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New Record of Civets at Bharatpur, Chitwan and a Review of the Species Diversity in Nepal

Budhan Chaudhary

Birendra Multiple Campus, Tribhuvan University, Bharatpur, Chitwan, Nepal
Email: chaudharybudhan@gmail.com

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Abstract

Civets are alluring nocturnal carnivores having variant external features with different coat colors, stripes and spots, carpal and metatarsal pads, closed or open peri-anal scent glands in both sexes which have great taxonomic value and make these animals acclimatize in a wide range of geographical landscapes from hilly areas to patchy gardens and thin forests of the low land (Terai) located in or near the human settlement areas. The range of Head Body Length (HBL) and Tail Length (TL) in *Paradoxurus* spp. and *Viverricula* spp. distinguishes civets from felids. The study of civets was carried out by direct observation and videos and/or photographs were taken in the sighted places with the record of geological coordinates as evidence. For the record of civets, four wards (*i.e.* 7, 10, 11 and 12) were selected from Bharatpur Metropolitan City by lottery methods from the purposively selected 15 wards out of 29. These selected wards were visited randomly once or upon call in a month riding on a motorbike at the speed of 10 to 20 kilometer per hour in average speed and was crossed 2400 kilometers during four years beginning from January, 2016 to December, 2019. As a result, 11 civets of three Species, six Subspecies and two genera (*i.e. Paradoxurus* spp. and *Viverricula* spp.) were recorded. Among these animals, four subspecies were from Paradoxurinae and two were from Viverrinae subfamilies. Likewise, *Paradoxurus jerdoni caniscus* were reported, 9.09% (n = 1); *Paradoxurus hermaphroditus minor*, 9.09% (n = 1); *Paradoxurus hermaphtoditus pallasii*, 54.55% (n = 6); *Paradoxurus hermaphroditus hermaphroditus*, 9.09% (n = 1); *Viverricula indica baptistae*, 9.09% (n = 1); and *Viverricula indica mayori*, 9.09% (n = 1). Conclusively, the first records of the civet Species and Subspecies from thin gardens of fruiting trees and human houses or settlement areas in the city of Bharatpur, Chitwan, have created a great field to explore ecology and population status. However, human-civet conflicts have been created by the potential harm to poultry and pets as well as possible reservoir hosts of parasitic zoonoses and Covid-19 Viruses. Consequently, the population of civets is de-

clining in an alarming rate due to the threats of vehicle and electric accidents, snaring and random killing by the people.

Keywords

Carnivores, First Record, Mammals, Musk, Parasitic Zoonoses

1. Introduction

Civets are small, nocturnal and charismatic carnivore mammals having civet musks or peri-anal scent glands and belonging to the Order Carnivora, Family Viverridae and subfamilies Paradoxurinae (e.g. *Paradoxurus* spp.) and Viverrinae (e.g. *Viverricula* spp.) [1] [2] [3] The Family Viverridae comprises seven subfamilies (*i.e.* Viverrinae, Paradoxurinae, Hemigalinae, Fossinae, Galidinae, Herpestinae and Cryptoproctinae) with 36 genera and 70 species [3] enlisted from southwestern Europe, Southern Asia (Sri Lanka, Bangladesh, Bhutan, India, Nepal, China, Indonesia, Philippines, Singapore, Thailand, Vietnam, Cambodia, Brunei, Laos) [4] [5] [6], the East Indies, Africa and Madagascar [3]. Besides, scanty studies on civets in the world, species diversity, distribution patterns, ecological behaviors and population status in ex-situ and in-situ habitats are yet to substantiate in Nepal through validated and ample researches. The study on the distribution of civets in the globe has accomplished in several countries which may not suffice to generalize the habitat preference of these listless carnivores. In contrary, several natural and environmental entities can influence habitat selection and hence Nepal is a virgin area for the specific study of civets to prioritize biodiversity conservation.

The vegetation types have a strong influence on the living of civets [7] [8] although these animals have learned to live near or in human habitats. *Paradoxurus* spp. prefers to live close to human dwellings of rural and urban areas where there are fruit bearing trees to get foods [5] [9] [10], bushy and open places to hide and roofs of quiet and abandoned houses to rest on safely. However, *Viverricula indica* prefers to live in the forest with tall grasses and shrubs as well as paddy fields [11]. Generally, civets feed on flowers, nectars and fruits like nuts, berry, coconuts, papaya, banana, litchi and mangoes, etc., among plant products and small animals like frogs, lizards, rodents and eggs or babies of birds as well as the human fetus as anomalous feeding behaviors [12]. Such recurrently living of civets in and around human occupancy can develop human-civets conflict in some residential areas causing harm to poultry and pets. The great risk for civets is also associated with vehicle accidents in Nepal due to fearless lashing locomotion in search of foods at dawn and dusk.

The civets have great importance in prospect to human health harboring different parasites, bacteria and viruses [13] [14] [15] [16] and as an ecological regulator. The civets are also used for materials of animal products like natural

scents, skins, fur and bones, etc. The secretion of peri-anal glands called civet musk is used as the basic gradients in valuable natural perfumes for the pleasant odor. The civet musk collection and export are the national income source in Ethiopia [17] and yet, Nepal has no such practices despite illegal exports of skins and bones by poachers. The indiscriminate killing of civets can lead to a dramatic decline in population to the verge of extinction. Therefore, to unveil the urgency of conservation strategies, the current distribution, population status and species diversity is crucial to report through the research works.

Review of Civet Species in Nepal

The extensive study on mammals of South Asian countries began in nineteenth century nevertheless very little works have been completed in Nepal. The Species and Subspecies diversities of civets reported from protected (*i.e.* National Parks, Conservation Areas) and non-protected areas (*i.e.* human settlement areas, community forests) of Nepal, are reported differently in diverse journals [12] [18] [19] [20] [21] and books [3] [22] [23] [24] [25] [26] published by various researchers and authors. Altogether, six species of civets (*i.e. Viverra zibetha*, *Viverricula indica*, *Prionodon pardicolor*, *Paguma larvata*, *Paradoxurus hermaphroditus* and *Arctictis binturong synonym Paradoxurus albifrons*) were enlisted in the books written by [25] [26]. Similarly, six genera from Paradoxurinae (*i.e. Nandinia*, *Paradoxurus*, *Macrogalidia*, *Arctogalidia*, *Paguma* and *Arctictis*) and seven genera from Viverrinae (*i.e. Viverrra*, *Genetta*, *Poiana*, *Civettictis*, *Osbornictis* and *Prionodon*) were reported from southwestern Europe, southern Asia, the East Indies, Africa and Madagascar [22]. Among these civets *Viverra zibetha* was reported from hilly areas and Central and Eastern Nepal by [3] [27]. Similarly, the *Paradoxurus hermaphroditus bonder* was reported from Central and Eastern Terai, *Paradoxurus hermaphroditus pallasii* from the hills, *Paguma larvata*, *Paguma larvata grayi* and *Paradoxurus hermaphroditus vellerosus* from Central, Eastern and Western hilly regions, *Paguma larvata neglecta* from low-lying districts of Nepal were reported by [3] [22] [23] [25] [26] [27] [28]. These *Paradoxurus* spp. and *Viverricula* spp. were reported with the help of anecdotes prepared from the skins kept in museum and the skins abducted from the poachers although the distribution can be just anticipated. In addition to this, the premier study accomplished by [12] was reported *Paradoxurus hermaphroditus pallasii* and *Paradoxurus hermaphroditus* in low land (Terai) of Nepal. However, the distribution with population status of civets including altitudinal variations is vague. The International Union for Conservation of Nature and Natural Resources (IUCN) placed all the Species of the genera *Paradoxurus* and *Viverricula* in the Least Concern (LC) as National and Global Conservation Status due to wide range of habitat acclimatization [11] [12] [28] [29] [30] even in community and fragmented private forest, grass lands and paddy fields. However, the conservation status LC [28] [30] is almost all unsatisfactory for civets because their natural patterns of distribution are uncertain. In contrary, the

population status may be declining more than expected by poisoning, trapping and hunting for skin trade and to get rid of unnecessary noise at night because of their intense sound production especially during walking on tin roofs and copulation at night.

Overall, the reporting in existence and distribution of *Paradoxurus hermaphroditus hermaphroditus*, *Paradoxurus hermaphroditus minor*, *Paradoxurus jerdoni caniscus*, *Viverriculla indica baptistae* and *Viverricula indica mayori* up to Subspecies may not prevail in Nepal.

2. Materials and Methods

2.1. Materials

The normal camera-Nikon COOLPIX S6400 of 16 Megapixel and 12X zoom was used to take photographs and/or videos of the Civets. The Observation Data Sheets were used to note time and date of records. The pen, pencil, erasers and measuring tape were also used to keep records and to measure Head Body Length (HBL) and Tail Length (TL).

2.2. Methods

2.2.1. Study Area

The study of civets was accomplished in randomly selected four wards (*i.e.* 7, 10, 11 and 12) by lottery method from the purposively selected 15 wards (*i.e.* 1, 3, 5, 6, 7, 8, 9, 10, 11, 12, 14, 18, 23, 26, 29) out of 29 wards of Bharatpur Metropolitan City. The city occupies 433 square kilometers and represents 19.34% area of Chitwan District (*i.e.* 2238.39 square kilometers). The coordinates of this city are 27.6833 N to 84.4333 E with altitude of 208 meter above sea level (a.s.l.). The boundaries of the study areas are Barandabhar corridor forest in the East, Chitraban Municipality and Narayani River in the West, Narayani River and Nawalparasi District in North and Chitwan National Park with community forests in the South. The temperature of these localities ranges from 24 to 35 degree Celsius in summer and 7 to 24 degree Celsius in winter season. The annual rain fall is about 2407 millimeters (mm) [31] that flourishes fruit bearing trees such as Litchi, Mangoes, Guava, Plum tree, Berries, Papaya, China berry, Figs (Peepal), Cherry tree, Black berry (Jamun), Rosary tree (Rudraksha) etc., grown in the Aroma English Secondary School premises (AESS) and in the other localities of Bharatpur. The patchy gardens with tall plants like Bottle palm, Bottle brush, Neem trees, Black berry, China trees (Bakayanu), Coconut trees etc., in open areas and fruiting trees of the private and fragmented gardens as well as availability of crops like maize, carrots and organic kitchen garbage, attract civets to the city where these animals can get foods and hiding places. The study areas are within the distance of 50 to 2000 meters (m) from the community and Barandabhar corridor forests which encompass the home range of civets as recorded by [2] from 0.53 to 1.62 kilometers (km) in distance and 0.64 to 4.51 square km in area (**Figure 1**).

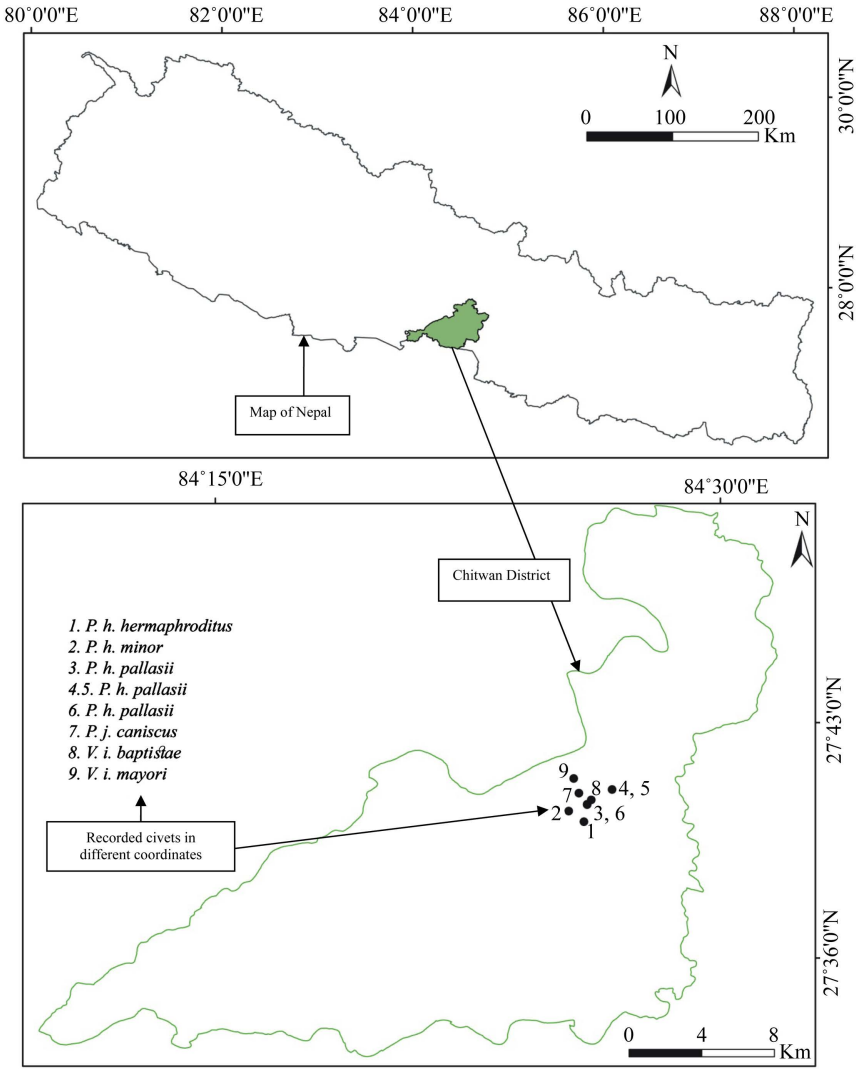

Figure 1. Map of Chitwan district showing recorded civets at Bharatpur (study area) in different coordinates.

2.2.2. Collection of Data

All the data were collected by direct observation of live or dead civets taking photographs or videos from the purposively selected 15 wards (*i.e.* 1, 3, 5, 6, 7, 8, 9, 10, 11, 12, 14, 18, 23, 26, 29) at first and then four wards (*i.e.* 7, 10, 11 and 12) were selected randomly by lottery method. The collection of data was continued for the period of four years beginning from last January, 2016 to December, 2019. During study time, total 2400 km (*i.e.* 4 years × 12 months per year × 1 times bike ride per month × 50 km in average) was crossed. The main roads and subways were visited randomly once in every month at the time of early morning (5 AM) or midday (12 to 2 PM) or in the evening (5 to 7.30 PM) riding on motorbike at the speed of 10 to 20 km per hour that made visible all around the road sides and made easy to stop immediately at need. The bike was stopped when civets were suspected to exist and the areas were closely inspected. The dead animal bodies on or at the sides of the roads were examined to confirm

whether the dead animals were civets. Dead civets were photographed from all possible dimensions to ease identification. However, the body parts of all dead civets were not measured to escape from foul smell and to prevent viral or parasitic infections, except *P. hermaphroditus minor* and *P. jerdoni caniscus* which were measured during taxidermy in the laboratories. In spite of these works, few shots of civet photographs were missed in low light of the evening due to use of normal camera (Nikon COOLPIX S6400, 16 megapixels and 12X wide zoom). The civets missed in photographs were not included in the results in absence of evidences.

3. Analysis of Data

The collected data were tabulated (Tables 1-3) and were analyzed using MS-Excel.

Table 1. Lists of the mammals subspecies of the order-carnivora, family-viverridae and subfamilies-paradoxurinae and viverrinae.

S.N.	Scientific Name			Common Name	Local Name	Scientists and Date	Conservation Status [28] [30]		Recorded Number	Recorded Stages	Recorded Sites
	Genus	Species	Subspecies				National	Global			
1	*Paradoxurus*	*hermaphroditus*	*hermaphroditus*	Asian Palm Civet	Tadi Nir Biralo	Schreber, 1778	LC	LC	1	Adult, dead	BMPC-09, Hakim Chowk
2	*Paradoxurus*	*hermaphroditus*	*minor*	Common Palm Civet	Mal Sapro	Bonhote, 1913	LC	LC	1	Adult, Dead	BMPC-7, Krishnapur, Shanti Tole
3	*Paradoxurus*	*hermaphroditus*	*pallasii*	Common Palm Civet	Mal Sapro	Gray, 1832	LC	LC	3	Babies, live	BMPC-10, AESS Premises
4	*Paradoxurus*	*hermaphroditus*	*pallasii*	Common Palm Civet	Mal Sapro	Gray, 1832	LC	LC	1	Adult, live	BMPC-11, Pokhari Chowk
5	*Paradoxurus*	*hermaphroditus*	*pallasii*	Common Palm Civet	Mal Sapro	Gray, 1832	LC	LC	1	Adult, live	BMPC-11, Pokhari Chowk
6	*Paradoxurus*	*hermaphroditus*	*pallasii*	Common Palm Civet	Mal Sapro	Gray, 1832	LC	LC	1	Adult, live	BMPC-10, AESS Premises
7	*Paradoxurus*	*jerdoni*	*caniscus*	Brown Palm Civet	Mal Sapro	Pocock, 1933	LC	LC	1	Adult, Dead	BMPC-10, Chaubis Kothi
8	*Viverricula*	*indica*	*baptistae*	Small Indian Civet	Sano Nir Biralo	Pocock, 1933	LC	LC	1	Adult, Dead	BMPC-10, NTC Road
9	*Viverricula*	*indica*	*mayori*	Lesser Oriental Civet	Sano Nir Biralo	Hodgson, 1838	LC	LC	1	Adult, Dead	BMPC-10, Bhat Bhateni Road
Total	**2**	**3**	**6**						**11**		

*Note: BMPC = Bharatpur Metropolitan City, AESS = Aroma English Secondary School, NTC = Nepal Telecom.

Table 2. Civets recorded sites with coordinates, date, time and evidences.

S.N.	Scientific Name			Recorded Sites	Location Coordinates (Googlemap.com)	Recorded Date and Time	Recorded Evidences
	Genus	Species	Subspecies				
1	*Paradoxurus*	*hermaphroditus*	*hermaphroditus*	BMPC-09, Hakim Chowk	27.667578N 84.432520E	Thursday, 18 June, 2020; 09:37 PM	Photos
2	*Paradoxurus*	*hermaphroditus*	*minor*	BMPC-7, Krishnapur, Shanti Tole	27.672846N 84.424979E	Tuesday, 13 February, 2018; 01:48 PM	Photos
3	*Paradoxurus*	*hermaphroditus*	*pallasii*	BMPC-10, AESS Premises	27.676186N 84.434113E	Sunday, 23 June, 2019; 01:30 PM	Photos
4	*Paradoxurus*	*hermaphroditus*	*pallasii*	BMPC-11, Pokhari Chowk	27.683516N 84.446462E	Monday, 16 April, 2018; 09:30 PM	Video
5	*Paradoxurus*	*hermaphroditus*	*pallasii*	BMPC-11, Pokhari Chowk	27.683516N 84.446462E	Tuesday, 17 April, 2018; 09:56 PM	Video
6	*Paradoxurus*	*hermaphroditus*	*pallasii*	BMPC-10, AESS Premises	27.676003N 84.434125E	Thursday, 11 February, 2016; 1:34:00 PM	Photos
7	*Paradoxurus*	*jerdoni*	*caniscus*	BMPC-10, Chaubis Kothi	27.681690N 84.430037E	Thursday, 17 November, 2016; 01:20 PM	Photos
8	*Viverricula*	*indica*	*baptistae*	BMPC-10, NTC Road	27.678379N 84.436146E	Saturday,13 August, 2016; 01:25 PM	Photos
9	*Viverricula*	*indica*	*mayori*	BMPC-10, Bhat Bhateni Road	27.688967N 84.427439E	Sunday, 24 September, 2017; 07:12 AM	Photos

*Note: BMPC = Bharatpur Metropolitan City, AESS = Aroma English Secondary School, NTC = Nepal Telecom.

Table 3. Diversity of civets subspecies with common and Nepalese names and recorded percentage.

SN	Family	Subfamily	Genus	Species	Subspecies	Common Name	Nepalese Name	Recorded Frequency	Total Recorded Number	Recorded Percentage (%)
1	Viverridae	Paradoxurinae	*Paradoxurus*	*hermaphroditus*	*hermaphroditus*	Asian Palm Civet	Tadi Nir Biralo	1	11	9.09
2				*hermaphroditus*	*minor*	Comman Palm Civet	Mal Sapro	1	11	9.09
3				*hermaphroditus*	*pallasii*	Comman Palm Civet	Mal Sapro	6	11	54.55
4				*jerdoni*	*caniscus*	Brown Palm Civet	Mal Sapro	1	11	9.09
5		Viverrinae	*Viverricula*	*indica*	*baptistae*	Small Indian Civet	Sano Nir Biralo	1	11	9.09
6				*indica*	*mayori*	Lesser Oriental Civet	Sano Nir Biralo	1	11	9.09
Total	**1**	**2**	**2**	**3**	**6**			**11**	**11**	100.00

The IUCN categories [28] [30] such as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Least Count (LC) and Data Deficient (DD) were used for categorization of Global and National Status of civets. The reference section was managed manually as well as using free version "Mendeley" software. In confirming Species and Subspecies of the civets, the distinguishing characteristics were thoroughly examined and verified.

3.1. Identification and Classification

The morphological identification of mammals was performed on the basis of body size and distinguishing characters such as presence of scent glands in both sexes (*i.e.* in male between scrotum and prepuce which are not pendulous, and in female encircling or behind vulva), hair color, spots and patterns in the head and body, extension and number of stripes, tail length with or without rings, snout size, shape of the rhinarium, limbs with flanks, noticed behaviors, habitat of records and comparing with literatures or pictures given in the research articles of different journals [1] [19] [21] [32] [33] and reference books, [3] [22] [23] [24] [25] [26] For further confirmation, online search of relevant literatures and pictures in Wikipedia, Wikimedia, Integrated Taxonomic Information System (ITIS) and Worlds Animal Diversity (WAD) were equally executed to compare the range of Head Body Length (HBL), 450 to 630 mm and Tail Length (TL) 300 to 430 mm in *Viverricula* spp. and 432 to 710 mm HBL with 406 to 660 mm in TL of *Paradoxurus* spp.

The genus *Paradoxurus* spp. are included in the Subfamily Paradoxurinae and have peculiar morphological characters such as: the feet are short and broad with five digits and adapted for scansorial habitat, semi-plantigrade, double touching carpal and metatarsal pads as wide as the inferior planter pads, less specialized glandular pouches (more widely-spread area bordered with naked skin), non pendulous large scent glands surrounding vulva in female and extending from prepuce to penis in male (in male the glands open at the naked neck of penis and in female the opening embrace with vulva), in the hind legs major parts are naked from the heel to downwards. The tail is non-prehensile, hairy hind feet with heel, coat not so long and shaggy, short hairs at the back of ears, definite patterns of dorsal stripes with lateral spots and often concealed by the long black hair tips (**Figure 2**) [3].

The genus *Viverricula* spp. is included in the Subfamily Viverrinae and has peculiar morphological characteristics. The feet are terrestrial, digitigrades, single and conical carpal pad remote from planter pad, metatarsal pads absent, hind foot hairy from heel to downwards, sent glands locate in the perineum and in both sexes (*i.e.* in male between scrotum and prepuce and in female surrounding the vulva), and open into highly specialized pouches. The anterior edges of the ears set close to each other; the fore head is narrow, no dorsal crest of long hairs, claws without protecting skin sheaths. Very long cheek suture, short and slender muzzle (**Figure 3**) [3] [22] [24].

(a) (b) (c) (d) (e) (f)

Figure 2. Different subspecies of Civets: *Paradoxurus hermaphroditus hermaphroditus* (a), *Paradoxurus hermaphroditus minor* (b), *Paradoxurus hermaphroditus pallasii*-babies (c) and an adult (d), *Paradoxurus jerdoni caniscus* (e), and *Viverricula indica baptistae* (f).

3.1.1. Common Palm Civet (*Paradoxurus hermaphroditus hermaphroditus*)

The common palm civets differ from Small Indian Civets having no patterns in the neck and tail. The neck hairs are long and shaggy, directing backwards. The body color varies from creamy white to brownish black or jet-black markings. The dark or black spots coalesce into three dorsal stripes on both sides and continues up to the base of the tail. The stripes are visible in close inspection and

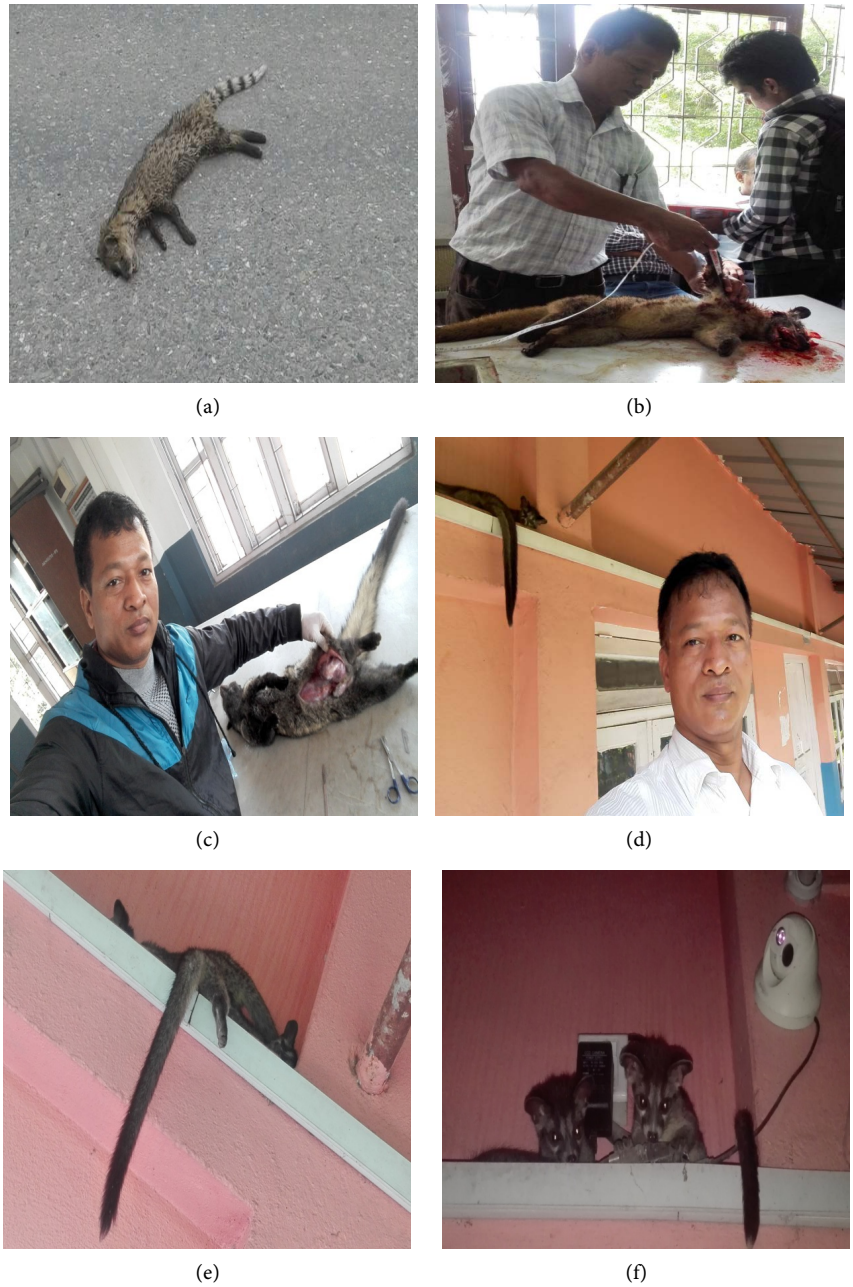

Figure 3. *Viverricula indica mayori* (a), and taxidermy of *Paradoxurus jerdoni caniscus* (b) and *Paradoxurus hermaphroditus minor* (c) in the laboratories of Birendra Multiple Campus and Aroma English Secondary School respectively, babies of *Paradoxurus hermaphroditus pallasii* sleeping fearlessly at day (d) and (e), and active at dusk (f).

these markings of the body distinguish from Himalayan Palm Civets and Brown Palm Civets. The civets have grayish face with dark mask and variable white on the face with remarkable pale or white patches on forehead as well as below the eyes and ears but lacks white bands in the fore head and nose. Rather, the face looks darker in this species and differs from Himalayan Palm Civets with pale face. The HBL ranges from 420 to 710 mm, TL 400 to 660 mm with body weight 1.5 to 4.5 kg (**Figure 2**) [3] [22] [24].

3.1.2. Common Palm Civet (*Paradoxurus hermaphroditus minor*)

Presence of definite dorsal stripes and lateral spots on the coat, contour hairs long and shaggy, frequently concealed by the black hair tips, the neck hairs directed backwards, black vibrissae in the face, closely resembling to *pallassi* in contour and pattern but skull and teeth smaller with less distinct white areas on the mask, muzzle patches absent, brow band typically obliterated by black, and smaller than *laotum* in size with narrow muzzle, less robust body, ground color more brighter and ochreos, mask dominantly black instead of white. HBL is 447 to 503 mm and TL is 432 to 508 mm with body weight 4.5 kg (**Figure 2**) [3].

3.1.3. Common Palm Civet (*Paradoxurus hermaphroditus pallasii*)

The common palm civets differ from Small Indian Civets having no patterns in the neck and tail. The body color varies from creamy white to brownish black or jet-black markings. The dark or black spots coalesce into three dorsal stripes on both sides and continues up to the base of the tail. These stripes are visible in close inspection. These markings of the body distinguish from Himalayan and Brown Palm Civets. *Paradoxurus hermaphroditus pallasii* has grayish face with dark mask and variable white on the face with remarkable pale or white patches on fore head as well as below the eyes and ears. However, white bands in the fore head and nose are lacking. The face looks darker in this species and differs from Himalayan Palm Civets (*Paguma larvata*) with pale face. The pale furs locate at the base of ears and extend to the neck which differs from *Paradoxurus hermaphroditus hermaphroditus*. The HBL ranges from 420 to 710 mm, TL 400 to 660 mm with body weight 1.5 to 4.5 kg (**Figure 2**) [3] [22] [24].

3.1.4. Brown Palm Civet (*Paradoxurus jerdoni caniscus*)

Similar to palm civet and has no markings on the face and the body. The body is uniformly chocolate-brown with brown to blackish vibrissae. The head, tail and limbs are darker with buff shoulder and greyer flanks. The tail is longer often with pale tip and the neck hairs grow in opposite direction to rest of the fur. The HBL ranges from 430 to 620 mm and TL 380 to 530 mm with body weight 1.2 to 4.3 kg (**Figure 3**) [3] [24].

3.1.5. Little Civets or Small Indian Civet (*Viverricula indica baptistae*)

The Small Indian Civets are the mammals of carnivore having buff to grey body colors with small dark spots on the fore quarter and larger spots tending to run to posterior side, stripes all over the flanks associated with 3 to 5 dark dorsal lines. The tail is black and white ringed with 6 to 10 dark bands with a pale tip. The animals are smaller in size and lack dorsal crest of long hairs that differs from Malabar Civets and have less developed scent glands. The ears are small, round and closely set on the top of head similar to cats while legs are dark and longer. The body is elongated in low-slung unlike cats and the muzzle is short and pointed with white patches on cheeks and indistinct white spots between the eyes. The throat is creamy white with two dark cross bands with a bold dark spot on the anterior band which is located at the beginning of the neck connecting

each other dorso-laterally with dark cross band located at the end of neck. Two thin and incomplete dark bands also begin from dorso-lateral dark lines that begin from the postero-lateral sides of each ear. The HBL ranges from 450 to 630 mm, TL 250 to 430 mm with body weight 2 to 4 kg (**Figure 3**) [3] [24].

3.1.6. Little Civet or Small Indian Civet (*Viverricula indica mayori*)

The Small Indian Civets are the mammals of carnivore having buff to grey body colors with small dark spots on the fore quarter and larger spots tending to run to posterior side as stripes all over the flanks associated with 3 to 5 dark dorsal lines. The tail is black and white ringed with 6 to 10 dark bands with a pale tip. The animals are smaller in size and lack dorsal crest of long hairs that differs from Malabar Civets and have less developed scent glands. The ears are small, round and closely set on the top of head similar to cats while legs are dark and longer. The body is elongated in low-slung unlike cats and the muzzle is short and pointed with white patches on cheeks and indistinct white spots between the eyes. The throat is creamy white with two dark cross bands with a bold dark spot on the anterior band which is located at the beginning of the neck connecting each other dorso-laterally with dark cross band located at the end of neck. Two thin and incomplete dark bands also begin from dorso-lateral dark lines that begin from the postero-lateral sides of each ear. The HBL ranges from 450 to 630 mm and TL 250 to 430 mm with body weight 2 to 4 kg (**Figure 3**) [3].

4. Result

In this study, total 11 civets with six Subspecies were recorded live or dead in videos or photographs during field visits. Among the recorded civets, eight were adults and three were babies belonging in two genera (*i.e. Paradoxurus* and *Viverricula*), three Species (*i.e. Paradoxurus hermaphroditus*, *Paradoxurus jerdoni*, and *Viverricula indica*) and six Subspecies (*i.e. Paradoxurus hermaphroditus hermaphroditus*, *Paradoxurus hermaphroditus minor*, *Paradoxurus hermaphroditus pallasii*, *Paradoxurus jerdoni caniscus*, *Viverricula indica baptistae*, *Viverricula indica mayori*) of the Family Viverridae and subfamilies Paradoxurinae and Viverrinae. The *P. h. pallasii* were recorded the highest, 54.55% (live adult, n = 3; live babies, n = 3); and others were *P. h. caniscus*, 9.09% (dead adult, n = 1); *P. h. minor*, 9.09% (dead adult, n = 1); *P. h. hermaphroditus*, 9.09% (live adults, n = 1); *V. i. baptistae*, 9.09% (dead adult, n = 1); and *V. i. mayori*, 9.09% (dead adult, n = 1) (**Tables 1-3**, **Figure 2** and **Figure 3**).

The Common Palm Civet, *Paradoxurus hermaphroditus minor*, Brown Palm Civet, *Paradoxurus jerdoni caniscus* and Lesser Oriental Civet (*Viverricula indica mayori*) appears to be the first record from Nepal and other three Sbspecies *Paradoxurus hermaphroditus hermaphroditus*, *Paradoxurus hermaphroditus pallasii*, and *Viverricula indica baptistae* are also premier in records from Central and Urban areas of Bharatpur, Chitwan, Nepal.

An adult Asian Palm Civet, *P. h. hermaphroditus* was killed at neighbor's house at night which was biting in the legs of a dog kept in kennel (**Table 1**,

Figure 2) and an adult Common Palm Civet, *P. h. minor* was recorded killed by electric shock at Shantitole, Krishnapur-7 (Table 1, Figure 2) whereas there were three litters and an adult of *P. h. pallasii* photographed live at AESS premises (Table 1, Figure 2 and Figure 3). Similarly, an adult Brown Palm Civet, *P. h. caniscus* was killed by an unknown vehicle at night at Chaubis Kothi chowk (Table 1, Figure 2). Likewise, an adult *V. i. baptistae* was recorded killed in accident with unknown vehicle at night in the road of Nepal Telecom Office (Table 2, Figure 2) and another adult *V. i. mayori* was also found killed by a vehicle in the early morning at the road in front of Bhat-Bhateni Supermarket (Table 2, Figure 3).

Recorded Behaviors

The civets were found aggressive for searching foods like Litchi, Mangoes, Papaya, Coconut, Berries etc., and easy pet animals such as poultry and poppies that made these animals unable to detect risk at hunger. The restless behaviors lead to tragic cases like electric shocks, vehicle accidents and also were killed by people while trying to steal poultry and injured pet dogs. The *P. hermaphroditus minor* which was killed in electric shock had produced offensive odor from scent glands that was persistent for three weeks in the AESS Biology Lab where taxidermy was made.

The civets were found walking comfortably on small branches of trees, in the electric wires and in the outlet pipes of the tin roofs. These animals were found living carelessly at day time in the nest of birds after dine of eggs and under the tin roofs that can invite threats and became gradually active with frequent yawning while the darkness was increasing. Two babies were observed sleeping carelessly from 12 Noon and became fully active at 7 PM and one more baby was appeared at 7:15 PM with them. These babies and the mother became invisible making noise in tin roofs as the darkness was increased (Figure 2 and Figure 3).

5. Discussion

Recording of the civets in the wild is hard slog due to nocturnal behavior of these timid animals and yet two genera, three Species and six Subspecies of the civets laid on the Family Viverridae and two subfamilies Paradoxurinae and Viverrinae, were reported. The records of these civets qualify uniqueness in Species and Subspecies from urban areas and low lands of Bharatpur, Nepal. The genetic study of *Paradoxurus* spp. declares variations in Species and Subspecies [20] with varieties of morphological distinctiveness such as coat colors, patterns of stripes, spots, carpal and metatarsal pads, shape and size of the snouts, color of vibrissae, etc. Among the sporadic research reports published by [27] [28] [30] remain imprecise in context to Nepal regarding typical recordings and reporting of particular location, date and time. The study of civet behaviors, associated threats and population status is still in the base line although the sympatric association of wild mammals and the people was reported by [34] from Bharatpur,

Chitwan due to availability of fruit bearing plants and organic kitchen garbage.

The present study revealed six Subspecies of the civets such as *Paradoxurus hermaphroditus hermaphroditus*, 9.09% (n = 1); *Paradoxurus hermaphroditus minor*, 9.09% (n = 1); *Paradoxurus hermaphroditus pallasii*, 54.55% (n = 6); *Paradoxurus jerdoni caniscus*, 9.09% (n = 1); *Viverricula indica baptistae*, 9.09% (n = 1); and *Viverricula indica mayori*, 9.09% (n = 1) which were exclusive to the former reports given by [28] [30] for *Paradoxurus hermaphroditus*, *Viverra zibetha*, *Paguma larvata*; by [28] [35] and *Paradoxurus* spp., *Viverricula indica* by [28] [30], with pictorial and distinguishing characteristics explained in different books of mammals [22] [23] [24] [25] [26]. The behaviors, population status and patterns of distribution are yet to confirm in Nepal. Few international researchers such as [1] [3] [33] had attempted to explore the species diversity through collected skins of the civets in the museums of Nepal and scarcely was recorded through direct observation in natural habitat which may not be adequately effective as local researchers or investigators can report species diversity and behaviors although species identification may delude by sole basis of morphology.

Like non-matching predicted behaviors of wildlife, some aberrant behaviors of civets were observed during field works. The animals were careless from the risk at day time, especially babies. The restless behaviors at dawn and dusk lead to tragic cases like electric shocks, vehicle accidents, and were killed by people while making noise on/under the tin roofs and trying to dine poultry and injure pets as well (**Figure 2**) [34].

The Lesser Oriental Civet (*Viverricula indica mayori*); Brown Palm Civet, *Paradoxurus jerdoni caniscus* and Common Palm Civet, *Paradoxurus hermaphroditus minor*; appears to be the first record from central and low lands (Terai) of Nepal. Although some species like *Paradoxurus hermaphroditus hermaphroditus* and *Paradoxurus hermaphroditus pallasii* were reported from the Terai and Central and Eastern hilly regions [3] [12] [33]. The *Viverricula indica baptistae* was described to exist in erratic place of hills in Nepal [32] and there were cynical descriptions about distribution and records in absence of photographic evidences. Still there are some published books from Nepal listing up to Species level of Common Palm Civets (*Paradoxurus hermaphroditus*) and Little Indian Civets (*Viverricula indica*) [23] [25] [26] which are limited in description to the Species and proper recorded time, date and localities are missing, although South-east Asia contributes in the largest scale to publish papers regarding small mammals including civets [13].

The civets are also the reservoirs of different parasites, bacteria and Viruses [36] [37] [38] [39] which can spread epidemics of bacterial, viral and zoonotic diseases. The similar case was experienced by the researcher as there was symptoms of Covid-19 such as mild fever, heavy head, taste loss, smell loss, muscle pain and throat sore within third and fifth days of taxidermy of both *Paradoxurus jerdoni caniscus* and *Paradoxurus hermaphroditus minor* in the Zoology Laboratory of Birendra Multiple Campus, Tribhuvan University and AESS at Bharatpur, Chitwan, respectively. In contrary to it, the disease was impossible to

confirm at that time in Nepal due to lack of sophisticated laboratory facilities (Figure 3).

6. Conclusion

The primarily reported species diversity of civets in the low land (Terai) and sporadic records from the hilly regions of Nepal, from thin gardens of fruiting trees and on/under the tin roofs of human houses in the city areas, have created human-civet conflicts as the civets cause potential harm to poultry, pets, etc., and acts as significant reservoir hosts for parasites, bacteria and viruses like Covid-19 Virus as well. The increased threats of vehicle accidents, snaring and random killing of civets by the people have also created alarming situations in the conservation of fascinating animals (civets) in spite of the Data Deficient (DD) population status throughout the country.

Recommendations

The emphasis should be given in the listing of civet Species throughout the country to recognize the population status that helps to develop conservation strategies to mitigate alarming threats of the civets and to protect human health from possible zoonoses in the future. Therefore, plantation of fruit bearing plants in the urban areas is highly recommended in addition to developing awareness in conservation to the community level.

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Conflicts of Interest

The author has no conflicts of interests regarding publication of this research paper.

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