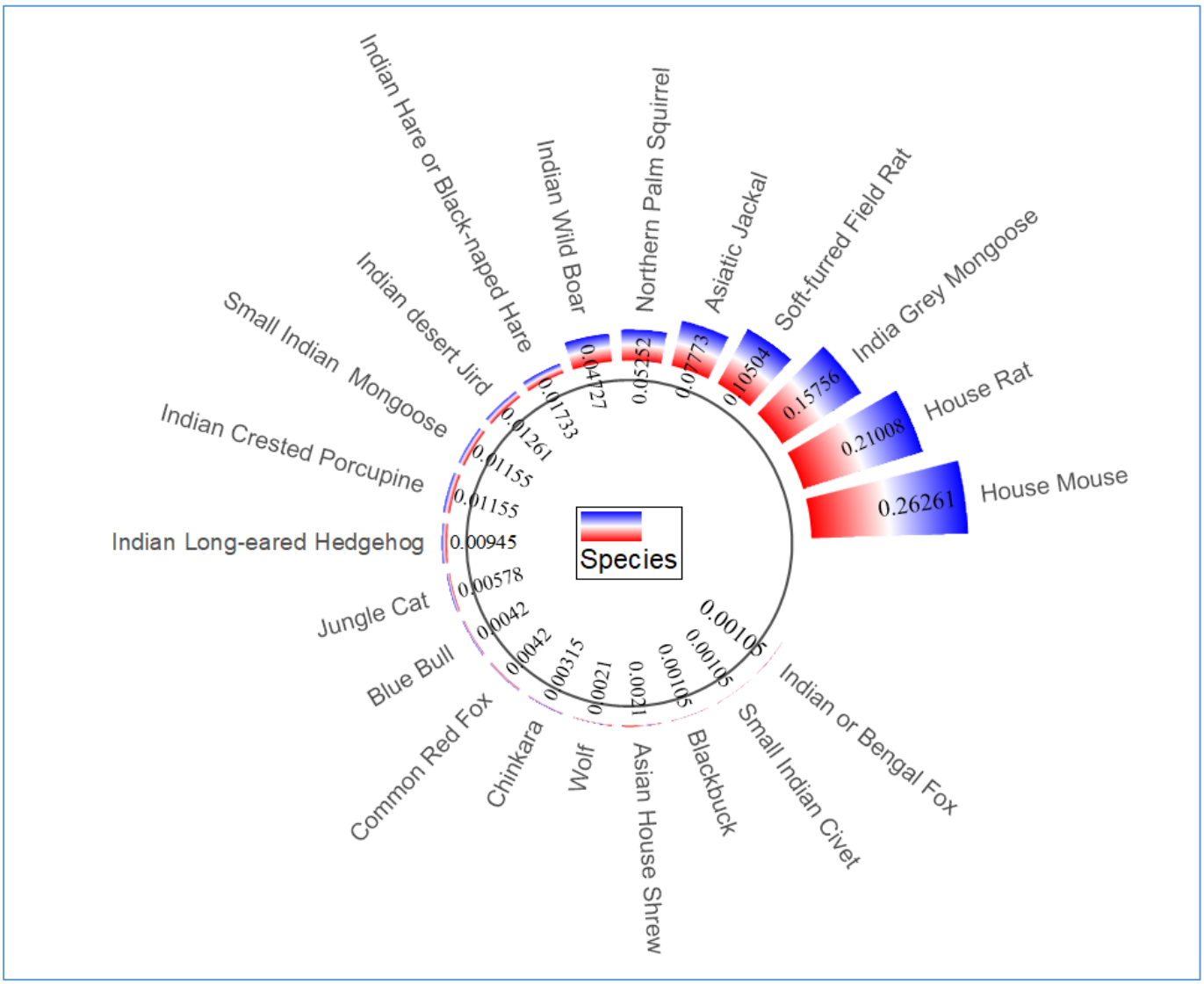

Figure 4. Mammalian species of study area

Figure 5. Mammalian species of study area i.e. (A) Indian Long-eared Hedgehog, (B) Northern Palm Squirrel and (C) Indian desert Jird

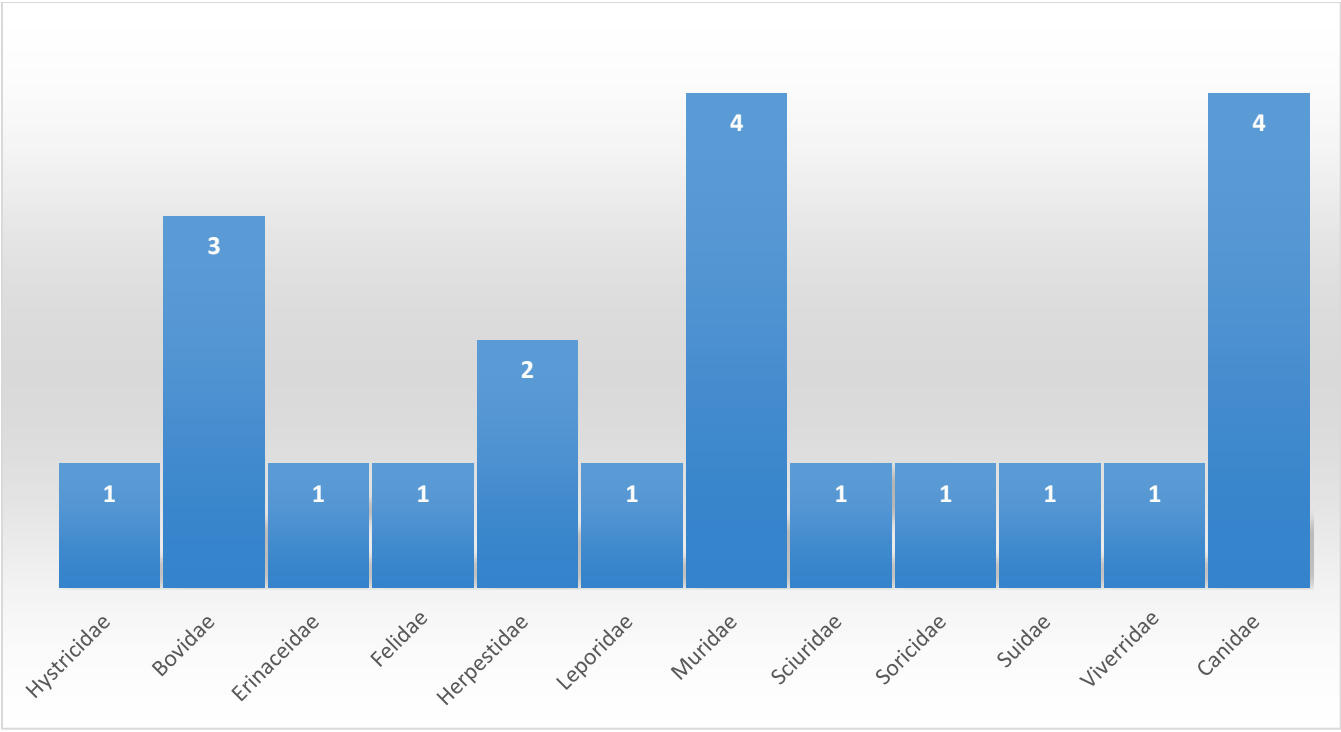

Figure 6. Families of mammalian species in the study area

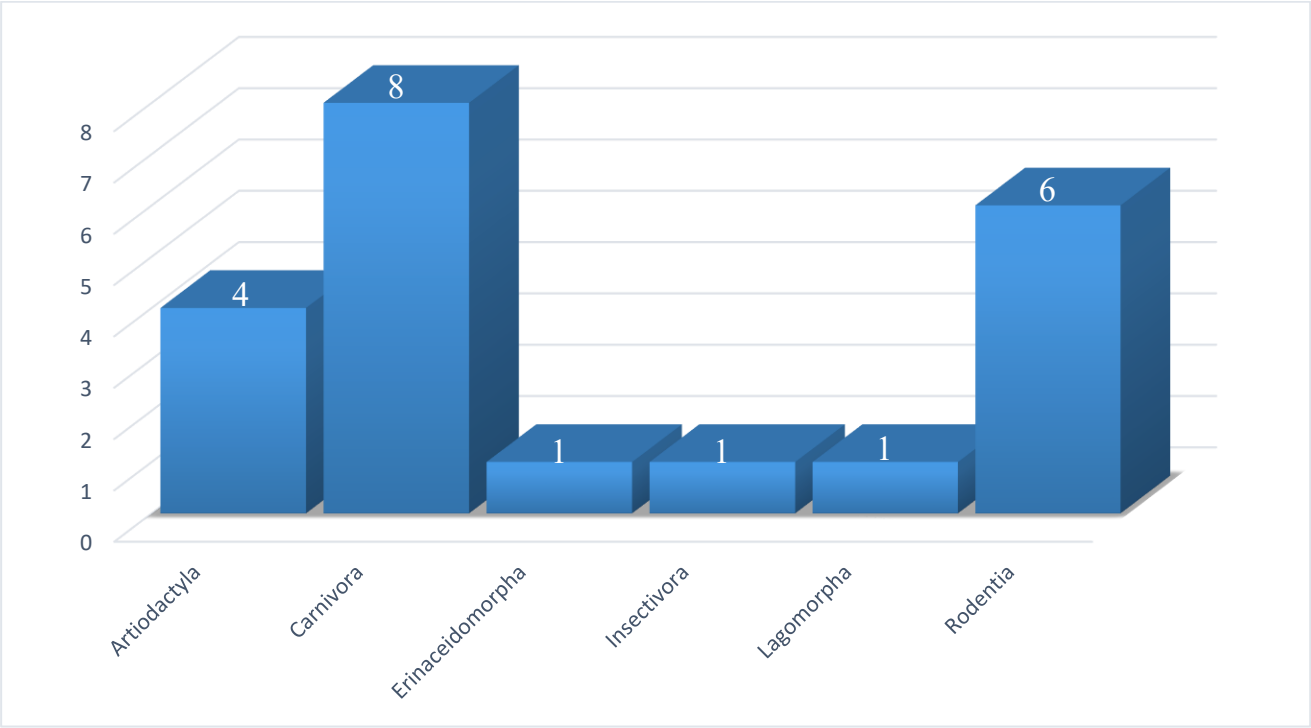

Figure 7. Orders of mammalian species in the study area

The diversity indices show that the area has a high and rich diversity, as the Dominance Index is 0.1605, the Simpson Index is 0.8395, the Shannon-Wiener diversity index (H') is 2.124, the evenness (E) is 0.3982, and the richness index (R) is 2.648, in the study area (Table 2). M Altaf et al. (2014) documented that the Shannon-Wiener diversity index for mammal species at Head Marala, Head Khanki, and Head Qadirabad was 0.86, 0.97, and 0.98, respectively. Species evenness was 0.38 at Head Qadirabad, 0.39 at Head Khanki, and 0.2 at Head Marala. Additionally, species richness was measured at 6.6 for Head Qadirabad, 6.2 for Head Khanki, and 7.1 for Head Marala. Sial (2024) reported the Shannon−Wiener indices for Sulmanki, Islam, and Panjnad as 2.20, 2.13, and 2.45, respectively. The species richness index was consistent across all three sites, measuring 1.61. Additionally, the species evenness values were 0.95 for Sulmanki, 0.92 for Islam, and 1.00 for Panjnad.

Table 2. Diversity indices of mammalian species of Bahawalnagar, Pakistan

Diversity Indices	Number
Species	21
Populations	1904
Dominance Index	0.1605
Simpson Index	0.8395
Shannon-wiener Index	2.124
Evenness Index	0.3982
Richness Index	2.648

During the survey, the highest relative abundance (abbreviated as RA = 0.26261) of *Mus musculus* is documented from Bahawalnagar. The lowest relative abundance (RA = 0.00105) is noted in three species (i.e., *Vulpes bengalensis, Viverricula indica,* and *Antilope cervicapra*) in the natural habitats of Bahawalnagar. It is documented that *Rattus rattus, Herpestes edwardsii, Millardia meltada,* and *Canis aureus* also have high relative abundances of 0.21008, 0.15756, 0.10504, and 0.07773, respectively. *Funambulus pennantii* (0.05252), *Sus scrofa* (0.04727), *Lepus nigricollis* (0.01733), *Meriones hurricane* (0.01261), *Herpestes javanicus* (0.01155), *Hystrix indica* (0.01155), *Hemiechinus collaris* (0.00945), *Felis chaus* (0.00578), *Boselaphus tragocamelus* (0.0042), *Vulpes vulpes pusillus* (0.0042), *Gazella bennettii* (0.00315), *Canis lupus* (0.0021) and *Suncus murinus* (0.0021) are less common in the Bahawalnagar (Table 1). M Altaf et al. (2014) documented that Indian wild boar were the most abundant species along the river Chenab. According to Roberts (1997), the species can be found at elevations of up to 900 m in Pakistan and is a common mammal in Punjab and Sindh.

Varieties of mammals have been observed in cities instead of forests, with some choosing completely or partially disturbed places (Altaf et al., 2023). During the study noted that large and medium-sized animals are generally found in forested areas. Indian crested porcupines, small Indian mongooses, Northern palm squirrels, Asiatic jackals, and soft-furred field rats prefer

minimally disturbed environments. House rats, mice, and shrews, on the other hand, flourish in extremely disturbed habitats. Other studies have supported this finding (Altaf et al., 2023).

Garbage in metropolitan areas provides food for carnivorous and omnivorous animal species alike (M Altaf, 2016). The data suggest that an open environment with animal food is the most critical factor in mammal dispersal. Both urban and rural areas provide food and human shelters, such as roofs and dwelling units. Some animal species are naturally shy and reject human interaction in their environment (Agravat et al., 2025). This could be a significant element in the dispersal of animals in urban environments (Ahmad et al., 2025; Altaf et al., 2023; Altaf et al., 2012; Khushbakhat et al., 2025). But the Asiatic jackal and wild boar invade residential areas when humans are not present or at night. While the reality is that medium and small mammals (such as the small Indian mongoose, jungle cat, and Indian crested porcupine) live in houses, a lot of people do not know about them.

Mammalian species in Bahawalnagar face serious dangers to their survival. Deforestation, a significant concern, involves the destruction of natural forests and plants for firewood or other uses, eliminating many species' natural habitats. Overhunting also contributes to the reduction of mammal populations, as people hunt them for medicine (Altaf, Khan, et al., 2021; Altaf et al., 2018), meat (Muhammad et al., 2024), fur (Altaf, Altaf, et al., 2021; M Altaf et al., 2017), and trophies. Furthermore, agricultural intensification, which expands territory dedicated to crops and livestock while eliminating natural barriers, causes habitat loss (Khushbakhat et al., 2025) and pollution (Altaf et al., 2024). Urbanization exacerbates these challenges by transforming woodlands and grasslands into cities and towns with roads and houses, making it difficult for animals to find food and shelter. Finally, climate change alters temperature and precipitation

patterns, resulting in water and food deprivation for mammals. Together, these factors threaten the survival and prosperity of many mammal species in Bahawalpur.

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Table 1. Mammalian species of Bahawalnagar, Pakistan

Sr.	Order	Family	Common name	*Scientific name*	Species Authority	IUCN
1	Artiodactyla	Bovidae	Blackbuck	*Antilope cervicapra*	(Linnaeus, 1758)	LC
2	Artiodactyla	Bovidae	Blue Bull	*Boselaphus tragocamelus*	(Pallas, 1766)	LC
3	Artiodactyla	Bovidae	Chinkara	*Gazella bennettii*	(Sykes, 1831)	LC
4	Artiodactyla	Suidae	Indian Wild Boar	*Sus scrofa*	Linnaeus, 1758	LC
5	Carnivora	Canidae	Asiatic Jackal	*Canis aureus*	Linnaeus, 1758	LC
6	Carnivora	Canidae	Wolf	*Canis lupus*	Linnaeus, 1758	LC
7	Carnivora	Herpestidae	India Grey Mongoose	*Herpestes edwardsii*	(É. Geoffroy Saint-Hilaire, 1818)	LC
8	Carnivora	Herpestidae	Small Indian Mongoose	*Herpestes javanicus*	(É. Geoffroy Saint-Hilaire, 1818)	LC
9	Carnivora	Viverridae	Small Indian Civet	*Viverricula indica*	(Geoffroy Saint-Hilaire, 1803)	LC
10	Carnivora	Canidae	Indian or Bengal Fox	*Vulpes bengalensis*	(Shaw, 1800)	LC
11	Carnivora	Canidae	Common Red Fox	*Vulpes vulpes pusillus*	Blyth, 1854	LC
12	Carnivora	Felidae	Jungle Cat	*Felis chaus*	Schreber, 1777	LC
13	Erinaceidomorpha	Erinaceidae	Indian Long-eared Hedgehog	*Hemiechinus collaris*	Gray, 1830	LC
14	Insectivora	Soricidae	Asian House Shrew	*Suncus murinus*	Linnaeus, 1766	LC
15	Lagomorpha	Leporidae	Indian Hare	*Lepus nigricollis*	F. Cuvier, 1823	LC
16	Rodentia	Sciuridae	Northern Palm Squirrel	*Funambulus pennantii*	Wroughton, 1905	LC
17	Rodentia	Hystricidae	Indian Crested Porcupine	*Hystrix indica*	Kerr, 1792	LC
18	Rodentia	Muridae	Indian Desert Jird	*Meriones hurricane*	Jerdon, 1867	LC
19	Rodentia	Muridae	Soft-furred Field Rat	*Millardia meltada*	Gray, 1837	LC
20	Rodentia	Muridae	House Mouse	*Mus musculus*	Linnaeus, 1758	LC
21	Rodentia	Muridae	House Rat	*Rattus rattus*	Linnaeus, 1758	LC