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Small Mammals Conservation Issues

Conserve Small Mammals for Sustainable Forest

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We were glad to welcome Acting Director General, DNPWC Mr. Fanindra Kharel as the chief Guest. Here by, we are grateful to his presence, Prof. Karan B. Shah for keynote, Dr. Sarala Khaling for the session chair, Mr. Jhamak Karki for invited presentation and session chair. We are thankful to Dr. Nanda Bahadur Singh, Assistant Professor, Central Department of Zoology, Prof. Khadga Basnet from Central Department of Zoology, Dr. Narendra Man Babu Pradhan WWF Nepal and Dr. Rinjan Shrestha for their precious time as guest in the program.

We thank Ms. Anita Shrestha for cover design. We also appreciate the tireless contribution of volunteers, SMCRF Executive members and other direct and indirect supporters.

Editors

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KEYNOTE

CONSERVE SMALL MAMMALS FOR SUSTAINABLE FOREST

KARAN BAHADUR SHAH
Natural History Museum, Department of Zoology, Tribhuvan University, Swoyambhu, Kathmandu, Nepal

It is widely acknowledged that due to variable topography, altitudinal variation, variation in climate and vegetation, Nepal has biodiversity values that are of global significance. In fact, nature has endowed our country with a magnificent asset, in the form of marvelous variety of flora and fauna, an asset which cannot fail to be generally appreciated and cannot be comparable with that of any country in the world. Nepal harbors the fauna of Indomalayan and Palaearctic affinity with predominantly Indomalayan distribution. The availability of scientific information on the overall native biodiversity still remains scanty, as a result the richness of the biodiversity is not fully known. However, probably due to their dominating characteristics, charismatic values, threatened status, biological role played in an ecosystem and interactions with human being comparatively more information are available on the mammalian fauna of the country.

B. H. Hodgson was the first collector of Nepalese mammals and he collected 373 mammal specimens belonging to 70 genera and 114 species. However, he had used native collectors, so most of his specimens were lacking exact locality data. Subsequently, a few other scientists have contributed on the mammalogy of Nepal and since last few decades Nepalese mammalian fauna have been appeared in several publications by native and foreign scientists. So far, 1041 species of mammal belonging to 322 genera has been recorded from the Indomalayan region. However, a review of the available literature confirms the occurrence of only 210 species of mammal in our country. This is because a huge information gap exists on the scientific inventories related to the small mammals as most of the works to date being carried out on the large charismatic mammals like wild elephant, tiger, rhino, snow leopard and red panda. Many parts of the country especially outside the protected areas are still to be surveyed in order to record the existing biodiversity, especially the small mammals. In future, surveys on these areas will definitely add further species, both as a new species records for the country and new for science as well. Therefore, a great opportunity waits on this field for scientists.
The occurrence of pigmy hog (*Sus salvanius*), Indian chevrotain (*Moschiola memina*), wild yak (*Bos mutus*), and chiru (*Pantholops hodgsoni*) has not been reconfirmed in recent years, therefore their presence is doubtful in the country. The pigmy hog and Indian chevrotain were formerly recorded from Terai region, while wild yak and chiru inhabit in the high altitude Trans-Himalayan mountainous regions. Virtually, there has been no available standard literature, which had confirmed occurrence of chiru in any of the Trans-Himalayan regions of the country. However, many pairs of horn of wild yak kept on the *chortens* are still could be seen in different parts of Mustang district and it is commonly said that the last incident of killing a wild yak took place some 40 years ago by a Tsaile village hunter.

Among the recorded 210 species of wild mammal, two species, a rodent Himalayan field mouse (*Apodemus gurkha*) and a bat Csorba's myotis (*Myotis csorbai*) are endemic to the country. So far the Himalayan field mouse is recorded from Gorkha, Lamajung, Kaski and Mustang districts, while Csorba's myotis occurs in the mid-mountain regions. Besides, harboring mammals of fairly common to rare and endangered status, Nepal also has introduced species. The mammalian fauna are widely distributed throughout the country. They are recorded from most of the nooks and corners of Mechi to Mahakali regions, with vertical distribution ranging from < 100 m in Terai regions to > 6000 m in the Himalayas.

As many as 47 species of Nepalese mammals are included in different Appendices of CITES, more than 50 species are listed in different threat categories of IUCN Red Data Book and 27 species are included in the Nepal Government's National Parks and Wildlife

Conservation Act 1973

The small mammals constitute more than 65% of the total mammalian fauna recorded from Nepal. Some small mammals are remarkable for the beauty of their coloration, unique shape, size and behavior. Take the example of Scaly ant eater, which with its long scaly body looks more like a reptile than any form of mammal. A further interest attaches to small mammals from their association with the folklores and the legendry beliefs of the country, especially in our rural parts. It is an interest not confined to only Nepal alone, but exists everywhere, wherever human civilization occurs, because of the high esteem and admiration of this group. A cat crossing one's path is regarded to be an ill omen and a devout person would, therefore, discontinue his journey along the same path, although contrary to this belief cat is regarded as the charger of Shasti, a goddess of the Hindus.

Among Nepalese small mammals mongoose figure in the Mahabharata as a teacher of wisdom to king Yudhistira. The Vasudhara (consort of Jambhala) represents five specimens of Newari art and her vehicle is a mongoose. Rat or mice is regarded as the *vahana* (vehicle) of Ganesha and the animal is worshipped along with the deity. Hare is regarded as a cultural hero, who teaches the medicine, dance and art of life. In fact, one could cite many more references from the sacred books concerning the religious and cultural aspects of small mammals in the country.

Many products derived from small mammals are held for various reasons in high esteem. Some small mammals are indicator of change in environment, climate change and natural calamities like landslides, floods and earthquakes. In search of food, when they rootle the ground they increase its fertility.

Many small mammals play a vital role in the wellbeing of the forests, but this fact is not sufficiently recognized in our country. We need to realize that any undue increase or decline in the number of one species affects the lives, habits and economy of many others. The small mammals serve man by keeping down the numbers of animals which would otherwise become a still greater threat to his crops, orchards, natural forests and various other plantations. Some small mammals like shrews, bats, moles etc. are strictly insectivorous; therefore they are an indispensable balancing force in the nature. The small mammals are one of the principal agencies that control the bewildering multiplication of insect life, which, if

unchecked, would overwhelm all life in this planet. It is sure that without their support, our crops, our orchards, our food supplies, our forests would be completely devoured by hordes of ravaging rodent and insect pests.

Of all the mammals which have become parasitic on man, none are greater pests and more destructive than rats and mice. Grains of all sorts are their chief and favorite food. Before the grain is sown, in every stage of its growth and after the harvest, wherever it is stored and in whichever form it is used it is subject to the attacks of these animals. The small cats, civets, mongoose and foxes provides the ecosystem services to the human being by helping to reduce the swarms of these rodent pests which damage our valuable belongings. The weasels though are destructive to man's domestic stock, they play an essential and effective role in keeping down the overwhelming number of rats, mice and vermin which are notorious pests on the various plants. Foxes are great destroyers of rodents and smaller vermin and this is more than repay of the damages they are believed do to the poultry and other human properties.

Carnivore small mammals check upon the over-increase population of some herbivorous species. Cats of small mammal group prey upon yet smaller animals especially hares, rats and mice and become a check upon the superabundant increase of these species. There are plenty of examples, when carnivorous small mammals like weasels, stoat, mongoose were killed to protect reared poultry species from their attack, led to an overwhelming increase in the number of rabbits and consequently to serious damage both to crops and soil.
There is a relationship between small mammals and plants. As many of these are fruit eaters and they play important role in the dispersal of seeds, which they pass out in their droppings. Coffee berry seeds defecated by civets are collected and used for producing high quality coffee, which fetches high market price. In Eastern Nepal, the accumulation of cardamom seeds found in civet's fecal matter are collected and used for further plantation, they germinate into high quality seedlings, grow as healthy plants and produce bumper crop.

The small Indian mongoose was introduced from India into Jamaica for the express purpose of destroying rats, which infested the plantation. They did their work exceedingly well and received honorable mention in the parliament. Fruit bats are habitual raiders of our plantations, but by doing so they also play vital role in their pollination and seed dissemination. Insect eating bats by their destruction of myriads of crop and other insect pests play a useful role in human economy. In facts, majority of bats function as a potent check on insect life. Thus, all small mammals play a significant role in the sustainability of the forests. Therefore, we must appreciate their value and strive for their conservation.

Many living beings share this planet with human being. Human and wildlife species are dependent on plants and animals serving as different levels of producers in the nature. Human derive most of their requirements i.e. food, shelter, medicine, fuel wood, aesthetic/spiritual fulfillment etc. from wild sources. The wild sources are limited, therefore their conservation is imperative. However, the influence of man is seen firstly in his role as exterminator. Quite apart from a sentimental, religion, economic values, small mammals render incalculable service to human being. Although certain species may damage crops and other items, such harm as is done by small mammals is

overwhelmingly offset by the benefits we derive from them.

There is need to put an end to the wanton destruction of small mammals and their precious habitats everywhere in the country. Because of their beautiful and high quality fur, many small mammals fall victims to man's love of self-adornment and this growing demands for fur will definitely led to their ultimate decrease. The forests must not be burned either for mischief or wrong beliefs to destroy these creatures. We give more emphasis in the protection of charismatic species and small mammals are usually neglected. It must be noted that any scheme for the protection of wildlife would be incomplete without due provisions for the protection of our beautiful creatures the small mammals. The time has surely come when it is necessary for us to review our conservation efforts directed to small mammals, and to take such measures as are necessary to give them real protection in the country.

The vital question is what to be conserved? You cannot conserve a species about which you do not know or no name - no conservation. So far our small mammals are poorly known, insufficiently recorded and enumerated, still a huge information gap exists on their diversity, distribution and other ecological parameters. Because of these and other reasons only 7 species are included in Nepal government's National Parks and Wildlife Conservation (NPWC) Act, 1973. Since more taxa amongst the recorded species deserve their inclusion in the Act, in early 2010 a recommendation has been made to the government for the inclusion of 36 species of small mammals (out of 71 recommended species of mammal) on the next amendment of the NPWC Act. In situ conservation is a primary approach to protect small mammals from extinction therefore, support and initiate their systematic collections and systematic researches so that their existence would be made known to scientific fraternity. But if we fail in this pursuit, it is inevitable that some of them will get extinct even before we could record their occurrence and realize importance.

Small mammals are natural beauties, an asset to the country and its people, they must be protected and preserved to their own advantage and to the advantage of future generations. If you save them they will provide you a healthy and naturally balanced environment. They are in great danger, but there are certain encouraging developments in the country. The attention drawn by some organizations and publications, have helped to create an awareness of the urgency for active measures for small mammals conservation. The Small Mammals Conservation and Research Foundation (SMCRF) is frontrunner in this regards, the foundation has injected new dynamism in this field. I appreciate its endeavor and also wish for great success in achieving its noble objectives.

I firmly believe this seminar and future activities of SMCRF will produce vital guidelines and create sufficient conservation awareness in drawing the attention of people towards the conservation of small mammals in the country. Let us hope, our people with the utilization of modern technologies, and realization of the wildlife conservation values, with the spread of education, peace and stability in the nation will be in a better position to appreciate small mammals' importance in coming days.

INVITED PRESENTATION

DISTRIBUTION OF SOME SMALL CATS IN CHITWAN NATIONAL PARK

JHAMAK B. KARKI
Department of National Parks and Wildlife Conservation, Babar Mahal, Kathmandu, Nepal
Email: jbkarki@gmail.com

ABSTRACT

The study is the outcome of Camera Trap results conducted for the estimation of the status of tiger (*Panthera tigris*) in Chitwan National Park. Small cats, asian or common palm civet (*Paradoxurus harmaphradotis*), small Indian civet (*Vivericulla indica*), large Indian civet (*Viverra zibetha*), jungle cat (*Felis chaus*), leopard cat (*Felis bengalensis*), fishing cat (*Felis viverrinus*) were recorded during the study period on different location of CNP. Fishing cat had the very restricted distribution where as other cats were more widely distributed.

Key words: *Small cat, Chitwan national Park, Camera trap, distribution*

INTRODUCTION

Asian or common palm civet (*Paradoxurus harmaphradotis*) is reported to occur below 1500 m in Parsa Wildlife Reserve (PWR) and Chitwan National Park (CNP). Small Indian civet (*Vivericulla indica*) is reported to occur up to 3500m altitude in Nepal and found in Langtang National Park (LNP), Suklaphanta Wildlife Reserve (SWR) and Bardia National Park (BNP). Large Indian civet (*Viverra zibetha*) is distributed in Nepal and found in PWR,SWR, BNP,CNP, Kangchanjungha Conservation Area (KCA), Makalu-Barun National Park (MBNP), Annapurna Conservation Area (ACA) and Dhorpatan Hunting Reserve (DHR) (Baral and Shah, 2008).

Jungle cat (*Felis chaus*) is reported to occur between 68-4000m in almost all the protected areas of Nepal. Leopard cat (*Felis bengalensis*) is reported to occur between 200-3000m and found in PWR, SWR, BNP, CNP and ACA. Fishing cat (*Felis viverrinus*) is reported to distributed below 300m and occur in KTW, PWR, SWR, BNP and CNP (Baral and Shah, 2008). Three species of civets, three species of small cats, has been listed as found in CNP.

A very limited study exists on these civets and cats in Nepal. Status of these civets and cats are not known so far in CNP. Influence of food distribution and predation pressure on spacing behavior in Palm civets was studied during 1989/1990 in Chitwan National Park by Joshi et al. (1995) by fitting radio-collar to three common palm civet (*Paradoxurus harmaphradotis*) and two large Indian civets (*Viverra zibetha*).

I present the distribution of location of photographs of these three species of civets and three species of small cats captured from Camera traps. The camera trap was conducted to estimate the status of tiger (*Panthera tigris*). Thus, the limitation of this distribution is that the camera trap spacing was about 1.5 Km in average and individual identification was not performed from the photographs.

MATERIALS AND METHODS

Reconnaissance survey

Camera trapping to capture tiger was designed for CNP on the basis of tiger monitoring protocol, Nepal (DNPWC, 2009). Intensive carnivore and their wild prey sign survey was conducted across Churia of CNP prior to the actual placement of cameras and thoroughly searched all the potential places especially along the major streams and its branches for tiger pug marks, scats, scrape marks and scent marks.
Whole park was divided into 1) Western (West of Reu river, Narayani Island and Triveni area), 2) Eastern (Northern slope of Churia and lowland east of Kasara) and 3) Madi (Southern slope of Churia west of Shikaribas, lowland east of Reu river to Kasara) blocks.

Sign survey from western block started on 7th December, 2009. The survey of western and Madi block was completed by the end of December 2009. The eastern block was surveyed on the last week of December 2009 to first week of January 2010.
Based on the sign survey on Churia and camera locations of 2009 from lowland in CNP, camera locations were proposed.

A distance of 1.5 km between two camera trap locations was maintained so as to cover every 2x2 Km^2 grid by at least one camera. The total period of camera trapping in all the three blocks was of 62 days duration with 4,793 camera trap nights, including 3,582 man days and 170 elephant days. We selected a total of 310 camera locations (Figure 1). Continuous monitoring and technical support was provided through visits to the different camps by researcher along with CNP officials, National Trust for Nature Conservation (NTNC)/BCC and World wide Fund for Nature (WWF) technical team.

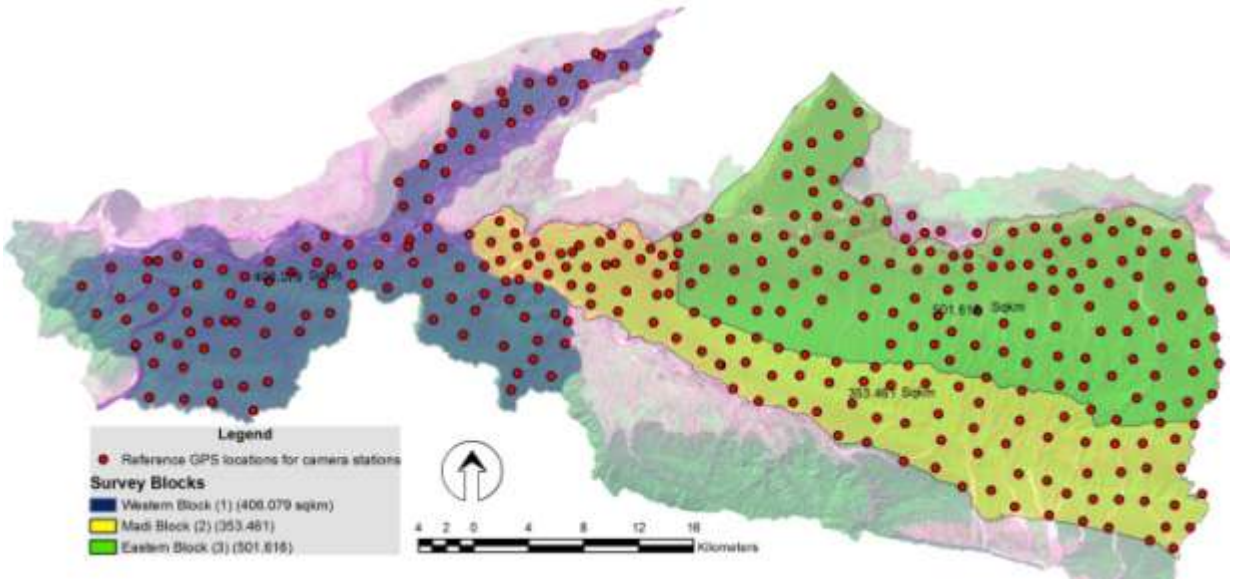

Figure 1: Camera Locations for Tiger Monitoring in Chitwan National Park 2010.
(Source: DNPWC 2010)

Camera types and placement

Moultrie and Stealth Cam passive digital camera traps were used for 299 locations and Trail Master® 1550 active camera trap was used for 11 locations.

Camera traps were placed along the park road, fire-line, river and stream bed, trail and animal movement path along the ridge. We operated the cameras for 24 hours except at Barandabhar where they were set at dusk and removed by dawn owing to their proximity to surrounding villages and higher chances of theft.

RESULTS

Three species of small cats were recorded from the camera trap. Fishing cat was recorded from three locations around Sauraha where as leopard cat was recorded in 25 locations and jungle cat was recorded from 34 locations (Table 1).

Table 1: Summary of capture of small cats in Chitwan National Park.

SN	Small cat	Number of Photos	Number of traps	Altitude range (m)
1	Fishing cat	7	3	156-171
2	Leopard cat	61	25	128-567
3	Jungle cat	102	34	125-171

(Source: DNPWC 2010)

Three species of civets, Asian palm civet, large Indian civet and small Indian civet were captured from camera traps (table 2).

Table 1: Summary of capture of civets.

SN	Civet	Number of Photos	Number of traps	Altitude range (m)
1	Asian Palm civet	96	40	125-500
2	Large Indian civet	249	79	104-609
3	Small Indian civet	214	65	113-534

(Source: DNPWC 2010)

Species such as Ratel (*Mellivora capensis*), porcupine (*Hystrix* sp.), small Indian mongoose *(Herpestes javanicus)* and crab eating mongoose (*Herpestes urva*) were recorded (Table 3).

Table 2: Summary of capture of other animals.

SN	Other wildlife	Numbers of Photos	Number of Trap sites	Altitude range (m)
1	Ratel	2	2	127-159
2	Porcupine	322	41	123-439
3	Small Indian mongoose	36	12	113-468
4	Crab eating mongoose	52	18	135-565
5	Bengal fox	3	2	157-193
6	Golden jackal	8	3	129-168
7	Yellow-throated marten	13	4	292-634
8	Indian hare	224	25	116-534

(Source: DNPWC 2010)

DISCUSSIONS AND CONCLUSION

This preliminary assessment of the distribution of photographs indicates the potential distribution of small cats. There is very restricted distribution of fishing cats in this current camera traps (figure 2) whereas jungle cat and leopard cat are more widely distributed compared to fishing cat. The distribution is particularly low in Kana Mana valley and eastern sector in Sunachari area. In general, there is poor distribution of civets in southern part of Kana Mana Valley, Dhoba and Botesimara and Sunachuri-Harda area (figure 3)

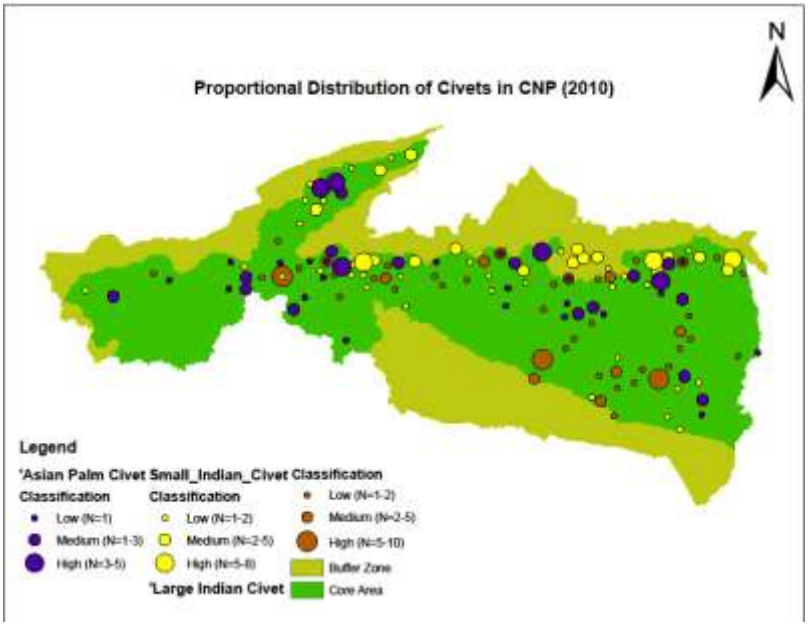

Figure 2: Proportional Distribution of Civets in Chitwan National Park 2010.

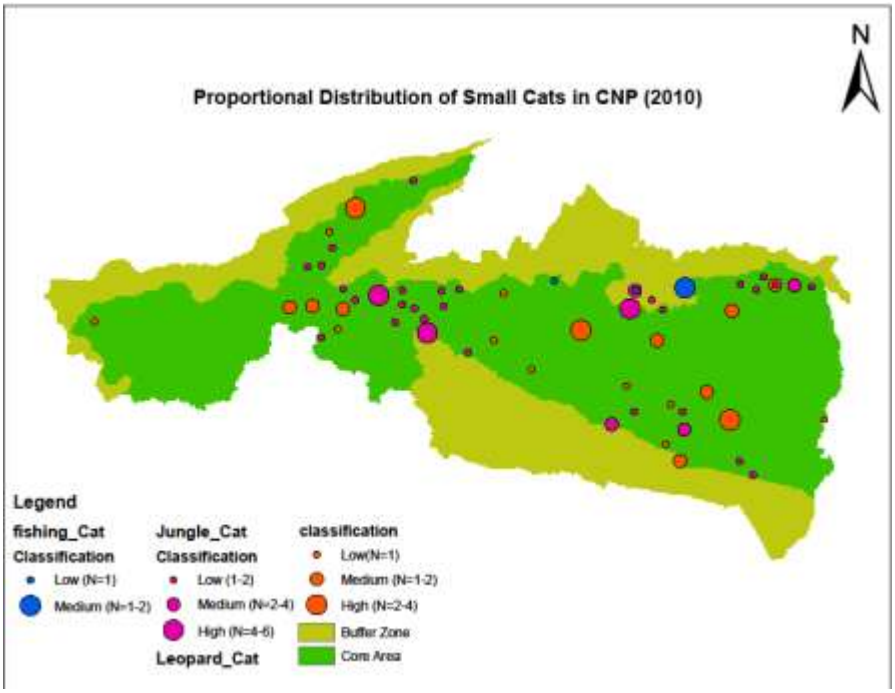

Figure 3: Proportional Distribution of Civets in Chitwan National Park 2010.

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REFERENCES

Baral, H.S. and K.B. Shah 2008. Wild Mammals of Nepal. Himalayan Nature, Kathamandu.

DNPWC 2009. A Monitoring protocol: Tiger (*Panthera tigris*) and prey base monitoring in the Terai Arc Landscape Nepal. DNPWC.

DNPWC 2010.Database (unpublished). DNPWC, NTNC and WWF Nepal.

DNPWC 2010. Population Estimates of Tiger in Chitwan National Park, Nepal. Final Technical Report (Agreement # WI28). CNP, NTNC and WWF Nepal.

Joshi,A.R., J.L. David and F.J. Cuthbert 1995. Influence of food distribution and predation pressure on spacing behavior in Palm Civets. Journal of Mammalogy, 76(4) 1205-1212.

ORAL PRESENTATIONS

HABITAT STATUS AND CONSERVATION OF RED PANDA *(Ailurus fulgens)* IN DHORPATAN HUNTING RESERVE, NEPAL

TULSI R. SUBEDI[1] AND ARJUN THAPA[2]
1 Red Panda Network, Baluwatar, Kathamdnu, Nepal
2. Small Mammals Conservation and Research Foundation Nepal
Emails: subeditr@yahoo.com
thapa.nature@gmail.com

ABSTRACT

Red panda is an herbivorous mammal belongs to order carnivora and only member of family Ailuridae. It is endemic to the Himalayas in south Asian countries like Nepal, India, Bhutan, China and Myanmar. Only recently, have scientists (e.g., Wei et al., 2000, Pradhan et al., 2001) obtained information on red panda microhabitat use and information on the species' distribution and abundance remains extremely limited, although there have not been any studies providing comprehensive data on the species' population status. It is believed to have red panda population is declined considerably in last decade therefore now listed as schedule I or top priority endangered species (IUCN, 2007) facing threat of extinction and protected by Government of Nepal by National Parks and Wildlife Conservation Act 1973. Red panda, has no reliable numbers exists for the total population in Nepal and is very threatened due to the fragmentation and degradation of its natural habitat, poaching for "good luck charm" hats and fur clothing, illegal pet trade. They are highly specialized on diet and even sensitive to a small change in the habitat. Therefore, red pandas can be used as a focal species for conservation in the Himalayan temperate forests as well as an indicator of habitat quality and is an umbrella species for sub-alpine forests in the Himalaya (Yonzon et al., 1991).

Therefore, this study has been carried with the aim to find out species habitat status and distribution in Dhorpatan Hunting Reserve (DHR) using altitudinal line intercept survey method following Sutherland 1996, Pradhan et. al 2001a and Yonzen 1989. The habitat was surveyed using plot less (Mueller- Dombois and Ellenberg 1974) and quadrate sampling method to access microhabitat characteristics. Total of 21.043 km transect was surveyed from 3000 to 3600 m where altitude starts from 3000 m in the reserve. Total scat distribution was observed 4.3/ km where scat was observed zero between 3000m – 3200 m and highest (8.3 /km) was between 3200m – 3400 m. Chi-square indicates red panda distribution is significantly related to altitude ($\chi 2 = 148.9$, df = 5, $P << 0.05$) as well as sites ($\chi 2 = 152.59$, df = 8, $P << 0.05$) of the reserve. Scat measurement (for adult: 19.2 ± 2.3 mm diameter, 41.6 ± 6 mm length and for young: 14.9 ± 2.6 mm diameter, 34-7 ± 7.1 mm length) shows that the study area holds 4 small isolated red panda population with three groups bearing cubs.
Microhabitat analysis study found 10 species of trees and 7 species of shrubs in red panda plots that was highly dominated by *Tsuga dumosa, Rhododendron arboretum, Betula utilis* and *Arundinaria sp.* This shows red pandas are mainly distributed between the altitudinal range of 3200 to 3400 m dominated by *Tsuga dumosa, Rhododendron, Betula utilis* and *Arundinaria sp*.

Key words: *Red panda, Distribution, microhabitat*

INTRODUCTION

Red Panda is a herbivore mammal, an inhabitant of the montane forest zone endemics to the Himalayas of Nepal, Bhutan, India, Myanmar and southern China. They are habitat specialists (Yonzon et al., 1991), prefer *Abies* – Fir forests with a undestroyed ringal bamboo in average elevation of 2800 – 3900 m in areas of high precipitation and rarely seen due to its nocturnal habits. Thus they are largely limited to a narrow altitudinal band where temperate fir – ringal habitat predominates. Red Pandas feed predominantly on ringal bamboo leaves and shoots (about two-thirds) but they also eat wild fruits and berries, mushrooms, roots, acorns, lichen, grasses, and they are known to supplement their diet with young birds, eggs, small rodents, and insects on occasion.

The Red Panda is a mammal of the Order Carnivora and single member of Family Ailuridae. It has glossy fur of reddish, rich auburn color and a white somewhat cat like face, head is round, ears are erect and pointed. The Red Panda is quite long: 79-120cm (including the tail length of 30 to 60 cm). Males weigh 4.5 to 6.2 kg: females 3.7 to 4.5 kg. Their average lifespan is nine to ten years but can reach a maximum of fourteen years. After a gestation of about 134 days, litters of one to four young are born. Young stay in the nest for about 90 days, remain close to their mother until the next mating season begins, and reach adult size at about 12 months. Adult Red pandas lead solitary lives.

Red Pandas have a naturally low birth rate (usually single or twin births per year) and the mortality among Red Panda is very high in natural habitat; Yonzon et al. (1991) studied Red Pandas in Langtang National Park and found cub mortality 67 – 86 % and adult mortality 44 %. The cause of high mortality is associated with disturbance from cattle and human related activities (WWF and ICIMOD, 2001). Thus, habitat loss and degradation in mountain forest ecosystems is fetal for these species and have significant consequences for species with small geographic ranges and are adapted to a narrow range of habitats. Due to the habitat specialization and even sensitivity to a small change in the habitat Red Pandas can be used as a focal species for conservation in the Himalayan temperate forests. The Red Panda is an indicator of habitat quality and is an umbrella species for sub-alpine forests in the Himalaya (Yonzon et al., 1991). Despite its small size (about size of house cat) the Red Panda is also charismatic and is thus a flagship species. Natural population has been worsened by human encroachment, leading to severe fragmentation of the remaining wild population. Small groups of animals, with little opportunity for genetic exchange between them, face the risk of inbreeding, decreased genetic diversity, and even extinction.

Red Pandas are classified as endangered. No reliable numbers exist for the total population but it is very threatened due to the fragmentation of its natural habitats, their small numbers, and their food specialization needs. In the red panda habitat ranges of Nepal threats are associated with habitat loss by deforestation, slash and burn practice for farming in the forest area, overgrazing by chouri (cattle-yak hybrid) impacting ringal-bamboo growth, and intrusion by herders and dogs (often attacking cubs). Poaching for 'good-luck charm' hats, other fur clothing, and illegal pet trade are some other threats to this endangered species for their survival.

The continuous clearing of forests, has significantly reduced the population. It is now protected in all countries in which it lives, and the hunting of Red Pandas is illegal everywhere. The IUCN has mandated that Red Pandas are a "Threatened species" since 1996; however it is now listed as endangered (IUCN, 2007). In Nepal; Red Pandas are protected by Government of Nepal by National Parks and Wildlife Conservation Act 1973. It is very difficult to estimate the total population, yet one can assume that they cannot bear much more of a habitat change and that they are in danger of extinction due to the disappearance of the forests and the furtive hunting for its highly-valued tail and fur. They are also susceptible to their predators such as snow leopards (*Uncia uncia)*, martens, eagles and humans. Due to lack of awareness the local people use to catch these endangered Red Pandas and sell alive as well as raw skin in the market (DNPWC, 2006). Due to lack of sensitization programs local peoples are still killing these endangered animals in different parts of the country. This study was aimed to access the distribution pattern, microhabitat characteristics and conduction of conservation education of red panda in surrounding communities of the reserve.

MATERIALS AND METHODS

Study area

The study was conducted in Dhorpatan Hunting Reserve that lies in the Dhawalagiri Himalayan range and it is surrounded by mountains on all sides except in the west. The reserve was established in 1983 and gazetted in 1987 that covers the area of Rukum, Myagdi and Baglung district. Dhorpatan is the only hunting reserve in Nepal and was primarily established to cater for the needs of sports hunting for Nepalese and foreign hunters of blue sheep and other game animals and for the conservation of representatives of temperate, sub-alpine and alpine ecosystems of west Nepal.

The reserve covers an area of 1325 sq km within the altitudinal range of 3000 m – 7000 m (DNPWC, 2002). Geographical coordinates of the reserve is 28°36’ N latitude and 83°00’ E longitude. The higher elevation remains snow-capped throughout the year. The flat meadows above tree line (4000 m) locally known as patans, are important for animals like blue ships and other herbivores animal. The reserve is divided into six blocks namely Sundaha, Seng, Dogari, Barse, Phagune and Gustung for the hunting management purpose. The reserve lies on an important trading route for Bhotias from Tarakot and Dolpo to the north. The reserve receives license hunters, many caterpillar fungus collectors and few other visitors.

The reserve is important habitat for many globally threatened mammals such as Musk deer *Moschus chrysogaster*, Red panda *Ailurus fulgens,* Grey wolf *Canis lupus,* Snow leopard *Uncia uncia,* Asiatic black bear *Ursus thibetanus,* Himalayan thar *Hemitragus jemlahicus,* Serow *Capricornis sumatraensis* etc.

Encroachment on wildlife habitat, illegal cutting of forest, forest fire, overgrazing, over collection of forest resources, pheasants and mammals trapping/ hunting are the major conservation issues (DNPWC, 2006). The local people lack awareness about sustainable natural resources use in and around the reserve.

The study was focused in Barse, Phagune and Surtibang block of the reserve to access the distribution of red panda. In Barse Block survey was conducted in Shivaodar, Ratmate and Jhulekhola area, in Phagune Block survey was carried in Khukriban and Dija while in Surtibang survey was conducted in Kangakhung and Jalthala area.

Methods

Potential red panda habitat was identified on the basis of interview and questionnaires survey with local peoples, reserve staffs and field observation. Each site has been given different number and study site was selected using random number. Using GPS and topographic map as altitudinal guides several altitudinal lines intercepts of variable length were laid in each site for the survey of red panda. Census of direct (animal sightings) and indirect (scat, paw print, feeding signs, snow track) evidences of animal was conducted in each altitudinal line intercepts to find out red panda distribution. Count of the animal evidences was made within a 50-meter distance of each line intercept. The points of animal and sign location were marked on a map to demonstrate the area covered by the species (Sutherland, 1996). Panda presence was measured by recording the latitude and longitude of indirect (paw print, scat) and direct (sighting) red panda signs with GPS *Garmin-Etrex*. Measurement of snow track and pellets size was carried out to determine the age group. Habitat survey was done using ten tree-plot less method (Mueller-Dombois and Ellenberg, 1974) and quadrate sampling methods to access microhabitat characteristics and use including estimate density, frequency, dominance and importance value of trees and shrubs and red panda tree and substrate used (Sutherland, 1996).

Conservation education was conducted in local level to raise the awareness, importance, conservation and management issues of red panda and other wildlife.

RESULTS

Distribution and population status of red panda

Total of 21.043 km transect was surveyed for the red panda study in Dhorpatan Hunting Reserve. Based on Pradhan et al. (2001a) red panda was surveyed within the altitudinal range of 3000 m to 3600 m. In the reserve 3000 m was lower altitudinal range. Scats, paw print and feeding of bamboo shoots were considered as signs and total sign was observed 4.3/km in the surveyed area. Red panda signs were not observed between 3000m – 3200m altitudinal range. At 3200m – 3400m range it was observed at the rate of 8.3/km and at the altitudinal range 3400m – 3600m it was 6.9/km.

In the study, red panda distribution is found significantly related to altitude ($\chi 2 = 148.9$, df = 5, $P << 0.05$) as well as sites ($\chi 2 = 152.59$, df = 8, $P << 0.05$) of the study area. Most of red panda signs were observed in north facing slopes of the reserve where the day light period was comparatively shorter which indicates the distribution of red panda is limited to the exposure day light i.e. red panda prefer short exposure of light due to its nocturnal habitat. It is difficult to distinguish sexes of red panda through visual observation however; it is possible after handling of animals and molecular technology. For simple way to estimate the population structure (adult and young), measurement of droppings play significant role. We estimated the population structure based on the measurement of droppings (for adult:19.2 ± 2.3 mm diameter, 41.6 ± 6 mm length and for young: 14.9 ± 2.6 mm diameter, 34.7 ± 7.1 mm length) (Yonzon 1989) showed that the study area holds 4 small isolated groups of red panda in which three groups bearing cubs.

Habitat composition and micro-habitat characteristics

Microhabitat analysis of red panda habitat found total of 10 species of trees and 7 species of shrubs in red panda plots. Habitat

analysis showed red panda habitat was highly dominated by *Tsuga dumosa* with relative density 44.51, relative frequency 15.28, relative dominance 62.22 and importance value index 122.01 that is followed by *Rhododendron arboreum* and *Betula utilis* among tree species and *Arundinaria sp.* with relative density 326.68 and relative frequency 19.44. Thus the analysis of microhabitat showed red pandas are abundant in *Tsuga dumosa, Rhododendron, Betula* and *Arundinaria sp*. dominated habitat in altitude between 3200 m to 3400 m in Dhorpatan Hunting Reserve.

Threats and Conservation efforts for red panda conservation

Disturbance and destruction of habitat by seasonal overgrazing of myriad of livestock is the major problem for the conservation of red panda and other wildlife in the reserve. Large number of livestock, including buffaloes, cows, horses, goats, and sheep, freely graze the forest land. Our study indicates total of about 3500 buffaloes, 25000 cows, 3500 horses and 70000 sheep/goats graze in the reserve area impacting the potential habitat of red panda. Beside this, fodder such as ringal bamboo (*Arundinaria spp* and *Thamnocalamus spathiflorus*), food of red panda, is also heavily used. Collection of ringal bamboo for their young livestock's calf is other threat for the existence of this endangered species. This bamboo usage may be creating food competition because the livestock graze and browse in the same ecological niche as red panda. Illegal trapping of wild animals including red pandas by the poachers is the another threat to red panda. During our study period we found two red panda hides in the reserve. One hide was found in *Goth* at Shivaodar and other in Chhantung village by the reserve staff. Illegal tree logging for firewood and timber (huge volume of wood consumed for firewood, building huts, cowsheds and hotels),

Our study showed large area of forest was burned during confrontation time in Nepal which totally destroys massive forest area of the reserve.

To increase the knowledge and change attitude of local people towards red panda and other wildlife conservation, total of 6 conservation awareness programs had been conducted to community peoples, herders, school students and teachers covering 186 individuals. In the reserve area three red panda conservation groups were formed with the aim to monitor red panda and perform community based conservation activities such as anti-poaching, control fuel-wood/timber/ringal bamboo collection and over grazing of livestock in Red panda habitat. To raise the knowledge and encourage youths on red panda conservation, nature conservation groups were formed in schools are actively involving to distribution of information and sensitize local community for red panda conservation.

DISCUSSION AND CONCLUSION

Thus the distribution of red panda signs during this study indicates that red panda are more abundant in between the altitudinal range of 3200m – 3400m in Dhorpatan Hunting Reserve. Similarly, Kandel (2008) recorded distribution of red panda in the altitude between 3000-3700m in Dhorpatan hunting reserve being abundant in the range between 3200-3500. In Kanchenjunga conservation area, Mahato (2003) reported red panda fecal groups between 2800-3650m above sea level (asl), where as Sharma (2008) reported the distribution of red panda between 3100-3600m in Rara National Park. In Langtang National Park, Yonzon and Hunter (1991b) reported red

panda within an altitudinal range of 2800-3600m where as in Sagarmatha National Park red panda signs were found to be distributed within the altitudinal range between 2800-3400m (Mahato 2004). In Jamuna and Mabu village development committees (VDCs) of Ilam district, Williams (2004) reported red panda signs between 2400-3000m. Similar to this study Yonzon (1989) and Karki (2009) also found red panda to prefer northern slope in Langtang National Park and which also further support by the result of Kandel (2009) in DHR.

Study on floral composition in the red panda habitat of langtang National park suggest 17 tree species among them *Sorbus cuspidata, Sorbus microphylla* and *Abies spectabili* provided for foraging and shelter (Shrestha 1988). Study carried in Eastern Himalaya point up 16 species of tree species used by red panda where *Lithocarpus pachyphylla* mostly used (Williams 2004). This study figures out total of 10 species of trees and 7 species of shrubs in red panda plots through microhabitat analysis.

Our study showed forest fire is the major problem for deteriorating red panda and other wildlife habitat in Dhorpatan Hunting Reserve. Generally forest fire was made, to grow new vegetative shoots for their livestock by herders, to extend the agricultural land by farmers and force to congregate wild animals in narrow belt by poachers to make easy for hunting and trapping. Studies carried out in eastern Nepal also shows the similar kinds of threats (Williams et al, 2010), so these are the common threats in most of the red panda range. The conservation initiative approached during this project was the first hand piece of work.

Our study showed that the red panda is distributed within very narrow range of the study area in Dhorpatan Hunting Reserve that is dominated by *Tsuga dumosa, Rhododendron arboreum, Betula utilis and Arundinaria sps*. Livestock farming is the major occupation of people in Dhorpatan area. Therefore red panda habitat is highly threatened and highly impacted by overgrazing of large number of livestock in Dhorpatan hunting reserve. There is a real need of further research on practical ways including contemporary research methods on ecology of red panda in western region where only few works were carried. Landscape level concerted conservation efforts should be made that will effort to protect the red panda population in the region. It is necessary to understand the resource use interest of local communities and their economic aspiration which help to enhance the long term conservation initiative.

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REFERENCES

Choudhury, A. U. 2001. An overview of the status and conservation of the red panda in

India, with reference to its global status. *Oryx* 35: 250-259.

DNPWC 2002. Dhorpatan Hunting Reserve, Booklet. Department of National Parks and Wildlife Conservation, Kathmandu.

DNPWC 2006. Wildlife Nepal. Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

IUCN 2007. IUCN Red List of Threatened Species. Version 2009.2. <*www.iucnredlist.org*>. Downloaded on 20 December 2008.

Kandel, R. N. 2008. Distribution and conservation status of red panda *(Ailurus fulgens)* in Dhorpatan Hunting Reserve, Nepal. M. Sc. Thesis Central Department of Zoology, Tribhuvan University, Kirtipur, Nepal.

Kandel, K. 2009. Distribution and habitat use of red panda *(Ailurus fulgens)* in eastern Nepal. Nepal. *M. Sc. Thesis*. Central Department of Zoology, Tribhuvan University, Kirtipur, Nepal.

Karki, K. 2009. Habitat and feeding behavior of red panda (*Aliurus fulgens*) in Choloangpati-Dokachet area Langtang National Park, Nepal. M. Sc. Thesis Central Department of Zoology, Tribhuvan University, Kirtipur, Nepal.

Mahato, N. K. 2003. Status of Red panda, *(Ailurus fulgens*) in the Kangchenjunga Conservation Area, Nepal. A project paper submitted in partial fulfillment of requirement of B.Sc. Institute of Forestry, Tribhuvan University, Pokhara. Pages 40.

Pradhan, S., G. K. Saha, and J. A. Khan. 2001a. Ecology of the red panda *(Ailurus fulgens)* in the Singhalia National Park, Darjeeling, India. *Biological Conservation* 98: 11-18.

Pradhan, S., G. K. Saha, and J. A. Khan. 2001b. Food habits of the red panda *(Ailurus fulgens)* in the Singhalia National Park, Darjeeling, India. *Journal of Bombay Natural History Society* 98(2): 224-230.

Sharma, H. P. 2008. Distribution of red panda (*Ailurus fulgens*) in Rara National park, Nepal: An assessment of their conservation status. Final report submitted to People's Trust for Endangered Species, London.

Shrestha, M. K. 1988. Vegetation study of red panda habitat in Langtang National Park, Central Nepal. M. Sc. Thesis, Tribhuvan University, Nepal.

Sutherland, W. 1996. Ecological census techniques: A handbook. Cambridge University Press, Cambridge UK.

WWF and ICIMOD 2001. Biological Conservation in the Eastern Himalaya: Focal species and ecological processes. In: *Ecoregion-Based Conservation in the Eastern-Himalaya. Identifying Important Areas for Biodiversity Conservation*. WWF-Nepal Program, Kathmandu.

Williams, B. H. 2004. The Status of Red Panda in Jamuna and Mabu Villages of Eastern Nepal. M. Sc. Thesis Submitted to San Jose state University, USA.

Williams, B.H., B.R. Dahal and T.R. Subedi. 2010. Project Punde Kundo: Community-based monitoring of a red panda population in eastern Nepal. *Red Panda: biology of the first panda:* 393-408, Elsevier Inc.

Yonzon, P. B. 1989. Ecology and conservation of the red panda in the Nepal-

Himalayas. Ph. D. Dissertation. University of Maine, USA.

Yonzon, P. B, R. Jones and J. Fox 1991. Geographic information system for assessing habitat and estimating population of Red Pandas in Langtang National Park, Nepal. *Ambio* 20 (7): 285-288.

PRESENCE / ABSENCE AND STATUS OF SQUIRRELS (SCIURIDAE) IN MAKALU BARUN NATIONAL PARK

YADAV GHIMIRE, RAJU ACHARYA, BINOD GHIMIRE AND VICKY KOIRALA
Friends of Nature, Baneshwor, Kathmandu, Nepal
Email: pantherapardusypg@gmail.com

ABSTRACT

There are eleven species of squirrels recorded from Nepal. Documentation of species occurrence is absent from protected areas database. This is baseline information from Makalu Area. The study was carried out in Makalu-Barun National Park and buffer zone. Direct observation and Camera trapping were the methods applied. The present study provides evidences of presence of six species of squirrels in MBNP. Furthermore, information on status of four species is also presented however further in-depth studies are needed to ascertain their conservation status and the threats to them.

Keywords: *Squirrels, Makalu-Barun National Park, Camera trapping, conservation status, threats.*

INTRODUCTION

Squirrels and flying squirrels belong to a large family of small or medium-sized rodents called the Sciuridae. Nepal harbors eleven species of squirrels including flying squirrels (Baral and Shah, 2008). However, documentation of species occurrence in most of the protected areas has not been done. Such documentation will provide a good baseline for future studies that assess the status of different species.

MATERIALS AND METHODS

Study Area

The study was carried out in Makalu-Barun National Park and buffer zone. It was established in 1992 with an area of 1500 + 830 sq km. The study area comprised a narrow zone along the upper reaches of the Arun River in the eastern Makalu Barun National Park and Conservation Area (Fig. 1). Tropical and subtropical monsoonal rain forests in the Arun River Basin represent ecologically and economically important repositories of regionally endangered biological diversity. Although, geographically outside the tropics, this zone is frost free with mean monthly temperature above 18^0C throughout the year for elevations below 1000 m. Average annual precipitation is 4000 mm. The protected area exhibits a high diversity of vegetation types: tropical sal forest below 1,000 m altitude; subtropical Schima-castanopsis forests at 1000-2000 m; temperate broadleaf forests at 2000-3000 m; subalpine conifer forest with stands of Himalayan birch and rhododendron at 3000-4000 m; alpine pastures above 4000m with juniper shrubs, aromatic herbs and dwarf rhododendron. Average annual precipitation within this region of eastern Nepal generally is high (4000 mm). (Zomer et al., 2001).

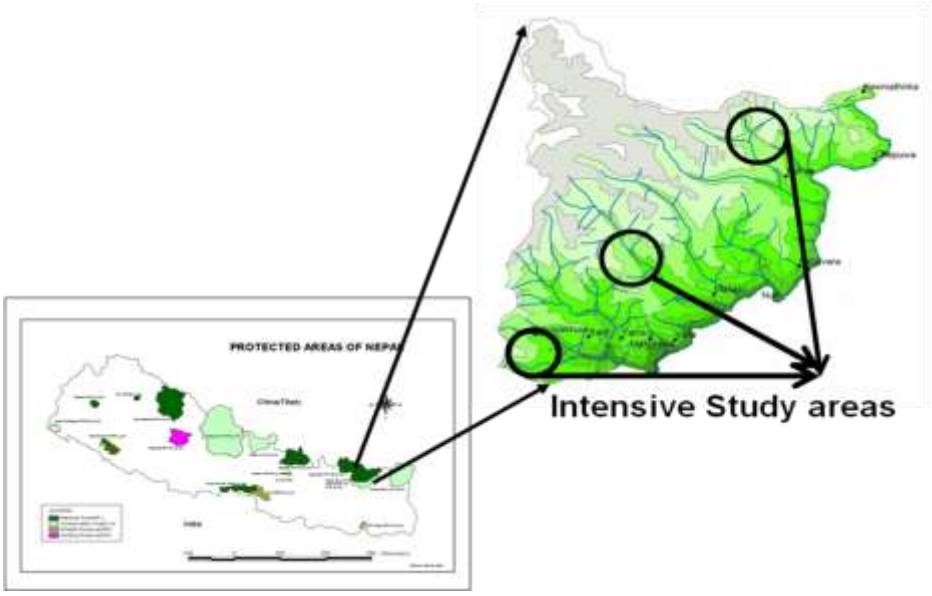

Figure 1: Study area

Methods

Transects were laid in the topo sheets of the study area. The length of single transects were kept between 500 – 1000 mm (Gurnell et al., 2008). Ten trails were walked in five habitats during the study period of April-May 2009, November-December 2009 and June 2010. Visual survey was done in the pre-determined transects. Sightings of squirrels were recorded on the trails. Normal walk at the rate of 2 km/hour was done to conduct the survey which was conducted thrice a day. Survey using spotlight was also done during the nights however it was only opportunistic. Camera trapping was also done for capturing squirrels and flying squirrels however visual survey was primary method used. The cameras used were 1) heat and motion sensored Sony P32 (Zack Young, Gobble Cams LLC, 601.248.3801) and 2) passive infra-red Reconyx RM45 (RECONYX, Inc. 3828 Creekside Lane, Suite 2, Holmen, Wisconsin 54636). Camera trap stations were selected on the basis of relatively more activity of the squirrels. The trap units were placed at a height of 20-30 cm above the ground level. Time delay of 15 seconds was kept between two successive triggers.

RESULTS

Total length of 84 km was walked on transects. Squirrels were observed on 7 occasions however only two species of squirrels could be identified during the visual survey. Sampling effort for camera trapping were eleven hundred eighty four trap nights. The total sampling effort of eleven hundred eighty four trap nights yielded seven hundred and four pictures out of which two hundred thirty five images were accounted for independent pictures of the following species: rodents (21, 8.9%), felids (16; 6.4%), canids (1, 0.4%), bears (1, 0.4%), ungulates (35, 14.9%), viverrids (8, 3.4%), domestic livestock (44, 18.7%), birds (37, 15.7%) and people (40, 17%). The remaining 469 (66.6%) images were blank. Six species of squirrels were recorded from the study area. These are presented in the following table

S. No.	Squirrels	Recording media	Independent images (I)	Capture rate (I/1184)*100
1	Hoary bellied squirrel	Camera trapping	1	0.1
2	Particolored flying squirrel	Camera trapping	1	0.1
3	Orange bellied Himalayan squirrel	Camera trapping, direct observation	1	0.1
4	Red giant flying squirrel	Pelt, interview		
5	Black giant squirrel	Pelt, interview		
6	Himalayan striped squirrel	Direct observation, photo		

CR: Numbers of captures per 100 trap nights

Hoary bellied squirrel *Callosciurus pygerythrus*

This species is widely distributed in Bangladesh, Bhutan, India and Nepal at elevations of 500 to 1,560 m a.s.l. (Molur et al., 2005). This species was not observed during the visual surveys however was camera trapped on one occasion. It was camera trapped in Simkharka area of Sisuwa valley, Makalu-Barun national park. One individual was observed near Num, Sankhuwasabha in 2009 (Sanjan Thapa pers. comm.).

Status

It has been generally reported from dense forested areas however it is also said to be quite tolerant to some habitat modifications (Sarker pers. comm.). However, the exact threats to the species in Nepal are not properly known. It was found to be relatively rare in the area with no visual observations and a single camera trapping image.

Red giant flying squirrel *Petaurista petaurista*

Red giant flying squirrel is the most identifiable flying squirrel of Nepal. The species was neither camera trapped nor visually observed during the survey walk. However, its pelt was discovered on two occasions. One pelt was recorded at MBNP Hatiya sector office, Hatiya village. Another pelt was discovered at Kapdane village.

Status

It has been harvested for the pet and fur trade in South Asia (Molur et al., 2005). As such, the population of the species is decreasing globally. There were no indications of existence of fur trade in the study area however incidents of catching the pups and rearing them in captivity were high. Keeping these animals as pets is also common in the eastern district of Ilam where a pair (Male and female) was found in captivity in Jamuna-2 (Sanjan Thapa pers. comm.). Their present status in the study area is not properly known and the practice of keeping them as pets will ultimately affect their population.

Orange bellied Himalayan squirrel *Dremomys lokriah*

It is diurnal and arboreal species that also forages on the forest floor. It occurs in subtropical montane evergreen and broadleaved forests (including oak-rhodedendron forest in Nepal Shrestha pers. comm.). This species has been widely recorded from Bangladesh, Bhutan, India and Nepal in South Asia at elevations of 900 to 3,000 m asl (Molur et al., 2005). It has earlier been reported from Bokajhunda, west of Syang Gumba, Khurumsang (Abe, 1971).

This species was observed between Dobatak and Saisimma villages inside the national park on April 09, 2009 at an altitude of 2400 m. A pair, most probably male calling a female, was observed. The animal was raising its tail and slamming it to the ground at the end of each call. It could be a mating call. It was also camera trapped 3 times during the study period. The highest altitude at which it was recorded is 3200 meters.

Status

The species is assessed as having least conservation concern globally. It was observed to inhabit in the core forest areas with little human interference as such the species do not seem to have serious threats for their population. No targeted killings of the species were documented during the study period. The species is common to fairly common in the study area with no serious threats at present.

Himalayan striped squirrel *Tamiops macclellandi*

This squirrel has a wide distribution and has been recorded from northeastern South Asia, southern China and much of mainland Southeast Asia. In South Asia, this species has been recorded from Bhutan, India and Nepal where it widely distributed above 1,500 m asl (Prater, 1971). However, it is difficult to detect partly because of its small size and also because of its color and its habit of keeping to the dense cover (Prater 1971). We also recorded the species at around 2100 m in a forest with a very good crown cover.

Status

The global population of the species is believed to be stable which may be true for the study area also. No incidents of this species being kept as a pet or being killed were recorded in the study area during the period of study.

Black giant squirrel *Ratufa bicolor*

Nepal is believed to be the westernmost country in the species' distribution range (Shrestha et al., 2011). However, distribution range of the species within Nepal is not documented specifically. One pelt was recorded from Num village just outside of buffer zone. The animal was killed by a small boy perceiving it to be civet. There have also been incidences of people killing the animal just to fetch its skin to use it as a scarecrow (personal observation).

Status

The population of this species is declining in South Asia, but the rate of decline is unknown (Molur et al., 2005). In Nepal too, the species' population is declining without actually documenting the rate of decline (Hem Baral pers. comm.). No visual observation of the species could be recorded during the survey. The species is found to be killed during retaliatory actions perceiving it to be a masked palm civet (personal observation). Large part of forests in buffer zone has been increasingly used for cardamom plantation in recent years. As such the rate of decline of the species my go up as this species inhabits the same forests. This is one of the most threatened squirrel species in MBNP.

Particoloured flying squirrel *Hylopetes alboniger*

The species has been recorded from mountainous regions of Nepal, Bhutan and northeastern India up to 4,000 m asl (Molur et al., 2005). This is an arboreal and nocturnal species, found in tropical and subtropical montane forests, and in more temperate oak and rhododendron forests at middle to high elevations (1,500 to 3,400 m asl). One individual was camera trapped at an altitude of 3200 meters. It was recorded

at 10:07 pm at night. No visual observation of the species was done and no calls were recorded.

Status

In South Asia, the species is threatened by habitat loss due to shifting (Jhum) agriculture, small wood plantations, mining activities, infrastructure development, establishment of human settlements, construction of dams and forest fires (Molur et al., 2005). The global population trend for the species is decreasing at present. The status of the species in the study area is uncertain because of its elusive behavior and also because very few respondents recognized the species.

DISCUSSIONS AND CONCLUSION

Six species of squirrels were recorded during the study period. Out of these species, Black giant squirrel and red giant flying squirrel seem to be relatively more threatened. Population of black giant squirrel has declined because of conservation ignorance of locals as well as a result of retaliation since it visits cardamom plantations in the area. Red giant flying squirrels were found to be killed for their skin however no evidence of fur trade was recorded. They were also kept as pet on many occasions.

Other species of squirrels namely orange bellied Himalayan squirrel is relatively less sought after for killing. The direct observation and camera trapping records also suggest this finding. Himalayan striped squirrel was also observed only once however its size, mobility and habitat make it difficult to observe often. Responses from people suggest that it may not be threatened in the area however no conclusive statement can be given regarding its status.

Hoary bellied squirrel was camera trapped once but no additional information could be mustered beside that. Particolored flying squirrel was also trapped on a single occasion without any further informations. As such no information regarding their status, beside presence/absence can be drawn from the study.

The present study provides evidences of presence of six species of squirrels in MBNP. Furthermore, information on status of four species is also presented however further in-depth studies are needed to ascertain their conservation status and the threats to them.

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REFERENCES

Abe, H. 1971. Small mammals of Central Nepal. Journal of the Faculty of Agriculture, Hokkaido University, 56(4): 367-423.

Baral, H. S. and K.B. Shah 2008. Wild Mammals of Nepal, Himalayan Nature, Kathmandu

Gurnell, J., P. Lurz, R. McDonald and H. Pepper 2009. Practical techniques for surveying and monitoring squirrels, Forestry Commission Practice Note (FCPN 011).

Molur, S., C. Srinivasulu, B. Srinivasulu, S. Walker, P.O. Nameer and L. Ravikumar 2005. Status of South Asian Non-volant Small Mammals: Conservation Assessment and Management Plan (C.A.M.P.) Workshop Report. Zoo Outreach Organisation /CBSG-South Asia, Coimbatore, India, 618pp.

Prater, S. H. 1971. The book of Indian animals. Bombay Natural History Society, xx+316pp.

Shrestha, N., S.K. Sarkar, D. Lunde, J.W. Duckworth, B. Lee, R.J. Tizard and S. Molur. 2008. *Callosciurus pygerythrus*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Downloaded on 17 April 2011.

Zomer, R. J., S.L. Ustin and C.C. Carpenter 2001. Land Cover Change Along Tropical and Subtropical Riparian Corridors Within the Makalu Barun National Park and Conservation Area, Nepal. *Mountain Research and Development*, 21 (2): 175–183.

REPRODUCTIVE BEHAVIOR AND POPULATION DYNAMICS OF INDIAN FLYING FOX (*Pteropus giganteus*)

VIRENDRA MATHUR, YUVANA SATYA PRIYA, HARENDRA KUMAR AND VADAMALAI ELANGOVAN

Department of Applied Animal Sciences, Babasaheb Bhimarao Ambedkar University, Vidya Vihar, Rae Bareli Road, Lucknow – 226 025, India,

Email: elango70@yahoo.com

ABSTRACT

Reproductive behavior and population dynamics of Indian flying fox (*Pteropus giganteus*) were studied in an age-old maternal colony in Uttar Pradesh. About 300 individuals of *P. giganteus* roost in the maternal colony during early spring which increased exponentially when they actively engaged on pair formation and copulation. After the occurrence of mass copulation, the population size of colony was declined gradually and maintained an apparent stability. General maintenance behaviors such as wing fanning, wing stretching, grooming, locomotion, sleeping, urination and defecation were observed along with social behaviors including antagonistic vocal display, courting females and copulation. Two modes of copulatory behaviors (frontal and dorsal) were observed during copulation of *P. giganteus*. Courtship displays and copulatory behaviors were observed throughout the day at the diurnal roost. Peak copulation was observed between 1000 h and 1200 h and an average each mating held for 90 ± 19.5 sec. *Pteropus giganteus* used auditory, olfactory and tactile communications during pre and post-copulation period. In contrast to the earlier reports, *P. giganteus* had undergone two mating cycles (spring and autumn). Female bats which involved in copulation during the spring season given birth at the beginning of June. The lactating females retained their pups with them until the latter become three months old. The postpartum females left their first cohort and involved on pair formation and copulation during autumn reproductive season of the same year.

Key words: *colony aggregation, mating season, population size, Pteropus giganteus, reproductive behavior.*

INTRODUCTION

The Indian flying fox (*Pteropus giganteus*) is widely distributed in the tropical region of South Central Asia, from Pakistan to China, and as far south as the Maldives Islands (Nowak, 1999). *Pteropus giganteus* is a social species, lives in a large diurnal roost which comprises several hundreds or even thousands of individuals usually located in well exposed trees such as *Ficus bengalensis*, *F. religiosa*, *Tamarindus indicus*, *Mangifera indica*, *Dalbergia sisso* and *Eucalyptus* sp. *Pteropus giganteus* visits many fruiting trees such as *M. indica, Achras sapota, Polyalthia longifolia, P. pendula, F. bengalensis, F. religiosa,* and *F. benjamina* for their food and many plants depend on flying foxes for their pollination and seed dispersal. The Indian flying fox is considered sacred in many parts of India (Marimuthu, 1988). The colony size of *P.*

giganteus varies according to food availability in its nightly foraging habitat (Parry-Jones and Augee, 1991; Eby, 1996; Parry-Jones and Augee, 2001; Williams et al., 2006) and aggregation of individuals of both sexes during mating season (Nelson, 1965; Parry-Jones and Augee, 2001; Holmes, 2002).

In terms of population ecology, species with high natural survival rate tends to experience long life expectancy, delayed sexual maturity, long gestation period, slow developmental rate and small litter size (Saether and Bakke, 2000). Flying foxes are long living seasonal breeders, with a rigid, well defined breeding season that is largely or wholly genetically determined (McIlwee and Martin, 2002). Many species of *Pteropus* give birth to a single young per year, e.g. *P. vampyrus* (Lekagul and McNeely, 1977), *P. samoensis* (Pierson and Rainey, 1992), *P. poliocephalus* (Tidemann, 1999; Holmes, 2002). Earlier studies reported that *P. giganteus* copulates from July to October and gives birth to one or two young from February to March, with 140 to 150 days of gestation (Nowak, 1999; Koilraj et al., 2001). Few other studies suggest that *P. giganteus* gives birth to a single young during January – March (Neuweiler, 1969). An accidental observation was made on the reproductive behavior of *P. giganteus* during early October in Southern India (Koilraj et al., 2000). In addition, the reproductive behavior of a few Indian frugivorous bats had been studied considerably (Sandhu and Gopalakrishna, 1984; Sandhu, 1985). The Indian flying fox is the biggest and most conspicuous of all fruit bats but a little information is available on its reproductive behavior. This study documents the reproductive behavior and effect of reproduction on population dynamics in the Indian flying fox, *Pteropus giganteus* under natural conditions.

The study was conducted between January 2007 and October 2008 in a traditional colony located at Mohanlal Ganj, about 25 km South of Lucknow (26.55 N, 80.59 E), Uttar Pradesh, India. The maternal colony was situated in 1400 sq m area botanical garden established by the Indian Railways under the scheme of Social Forestry. The garden consists of about 3000 *Eucalyptus* trees and few other trees such as *M. indica, Techtona grandis*, *Azardiracta indica* and *F. religiosa*. The garden was surrounded by residential area, school, market, bus stop and railway station. There was a goat slaughtering centre just beneath the noisy colony which attracts a large number of local people everyday.

MATERIALS AND METHODS

A total of 79 days observations were carried out during the study period. Observations on social and reproductive behaviors of *P. giganteus* were carried out at two distinct breeding seasons, viz. spring and autumn. Population of *P. giganteus* was estimated by counting number of individuals on each roost tree and then total was made. Four trees were selected amid of the colony and the mating behavior of *P. giganteus* was observed from a vantage point between 0600 h and 1800 h using a binocular. Video recordings were carried out to study the mating behavior of P. giganteus.

RESULTS

A large colony of *P. giganteus* was located at Mohanlal Ganj amid of human habitation, vehicle movements, and infrequent visits of natural predators like kite, hawk and crow. The flying fox colony located at Mohanlal Ganj was one among the traditional maternal colonies located in Lucknow district. The existence of a goat slaughtering centre just

beneath the bat colony attracts the predatory birds such as kite, hawk and crow which used to collect the leftover flush at the goat slaughtering centre. The predatory birds rarely chased the flying foxes, however predation was not observed.

Individuals of *P. giganteus* were continuously fanned their wings and often squawked towards neighboring individuals during sunny hours. However, they were silent with wrapped wings around their body and head during cloudy hours. Bats actively groomed their body and wing membrane using fore and hind claws, mouth and tongue. In addition, general behaviors such as locomotion, wing stretching, urination and defecation were also observed during the study period. Individuals of *P. giganteus* which roost at the top most stratum of the colony made many circling flights before the onset of emergence. The emergence of *P. giganteus* was observed between 18:15 h and 19:00 h during spring–summer and between 17:50 h and 18:40 h during autumn–winter seasons.

The population of *P. giganteus* at Mohanlal Ganj maternal colony was 328 ± 23 during early spring 2007. The number of individuals in the colony started increasing steadily with apparent visits of male individuals of *P. giganteus*. After the first week of February 2007, the population of *P. giganteus* increased exponentially to a maximum of 1194 ± 13 individuals (Fig. 1). The peak population of *P. giganteus* during mid February 2007 was coincided with the mass copulation. After the mass copulation, the population was declined to 492 ± 25 due to apparent emigration of male individuals from the colony (Fig. 1). The bats were quite silent during non reproductive period compared to the reproductive period, however they were actively involved on wing fanning, grooming, shifting of roost place etc. In consistent with the spring breeding, the population of *P. giganteus* was increased steadily from mid July to the end of August (autumn) at which the colony size became 947 ± 147. In addition, the peak population during autumn season synchronized with the mass copulation of *P. giganteus*. After the mass copulation, the population size declined steeply until early October 2007 and the frequency of mating was also almost seized. The colony maintained an apparent stability (653 ± 17) from mid October 2007 to mid January 2008 when the individuals of *P. giganteus* were not reproductively active. The mean population size of the colony during autumn reproductive season was significantly higher than spring population size ($t = 2.093$, $P < 0.05$). A similar trend of increase in population size of *P. giganteus* was observed during spring 2008 reproductive season (Fig. 1).

The first mating season was observed from mid January to early March (spring), while the second mating season found between early August and end of September (autumn). The male bats which occupied the peripheral area frequently shifted their roosting positions and many of them moved towards centre of the colony where more females gathered. Few individuals made circling flights over the colony very often and settled at different positions. Simultaneously, males started approaching females by fanning their wings in front of females, biting the neck of females and wrapping them by their wings. In addition, males tried to maintain physical contact with females by pulling the females as well as touching the females by stretched wings. In addition, the males snuffled the vaginal region of females. The frequency of male's approach towards females increased gradually until the formation of perfect pair bonding. However, some females ignored

the males' approach and screamed against the males.

After successful pair formation, both male and female settled about 15 cm apart each other. Thereafter, the male bat approached the female persistently for about 30 min with physical contact but the latter did not resist the male's approach and moved along the branch. At last the female settled down and showed her resistance towards male's approach which was more forceful. Thereafter, the male seized the female using wings and copulation held for 90 ± 19.5 sec. Individuals of *P. giganteus* were actively involved in courtship display and copulation throughout the day, however, peak copulation was observed at 1100 h (Fig. 2). The male *P. giganteus* was very aggressive during copulation and produced long cry while the female try to release herself from the male using force and screams. However, the male bat reluctant to release the female until the completion of copulation. The male bats licked the scruff, face, and vaginal region of the females after the completion of copulation. The reproductively active pairs of *P. giganteus* were resumed mating after 2-3 h of latency. The copulation in *P. giganteus* was observed in two modes viz. frontal and dorsal, however the frontal mode of copulation was often observed than the dorsal mounting. During frontal mode of copulation the male was holding female's body and thrusting forcefully while the female rapidly fluttered its patagium and made shrill. However, during dorsal mode of copulation shrill was observed without wing fluttering. Male intruders were often observed during pair formation as well as copulation but they were chased away by the male partner. However, polygyny was also rarely observed in *P. giganteus*. The females which copulated during spring 2007 had given birth at the beginning of June 2007 and the pups were observed with them until they become three months old. The females which had given birth during summer 2007 involved in mating during autumn 2007 reproductive season. The postpartum females maintained their summer cohort at their close proximity but they left their young for a short period (35 – 45 min) during mating. Thereafter, the postpartum females came closer to their young and often wrapped them with their wigs.

DISCUSSIONS AND CONCLUSION

The results of current study are consistent with the earlier reports on social and reproductive behavior of flying foxes (Nelson, 1965; Neuweiler, 1969; Marimuthu, 1988; Koilraj et al., 2001; Cayunda et al., 2004). Decline in the population size of *P. giganteus* after the mass copulation in the current study suggests the emigration of male bats and thus the colony segregation. The seasonal breakup of colony occurs after the mating season of *P. poliocephalus* (Nelson, 1965; Parry-Jones and Augee, 2001; Williams et al., 2006; Sugita, 2009). Among the reproductive behaviors, copulation is the least observed behavior in *P. giganteus* as observed in other *Pteropus* (Cayunda et al., 2004). In accordance to the earlier report (Fenton, 1985) bats are 'K' strategists which produce relatively few young per litter and few litters in a year. Temperate bats are typically monoestrus, while some tropical species are polyestrus, usually with two litters per year. However, the available reports on reproductive behavior of *P. giganteus* did not reveal the occurrence of two reproductive seasons in a year. A detailed study conducted on Indian flying fox reported that *P. giganteus* undergone mass copulation between July and October and given birth during March (Neuweiler, 1969). In consistent with previous reports

mass copulations were observed in the current study during August – September 2007 and 2008. However, another reproductive season observed during spring was an exiting report in the current study. The duration of pregnancy during both spring and autumn seasons was similar to earlier study (Brosset, 1962).

As like other pteropodids, *P. giganteus* also exhibited antagonistic behavior to defend the females against intruding males that live in the colony (Altringham, 1996). Vocalizations and physical attacks on intruders were also observed during mating season of *P. poliocephalus* (Nelson, 1965). The vocal displays made by male bats might be a behavioral approach to advertise their presence to the courting females. The continuous wing fanning during pair formation might favour the male *P. giganteus* to spread the odour from the scent glands. The shoulder gland secretions of *P. giganteus* consist of sixty five odorous compounds (Wood et al., 2005). Earlier report suggests that the auditory, olfactory and tactile stimuli are important before and during copulation (Fenton, 1985). A characteristic release sound made by females followed by mating suggests mating success (Bradbury, 1977). The constant physical approaches such as licking the scruff, face, and vaginal region of the females suggest that *P. giganteus* also use tactile communication during mating (Marimuthu, 1988). In the current study, reproductively active male bats snuffled the vaginal region of females at the beginning of pair bonding, and it suggests that the olfactory communication playing a crucial role in *P. giganteus* reproduction. Similar sorts of tactile and olfactory approaches were observed during the mating behavior of *P. vampyrum* (Cayunda et al., 2004). Grooming and licking of genital area were also observed in *P. poliocephalus* and the dorsal mode of copulation was a common posture among the Chiroptera (Nelson, 1965; Fenton, 1985). However, in the current study mating was observed by dorsal mode as reported by earlier observers (Nelson, 1965; Neuweiler, 1969), as well as frontal mode.

Bats live longer than other placental mammals with respect to their body mass (Bouliere, 1958; Austad and Fischer, 1991; Wilkinson and South, 2002). *Pteropus giganteus* is one among the six species known to live longer over 30 years (Nowak 1999; Wilkinson and South, 2002) and the longevity of bats influenced by reproductive rate (Wilkinson and South, 2002). Thus, bats either produce multiple pups per year or give birth multiple times per year have shorter longevity and species that produce single pup per year live longer. In contrast to the prediction of earlier study (Wilkinson and South, 2002) the current study reveals the occurrence of multiple reproductive cycles in *P. giganteus* which has long life span. The present study substantiates the earlier reports (Neuweiler, 1969; Marimuthu, 1988 and Koilraj et al., 2001) on reproductive behavior of *P. giganteus* while it overrules the number of reproductive cycles in a year.

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REFERENCES

Altringham, J.D. 1996. *Bats: biology and behavior*. Oxford University Press, New York.

Austad, S.N. and K.E. Fischer 1991. Mammalian aging, metabolism, and ecology: evidence from the bats and marsupials. *Journal of Gerontology A* 46: B47–B53.

Bouliere, F. 1958. The comparative biology of aging. *Journal of Gerontology A* 13: 16–24.

Bradbury, J.W. 1977. Lek mating behavior in the hammer-headed bat. *Zeitschrift fur Tierpsychology* 45: 225–235.

Brosset, A. 1962. The bats of central and western India. *Journal of Bombay Natural History Society* 59(3): 707–746.

Cayunda, I.E., B.J.C. Ibañez and Jr. S.T. Bastian 2004. Roosting behavior and roost site characterization of *Pteropus vampyrum* in Malagos watershed, Davao city. *Agham Mindanaw* 2: 61–72.

Eby, P. 1996. Interactions between the grey-headed flying-fox, Pteropus poliocephalus (Chiroptera: Pteropodidae) and its diet plants - seasonal movements and seed dispersa. *Dissertation*, University of New England, Armidale.

Fenton, M.B. 1985. *Communication in the Chiroptera*. Indiana University Press, Bloomington.

Holmes, J.L. 2002. Roosting ecology of the grey-headed flying fox, Pteropus poliocephalus: spatial distribution in a summer camp. *PhD thesis*. The University of Tennessee, Knoxville.

Koilraj, J.A., G. Agoramoorthy and G. Marimuthu 2001. Copulatory behavior of Indian flying fox *Pteropus giganteus. Current Science* 80: 15–16.

Lekagul, B. and J.A. McNeely 1977. *Mammals of Thailand*. Association for the Conservation of Wildlife, Bangkok.

Marimuthu, G. 1988. The sacred flying fox of India. *Bats* 6: 10–11.

McIlwee, A.P. and L. Martin 2002. On the intrinsic capacity for increase of Australian flying foxes (*Pteropus* spp., Megachiroptera). *Zoologist* 32: 76–100.

Nelson, J.E.W. 1965. Movements of Australian flying foxes (Pteropodidae: Megachiroptera). *Australian Journal of Zoology* 13: 53–73.

Nelson, J.E.W. 1965. Behavior of Australian Pteropodidae (Megachiroptera). *Animal Behavior* 13: 44–557.

Neuweiler, G. 1969. Verhaltensbeobachtungen an einer Indischen Flughundkolonie (*Pteropus g. giganteus*). *Zeitschrift fur Tierpsychology* 26: 166–199.

Nowak, R. 1999. Walker's Mammals of the world. The Johns Hopkins University Press, London.

Parry-Jones, K.A. and M.L. Augee (1991). Food Selection by Grey-Headed Flying Foxes (*Pteropus poliocephalus*) occupying a

summer colony site near Gosford, New-South-Wales. *Wildlife Research* 111–124.

Parry-Jones, K.A. and M.L. Augee 2001. Factors affecting the occupation of a colony site in Sydney, New South Wales by the Grey-headed Flying-fox, *Pteropus poliocephalus* (Pteropodidae). *Australian Ecology* 26: 47–55.

Pierson, E.D. and W.E. Rainey 1992. The Biology of Flying Foxes of the Genus *Pteropus*. *Biological Reproduction* 90: 1–17.

Saether, B.E. and O. Bakke 2000. Avian life history variation and contribution of demographic traits to the population growth rate. *Ecology* 81: 642–653.

Sandhu, S. and A. Gopalakrishna, 1984. Some observations on the breeding biology of the indian fruit bat *Cynopterus sphinx* (Vahl) in Central India. *Current Science* 53: 1189–1192.

Sandhu, S. 1985. Observations on the reproduction and associated phenomena in the male fruit bat, *Cynopterus sphinx* (Vahl) in Central India. *Journal of Bombay Natural History Society* 85: 135–142.

Sugita, N., M. Inaba and K. Ueda 2009. Roosting pattern and reproductive cycle of Bonin flying foxes (*Pteropus pselaphon*). *Journal of Mammalogy* 90: 195–202.

Tidemann, C. R. 1999. Biology and management of the grey-headed flying-fox *P. poliocephalus*. *Acta Chiropterologica* 1: 151–164.

Wilkinson, G.S. and J.M. South 2002. Life history, ecology and longevity in bats. *Aging Cell* 1: 124–131.

Williams, N.S.G., M.J. McDonnell, G.K. Phelan, L.D. Keim and R. Van Der Ree 2006. Range expansion due to urbanization: Increased food resources attract Grey-headed Flying-foxes (*Pteropus poliocephalus*) to Melbourne. *Australian Ecology* 31: 190–198.

Wood, W.F., A. Walsh, J. Seyjagat and P.J. Weldon 2005. Volatile compounds in shoulder gland secretions of male flying foxes, genus *Pteropus* (Pteropodidae, Chiroptera). *Zeitschrift fur Naturforshung* 60: 779–784.

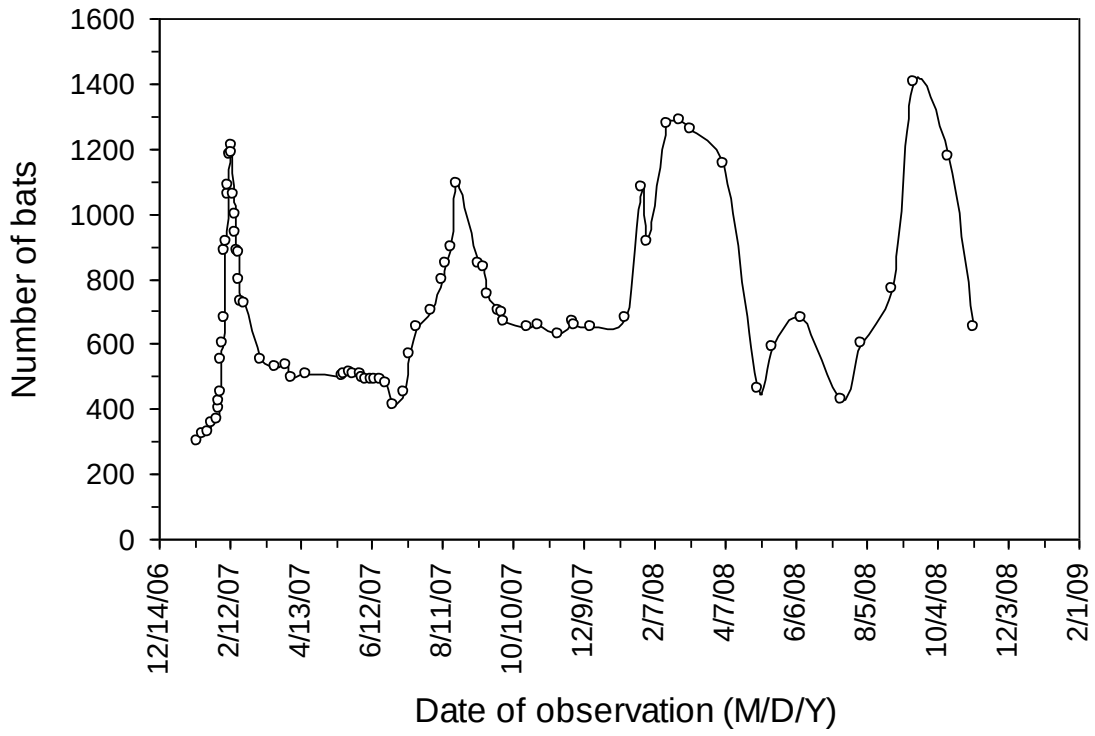

Figure 1. Population of *Pteropus giganteus* in Mohanlal ganj colony during spring (February – March) and autumn (August – September) breeding seasons.

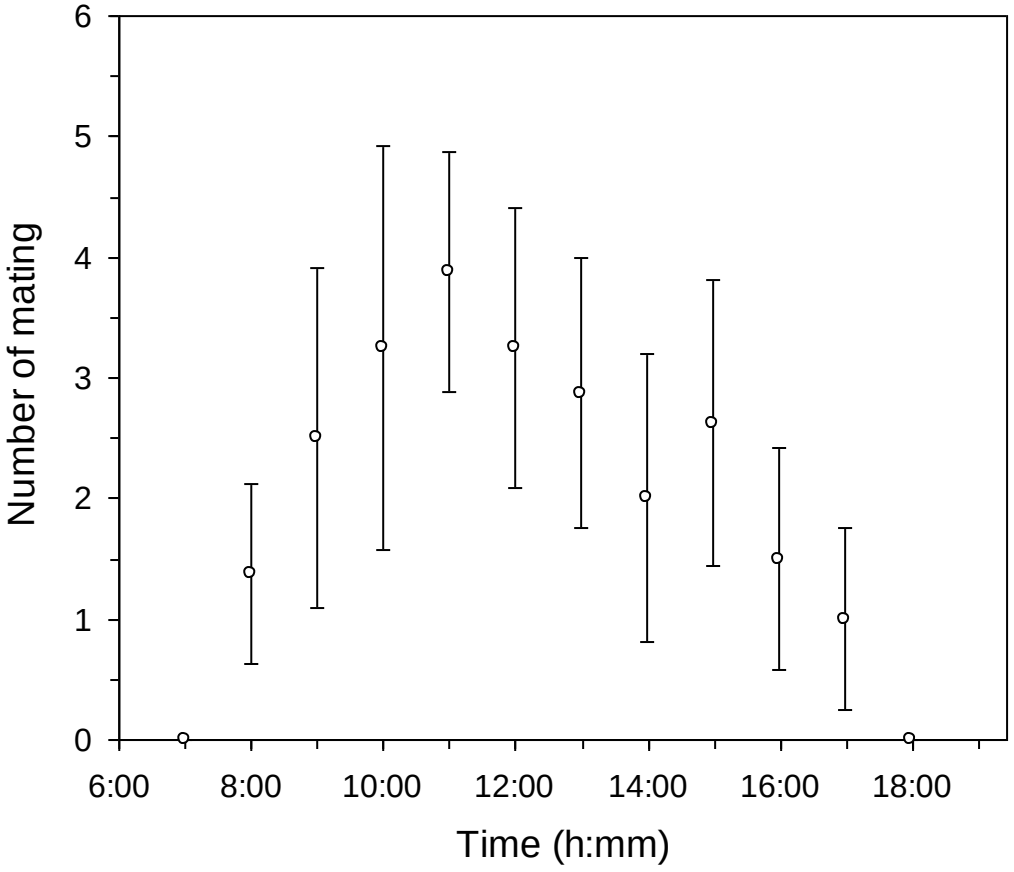

Figure 2. Temporal variations in the mating frequency of *P. giganteus*. Values are given as Mean ± SD.

SMALL MAMMALS SURVEY IN AND AROUND KOSHI TAPPU WILDLIFE RESERVE, NEPAL

PRAVA PANDEY AND PRATIVA KASPAL
Himalayan Nature, Lazimpat, Kathmandu, Nepal
Emails:research@himalayannature.org
data@himalayannature.org

ABSTRACT

Small mammals are regarded as "pests" in Nepal including Koshi Tappu Wildlife Reserve. In spite of the fact that they play significant influences on vegetation and soils, exert predatory pressure on other animals and provide food for predators. The small mammal composition and diversity has been overlooked even though they constitute a large mass of wild animals. The scenario is same in Koshi Tappu Wildlife Reserve. Survey on small mammals was thus conducted to know their diversity and distribution in the area. Camera trappings and semi structured questionnaires were deployed during the research. Altogether 5 species of small mammals belonging to 5 genera and 4 families were recorded during the study period.

Key words: *Small mammal, diversity, Koshi Tappu Wildlife Reserve (KTWR), camera trappings*.

INTRODUCTION

Nepal has a great wealth of mammals; as many as 208 species are reliably reported (Baral and Shah, 2008). Taxonomic study on the mammals of Nepal was started by Hodgson (1831, 1833, 1835, 1836, 1837, 1838, 1839, 1841, and 1844). The contribution of Hodgson on the mammals of Nepal and Sikkim actually laid the foundation of Himalayan mammals.
Later on, (Blyth, 1844) and (Horsefield, 1855) added several species to the list of mammals of Nepal. (Hinton and Fry, 1923) listed 34 genera and 44 species of mammals from Nepal. (Biswas and Khajuria, 1955 and 1957) collected small mammals from Khumbu region of eastern Nepal and described several species of rodents and pikas. (Abe, 1982) reported 28 species of small mammals from central Nepal. However, the information on Nepal's small mammals is scanty and scattered. Of the 208 mammal species in Nepal, only for large charismatic animals eg, Rhino, Tiger, Leopard, Gaur etc are concerned.
31 mammalian species are recorded in Koshi Tappu Wildlife Reserve Asian elephant, spotted deer, hog deer, Wild pig, Smooth-coated otter golden jackal and Gangatic River Dolphin are found. It also has the largest heronry in Nepal. The reserve is the only remaining habitat of Asian Wild Water Buffalo in Nepal, whose population is 219 according to 2009 census. Besides, it is a home for the variety of small mammals (CSUWN, 2009).

This study aimed at identifying small mammals that roam in and around KTWR. Our purpose is to identify the small mammalian species, their habitat distribution and raise awareness in Koshi Tappu Wildlife Reserve, Nepal; to enlist the small mammalian diversity in and around the KTWR and to know their distribution in the area.

MATERIALS AND METHODS

Study Area

Koshi Tappu Wildlife Reserve

The Koshi Tappu Wildlife Reserve belongs to Terai wetlands of Nepal which extends between 86°55'-87°05'E and 26°34′-26°45'N on the alluvial flood plain of the Sapta Koshi River. Due to the presence of diverse types of wetlands, floodplain and large forest area, it consists different types of mammals though it was established for the protection of endangered species, the wild water buffalo (*Bubalus bubalis*). The climatic condition of this area is tropical monsoonal type and experiences three distinct seasons i.e., summer (February to May), rainy (June-September) and winter (October-January).

KTWR was established in 1976 and spread over three districts of eastern Nepal along the flood plain of Koshi River. The flood plain is a complex mosaic of lotic and lentic ecosystem and characterized by grassy marshes, oxbow lakes, swamp lakes and many depressions which retain water throughout the year. It lies between 75 to 81 m above sea level. Including the buffer zone it covers an area of 348 km², however the core area is only 175km² and is in rectangular shape. The reserve is the first Ramsar site of the country which was enlisted on 17 December 1987. This area is managed under protected area system of the country.

The existing vegetation of the reserve consists of diverse physiographic types, which harbors 658 species of plants including submerged, aquatic, floating and tall reed grassland. The forest types include *Dalbergia-Acacia, Bombax* and the grassland includes *Typha, Vetivera, Phragmites, Saccharum* etc (DNPWC, 2010).

Methods

Research Design

The study site was located from $26^0$41.340'N and $87^0$04.962'E to $26^0$37.196'N and $87^0$01.845'E in and around the KTWR. During a reconnaissance survey in February 2011 to April 2011, we came across for indirect signs of mammals on all available trails and selected potential sites for intensive camera trapping based on sign abundance. Four sampling blocks were selected on the basis of the sign abundance: Jabdi, Madhuban, Kusaha and Prakashpur.

Camera trapping

Camera trapping was the primary method used for the survey. Transects of different lengths, preferably shorter than 1 km were laid down on the available trails. Five meter belts were searched for scats, pugmarks and other indirect signs of the concerned species. Any direct sightings of the prey species were also recorded. Trap stations were selected based on sign abundance indicative of frequent activity to maximize the capture probability of the concerned species.
Habitat characteristics of the site were noted down. The GPS points of the trap stations were saved in the GPS unit (GPS garmin 60CSX, Garmin corp. USA). Four blocks were made for the study purpose. Six cameras were deployed in a block. Cameras were placed from 19th February to 19th April 2011, for a total of 60 days. The minimum distance between two consecutive camera traps was kept at 500 – 1000 m. Cameras were mounted at 30–50 cm above ground depending upon the targeted species. They were operated for 5 pm to 8am to avoid human movement during daytime.

The interval between successive triggers was kept at 15 seconds.
Only independent images of a particular species were counted as valid. The independence of capture was defined as (1) successive photographs of different individuals, (2) consecutive photographs of individuals of the same species taken more than 0.5 h apart, and (3) non-consecutive photos of individuals of the same species. The camera trap images were also used to analyze the activity pattern of some species. Their identification was done by following (Baral and Shah, 2008).

Questionnaire survey
Semi-structured questionnaires were used to acquire information from local people about the status of the field and threats associated with their survival. These were carried out in settlements areas adjacent to the KTWR along with the camera trapping. Emphasis was given to informal discussions with local people, during which unreliable evidences were also documented.

RESULTS

This is only a preliminary phase of our research. Altogether 5 species of small mammals belonging to 4 families and 4 genera were found during the study period (Please refer Table 1)

DISCUSSIONS AND CONCLUSION

The present study area shelters diverse small mammals along with the mega flagships. It is due to the assemblages of wetlands, forest area and water bodies. Small mammals prey on insects and occasionally other small mammals, provide a prey base for carnivores, and modify their environments in such a way as to provide habitat for other animals. Light grazing by small mammals may stimulate plant production. The ability of small mammals to exploit environmental resources, based upon a rapid adaptation to short-term changes in population and/or the environment, as well as to a variety of local conditions, implies a strong impact upon natural resources. The role played by small mammal consumers in the flow of energy within natural and man-modified ecosystems is therefore of equal importance to that of larger, longer-lived species which have been studied more intensively.

Altogether, 5 species of small mammals were recorded during this study period. According to the local people, the Koshi Tappu area was covered with dense riverine forest and tall grasses in the past where small mammals such as Five Striped Palm Squirrel, Three Striped Palm Squirrel, Common Otter, Smotth Coated Otter, Black Giant Squirrel and Indian Grey Mongoose were abundant. But now these small mammals could be occasionally. According to the local information, not only the small mammals, other various species of mammals and their number have been decreased in this area due to lack of awareness. Moreover, illegal hunting and clearing of forest in its surroundings also decreased the number of species.

Table 1. Diversity of small mammals in and around of Koshi Tappu Wildlife Reserve 2011

Family	Scientific name	Common name	Local status	IUCN Red list of Threatened Species
Felidae	*Felis chaus*	Jungle Cat	Rare	Least Concern
Felidae	*Felis viverrina*	Fishing Cat	Occasional	Endangered
Leporidae	*Lepus nigricollis*	Indian Hare	Rare	Least Concern
Viverridae	*Viverricula indica*	Small Indian Civet	Occasional	Least Concern
Hystricidae	*Hystrix brachyura*	Malayan Porcupine	Occasional	Least Concern

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REFERENCES

Abe, H. 1982. Ecological distribution of small mammals in central Nepal. *Mammalia* 46:477-503.

Baral, H.S. and Shah, K. B.2008. Wild Mammals of Nepal. Himalayan Nature, Kathmandu.

Biswas, B. and H. Khajuria 1955. Zoological results of the Himalayan Expedition, 1954. Four new mammals from Khumbu, eastern Nepal. *Proc.Zool. Soc.* Calcutta 8: 29-30.

Biswas, B. and H. Khajuria 1957. Zoological results of the Himalayan Expedition, 1954. Notes on some mammals of Khumbu, eastern Nepal.*Proc. Zool. Soc.* Calcutta Mookerjee Memor. pp. 229-253.

Blyth 1844. Notices of various mammalia. *J. Asiat.Soc.* Bengal 13: 463-474.

Hinton, M.A.C. and T.B. Fry 1923. Mammal survey of India, Burma and Ceylon. *J. Bomb. Nat.Hist. Soc.* 29: 399-428.

Hodgson, B.H. 1831. Some account of a new species of *Felis*. *Gleanings Sci.* 3: 177-178.

Hodgson, B.H. 1833. The wild goat and the wild dog of the Himalaya. *Asiatic Res.* 18: 129-138.

Hodgson, B.H. 1835. Synopsis of the Vespertilionidae of Nepal. *J. Asiat. Soc.* Bengal 4: 699-701.

Hodgson, B.H. 1836. Illustration of Nepalese Zoology. *J. Asiat. Soc.* Bengal 4: 521-525.

Hodgson, B.H. 1837. Description of the Gauri Gai of the Nepal forest. *J. Asiat. Soc*. Bengal 6: 499.

Hodgson, B.H. 1838. Classified catalogue of Nepalese Mammalia. *Annals Mag. Nat. Hist*. 1: 152-154.

Hodgson, B.H. 1839. On three new species of musk (*Moschus*). *J. Asiat. Soc*. Bengal 8: 202-203.

Hodgson, B.H. 1841. Classified catalogue ofmammals of Nepal. *J. Asiat. Soc*. Bengal 10: 907 916.

Hodgson, B.H. 1844. Classified catalogue of the mammals of Nepal. *J. Nat. Hist.* Calcutta 4:284-294.

Horsefield, T. 1855. Brief notices of mammalia in Nepal. *Annals Mag. Nat. Hist*. 16: 101-114.

Johnson, D.H, S.D. Ripley and K. Thonglongya 1980. Mammals from Nepal. *J. Bomb. Nat. Hist.Soc*. 77: 56-62.

Camera trapped pictures


Indian Hare *Lepus nigricollis*

IMPACTS OF ROADS ON SMALL MAMMALS IN THE AGRO-PASTORAL LANDSCAPE OF KACHCHH, GUJARAT

KAMLESH K. MAURYA[1], I. P. BOPANNA[1], SUTIRTHA DUTTA[1] AND Y. V. JHALA[1]
[1]Wildlife Institute of India, Post Box # 18, Chanadarbani, Dehradun-248001 (Uttrakhand)
E-mail: kamlesh_amu@yahoo.co.in

ABSTRACT

The unprotected agro-pastoral landscape of Kachchh hosts a plethora of wildlife including several endangered species, but is subjected to accelerated land use conversion through industrialization, mining and development of extensive road networks in recent years. Kachchh is the largest district in Gujarat and is traversed by several public roads. The impacts of roads on the wildlife of this landscape include habitat loss, fragmentation and human induced mortality. Road mortality of small mammals, birds and reptiles are very common. More than hundreds of mammals are killed annually from vehicle collisions, making the issue an important one for conservation biologists and environmental managers. Opportunistic surveys were carried out during an ongoing project in and around Abdasa tehsil of Kachchh. We recorded all readily identifiable kills on or immediately adjacent to roads in this region from 2006 to 2010. Over 5 years, we recorded 630 roads kills of 38 species including mammals (18), birds (9) and reptiles (11). The largest group of road kill was mammals which represented 58.1% followed by reptiles (33.2%) and birds (8.7%). The overall kill rate was estimated at 21.32 animals/100 km/day. Mammalian kill rate was found to be the highest (15.38 kills/100km/day) than bird (1.24kills/100km/day). Among mammals, 5 species were found to be most prone to collision: Domestic dog (*Canis familiaris),* Golden jackal (*Canis aureus*), Mongoose (*Herpestes Spp.),* Hedgehog (*Hemiechinus Spp.)* and Jungle cat (*Felis chaus*). Even endangered and threatened species like the Great Indian Bustard (*Ardeotis nigriceps*), caracal (*Caracal caracal*), Indian wolf (*Canis lupus pallipes*) and striped hyena (*Hyaena hyaena*) were observed as road kills. Our results show that there is high mortality in the agro-pastoral landscape of Kachchh, as well as differences between seasons, road types, and land use types. Conservation and management efforts should focus on identifying ways to reduce such high mortality on roads as it might exacerbate the local extinction of the endangered species of this region.

Key Words: *Road kills, road network, wildlife, Domestic dog, Golden Jackal, agro-pastoral landscape*

INTRODUCTION

Kachchh is the second largest district in India and this arid agro-pastoral landscape hosts a plethora of wildlife including some critically endangered species. As wild habitats in Kachchh are converted to agriculture or industrial use and remaining patches become increasingly fragmented, wildlife populations dwindle and may eventually become extinct (Dutta et al., 2010). Nevertheless, there is a great deal of variation in how different species of animals react to a given anthropogenic disturbance (such as intensive agriculture) and how different forms of disturbance influence the

same species. This multiplicity of response means that it is difficult to generalize about the effects of human activities on wildlife populations (Culter, 1991; Soule et al., 1992; Schwartz, 1997; Rosenblatt et al., 1999). Roads have a variety of ecological effects, including outright destruction of habitat for road construction and concomitant displacement of animals; pollution from pavement, vehicles, and litter; erosion; sedimentation of waterways; chemical alteration of soils; functioning as dispersal corridors for both native and exotic plants and animals and changing behavior of animals from as small to large animals (Spellerberg, 2002; Trombulak and Frissell, 2000). Animal mortalities due to vehicle collision are the most apparent and immediately recognizable ecological effect of roads. Animals of all sizes are affected, from insects to large cervids (Spellerberg, 2002; Trombulak and Frissell, 2000).

Recognition of the deleterious impacts of roads has prompted a range of interest in the last few years (Andrews, 1990; Bennett, 1991; Forman and Alexander, 1998; Spellerberg, 1998; Carr et al., 2002; Trombulak and Frissell, 2002; Sherwood et al., 2002; Forman et al., 2003). The impact of roads on wildlife can be pervasive as roads can cause numerous fatalities as a result of collisions with the vehicles that travel on them (Malo et al., 2004; Saeki and Macdonald, 2004; Ramp et al., 2005). Roads can also fragment populations by forming barriers to movement, isolating them from resources and mates (Richardson et al., 1997; Gerlach and Musolf, 2000). These impacts raise serious concerns about the stability and sustainability of roadside wildlife populations in road-affected environments, especially as the amount of transported goods and the numbers of people travelling on roads increases world-wide. In India the total length of roads and number of motorized vehicles have increased in the last 50 years (1954-2004) from 0.4 to 3.4 million kilometer and 0.3 to 30 million respectively (Rao and Girish, 2007). Gujarat's road networks allow people and products to travel to every corner of the state. Along the way, these roads cross through the habitat of many wildlife species. Gujarat alone contains more than 74,111 km of public roads and nearly 30000 km are under construction (Road and Building Department Government of Gujarat, 2010). Such an enormous network will certainly have detrimental effects on animals that cross roads.

There are several studies outside India on the impacts of roads on wildlife and their population density (Fahrig et al., 1995, Gibbs, 1998; Smith and Dodd, 2003; Dodd, 2004; Smith et al., 2005; Ramp et al., 2006; Ament et al., 2008; Smith-Patten and Patten, 2008) while in India there are some anecdotal studies (Kumar et al., 2000; Vijayakumar et al., 2001; Changani , 2004; Sundar, 2004; Das et al., 2007; Seshadri et al., 2009; Baskaran and Boominathan, 2010; Behera and Borah, 2010). Most of these studies are carried out in protected areas and focus on invertebrates. There are no studies in unprotected agro-pastoral areas where human pressure is increasing day by day. Our study arose from our casual observations of road-kills in 2-3 Talukas of Kachchh. We noticed apparent seasonal peaks in numbers of certain medium-sized mammals dead along roads, so we began to collect data systematically to test our suspicion that these peaks were related to the specific reproductive cycles of the species road killed, such as mate seeking, foraging with young, and dispersal of sub adults. Our research indicates patterns of small mammalian road kills in Kachchh as well as highlighting factors and conservation efforts that apply generally.

MATERIALS AND METHODS

Study Area

The area selected for this study area was in and around Abdasa taluka (23^0 17'N, 68^0 56'E), located in the south-western province of Kutch district (Fig. 1).The study area comes under semi-desert ecological zone where summer commences in March and continues until late June. May experiences the highest air temperature of 40-45 ^{0}C. Precipitation is scanty and stochastic, with an annual average of 384 mm. The vegetation in the study area has been classified as Northern Tropical Thorn Forest (6B/C1) and sub classified as desert thorn forest as per the classification of the forest types by Champion and Seth (1968). But since last 2-3 years study area has been highly modified due to agriculture and industrialization. The small and medium sized carnivore community in the study area is diverse and comprised of 8 species: Indian wolf (*Canis lipus pallipes*), Striped hyena (*hyaena hyaena*), Golden jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), Desert fox (*Vulpes v. pusilla*), Jungle cat (*Felis chaus*), Desert cat (*Felis sylvestris*) and Caracal (*Caracal caracal*). The study area also supports some endangered avian and reptilian fauna such as Indian Bustard (*Ardeotis nigriceps*), Lesser floricon (*Syphsseotides indica*) and Spiny tailed lizard (*Uromastix hardwiicki*).

Methods

The study was carried out between January 2006 and January 2011. We monitored three State Highways and more than 6 village metal roads which connect with main highway. The lengths of roads were varied from 5-120 km in length. Most of the roads are surrounded by pastoral land, agriculture field and scrub lands. Quantitative survey for wildlife killed by vehicles involves driving in an open vehicle and recording dead wildlife (road kills) seen on the road. Surveys were opportunistic and it was conducted while driving from study sites for *Vulture monitoring* or during field work. Both side of the road was scanned by 3-4 observers. No pattern of surveys was established, as some roads were monitored multiple times, others were not. We recorded all data systematically on standard sheets designed for this study. For each road kill, the location (GRAMIN GPS 72), species, sex and age class (adult and sub adult) was recorded whenever possible. Once details of the fatality were recorded the carcass was moved out of sight (especially mammals such as Golden Jackal (*Canis aureus*), Jungle cats (*Felis chaus*) etc.) so as to avoid double counting. For mammals, all species were classified into three classes based on their body size (large, medium and small bodied). This opportunistic survey might underestimate the true number of road kills because the difference removal rate of different size animals (Talyor and Goldingay, 2004). Based on our field experience and observation we used carcasses removal rate for large (5 days), medium (3 days) and small bodied (2 days) mammals. For bird and reptiles we used 2 days for carcasses disappearance from roads. The mortality rate of each group and species were calculated as: Mortality rate= total number of road kills/Efforts (km)/caracas removal rate. We also calculated numbers of road kills month-wise and season wise (*winter: November to February, summer: March to June, Monsoon: July to October)* to see whether there is any peak mortality periods of particular species in relation to their biological period .The number of animals and species killed were expressed per 100 km.

RESULTS

We covered 8892 km road length during the study period with repeated visits on some of the roads. We recorded 630 roads kills of 38 species including mammals (18), birds (9) and reptiles (11). The largest group of road kill was mammals which represented 58.10% followed by reptiles (33.17%) and birds (8.73%). The overall kill rate was estimated to be 21.32 kills per100 km per day (Table1). Mammalian kill rate was found to be the highest (15.38 kills/100km/day) than bird (1.24kills/100km/day). Among mammals, the mortality rate of large bodied animals was found to be highest (11.13 kills/100/day) than medium (1.42 kills/100/day) and small bodied animals (2.83 kills/100/day). Among mammals we found five species to be more prone to vehicle collision: Domestic Dog (*Canis familiaris*), Golden Jackal (*Canis aureus*), Hedgehog (*Hemiechinus spp*.), Grey Mongoose (*Herpestes edwardsii*) and Jungle Cat (*Felis chaus*). Together these five species accounted for 77.05 % (N=366) of total mammalian road kills (Table 1and2). It is also important to notice that some endangered and threatened carnivores such as Caracal (*Caracal caracal),* striped hyena *(Hyaena hyaena)* and Desert cat *(Felis sylvestris)* were found in road kills (Fig. 2). These results probably under represented the true loss of animals to road kills given that an unknown proportion of animals killed by vehicles are either eaten by carrion feeders (for example striped hyena and golden jackal) or dead in the nearby vegetation without being detected. Large bodied animals were killed more in winter while small and medium bodied animals were killed nearly equal rates in all season (Table 3). However, birds and reptiles were most prone to be killed in winter and monsoon respectively. Although animals were killed throughout the year with two peaks (June-Sept and Nov-Jan) (Table 4), there were no significant differences in the rate of kills/100km in winter, summer and monsoon. Winter was found to be a critical high mortality period for domestic dog (47.75 % of domestic dog kills) and golden jackal (54.55%). For hedgehog, mongoose and jungle cat, road kills were found to be 60.42% (between July to August), 60.61% (between March and July), and 45.83 % (August and September) of annual casualties, respectively (Table 4).

DISCUSSIONS AND CONCLUSION

By conducting surveys along the most frequented roads within the study area, results show how different species are affected by roads and agriculture practices in this human dominated landscape. The data on road kills revealed that vehicular traffic killed a minimum of 630 individuals of mammals, reptiles and birds during the study period. It was observed that mammals were most prone to vehicle collision and this may be explained by their abundance, as seen in other studies. Among mammals, the most frequent road kills encountered and recorded were domestic dog (*Canis familaris)*, golden jackal (*Canis aureus*), hedgehog (*Hemiechinus spp.*), mongoose (*Herpestes edwardsii*) and Jungle cat (*Felis chaus*). Indeed, the 5 most frequently killed species are the most known common species in study area (Aiyadurai and Jhala, 2006; Jhala, 2003). For a large-bodied mammal, striped hyaena (*Hyaena hyaena*) faced considerable threat from road kills. While the low number of road kills such as Indian fox (*Vulpes bengalensis*) and Blacknaped hare (*Lepus nigricollis*) is probably because of their disturbance avoiding behavior. Studies in different countries showed that mammals are major road hazards (Hubbard et al., 2000, Sielecki, 2004; Seiler, 2005; Behera and Boarh, 2010) and the traffic-

related mortality is highly detrimental, especially for species with declining populations (Spellerberg, 1998). Previous accounts of road kills in an unprotected area have documented high mortality of large bodied animals than small bodied animals (Sundar, 2004). We also observed the temporal variation in road kills. Highest road kills were recorded in 2006-2007. This variation in road kills could be because of drought, traffic volume and speed. Estimates were restricted to frequency of road kills of different species. Traffic volume and speed are generally regarded as being important factors explaining road fatalities (Forman and Alexander, 1998; Hubbard et al., 2000; Jones, 2000; Trombulak and Frissell, 2000; Dique et al., 2003; Seiler, 2003). Thus, data about traffic volume and speed would be necessary to quantify variation in vehicle collision rates that may result from changes in animal behavior with seasonal conditions and breeding patterns or from long-term environmental patterns such as drought.

Out of 18 species of mammal road kills, three species were found to be of particular concern such as striped hyaena, caracal and desert cat under the Wildlife (Protection) Act 1972. Previous studies of road-kills in India carried out in protected and forested areas have also documented death of many species of conservation concern (Kumara et al., 2000, Rajvanshi et al., 2001). The effects of roads are believed to be minimal for populations of common species, but there could be an impact on threatened (Scott et al., 1999) species. Most of the road-killed mammal species we encountered were nocturnal and therefore could have resulted in a high mortality rate.

We attempted to find out the relationship of frequently observed road kills with season and also to look biological periods such as mating (Davis, 1946) or juvenile dispersal (Conard and Gipson, 2006; Davis, 1940; Wilkins and Schmidly, 1980). We hypothesized that road kill patterns would correlate, within species, with three spurts in movement: mating season(s), post-weaning when the young forage with their mother, and dispersal of juveniles. Road-kills showed seasonal patterns that were consistent with individual carnivore life-history phenologies. The higher incidence of road casualties may be related to the higher mobility periods, e.g., dispersal and breeding. As expected, domestic dogs are killed at high rate during winter and mid-summer (Table 2). In our study area we observed the peak breeding period during winter season (*Bopanna pers. obs.*). The other explanation is scavenging on road kills such as birds. It was observed that dogs used to rest close to road especially near bus stops and this could also contribute to high mortality of this species.

Golden jackal (*Canis areus*) road kills show a bimodal distribution (Table 3). One peak was observed between November to February and the other June to early September. These peaks correspond well with breeding behavior. During this period jackals are more mobile to find their mates and food for pups (Jhala and Moehlman, 2004). They start excavating dens from April to May (Jhala and Moehlam, 2004) by moving and covering large distances to find suitable denning sites. Interestingly, the period of feeding the young was the most vulnerable for jackal. Post-weaning foraging and dispersal occur during monsoon (late June to early September). According to Moehlman (1989) and Moehlman and Hofer (1997) they visit the breeding sites several times to feed their pups and also to provision the lactating females. Our observation also shows that males were more vulnerable during pup rearing. Jackals were frequently killed while scavenging on other kills on road (pers.obs.). Jungle cat and hedgehog

showed a high mortality in July to September (Table 3). According to Huijser et al. (1998) hedgehogs are most prone to traffic in Netherlands and he estimated that between 113,000 and 340,000 hedgehogs may fall victim to traffic each year. During our field work we frequently observed them foraging on insects on road. Another reason could be their slow movement habits. The peak mortality of Jungle cat was found in monsoon, although breeding tends to commence in winter and cub rearing extended till May and June. Cubs start dispersing in monsoon when resources are more abundant. During this time Jungle cat could be more susceptible to road kills. Grey mongoose was the only of the 5 common road kills that did not exhibit a marked seasonality pattern. Species-specific behaviors may exhibit different age and sex ratio of road kills (Baker, 2007; Loughry and McDonough, 1996). These issues need to be explored further given the possible detrimental effects on breeding behavior and population size that, for example, skewing the operational sex ratio can cause, which could have far-reaching conservation implications.

The mortality rate of birds was found to be very low in comparison to other taxa. Out 9 species of birds road kills in the study area, one was found conservation concern such Black francolin (*Francolinus francolinus*). Grey francolin (*Francolin podicerinus*) was also found in road kills. The partridge's habit of crossing road in course of foraging and it place them in risk of vehicle collision. Babber was the most frequent bird road kills. Population abundance and choice of road side tree for nesting site could be described as the key attributing factors. Most of them were during winter and it appears that vehicular traffic causes minimal mortalities of birds. The mortality of birds recorded in this study, however, was far lesser than recorded by Sharma (1998) and Sundar (2004). While highest number of reptiles road kills were found during the monsoon. An increase in mobility and activity due to rains leads to their increased mortality due to vehicle traffic (Vijayakumar et al., 2001). Kumara et al. (2000) found a significant positive relationship between the rainy season and number of reptiles killed.

A number of important questions remain to be answered. Even with common species, the effects of the roads still need clarification. No doubt, this will vary by location and species. Further work on barrier effects and mortality, with emphasis on systematic surveys of population sizes near and away from roads, behavior, and gene flow (Riley et al., 2006; Baker et al., 2007; Beaudry et al., 2008), especially for less vagile species, would help refine our knowledge of road effects. Long term, consistently collected data would aid immensely in distinguishing the spatial and temporal patterns of road kill hotspots.

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REFERENCES

Aiyadurai, A. and Y.V. Jhala 2006. Foraging and habitat use by Golden Jackals (Canis aureus) in the Bhal region, Gujarat, India. *J. Bom. Nat. Hist. Soc.* 103:5-12.

Ament, R., P. Anthony, O. Clevenger, Yu. and A. Hardy 2008. An assessment of roads impacts on wildlife populations in U.S.

National Parks. *Environmental Management* 42:480–496.

Andrews, A. 1990. Fragmentation of habitat by roads and utility corridors: a review. *Australian Zoologist* 23: 130–141.

Baker, P.J., C.V. Dowding, S.E. Molony, P.C.L. White, S. Harris 2007. Activity patterns of urban red foxes (*Vulpes vulpes*) reduce the risk of traffic-induced mortality. *Behavioral Ecology* 18: 716–724.

Baskaran, N. and D. Boominathan 2010. Road kill of animals by highway traffic in the tropical forests of Mudumalai Tiger Reserve, southern India. *Journal of Threatened Taxa* 2(3): 753-759.

Behera, S. and Borah, J. 2010. Mammal mortality due to road vehicles in Nagarjunasagar-Srisailam Tiger Reserve, Andhra Pradesh, India. *Mammalia*. 74 (4):427–430.

Bennett, A.F. 1991. Roads, roadsides and wildlife conservation: a review.In: Saunders, D.A., Hobbs, R.J. (Eds.), Nature Conservation 2: The Role of Corridors. Chipping Norton, Australia, Surrey Beatty, pp. 99–117.

Beaudry, F., P.G. deMaynadier, M.L. Hunter Jr. 2008. Identifying road mortality threat at multiple spatial scales for semiaquatic turtles. *Biological Conservation*. 141:2550-2563.

Maurya, K. K., I.P. Bopanna, S. Dutta, Y. V. Jhala, and A. R. Rahmani 2010. Research and conservation of endangered and threatened fauna of Kutch: An Integrated Approacah. *Technical Report No 5*. Wildlife Institute of India, Dehradun.

Carr, L.W., L. Fahrig, S. E. Pope 2002. Impacts of landscape transformation by roads. In: Gutzwiller, K.J. (Ed.), Applying Landscape Ecology in Biological Conservation. Springer-Verlag, New York, pp. 225–243.

Champion, F.W. and S. K. Seth 1968. A revised survey of the forest types of India: 234-238. Govt of India, New Delhi.

Changani, A. K. 2004. Mortality of wild animals in road accidents in Kumbhalgarh Wildlige Sanctuary, Rajashthan, India. *Jouranl of Bombay Natural History Society* 101(1): 151-154.

Conard J.M, P.S. Gipson 2006. Spatial and seasonal variation in wildlife–vehicle collisions. *Prairie Nat* 38:251–260.

Cutler, A. 1991. Nested faunas and extinction in fragmented habitats. *Conservation Biology*. 5:496-505.

Das, A., M. F. Ahmed, P.L. Bibhuti and P. Sharma 2007. A preliminary report of reptilian mortality on road due to vehicular movements near Kaziranga National Park, Assam, India. *Zoo Print Journal* 22(7): 2742-2744.

Davis, W.B. 1940. Mortality on wildlife on a Texas highway. *Journal of Wildlife Management* 4:90–91.

Davis, W.B. 1946. Further notes on badgers. *Journal of Mammalogy*. 27:175.

Dique, D.S., J. Thompson, H.J. Preece, G.C. Penfold, D.L., de Villiers, R.S. Leslie 2003. Koala mortality on roads in south-east Queensland: the koala speed-zone trial. *Wildlife Research* 30, 419–426.

Dutta, S., A.R. Rahmani and Y.V. Jhala. 2010 Running out of time? The great Indian bustard *Ardeotis nigriceps*—status, viability, and conservation strategies. *European Journal of Wildlife Research.* DOI 10.1007/s10344-010-0472-z

Fahrig, I., J.H. Pedlar, S.E. Pope, P.D. Taylor, P. D. and J.E. Wegner, J. E. 1996. Effects of road traffic on amphibian density. *Biological Conservation* 73:177-182.

Forman, R.T.T., D. Sperling, J.A. Bissonette, A.P. Clevenger, C.D. Cutshall, V.H. Dale, L. Fahrig, R. France, C.R. Goldman, K. Heanue, J.A. Jones, F.J. Swanson, T. Turrentine and T.C Winter (Eds.) 2003. Road Ecology: Science and Solutions. Island Press, Washington, USA.

Forman, R.T.T. and L.E. Alexander 1998. Roads and their major ecological effects. *Annual Review of Ecology and Systematics*, 207–232.

Gerlach, G. and K. Musolf 2000. Fragmentation of landscape as a cause for genetic subdivision in bank voles. *Conservation Biology* 14: 1066–1074.

Gibbs, J. P. 1998. Amphibian movements in response to forest edges, roads and streambeds in southern New England. *Journal of Wildlife Management* 62 (2):584-589.

Hubbard, M.W., B.J. Danielson and R.A. Schmitz 2000. Factors influencing the location of deer-vehicle accidents in Iowa. *Journal of Wildlife Management.* 64: 707–712.

Huijser, M.P., P.J.M. Bergers, J.G. De Vries 1998. Hedgehog traffic victims: how to quantify effects on the population level and the prospects for mitigation. *In*: Evink, G.L., Garrett, P., Zeigler, D.,Berry, J. (Eds.), Proceedings of the International Conference on Wildlife Ecology and Transportation. Florida Department of Transportation, Tallahassee, Florida, pp. 171-180

Jhala, Y. V. and P. Moehlman. P. 2004. *Canis aureus In* C. Sillero-Zubiri, M. Hoffmann and D. Macdonald (Eds.) Canids: Foxes, Wolves, Jackals and Dogs. Status Survey and Conservation Action Plan. IUCN/SSC Canid Specialist Group Gland, Switzerland, 156-161.

Jhala, Y. V. 2003. Status, Ecology, and Conservation of the Indian Wolf. *Journal Bombay Natural History Society* 100 (2and3): 293-307.

Kumara, H. N., A.K. Sharma, A. Kumar and M. Singh 2000. Road kills of wild fauna in Indira Gandhi wildlife sanctuary, Western Ghats, India: implication for management. *Biosphere Conservation*. 3 (1): 41–47.

Loughry, W. J. and C.M. McDonough 1996. Are road kills valid indicators of armadillo population structure? *American Midland Naturalist.* 135:53–59.

Malo, J.E., F. Sua´ rez and A. Dı´ez 2004. Canwemitigate animal–vehicle accidents using predictive models? *Journal of Applied Ecology* 41: 701–710.

Moehlman, P. D. and H. Hofer 1997. Cooperative Breeding, Reproductive Suppresion, and Body Mass in Canids in N. G. Solomon and J. A. French Eds. Cooprative Breeding in Mammals. Cambridge University Press. Cambridge, U. K.

Moehlman, P. D. 1989. Intraspecific variation in canid socialsystems. *In* JL Gittleman (ed), Carnivore behavior,

ecology, and evolution. Cornell University Press, Ithaca, NY, USA, pp. 164–182.

Rajvanshi, A., V.B. Mathur, G.C. Teleki and S.K. Mukherjee 2001. Roads, sensitive habitats and wildlife: environmental guideline for India and south Asia. Wildlife Institute of India, Dehradun and Canadian Environmental Collaborative Ltd., Toronto.

Ramp, D., J. Caldwell, K.A. Edwards, D. Warton, D.B. Croft 2005. Modelling of wildlife fatality hotspots along the Snowy Mountain Highway in New South.

Ramp, D., K.W. Vanessa and B.C. Davis 2006. Assessing the impacts of roads in peri-urban reserves: Road-based fatalities and road usage by wildlife in the Royal National Park, New South Wales, Australia. *Biological Conservation* 129: 348 –359.

Rao, R.S.P. and M. K. S. Girish 2007. Road kills: Assessing insects casualities using flagship taxon.*Current Science* 92 (6):831-837.

Riley, S.P.D., J.P. Pollinger, R.M. Sauvajot, E.C. York, C. Bromley, T.K. Fuller, R.K. Wayne, R.K. 2006. A southern California freeway is a physical and social barrier to gene flow in carnivores. *Molecular Ecology* 15: 1733–1741.

Richardson, J.H., R.F. Shore, J.R. Treweek, S.B.C. Larkin 1997. Are major roads a barrier to small mammals? *Journal of Zoology* 243: 840–846.

Rosenblatt, D.L., E. J. Heske, S. L. Nelson, D. M. Barber, M. A. Miller and B. Macallister. 1999. Forest fragments in East-central Illinois: islands or habitat patches for mammals? *American Midland Naturalist.* 141:115-123.

Saeki, M. and D.W. Macdonald 2004. The effects of traffic on the raccoon dog (*Nyctereutes procyonoides viverrinus)* and other mammals in Japan. *Biological Conservation.* 118: 559–571.

Schwartz, M. W. (Eds.) 1997. Conservation in highly fragmented landscapes. Chapman and Hall, New York, p436.

Scott, L.K., I.D. Hume and C.R. Dickman 1999. Ecology and population biology of long nosed Bandicoots (*Perameles nasuta*) at North Head, Sydney Harbor National Park. *Wildlife Research.* 26: 805–821.

Seiler, A. 2005. Predicting locations of moose-vehicle collisions in Sweden. *Journal of. Applied Ecology* 42: 371–382.

Shamanna Seshadri. K. S., A. Yadav and K.V. Gururaja 2009. Road kills of amphibians in different land use areas from Sharavathi river basin, central Western Ghats, *Journal of Threatened Taxa.* 1(11): 549-552.

Sherwood, B., D. Cutler, J. Burton (Eds.) 2002.Wildlife and Roads: The Ecological Impact. Imperial College Press, London, UK.

Sielecki, L.E. 2004. WARS 1983–2002: wildlife accident reporting and mitigation in British Columbia: special annual report. British Columbia Ministry of Transportation, Environmental Management Section, British Columbia, Canada. pp. 222.

Smith-Patten, B. D. and M. A. Patten 2008. Diversity, Seasonality, and Context of Mammalian Roadkills in the Southern Great Plains *Environmental Management,* 41:844–852.

Smith, L.L., C.K. Dodd 2003. Wildlife mortality on US highway 441 across Paynes Prairie, Alachua County, Florida. Florida *Scientist.* 66: 128–140.

Soule, M. E., A. C. Alberts and D. T. Bolger 1992. The effects of habitat fragmentation on chaparral plants and vertebrates. *Oikos.* 63:39-47.

Spellerberg, I.F. 1998. Ecological effects of roads and traffic: a literature review. *Global Ecology and Biogeography* 7: 317–333.

Spellerberg, I.F. 1998. Ecological effects of roads and traffic: a literature review. *Global Ecology Biogeography Letter.* 7: 317–333.

Spellerberg I.F. 2002. Ecological effects of roads. Science Publ, Enfield, New Hampshire.

Sunder, G. K.S. 2004. Mortality of herpetofauna, birds and mammals due to vehicular traffic in Etawah district, Uttar Pradesh, India. . *J. Bom. Nat. Hist. Soc.* 101(3):392-398.

Talyor, B. D. and R. L. Goldingay 2004. Wildlife road-kills on three major roads in north eastern New South Wales.*Wildlife Research.* 31:83-91.

Trombulak S.C. and C.A. Frissell C.A. 2002. Review of ecological effects of roads on terrestrial and aquatic communities. *Conservation Biology* 14: 18– 30.

Vijayakumar, S. P., K. Vasudevan, and N. M. Ishwar 2001. Herpetofaunal mortality on raods in the Anamalasi Hills, Southern Western Ghats. *Hamadryad* 26 (2):253-260.

Wilkins, K.T. and D.J. Schmidly 1980. Highway mortality of vertebrates in southeastern Texas. Texas J Sci 4:343–350.

Table 1: Frequency of road kills recorded of different species during 2006-2011 in Kachchh

TAXA	SCIENTIFIC NAAME	Total Number of Kills							
		2006	2007	2008	2009	2010	2011	Total	% of Total
Domestic Dog	*Canis familiaris*	28.0	27.0	26.0	5.0	17.0	8.0	111.0	17.62
Golden Jackal	*Canis aureus*	8.0	22.0	17.0	5.0	12.0	2.0	66.0	10.48
Hedgehogs	*Hemiechinus Spp.*	25.0	11.0	6.0	2.0	4.0	0.0	48.0	7.62
Grey Mongoose	*Herpestes edwardsii*	4.0	10.0	6.0	1.0	12.0	0.0	33.0	5.24
Jungle cat	*Felis chaus*	10.0	2.0	8.0	1.0	0.0	3.0	24.0	3.81
Rodents	*Gerbillus Spp.*	3.0	8.0	5.0	0.0	3.0	0.0	19.0	3.02
Domestic Cats	*Felis catus*	3.0	4.0	6.0	2.0	0.0	0.0	15.0	2.38
Striped Hyena	*Hyaena hyaena*	4.0	2.0	3.0	1.0	1.0	0.0	11.0	1.75

Small Indian Civit	*Viverricula indica*	1.0	0.0	1.0	2.0	4.0	1.0	9.0	1.43
Indian Hare	*Lepus nigicollis*	1.0	4.0	2.0	0.0	0.0	0.0	7.0	1.11
Three Striped Squirrel	*Funambulus palmarum*	3.0	0.0	1.0	1.0	0.0	0.0	5.0	0.79
Indian Fox	*Vulpes bengalensis*	0.0	0.0	0.0	2.0	1.0	1.0	4.0	0.63
Nilgai	*Boselaphus tragocamelus*	1.0	0.0	0.0	1.0	2.0	1.0	5.0	0.79
Cattles	*Bos taurus*	0.0	1.0	0.0	0.0	2.0	0.0	3.0	0.48
Caracal	*Caracal caracal*	1.0	0.0	0.0	0.0	0.0	1.0	2.0	0.32
Wild Boar	*Sus scrofa*	0.0	1.0	0.0	0.0	1.0	0.0	2.0	0.32
Desert cat	*Felis sylvestris*	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.16
Indian Porcupine	*Hystrix indica*	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.16
Birds		17.0	14.0	16.0	2.0	6.0	0.0	55.0	8.73
Reptiles		60.0	73.0	36.0	3.0	37.0	0.0	209.0	33.17
	Total	**170.0**	**179.0**	**134.0**	**28.0**	**102.0**	**17.0**	**630.0**	

Table 2: Body Size effect on frequency and mortality rate of mammalian fauna in Kachchh.

TAXA	**SCIENTIFIC NAAME**	**Total No. of Kills**	**Encounter Rate (kill/100km/day)**
LARGE BODIED			
Domnestic Dog	*Canis familiaris*	111.00	6.24
Golden Jackal	*Canis aureus*	66.00	3.71
Striped Hyena	*Hyaena hyaena*	11.00	0.62
Wild Boar	*Sus scrofa*	2.00	0.11
Nilgai (Fawn)	*Boselaphus tragocamelus*	5.00	0.28
Cattles (calf)	*Bos taurus*	3.00	0.17
	Total	**198.00**	**11.13**
MEDIUM BODIED			
Jungle cat	*Felis chaus*	24.00	0.81
Domestic Cats	*Felis catus*	15.00	0.51
Caracal	*Caracal caracal*	2.00	0.07
Desert cat	*Felis sylvestris*	1.00	0.03
	Total	**42.00**	**1.42**
SMALL BODIED			
Hedgehogs	*Hemiechinus Spp.*	48.00	1.08

Grey Mongoose	*Herpestes edwardsii*	33.00	0.74
Rodents	*Gerbillus Spp.*	19.00	0.43
Small Indian Civit	*Viverricula indica*	9.00	0.20
Indian Hare	*Lepus nigicollis*	7.00	0.16
Three Striped Squirrel	*Funambulus palmarum*	5.00	0.11
Indian Fox	*Vulpes bengalensis*	4.00	0.09
Indian Porcupine	*Hystrix indica*	1.00	0.02
	Total	**126.00**	**2.83**
BIRD		55.00	**1.24**
REPTILES		209.00	**4.70**

Table 3: Seasonal Estimation of road kills in Kachchh

TAXA	**SCIENTIFIC NAAME**	**SEASON No, of Individuals (kills per 100km per day)**		
		Winter	**Summer**	**Monsoon**
LARGE BODIED				
Domestic Dog	*Canis familiaris*	53.00 (2.98)	25.00 (1.41)	33.00 (1.86)
Golden Jackal	*Canis aureus*	36.00 (2.02)	14.00 (0.79)	16.00 (0.90)
Striped Hyena	*Hyaena hyaena*	2.00 (0.11)	7.00 (0.39)	2.00 (0.11)
Nilgai	*Boselaphus tragocamelus*	3.00 (0.17)	1.00 (0.06)	1.00 (0.06)
Cattles	*Bos taurus*	2.00 (0.11)	1.00 (0.06)	0.00 (0.00)
Wild Boar	*Sus scrofa*	1.00 (0.06)	0.00 (0.00)	1.00 (0.06)
	Total	**97.00 (5.45)**	**48.00 (2.70)**	**53.00 (2.98)**
MEDIUM BODIED				
Jungle cat	*Felis chaus*	10.00 (0.34)	3.00 (0.10)	11.00 (0.37)
Domestic Cats	*Felis catus*	10.00 (0.34)	2.00 (0.07)	3.00 (0.10)
Caracal	*Caracal caracal*	1.00 (0.03)	1.00 (0.03)	0.00 (0.00)
Desert cat	*Felis sylvestris*	0.00 (0.00)	1.00 (0.03)	0.00 (0.00)
	Total	**21.00 (0.71)**	**7.00 (0.24)**	**14.00 (0.47)**
SMALL BODIED				
Rodents	*Gerbillus Spp.*	8.00 (0.18)	4.00 (0.09)	7.00 (0.16)
Hedgehogs	*Hemiechinus Spp.*	7.00 (0.16)	12.00 (0.27)	29.00 (0.65)
Grey Mongoose	*Herpestes edwardsii*	11.00 (0.25)	15.00 (0.34)	7.00 (0.16)
Small Indian Civet	*Viverricula indica*	4.00 (0.09)	4.00 (0.09)	1.00 (0.02)

Indian Hare	*Lepus nigicollis*	4.00 (0.09)	2.00 (0.04)	1.00 (0.02)
Three Striped Squirrel	*Funambulus palmarum*	2.00 (0.04)	2.00 (0.04)	1.00 (0.02)
Indian Fox	*Vulpes bengalensis*	2.00 (0.04)	0.00 (0.00)	2.00 (0.04)
Indian Porcupine	*Hystrix indica*	0.00 (0.00)	0.00 (0.00)	1.00 (0.02)
	Total	**38.00 (0.85)**	**39.00 (0.88)**	**49.00 (1.10)**
BIRD		**26.00 (0.58)**	**14.00 (0.31)**	**15.00** (0.34)
REPTILES		**17.00 (0.38)**	**57.00 (1.28)**	**135.00** (3.04)

Table 4: Monthly distribution of road kills in the study area`

TAXA	**SCIENTIFIC NAAME**	**MONTHS**												
		JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**Total**
Domestic Dog	*Canis familiaris*	20.00	16.00	10.00	4.00	1.00	10.00	8.00	19.00	3.00	3.00	8.00	9.00	111.00
Golden Jackal	*Canis aureus*	13.00	7.00	8.00	5.00	1.00	0.00	10.00	4.00	0.00	2.00	10.00	6.00	66.00
Hedgehogs	*Hemiechinus Spp.*	1.00	1.00	5.00	5.00	0.00	2.00	6.00	22.00	0.00	1.00	2.00	3.00	48.00
Grey Mongoose	*Herpestes edwardsii*	2.00	0.00	5.00	1.00	2.00	7.00	5.00	2.00	0.00	0.00	3.00	6.00	33.00
Jungle cat	*Felis chaus*	4.00	4.00	1.00	1.00	0.00	1.00	0.00	9.00	2.00	0.00	1.00	1.00	24.00
Rodents	*Gerbillus Spp.*	6.00	0.00	0.00	2.00	0.00	2.00	6.00	1.00	0.00	0.00	0.00	2.00	19.00
Domestic Cats	*Felis catus*	0.00	3.00	0.00	1.00	1.00	0.00	3.00	0.00	0.00	0.00	2.00	5.00	15.00
Striped Hyena	*Hyaena hyaena*	2.00	0.00	3.00	3.00	1.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	11.00
Small Indian Civet	*Viverricula indica*	1.00	0.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	2.00	2.00	9.00
Indian Hare	*Lepus nigicollis*	3.00	1.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	7.00
Three Striped Squirrel	*Funambulus palmarum*	0.00	0.00	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	5.00
Indian Fox	*Vulpes bengalensis*	1.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00	4.00
Nilgai	*Boselaphus tragocamelus*	1.00	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	5.00
Cattles	*Bos taurus*	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00
Caracal	*Caracal caracal*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00
Wild Boar	*Sus scrofa*	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	2.00
Desert cat	*Felis sylvestris*	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Indian Porcupine	*Hystrix indica*	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00
BIRDS	*Birds*	6.00	5.00	7.00	2.00	0.00	5.00	13.00	2.00	0.00	0.00	6.00	9.00	55.00
REPTILES	*Reptiles*	1.00	2.00	6.00	8.00	13.00	30.00	96.00	35.00	0.00	4.00	5.00	9.00	209.00
	Total	**68.00**	**35.00**	**50.00**	**35.00**	**20.00**	**59.00**	**154.00**	**96.00**	**5.00**	**10.00**	**42.00**	**56.00**	**630.00**

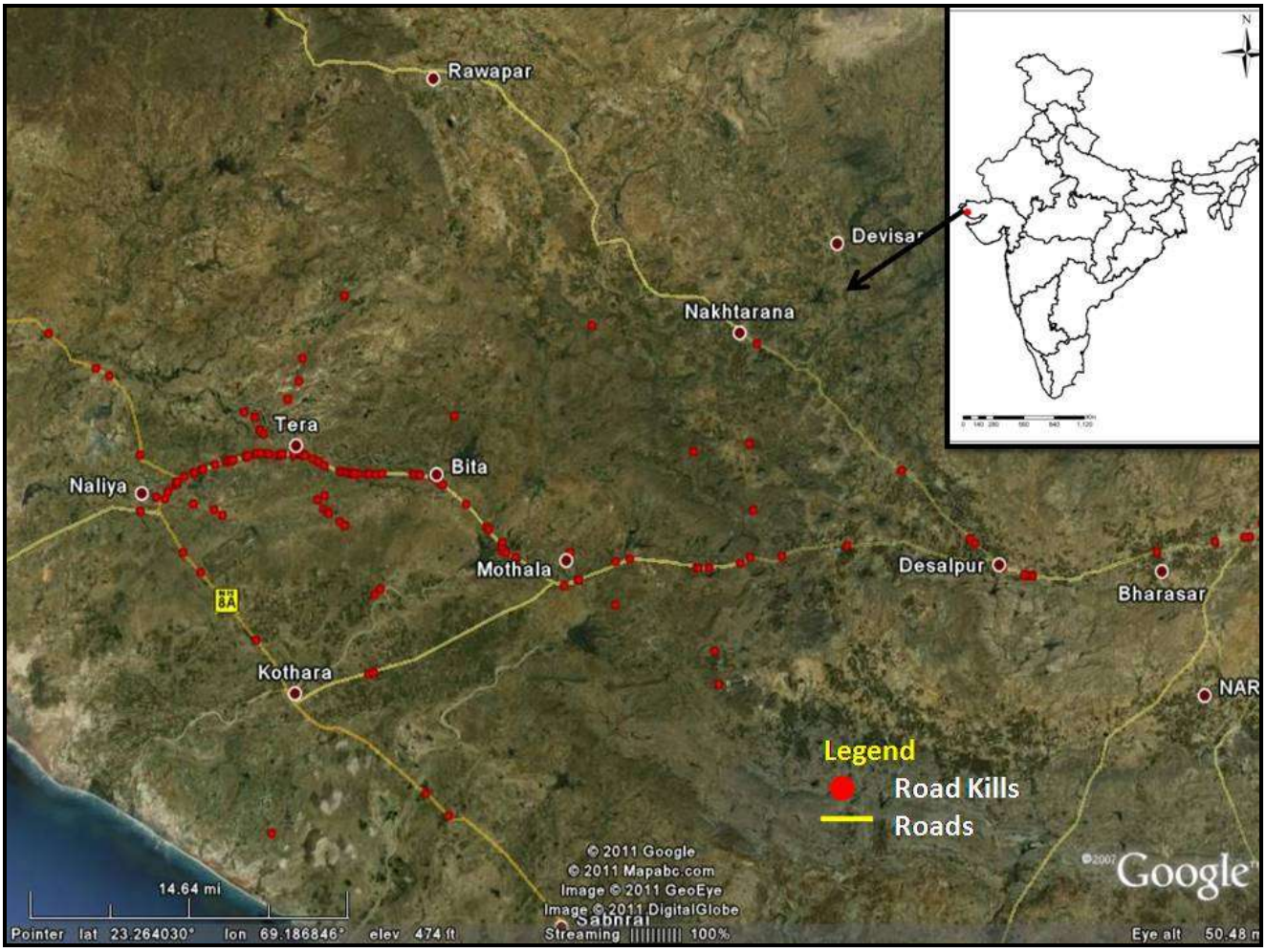

Fig.1: Map Showing Study area and State Highways with Road Kills

Fig.2. Picture Showing some mammalian road kills. Striped hyena (photo by Jyoti), Golden Jackal (photo by I. P. Bopanna), Caracal (photo by D.Ramesh)

A REVIEW ON OCCURRENCE OF BATS SPECIES IN PROTECTED AREAS AND THEIR BUFFER ZONES OF NEPAL

SANJAN THAPA
Small Mammals Conservation and Research Foundation, New Baneshwor, Kathmandu, Nepal
Email: sanjan_thapa@yahoo.com

ABSTRACT

In Nepal a total of 53 bat species has been recorded to date within elevations of 64m a.s.l. (Taaghandubba-5, Jhapa district) to 4154m a.s.l. (Makut, Dolpa district). Literatures reporting bats from 10 protected areas were reviewed. Number of bat species occurring in protected areas counts 41, distributed at an elevation range from 70m a.s.l. (Koshi Tappu Wildlife Reserve) to 3600m a.s.l. (Shey-Phoksundo National Park). Six species are exclusively reported from protected areas and their buffer zones. Annapurna Conservation Area harbors the maximum number of bat species assemblage amongst 10 protected areas. Detailed survey should be exercised to other untouched nine protected areas and their buffer zones. Since most of the literatures reviewed are outdated, monitoring of bat assemblage in those protected areas should also be carried out to prepare the up to date chiropteran database.

Key-words: *bat, elevation range, Annapurna Conservation Area, detailed survey, chiropteran database.*

INTRODUCTION

In Nepal, a total of 53 bat species can be found from the Tarai plains to Trans-Himalaya from 60m a.s.l. (lowest elevation of the country) to 4154m a.s.l. Taaghandubba-5, Jhapa district, at an elevation of 64m a.s.l. is the lowest and Makut (probably Mukut in Dolpa district) at an elevation of 4154m a.s.l. is the highest recorded localities. There are some missing localities references for eg. Kontoum, Annigera etc (Bates and Harrison, 1997). In some the regional distribution is only mentioned without any further details. Maps showing distributions are well presented in Baral and Shah (2008) and Acharya et al. (2010).

Fry (1925) reported *Rhinolophus sinicus* from Shivapuri-Nagarjun National Park. Sanborn, 1950 reported *Plecotus homochrous* from Jomsom, Annapurna Conservation Area (ACA). Abe (1971) reported *Myotis muricola* from Suikhet (misspelled Swingket), ACA. Sherpa, 1994 listed 12 bat species from Kanchanjunga Conservation Area (KCA), however, occurrence of *Eptesicus nilssonii* is erroneous (as the species is confined to Europe). Suwal et al. (1995) is the first compilation on probable occurrence of 23 bat species inside the six protected areas. However, their reporting of, *Myotis miniopteres* in Annapurna Conservation Area as well as, enumerating *E. nilssonii*, is erroneous. Sinha (1973) reported *Rhinolophus pusillus* from Sundarijal, Shivapuri-Nagarjun National Park. Kock, 1996 reported *Plecotus wardii* from Ringmo, Shey-Phoksundo National Park. Bates and Harrison (1997) reported *Rhinolophus pearsonii* and *Pipistrellus javanicus* from Sundarijal and Sipuri (probably Panimuhan) of Shivapuri-Nagarjun National Park. Csorba et al., (1999) made extensive survey in few sites

within ACA and recorded 15 species from there, also recorded; three species from Balaju Reserve Forest (Now, Shivapuri-Nagarjun National Park); *Rhinolophus ferrumequinum* from Langtang National Park ; *R. sinicus* from Kanchanjunga Conservation Area and first record of *Murina cyclotis* to Nepal from Chitwan National Park (CNP). Myers et al. (2000) conducted another extensive study in CNP and reported 13 species of bats from eight localities. They reported first record of *Eonycteris spelaea* and *Eptesicus dimissus* to Nepal with notes on its morphology and systematic status as well as verified presence of *Miniopterus pusillus* and *Kerivoula Picta* and also provided their locality records. Malla (2000) in his thesis for M.Sc. Zoology reported altogether four species of bats and carried out the diet analysis of *Hipposideros armiger* and *Rhinolophus pusillus* at Nagarjuna, Kathmandu (Now Shivapuri Nagarjun National Park). Thapa, 2008; 2009b reported *Pteropus giganteus* from Prakashpur Village Development Committee (V.D.C.), Sunsari district and Pathari V.D.C., Saptari district of Koshi Tappu Wildlife Reserve (KTWR). Thapa et al. (2009) reported *Rhinolophus pusillus* from Nagarjun Cave and *Hipposideros armiger* from Sundarijal of Shivapuri Nagarjun National Park. Thapa (2009a) reported namely *Megaderma lyra*, *Pipistrellus sp.* and *Scotophilus heathii* from Paschim Kusaha V.D.C., Sunsari district of KTWR. Acharya (2010) carried out bat survey in MBNP and KCA and reported three species each from MBNP and KCA. Thapa (2010) distinguished those unidentified *Pipistrellus* spp. into three species: *P. coromandra*, *P. tenuis* and *Scotozous dormeri*. This is the first record of monospecific genus *Scotozous* to Nepal. Thapa et al. (2010a, b) reported two species namely *Miniopterus schreibersii* and *Pipistrellus javanicus* from Panimuhan (Muhanpokhari) and *Hipposideros armiger* from Sundarijal of Shivapuri Nagarjun National Park (SNNP).

RESULTS

Number of bat species occurring in protected areas counts 41 from 32 specified and other unknown locations of 10 protected areas excluding some erroneous reporting such as *Myotis minopteres* and *Eptesicus nilssonii* in the case of reliance to Sherpa, (1994) and Suwal et al. (1995). They are distributed at an elevation range from 70m a.s.l. (KTWR) to 3600m a.s.l. (SPNP) within the protected areas. Six species are exclusively reported from protected areas and their buffer zones. Among them: *Plecotus homochrous* Hodgson, 1847 is distributed along KCA (Sherpa, 1994 in Kanchanjunga Conservation Area Management Plan, 2061-2066), MBNP (Suwal *et al.*, 1995); ACA (Suwal *et al.*, 1995; Sanborn, 1950 in Bates and Harrison, 1997) and RNP (Suwal *et al.*, 1995): *P. wardi* Thomas, 1911 is restricted to SPNP (Kock, 1996): *Eptesicus dimissus* Thomas, 1916 is restricted to CNP (Myers *et al.*, 2000): first record of *Scotozous dormeri* Dobson, 1875 has been reported from KTWR (Thapa, 2010): *Murina cyclotis* Dobson 1872 is restricted to CNP (Bates and Harrison, 1997; Csorba *et al.*, 1999; Myers *et al.*, 2000) and also *Kerivoula picta* (Pallas, 1767) is restricted to CNP (Suwal *et al.*, 1995; Myers *et al.*, 2000). Protected areas and their buffer zones harbors three species endemic to South Asia namely, *Myotis sicarius*, *M. csorbai* (also endemic to Nepal) and *Scotozous dormeri*. These 41 species are under different threat categories: 1 Vulnerable (*Myotis sicarius*); 1 Near Threatened (*Miniopterus schreibersii*); 35 Least Concern; and 2 Data Deficient; while status of *Plecotus homochrous* and *P. wardi* are not assessed; globally (IUCN, 2011): 3

Vulnerable; 8 Near Threatened; 25 Least Concern; and 1 Data Deficient; while status of 4 species are not assessed; regionally (Molur *et al.*, 2002): and 1 Critically Endangered (*Myotis csorbai*); 1 Endangered (*Scotomanes ornatus*); 2 Vulnerable (*Myotis sicarius* and *Philetor brachypterus*); 3 Near Threatened; 22 Least Concern; and 12 Data Deficient; nationally (National Red List of Nepal Mammals, 2010).

Annapurna Conservation Area harbors 23 species; 15 species inhabiting in Chitwan National Park; Kanchenjunga Conservation Area and Makalu Barun National Park shares 14 species each; Shivapuri Nagarjun National Park constitutes assemblage of 10 species; 7 species recorded from Koshi Tappu Wildlife Reserve; 5 species can be found at Rara National Park; 4 species occurs in Bardia National Park; 2 species each has been reported from Shey-Phoksundo National Park and Langtang National Park.

ACA constitutes more than 56 percents of the 41 bat species assemblage in protected areas and their buffer zones of Nepal. CNP ranks second with more than 36 percents. KCA and MBNP follow with more than 34 percents. SNNP consists more than 24 percents. KTWR reports more than 17 percents. RNP and BNP harbor more than 12 and 9 percents, respectively. While, SPNP and LNP shares only more than 2 percents, which is the minimum account amongst.

DISCUSSIONS AND CONCLUSIONS

Annapurna Conservation Area harbors the maximum number of bat species assemblage in protected areas and their buffer zones of Nepal.

There are altogether 20 protected areas (9 National Parks, 3 Wildlife Reserves, 7 Conservation Areas and 1 Hunting Reserve) throughout Nepal till the date (DNPWC, 2067). Therefore, ten protected areas are still untouched. ACA seems to be extensively surveyed, followed by CNP. SNNP seems to be favourable area for bat survey as frequent studies has been carried out and continued to this area. Bat survey in MBNP, KCA and KTWR is initiated. While, there are rare recordings from LNP, SPNP. Bat species occurrence from RNP and BNP needs further confirmation. The locations are unspecified in most of cases.

Since, there are only 32 specified locations even lesser than the total species number, it can be inferred that most locations of occurrence are just predicted. Among the 32 specified locations CNP and ACA has maximum (8) and RNP with zero specified locations. Despite of the easy access to SNNP (near from Kathmandu) extensive bat survey has not been carried out in comparison to ACA and CNP. However, we can keep faith upon the references since Bates and Harrison, 1997. In this manner, we have inconsistent data from Sherpa (1994) and Suwal et al. (1995).

Nine bat species have been recommended for legal protection on the Department of National Parks and Wildlife Conservation's protected species list (Himalayan Nature, 2010). Among them six species are also found in protected areas.

Detailed survey should be exercised to untouched protected areas. Myers *et al.*, 2000 work was carried out in 1990 in CNP. Since, most of the other literatures reviewed are also outdated, monitoring of the species occurring in these protected areas has become necessary.

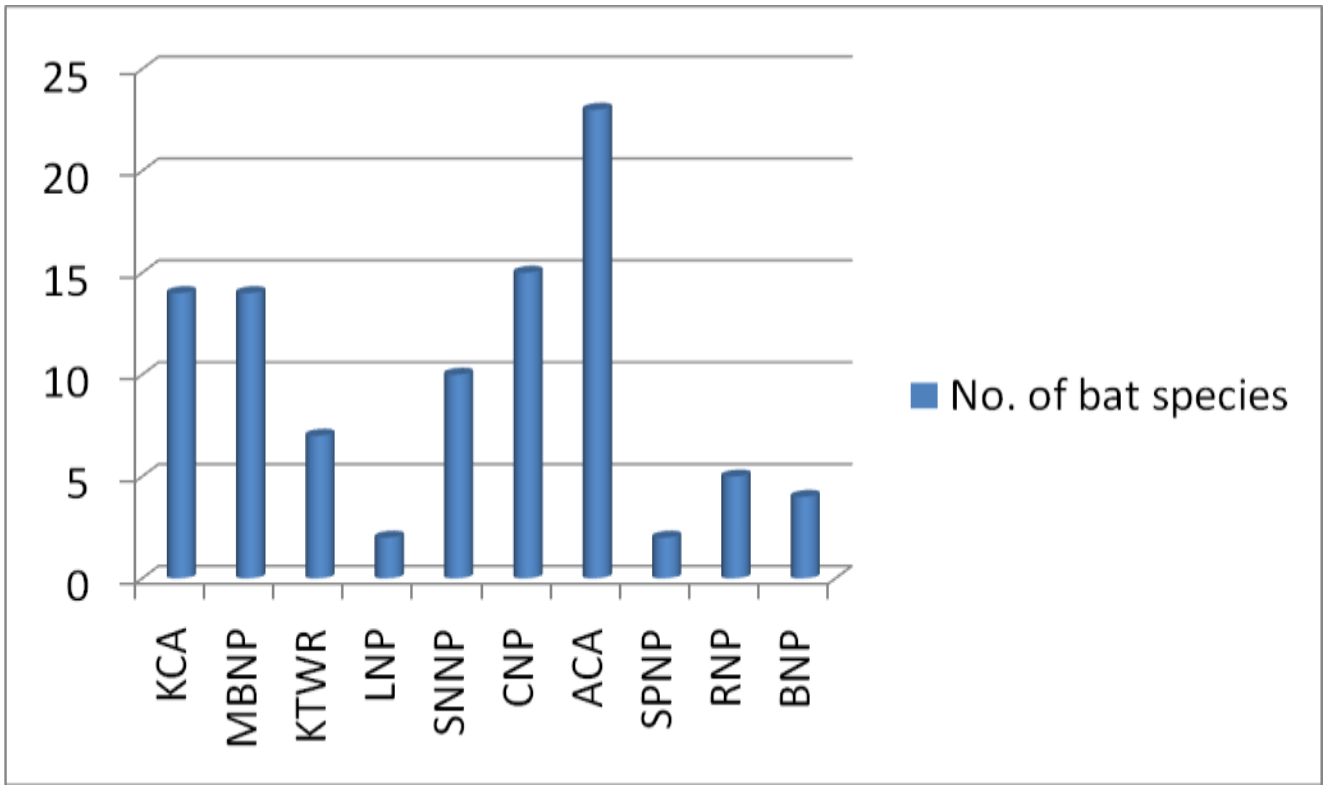

Figure 1. Number of bat species occurring in protected areas and their buffer zones of Nepal.

Table 1. Bat species occurring in protected areas and their buffer zones of Nepal.

S. N.	Name of species	KCA	MBNP	KTWR	LNP	SNNP	CNP	ACA	SPNP	RNP	BNP
1.	*Rousettus leschenaultia*	■	■				■	■		■	
2.	*Pteropus giganteus*	■	■	■			■	■			
3.	*Cynopterus sphinx*	■	■	■			■		■	■	■
4.	*Eonycteris spelaea*						■				
5.	*Rhinolophus ferrumequinum*	■			■	■		■			
6.	*Rhinolophus affinis*	■				■		■			
7.	*Rhinolophus sinicus*	■				■		■			
8.	*Rhinolophus pusillus*					■		■			
9.	*Rhinolophus macrotis*					■					
10.	*Rhinolophus luctus*						■				
11.	*Hipposideros cineraceus*							■			
12.	*Hipposideros armiger*	■	■			■		■			
13.	*Megaderma lyra*			■		■					
14.	#*Myotis sicarius* (VU)							■			
15.	*Myotis formosus*							■			
16.	*Myotis nipalensis*							■			
17.	*Myotis muricola*				■			■			
18.	*Myotis siligorensis*	■	■					■			
19.	##*Myotis csorbai*							■			
20.	*Plecotus homochrous**	■	■					■		■	
21.	*Plecotus wardi**								■		
S. N.	**Bat species**	KCA	**MBNP**	**KTWR**	**LNP**	**SNNP**	**CNP**	**ACA**	**SPNP**	**RNP**	**BNP**

22.	*Barbastella leucomelas*	■	■					■		■	
23.	*Scotomanes ornatus*							■			
24.	*Eptesicus dimissus**						■				
25.	*Eptesicus serotinus*	■	■								
26.	*Pipistrellus javanicus*	■	■			■	■	■			
27.	*Pipistrellus coromandra*	■	■	■			■	■			■
28.	*Pipistrellus tenuis*			■			■				
29.	*Arielulus circumdatus*							■			
30.	*Scotozous dormeri**			■							
31.	*Nyctalus noctula*						■	■			
32.	*Nyctalus montanus*	■	■					■			
33.	*Philetor brachypterus*		■					■			
34.	*Hesperoptenus tickelli*						■				
35.	*Murina aurata*					■					
36.	*Murina cyclotis**						■				
37.	*Murina huttoni*		■								
38.	*Kerivoula picta**						■				
39.	*Kerivoula hardwickii*		■								
40.	*Miniopterus schreibersii*					■		■			
41.	*Miniopterus pusillus*						■				

***** Reported only from protected areas and their buffer zones in Nepal # Endemic to South Asia ## Endemic to Nepal (VU) Globally Vulnerable

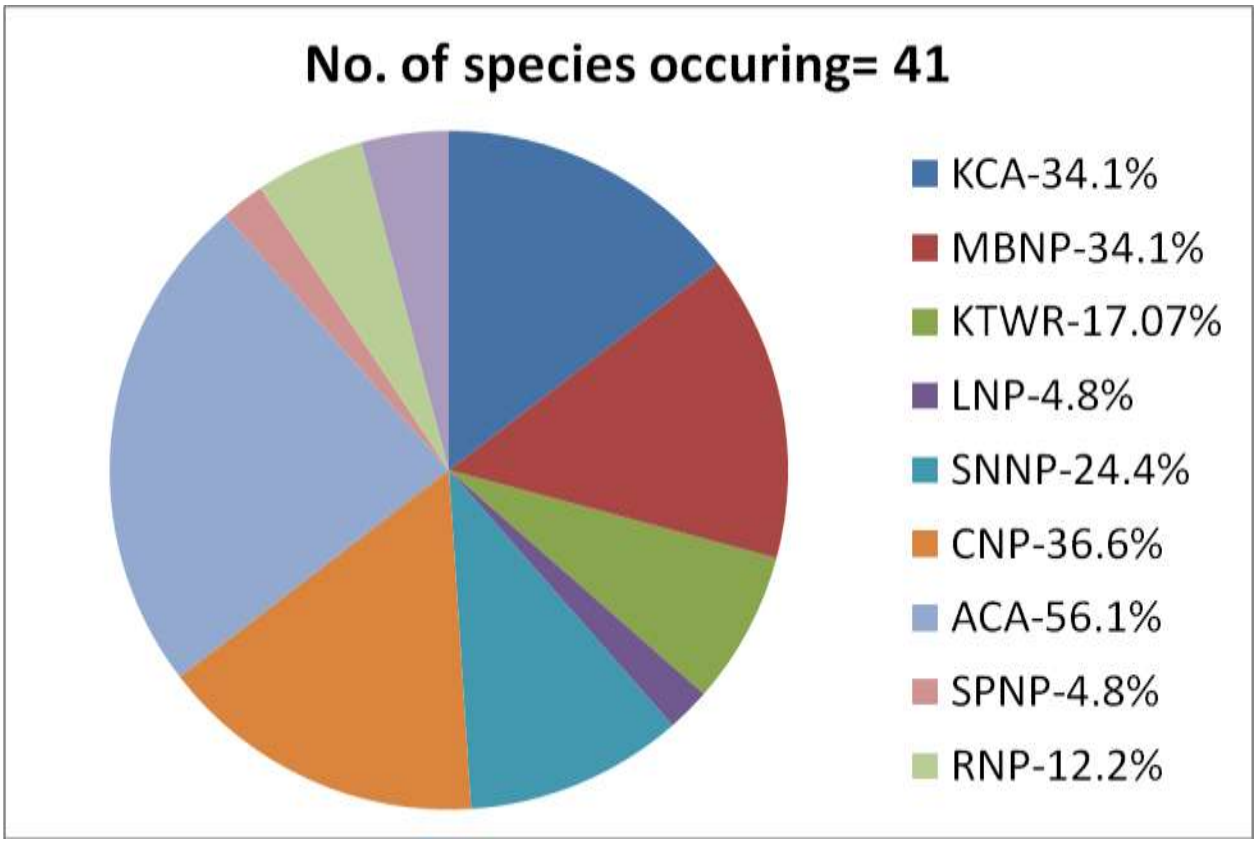

Figure 2. Percentage assemblage of bats in protected areas and their buffer zones of Nepal.

REFERENCES

Abe, H.1971. Small Mammals of Central Nepal. Mammalia. Jour. Facul. Agr., Hokkaido Univ., Sapporo, Japan, Vol. 56: 396-403.

Acharya, P. R. 2010. Bat Diversity Hot Spots and its Conservational Implication in Kangchenjunga Singalila Complex and Makalu Region of Eastern Himalaya, Nepal. Final report submitted to Critical Ecosystem Partnership Fund, WWF-Nepal, pp v+85.

Acharya, P.R., H. Adhikari, S. Dahal, A. Thapa and S. Thapa (Compilers and Editors). 2010. Bats of Nepal, A field guide, Small Mammals Conservation and Research Foundation, New Baneshwor, Kathmandu: pp116.

Baral, H.S. and K.B. Shah 2008. Wild Mammals of Nepal. Himalayan Nature, Kathmandu, pp128-157.

Bates, P.J.J. and D.L. Harrison 1997.Bats of Indian Subcontinent; Harrison Zoological Museum Publication, pp50-215.

Corbet, G.B. and J.E. Hill 1992. The Mammals of the Indomalayan Region. Nat. Hist. Mus/OUP pp488.

Csorba, G., S.V. Kruskop, A.V. Borissenko 1999. Recent records of bats (Chiroptera) from Nepal, with remarks on their natural history, Mammalia, issue 63, no.1: 61-78.

Fry, T.B. 1925. Report No. 37a: Nepal. Bombay Natural History Society's Mammal Survey of India, Burma, and Ceylon. Journal Bombay nat. Hist. soc. 30:525-530.

Hodgson, B.H. 1835. Synopsis of the Vespertilionidae of Nepal. Journal of Asiatic Society of Bengal 4: 699-701.

Johnson, D.H., S.D. Ripley, K. Thonglongya, 1980. Mammals from Nepal. J. Bombay Nat. Hist. Soc. 77, 56-63.

Kock, D. 1996. Fledermause aus Nepal (Mammalia: Chiroptera). Senckenbergiana biol. 67 (1-3):37-42.

Koopman, K.F.1983.A significant range extension for *Philetor* (Chiroptera, Vespertilionidae) with remarks on geographical variation. Journal Mammal. 64(3): 525-526.

Maeda, K. 1980. Review on the classification of little tube-nosed bats. Mammalia 44: 531-551.

Malla, R. 2000. Diet Analysis of *Hiposideros armiger* and *Rhinolophus pusillus* (Microchiroptera) of Nagarjuna Cave. A Thesis submitted to Central Department of Zoology, T.U., Kirtipur, Kathmandu, Nepal, pp 4-6.

Myers, P., J.D. Smith, H. Lama, B. Lama and K.F. Koopman 2000. A recent collection of bats from Nepal, with notes on *Eptesicus dimissus*. Zeitschrift fur Saugeteirkunde-International Journal of Mammalian Biology 65 (3): 149-156.

Sanborn, C.C. 1950. A Nepal record of the long-eared Bat (*Plecotus homochrous* Hodgson). Natural Hist. Miscell. Chicago Acad. Sci. 69:1-2.

Scully, J. 1887. On the Chiroptera of Nepal. Journal Asiatic Soc. Bengal 56: 233-259.

Sherpa, L.N. 1994. Preliminary Research on Wildlife of Kanchanjunga Conservation Area. In: Kanchanjunga Conservation Area Management Plan 2063/64-2067/68 Appendix iv, pp xxi.

Sinha, Y.P. 1973. Taxonomic studies on the Indian bats. Mammalia 34: 81-92.

Suwal, R., W.J.M. Verheugt and P. Yonzon 1995. Enumeration of Mammals of Nepal. Biodiversity Profiles Project Publication No. 6. Department of National Parks and Wildlife Conservation, Kathmandu, 22-31pp.

Thapa, S.B. 2008. Reporting *Pteropus* colonies and bat roosts from Eastern Nepal,
BAT NET-CCINSA Newsletter, Vol.9, No.1, 22-23pp.

Thapa, S.B. 2009a. First Phase Survey of Microchiroptera in Plains (Tarai) of Eastern Nepal. Small Mammals Conservation and Research Foundation, New Baneshwor, Kathmandu, Nepal, pp vi+19.

Thapa, S.B. 2009b. Additional Sightings of *Pteropus* colonies in plains of Eastern Nepal, Small Mammal Mail (combined) BAT NET - CCINSA Newsletter and Rat-A-Tattle RISCINSA

Newsletter Conservation and Information Network of South Asia, Volume 1, Number 1, p8.

Thapa, S.B., R. Kaphle, A. Thapa and S. Dahal 2009. A report on preliminary survey of microchiropteran bats in Kathmandu Valley. CDZ Small Mammals Club, Central Department of Zoology, Tribhuvan University, Kirtipur, Kathmandu, Nepal, pp ii+11.

Thapa, S.B. 2010. Skull-Baculum Morphology and PCR Approach in Identification of Pipistrelles (Chiroptera: Vespertilionidae) from Koshi Tappu Wildlife Reserve, Sunsari, Nepal. A Dissertation Submitted to Central Department of Zoology, Institute of Science and Technology, Tribhuvan University for the partial fulfillment of the requirement of Master's Degree in Zoology, pp xv+67.

Thapa, S., S. Shrestha and S. Dahal 2010a. Detailed monitoring survey of bats and their conservation through radio awareness programme and outreach programme to school children in Kathmandu Valley. A first phase report submitted to Rufford Small Grants, UK, pp vii+41.

Thapa, S., S. Shrestha and S. Dahal 2010b. Detailed monitoring survey of bats and their conservation through radio awareness programme and outreach programme to school children in Kathmandu Valley. A second phase report submitted to Rufford Small Grants, UK.

BACTERIAL ENTERITIS IN AN INDIAN PALM CIVET (*Paradoxurus hermaphroditus*) AND ITS SUCCESSFUL MANAGEMENT-A CASE REPORT

PRASENJIT DHAR[1*], VIJAY KUMAR[2], MANDEEP SHARMA[1], SHAILJA KATOCH[1], RAJESH CHAHOTA[1] AND SUBHASH VERMA[1]
[1] Department of Veterinary Microbiology, Veterinary College, CSKHPKV, Palampur Himachal Pradesh, India
[2] Veterinary Officer, Wild life, Monkey Sterilization Centre, Kanga, Himachal Pradesh, India
*Email:dharprasen@gmail.com

ABSTRACT

Enteritis was recorded in an Indian palm civet (*Paradoxurus hermaphroditus*) that was kept in an enclosure in a zoo. The animal had loss of appetite, showed sluggish movement and voided watery feces that had an offensive smell. Bacterial culture of the feces revealed the association of hemolytic *E coli* and an unidentified gram negative bacteria that were moderately sensitive to ciprofloxacin and streptomycin. The animal was successfully treated with injectable ciprofloxacin and oral rehydration solution. No parasitic eggs / protozoal oocysts or hemoprotozoan parasites could be detected in the animal. This appears to be a unique case of bacterial enteritis in a captive Indian palm civet.

Key words: Indian palm civet *(Paradoxurus hermaphroditus), E coli,* Diarrhea

INTRODUCTION

The Indian palm civet (*Paradoxurus hermaphroditus*) is a small member of the Viverridae family native to South and Southeast_Asia weighing 2 to 5 kg with an average body length of 53 cm (21 in) and a tail length of 48 cm (19 in) (Grassman,1998). Its long, stocky body is covered with coarse, shaggy hair that is usually greyish in color, with black on its feet, ears and muzzle. The animals are omnivores utilizing fruits such as berries and pulpy fruits as a major food source, and thus help to maintain tropical forest ecosystems via seed dispersal.

The IUCN has classified the species as Least Concern as it is tolerant of a broad range of habitats, is widely distributed with large populations that are unlikely to be declining (Duckworth et al., 2008). The Indian palm civet even though not endangered is under threat from deforestation and therefore drastic loss of much of its natural habitat. The main reason for such extensive deforestation in the area is either for logging or to clear the land to make way for palm oil plantations. There are various factors both infectious and non infectious that can result in the decline in civet population. Apart from the established factors like predation, loss of habitat and

killing of thousands of civets due to their suspected role in the spread of SARS infection (Guan et al., 2003, Kahn et al., 2004, Tu et al., 2004), diseases may be also one of the factors that can lead to death of the civet in the wild (Duan et al., 2001).

Enteritis is one of the most important diseases in domestic and wild animals but hardly any incidences have been reported in civet. The present communication puts on record an unusual incidence of bacterial enteritis in an Indian palm civet (*Paradoxurus hermaphroditus*) and its successful treatment in the state of Himachal Pradesh, India.

MATERIALS AND METHODS

A male Indian palm civet weighing around 5 kgs that was kept in the Dhauladhar National Park – Gopalpur, Distt Kangra of Himachal Pradesh, India for the past 3 years suddenly showed inappetance and sluggish movements. The animal was fed once a day. Close examination of the animal revealed that the animal had voided loose feces. The animal was given water mixed with oral rehydration solution but the animal remained off fed. The civet was restrained with the help of a sack and restraining stick to prevent self injury or injury to personnel. On external examination, the civet was found to be showing signs of enteritis like soiling of the anal area with watery feces that had an offensive smell. The animal had loss of appetite with slight loss of aggressiveness.

No external signs of any lesion or injury was observed on the body or feet of the animal. The temperature, heart rate, pulse rate and respiratory rates were however found to be within normal limits. The animal was orally rehydrated with oral rehydration solution (ORS) @ 100 ml (Intas Pharmaceutical Pvt Limited, India) with a syringe before any systematic treatment was initiated.

As the animal was showing signs of enteritis without any other sign, it was decided to send fecal samples and blood for culture and sensitivity studies. Keeping this in mind, rectal swabs in duplicate were taken in sterile normal saline and sent to the Department of Veterinary Microbiology, College of Veterinary and Animal Sciences, CSKHPKV, Palampur, Himachal Pradesh, India on ice for microbial isolation and drug sensitivity study (Fig 1). Blood samples (about 2 ml) of the animal was also taken from the recurrent tarsal vein and sent to the laboratory to check for any generalized septicemic infection or hemoprotozoa. Fecal samples were also collected to check for the presence of intestinal parasitic eggs and protozoal oocysts. A small amount of feed sample was also tested for the presence of any pathogens.

The rectal, feed and blood samples were immediately processed in the laboratory using routine bacteriological techniques. Briefly the swab was inoculated onto sterile blood agar media (containing 5 per cent defibrinated sheep blood), McConkey's lactose agar media (MLA) (Merck India limited) and thioglycollate broth (Himedia India limited,Mumbai). Selenite broth was also inoculated with these swabs for enrichment of *Salmonella*. The inoculated media was incubated at 37°C for 24 hours. After incubation, the enrichment broth culture was inoculated onto MLA, Hektoen enteric agar (HEA) and Brilliant green agar (BGA). The plates were incubated

at 37°C for 24-48 hrs in a bacteriological incubator.

After 24 hrs of incubation, the plates were examined for different bacterial types. Mixed

cultures of a hemolytic grey colored colony along with a medium sized grey colony (non hemolytic) was observed on blood agar media. On MLA media, both pink colonies (lactose fermenting) and a transparent colony (non lactose fermenting) were observed after 24 hours, while pure colonies exhibiting metallic sheen were observed on EMB agar. An oxidase test was performed on both the colonies culture using 1% aqueous tetramethyl-p-phenylenediamine dihydrochloride (Himedia India limited, Mumbai). Both the cultures were found to be oxidase negative, subsequently they were purified and were transferred to Nutrient agar slants and incubated at 37° C for 24 hours and stored at 4°C for further identification.

Identification of the isolate was done according to Kreig *et al* (1984) based on staining and bio-chemical tests (Catalase, Oxidase, Indole, Methyl Red, VP test, Citrate utilization, Nitrate reduction, H_2S production in TSI and Urease).No growth was however recorded in thioglycollate medium after 10 days of incubation. No culture was found to be positive for *Salmonella* sp.

Additionally, the fecal sample was examined by centrifugal flotation in concentrated NaCl and ZnSO4 solutions to detect parasitic eggs (Faust *et al*. 1939). Blood smears made from the collected animal was stained with both Leishman and Giemsa stain to check for any hemoprotozoal involvement.

Antibiograms:

Antibiotic sensitivity assay were performed using the high-concentration single disk method of Bauer *et al*. (1966). The Mueller-Hinton agar (Himedia Pvt limited,Mumbai, India) was used. The medium was prepared and poured into 15 x 150 mm petri dishes at a depth of 5–6 mm. The selection of antibiotics was based largely on gram staining pattern and varying combinations of 12 antibiotic disks of size 20 mm were used with no more than 10 disks per plate (Himedia Pvt limited). The organism was subjected to antibiotic assay against a range of antibiotics viz. Penicillin (P/ 10 U), Streptomycin (S/ 10 µg), Ampicillin (A/ 25 µg), Amoxicillin(Am/ 25 µg),Gentamicin (G/ 10 µg), Kanamycin (K/ 30 µg), Ciprofloxacin (Cf/ 10µg), Enrofloxacin (Ex/ 30µg), Norfloxacin (Nx/ 10 µg), Colistin (Cl/ 10 µg), Tetracycline (T/ 10 µg), Metronidazole (Mt/5 µg), Furazolidone (Fr/ 50 µg) incubated for 24 hrs. and the findings recorded.

RESULTS

The blood and the feed sample from the animal did not yield any bacterial pathogens.

The cultural characteristics, gram staining, oxidase reaction, motility and biochemical

pattern (IMViC pattern) and carbohydrate fermentation tests of the lactose fermenting culture matched with that of hemolytic *Escherichia coli (E coli)*. (Table 1). The other isolate could not be identified on the basis of biochemical reactions and further characterization is in progress.

Fecal examination of the animal did not reveal the presence of any parasitic eggs or ova. Blood smear examination also failed to detect any hemoprotozoan infection in the animal. Drug sensitivity

of both the organisms revealed highest sensitivity to ciprofloxacin, ofloxacin, furazolidone and streptomycin (80 per cent). Low sensitivity was noticed for gentamicin and enrofloxacin while the organism was found to be resistant to penicillin, ampicillin,cloxacillin, metronidazole and norfloxacin.

As the organism was found to be sensitive to ciprofloxacin, the animal was continuously

treated with Injection Cflox (Ciprofloxacin) (Intas Pharmaceuticals Pvt. Limited, India)

(40mg/ml) @ 200 mg / i/m, once a day for five days and injection Tribivet (B complex vitamins) (Intas Pharmaceuticals Pvt.Limited, India) @ 0.4 ml/ i/m on alternate days on three occasions. Oral rehydration therapy was continued for seven days with oral rehydration solution @ 100 ml o.i.d. and rest in water.

The animal recovered uneventfully to normal health and started taking feed (Fig 2). Fresh chicken and fruits @ 100 - 250 gms were provided to the animal with *ad lib* water.

DISCUSSIONS AND CONCLUSION

Enteritis or intestinal diseases are one of the most important diseases that affects all warm blooded animals. The loss of fluid from the body with resulting dehydration due to loss of essential metabolites can lead to death of the animal. Animals because of their habit are more susceptible to this type of infection as the food is often stale, rotten or decomposed or contaminated. In the wild, the animals may suffer and die or may recover because of their intrinsic immune status or other unknown factors. However, in a closed enclosure, the animals have to depend upon human intervention for recovery. The present study places on record an unusual case of enteritis in a captive Indian palm civet and its successful management.

E. coli is a normal inhabitant of the intestinal tracts of animals and animals is harmless as long as it is kept in check by other intestinal bacteria (Barnes et al., 2003). When an imbalance occurs in bacterial flora of the intestinal tract, *E. coli* may grow and cause an outbreak of colibacilliosis or enteritis. *E. coli* enteritis does not fit the classic definition or description of an infectious disease. This classic disease definition states that one microbe causes a given disease and that the illness can be reproduced in the laboratory by infecting susceptible animals with that one microbe (McMullin, 1998).

Civets are unique vertebrates that are normally classified as omnivores. In the wild these animals eat a lot of different materials. However, in a zoo these animals eat whatever is given to them by humans. *E. coli* is normally present in the animals and the disease can be triggered by numerous events. Immunosuppression due to diseases, fighting, mating stress may increase susceptibility to *E. coli* infection. However, other countless events or diseases can also increase susceptibility. For instance, an *E. coli* infection may appear if animals do not have regular access to feed or if their litter is too wet or if they are exposed to another disease. Generally, anything that causes stress in the animal may provide *E. coli* with the opening it needs (Durairaj and Clark, 2007).

The classification of *E. coli* strains that infect animals is known to be difficult, and

the pathogenesis of infections is poorly defined. The serologic and virulence factors used to classify the *E. coli* strains that infect humans and other mammals do not accurately predict which *E. coli* strain will be pathogenic in animals (Gerlach, 1994). All bacteria isolated from wild animals and birds have the potential to spread to other wildlife or human population passively on the animal's feet, body, faeces or regurgitated food items and can be the cause of diseases, especially *E.coli* (Houston and Cooper, 1975; Friend et al., 2001; Hubalek, 2004). However, due to insufficient information in the literature, further research is needed to understand the potential role of *E coli* in causing diarrhea in civets and its possible dissemination and transmission to other wildlife and possibly humans, as well as potential negative effects of pathogens like hemolytic *E coli* to the civet population health and conservation status. The present study therefore highlights the association of *E coli* with clinical enteritis in civets. As the organism was susceptible to ciprofloxacin in *in vitro* culture sensitivity assay, we used the same antibiotic in the animal which showed improvement very quickly.

Susceptibility of the *E. coli* isolates to flouroquinolones is also supported by the work of

Sharada et al. (2009) who found their *E coli* isolates to be highly susceptible to flouroquinolones. No report exists regarding the association of *E. coli* with the causation of diarrhea in civets and the rapid response to the antibiotic confirms our belief that *E coli* may be the cause of this incidence in the civet. In conclusion, although the case reported in this paper is unique due to the very small sample size and the natural resistance of the host animal like civets and can therefore be considered preliminary, this study revealed that intestinal bacteria like *E coli* along with other enteric bacteria that are considered to be normal commensals of the gastrointestinal tract can suddenly turn pathogenic under conditions of stress or depressed immune system. We could not definitely conclude whether this particular case was due to an indigenous *E coli* strain suddenly acquiring pathogenic potential or the infection was extraneous in origin. The successful management of this case offers hope of similar treatment protocols in future.

REFERENCES

Barnes, H. J., J. P. Vaillancourt, and W. B. Gross 2003. Colibacillosis. In: Diseases of Poultry,11th ed., Iowa State University Press, Ames, IA, USA.

Bauer, A.W., W.M.M. Kirby, J.C. Sheris and M. Truck 1966. Antibiotic susceptibility testing by a standardized single disc method. *Am J Clin Patho*. 145: 225-230.

Duan, W.W., K.M. Zhu, L. Li, , W.X. Jiang and X.C. Xiang 2001. The first incident of virus enteritis in masked civet: its diagnosis and prevention, *J. Econ. Anim.* 5 pp. 34–38.

Duckworth, J.W., P. Widmann, C. Custodio, J.C. Gonzalez, A. Jennings, G. Veron, 2008. "*Paradoxurus hermaphroditus*". *IUCN Red List of Threatened Species. Version 2010.4*. International Union for Conservation of Nature. http://www.iucnredlist.org/apps/redlist/details/41693.

Durairaj, V. and F. D. Clark 2007. *E. coli* an Opportunist that Causes Enteritis. *Avian Adv*,9(3).

Faust, E.C., W. Sawit, J. Toble, V. Odom, C. Peres, D.R. Linciocome 1939.Comparative efficiency of various techniques for diagnosis of protozoa and helminthes in feces. *J Parasitol* 25:241–262.

Friend, M., R.G. McLean, and F.J. Dein 2001. Disease emergence in birds: challenges for the twenty-first century. Auk 118(2):290–303.

Gerlach, H. 1994. Bacteria. *In*: Ritchie B.W., G.J. Harrison and L.R. Harrison (Eds) Avian medicine: principles and application. Wingers, Lake Worth, FL, pp 949–983.

Grassman, Jr., L. I. 1998. Movements and fruit selection of two Paradoxurinae species in a dry evergreen forest in Southern Thailand. *Small Carnivore Conservation* 19: 25-29.

Guan, Y., B.J. Zheng, Y.Q. He., X.L. Liu, Z.X. Zhuang, C.L. Cheung, S.W. Luo, Li, P.H., L.J. Zhang, Y.J. Guan, K.M. Butt, K.L. Wong, K.W. Chan, W. Lim, K.F. Shortridge, K.Y. Yuen, J.S. Peiris, L.L. and Poon 2003.Isolation and characterization of viruses related to the SARS coronavirus from animals in southern China, *Science* 302, pp. 276–278.

Houston, D. C., J.E. Cooper 1975. The digestive tract of the whiteback griffon vulture and its role in disease transmission among wild ungulates, *J Wildl Dis* 11 (3) 306–313.

Hubalek, Z. 2004. An annotated checklist of pathogenic microorganisms associated with migratory birds. *J Wildl Dis* 40:639–659.

Kan, B., M. Wang, H. Jing, H. Xu, X. Jiang, M Yan, W. Liang, H. Zheng, K. Wan, Q. Liu, B. Cui, Y. Xu, E. Zhang, H. Wang, J. Ye, G. Li, M. Li, Z. Cui, X. Qi, K. Chen, L. Du, K. Gao,Y.T. Zhao, X.Z. Zou, Y.J. Feng,Y.F. Gao, R. Hai, D. Yu, Y. Guan, and J. Xu 2005. Molecular evolution analysis and geographic investigation of severe acute respiratory syndrome coronavirus-like virus in palm civets at an animal market and on farms, *J. Virol.* 79, pp. 11892–11900.

Kreig, N.R., J.G. Holt, Williams and Wilkins (1984). Bergeys Manual of Systematic Bacteriology, Vol. 1: 428, East Preston street, Baltimore, M.D. 21202, USA.

McMullin, P. 1998. Wet litter in turkeys: Diseases and Interactions. Presentation at ADAS.NFU Turkey Conference. www.poultry health.com/library/turkeys/adastu98.htm, Visited 8/10/07.

Sharada, R., S.W. Ruban, M. Thiyageeswaran 2009. Antibiotic Resistance Pattern Of *Escherichia Coli* Isolated From Poultry In Bangalore *The Internet J Microbio* 7(1).

Tu, C., G. Crameri, X. Kong, J. Chen, Y. Sun, M. Yu, H. Xiang, X. Xia, S. Liu, T.

Ren, Y. Yu, B.T. Eaton, H. Xuan, L.F. Wang 2004. Antibodies to SARS coronavirus in civets. *Emerg. Infect. Dis*. 10, 2244–2248.

Whittam, T. S. 1996. Genetic variation and evolutionary processes in natural populations of *Escherichia coli*, p. 2708–2728. *In* F. C. Neidhardt, J. L. Ingraham, K. B. Low, B. Magasanik, M. Schaechter and H. E. Umbarger (Eds.), *Escherichia coli* and *Salmonella typhimurium*: cellular and molecular biology. American Society for Microbiology, Washington, D.C.

Table 1 Biochemical characteristics of the *E coli* isolate recovered from Indian palm civet

Test	Reaction
Gram's staining	Gram negative small bacilli
Oxidase test	(-)
Catalase test	(+)
Motility	(+)
Hemolysis	(+)
Indole production	(+)
Methyl Red	(+)
Voges-Proskauer	(-)
Citrate	(-)
Urease	(-)
Hydrogen sulphide production	(-)
Nitrate reduction	(+)
Gelatin liquefaction	(-)
Acid from	
Glucose	(+)
Lactose	(+)
Sucrose	(+)
Maltose	(+)
Mannitol	(+)

Mannose	(+)
Sorbitol	(+)
Rhamnose	(+)
Dulcitol	(-)
Inositol	(-)

Fig 1: Taking rectal swab from a civet

Fig 2: Civet after recovery

NON-VOLANT SMALL MAMMALS OF RAJASTHAN: AN ECOLOGICAL ANALYSIS

PARTAP SINGH
Department of Zoology, Government Dungar College, Bikaner – 334001, India
Email: partapsk@gmail.com

ABSTRACT

The state of Rajasthan is the largest state of India and quite interesting from Zoogeographic point of view. The Aravalli mountain range, one of the oldest in the world, diagonally bisect the state to western arid and eastern semiarid regions. Only hot desert of India, the Thar, is situated in North-western part of the state and occupies 61% of the geographical area of the state. State of Rajasthan is abode to 25 species of small mammals and out of these seven are endemic to Indian sub-continent. As far as IUCN status of small mammals of the state is concerned, most of them are categorized in "least concerned" or "near threatened" categories. General perception among public about small mammals, especially rodents, is that they are vermin and should be exterminated at the very first sight. Howsoever, very few people know that this largest group of mammals is one of the most threatened groups.

Some of the non-volant small mammals such as *Funambulus pennanti, Tatera indica, Rattus rattus, Cremnomys cutchicus, Golunda ellioti, Meriones hurrianae, Bandicota bengalensis, Mus musculus, Mus phillipsi* and *Suncus murinus* are widely distributed and abundant in number and presently have no serious threats. Some rodents of Thar such as *Gerbillus nanus, G. gleadowi* and *Millardia gleadowi* have restricted distribution to this region and very little is known about them. Major threats small mammals of Rajasthan are facing are: habitat loss due to fragmentation, rampant increase of pesticide use during last few years, Changing climatic conditions, canal irrigation and road accidents. The fact remains that this group of small mammals is still poorly studied in Rajasthan and lot is yet to be explored about these secluded animals.

Key words: *Rajasthan, Thar, Non-volant, small mammals, rodents, threats, distribution*

INTRODUCTION

Rajasthan bordering the neighboring country, Pakistan, is the largest Indian state. Rajasthan is rich in mammalian and avian diversity and as many as 65 species had been reported from here. Order Scadentia, which include tree shrews, is absent from Rajasthan. The other three orders are well represented in the state and as many as 25 species of non-volant small mammals had been reported from here. Order Rodentia with 21 species is the largest order of small mammals, while orders Soricomorpha and Erinacemorpha are represented by two species each (Singh & Tripathi, In Press). This group of mammals is one of the most successful group and is virtually found on all the places which humans occupy. The rodents of Rajasthan have have been widely studied,, especially the rodents of agriculture importance. These studies focussed on their population control, eco-physiology and

behavioural aspects.

MATERIALS AND METHODS

With the collaboration of the Central Arid Zone Researcch Institute (CAZRI) and Zoological Survey of India (ZSI), e surveys were carried by using snap and Sherman traps in various habitats as described in Prakash and Singh (2005). Two trap-lines of 30 traps each were laid with a distance of 15 meters between trap-lines. The distance between two consecutive traps was 10 meters. The traps were were run for 72 hours and trapped small mammals were retrieved every three hours from dawn to dusk. Peanut butter was used as baiting material and it was replenished every time trapped small mammals were removed. The trapped mammals were collected, measured, marked, weighed and preserved in 10% formaldehyde solution after ascertaining their reproductive status. The animals identified after Ellerman (1961) and Menon (2003).

RESULTS

A total of 25 species of small mammals were collected (Table 1) and out of these seven are endemic to Indian sub-continent. As far as IUCN status of small mammals of the state is concerned, most of them are categorized in "least concerned" or "near threatened" categories (Table 2). Some of the non-volant small mammals such as *Funambulus pennanti, Tatera indica, Rattus rattus, Cremnomys cutchicus, Golunda ellioti, Meriones hurrianae, Bandicota bengalensis, Mus musculus, Mus phillipsi* and *Suncus murinus* are widely distributed and abundant in number and presently have no serious threats. Some rodents of Thar such as *Gerbillus nanus, G. gleadowi* and *Millardia gleadowi* have restricted distribution to this region and very little is known about them. *Petaurista phillippensis, Gerbillus nanus* and *Millardia gleadowi* are placed in lower risk near threatened category and the hedgehog *Paraechinus micropus* is placed in the vulnerable category of the list. Most of the studies carried out here are on those species which are quite abundant or which are of economic importance from agriculture point of view. Two most under-studied rodents are *Gerbillus nanus* and *G. gleadowi* and all we know about them is their distribution status. Another small mammal which has been poorly studied and has its distribution limited to southern Rajasthan is elusive flying squirrel *Petaurista phillippensis.* Major threats small mammals of Rajasthan are facing are: habitat loss due to fragmentation, rampant increase of pesticide use during last few years, Changing climatic conditions, canal irrigation and road accidents.

Rajasthan is one of the states in country where population increase is higher than the national average. This rapid increase in population is forcing man to bring every possible stretch of land under farming.. The Canal irrigation through Gang Canal and Indira Gandhi canal was introduced in Western arid Rajasthan during 1940s and 1960s and during these five to seven decades the Thar has been completely transformed ecologically. As a consequence of ecological changes mammalian diversity has also changed. The ecological succession among mammals as observed during last seven decades suggest that xeric mammals are being replaced by the mesic faunal elements (Table 3).

DISCUSSIONS AND CONCLUSION

With the stream of canal water, many developmental activities have taken place. There is nothing controversial in case of large increases achieved in agricultural and livestock production, to reduce the threat of famine and also for improving the life style

and to open the door of increasing incomes and providing in employment opportunities. It is a positive impacts picture, which is helpful for making the appropriate development lines. But on the basis of ecological balancing pattern, it is noticed by environmentalist that introduction of I G canal has brought about changes in this fragile ecosystem. The desert ecosystem, which is rich in faunal diversity, is bound to witness negative effects in terms of loss of xeric species and increased utilization pressure on both soil and vegetation. Literature available of pre-canal irrigation period indicates that among macro fauna of the region three categories *viz*. Reptilia, Aves and Mammalia were quite preponderant. These species adapted themselves very well to such harsh and challenging climatic conditions and exhibited western affinities. But after coming of the IG canal water in such large quantities faunal diversity has changed. The species, which are associated with water and their development directly or indirectly depends on water, have invaded the region. Their presence has a significant role in increasing the total faunal diversity in all respect like genetic, species and ecological diversity.

Because of changes brought by IG canal like, changing soil moisture, soil texture, availability of water, changed crop pattern etc. new species of plants are invading the region. It is responsible for increase in whole biodiversity of the Thar flora and fauna and hence increased the total biomass of biotic factors of this fragile ecosystem. But, the major negative impact of IGNP on the natural fauna has been to greatly reduce or drive out, from the irrigated area, the larger mammals. This reduction in available habitat has been for some of the rare desert species, notably the Desert cat, Houbara and Great Indian Bustards. The rodent diversity has also been greatly altered due to development of irrigation. In general, the creation of irrigated cropland in desert environment has encouraged the replacement of xeric species such as *Gerbillus*, *Meriones* and *Tatera* by mesic forms such as *Rattus*, *Meltada*, *Bandicota* and *Nesokia*. Early species to disappear include *Gerbillus nanus*, *Gerbillus gleadowi* and *Meriones hurrianae*, the latter by far the most common rodent of the "Thar" desert region and then the desert mouse species *Mus platythrix sadhu*. These are being replaced by *Bandicota bengalensis*, *Nesokia indica*, *Mus booduga* and *Mus musculus*. The house mouse, *Mus musculus* is also reported to have colonized irrigated fields. Accompanying these behavioral changes, there is increase in the population of *Rattus meltada paliidior*, which is considered a good indicator of the establishment of irrigated crop fields.

REFERENCES

Paliwal, B.S. (1993). Geology of Rajasthan – A Summarium. In : *Natural and Human Resources of Rajasthan* (Ed. T.S. Chouhan). *Scientific Publishers*, 1-22.

Dhabriya, S. S. 1987. *Detection and Monitoring of Desertification, Using RS Data Products, Environmental Design and Development*, Scientific Publishers, Jodhpur, 1-505.

Bajaru, S. 2010. A Little-known world of small mammals. *Hornbill*, (4): 32-36.

Ellerman, J. R. 1961. *The Fauna of India Including Pakistan Burma and Ceylon, Mammalia (Rodentia). 2 Volumes.* Delhi: Govt. of India. 1961; 1-482, 483-884.

Prakash, I. and Singh P. In Press. Ecology and behaviour of murids of South Asia. In: AJT Johnsingh. editor. Mammals of South Asia. Oxford Univ. Press.

Prakash, I. and Singh P. 2005. *Ecology of small mammals of desert and montane ecosystems*. Scientific Publishers, Jodhpur, 1-153.

Menon, V. (2003). *A Field Guide to Indian Mammals.* DK Publication, Delhi. pp201.

Table 1. Distribution of small mammals in Rajasthan.

	COMMON NAME	**ZOOLOGICAL NAME**	**DISTRIBUTION***
Order : Rodentia			
1	Northern Palm Squirrel	*Funambulus pennanti*	A, T,SE,NE
2	Indian Giant Flying squirrel	*Petaurista phillippensis*	SE
3	Indian Gerbil	*Tatera indica*	A, T,SE,NE
4	Malayan Vandeleuria	*Vandeleuria oleracea*	A, SE
5	Roof Rat	*Rattus rattus*	A, T,SE,NE
6	Cutch Cremnomys	*Cremnomys cutchicus*	A, T,SE,NE
7	Common Metad	*Millardia meltada*	A, T,SE
8	Phillips's Mouse	*Mus phillipsi*	A, T,SE,NE
9	Flat-haired Mouse	*Mus platythrix*	A, T,SE
10	Saxicolous Mouse	*Mus saxicola*	A, T,SE
11	Earth-coloured Mouse	*Mus terricolor*	A, SE
12	Indian Bush Rat	*Golunda ellioti*	A, T,SE,NE
13	Lesser Bandicoot Rat	*Bandicota bengalensis*	A, T,SE,NE
14	House Mouse	*Mus musculus*	A, T,SE

15	Baluchistan Gerbil	*Gerbillus nanus*	T
16	Indian Hairy-footed Gerbil	*Gerbillus gleadowi*	T
17	Indian Desert Jird	*Meriones hurrianae*	T
18	Sand Coloured Metad	*Millardia gleadowi*	T
19	Little Indian Field Mouse	*Mus booduga*	T,SE
20	Short-tailed Nesikia	*Nesokia indica*	T
21	Indian Crested Porcupine	*Hystrix indica*	T, A, NE
Order : Soricomorpha			
22	Asian Musk Shrew	*Suncus murinus*	A, T,SE,NE
23	Anderson's Shrew	*Suncus stoliczkanus*	A, T
Order : Erinacemorpha			
24	Long-eared Hedgehog	*Hemiechinus collaris*	A, T, SE
25	Indian Hedgehog	*Paraechinus micropus*	T

*A= Aravallis, T= Thar, SE= South-east, NE= North-east

Table 2. IUCN status of small mammals of Rajasthan.

	ZOOLOGICAL NAME	FAMILY	IUCN STATUS*	TOTAL POPULATION IN INDIA	THREATS**
1	*Funambulus pennanti*	Sciuridae	LRlc	Unknown	T
2	*Petaurista phillippensis*	Sciuridae	LRnt	Unknown	I, H, Hf, L, Lf, T
3	*Tatera indica*	Muridae	LRlc	Many	Ps
4	*Vandeleuria oleracea*	Muridae	LRlc	Many	No
5	*Rattus rattus*	Muridae	LRlc	Many	I
6	*Cremnomys cutchicus*	Muridae	LRlc	Unknown	No
7	*Millardia meltada*	Muridae	LRlc	Unknown	Unk
8	*Mus phillipsi*	Muridae	LRlc	Unknown	Dr, Lf, Po
9	*Mus platythrix*	Muridae	LRlc	Unknown	No
10	*Mus saxicola*	Muridae	LRlc	Many	Dr, Po
11	*Mus terricolor*	Muridae	??	??	??

12	*Golunda ellioti*	Muridae	LRlc	Unknown	No
13	*Bandicota bengalensis*	Muridae	LRlc	Unknown	No
14	*Mus musculus*	Muridae	LRlc	Many	Unk
15	*Gerbillus nanus*	Muridae	LRnt	Unknown	L
16	*Gerbillus gleadowi*	Muridae	LRlc	Many	I, L
17	*Meriones hurrianae*	Muridae	LRlc	Unknown	L, Ps
18	*Millardia gleadowi*	Muridae	LRnt	Unknown	I, Ps, Po
19	*Mus booduga*	Muridae	LRlc	Many	Dr, Ps, Po
20	*Nesokia indica*	Muridae	LRlc	Unknown	Dr
21	*Hystrix indica*	Hystricidae	LRlc	Many	Hf, Tp, T
22	*Suncus murinus*	Soricidae	LRlc	Many	No
23	*Suncus stoliczkanus*	Soricidae	LRlc	Many	Unk
24	*Hemiechinus collaris*	Erinaceidae	LRlc	Unknown	No
25	*Paraechinus micropus*	Erinaceidae	VU	Unknown	H, Tp, T

*LRlc= Lower Risk least concern, LRnt= Lower Risk near threatened, VU= Vulnerable, ??= Not Mentioned[47]

** L= Loss of habitat, Lf= Loss of habitat due to fragmentation, H= Harvest, Hf= Harvest for food, P= Predation, Ps= Pesticides, T= Trade, Tp= Trade of parts, I= Human interference, Po= Pollution, Dr= Diseases?, Unk= Unknown, No= No threats

Table 3. Observed changes in the occurrence of mammal fauna.

Prior to incoming of canal irrigation: *Antilope, Gazella, Gerbillus, Meriones, Tatera*
30 yrs after incoming of canal irrigation: *Gazella, Tatera, Millardia, Meriones*
70 yrs after incoming of canal irrigation: *Boselaphus, Sus, Bandicota, Tatera, Mus*

Figure1. **Indian Gerbil *Tatera indica* is becoming commensal in some cities of Thar desert.**

Figure 2. **Desert Gerbil *Meriones hurrianae* is one of the most common rodent of Rajasthan.**

Small Mammals Conservation and Research Foundation (SMCRF)
114-Kantimarga, New Baneshwor, Kathmandu-10, Nepal
P.O.Box 13153, Sundhara, Kathmandu, Nepal
Tel: 977-01-4780984
Email: info@smcrf.org, URL: http://www.smcrf.org