

DYNAMICS OF CHIROPTERA POPULATION IN AND AROUND BIKANER CITY OF THE THAR DESERT, INDIA

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Abstract. We surveyed some roost sites and species composition of bats in Bikaner and its vicinity during the years 2010 to 2012. Bikaner is a part of the Thar Desert situated in the north-western part of India. It is situated almost in the heart of Thar and represents a vast area of continuous sand dunes, which are now being converted to crop fields. Six species of microchiropterans and one species of megachiropteran were found here: *Rhinopoma hardwickii*, *R. microphyllum*, *Rhinolophus lepidus*, *Pipistrellus tenuis*, *Taphozous perforatus*, *Hipposideros fulvus* and *Pteropus giganteus*. Among these, three species, *Taphozous perforatus*, *Hipposideros fulvus* and *Pteropus giganteus*, are reported for the first time. These changes of bat diversity are induced by the changing ecological conditions. *Rhinopoma hardwickii* is the most abundant species in the region, followed by *R. microphyllum* and *Pipistrellus tenuis*. Nokha doordarshan and Ranorao pond caves are most abundantly occupied caves. There are no eminent threats to these volant mammals but habitat destruction, garbage dumping and other anthropogenic activities that have deleterious effect on their population.

Keywords: chiroptera, Thar Desert, anthropogenic activities, risk factor.

Rezumat. Dinamica populației de chiroptere din orașul și împrejurimile Bikanerului, deșertul Thar, India. Lucrarea reprezintă un studiu al adăposturilor și dinamicii populațiilor de lilieci (Ord. Chiroptera), din orașul și împrejurimile Bikanerului, ce s-a desfășurat între anii 2010 și 2012. Bikaner este un oraș situat în NV-ul Indiei și face parte din deșertul Thar. În zona de studiu s-au identificat șase specii de microchiroptere și o specie de megachiroptere: *Rhinopoma hardwickii*, *R. microphyllum*, *Rhinolophus lepidus*, *Pipistrellus tenuis*, *Taphozous perforatus*, *Hipposideros fulvus* și *Pteropus giganteus*. Dintre aceste șapte specii, trei sunt pentru prima dată semnalate în zonă: *Taphozous perforatus*, *Hipposideros fulvus* și *Pteropus giganteus*. Schimbările produse la nivelul diversității populațiilor de chiroptere se datorează schimbărilor ecologice. *Rhinopoma hardwickii* este specia cea mai abundentă din regiune, urmată de speciile *R. microphyllum* și *Pipistrellus tenuis*. Adăposturile subterane Nokha doordarshan și Ranorao sunt din cele mai populate cu aceste specii. Factorii de risc identificați constau în distrugerea habitatelor prin activitățile antropice de vandalism.

Cuvinte cheie: chiroptere, Deșertul Thar, activități antropice, factori de risc.

INTRODUCTION

Chiropterans, commonly known as bats, are the only true flying mammals. According to WILSON & REEDER (2005), bats globally comprise of 1,116 species belonging to 202 genera, 18 families. They constitute about a quarter of the entire mammal species and are second to Rodents in term of diversity. Bats have been reported from almost all geographical areas of the world except for the Arctic and Antarctic, extreme desert area and a few isolated oceanic islands (MICKLEBURGH et al., 1992; HUTSON et al., 2001). In many countries bats are major contributors to mammalian biodiversity, while in some, particularly small oceanic islands, they are only indigenous mammals and play a vital role as “key stone species” in ecosystem (COX et al., 1992). Bats were traditionally divided into two major groups, usually given the rank of suborder Megachiroptera and Microchiroptera, although these groups do not probably represent monophyletic lineages and there are several relevant ecological differences between them (TEELING et al., 2002; 2005; BUSSCHE & HOOFFER, 2004; VAUGHAN et al., 2011; ALTRINGHAM, 1996). Megachiropterans feed primarily on plant material, fruits, nectar or pollen. The second suborder *i.e.* Microchiroptera feeds on insects; however, they have evolved to consume any kind of diet (rodents, others bats, reptiles, birds, amphibians and even fishes); some consume fruits, some are specialized for extracting nectar from flowers, and one subfamily (subfamily Desmodontinae with three species) feeds on nothing but the blood of other vertebrates. Microchiroptera use highly sophisticated echolocation for orientation. Microchiropterans together with the Megachiropteran genus *Rousettus* have evolved a system of echolocation, by means of which they orient themselves and find their food, and it also helps them find their roost in situation when light intensity is low (RACEY, 1999). *Rousettus* are capable of a simple form of echolocation that is not related to the echolocation in Microchiroptera (HILL & SMITH, 1984; NOWAK, 1991; VAUGAN et al., 2000).

Modern molecular evidences invalidate the traditional subdivision of Megachiroptera and Microchiroptera (HULVA et al., 2007). The studies of TEELING et al., 2000, 2002, 2005) indicate that one clade of microbats (Rhinolophoidea) is genetically closer to Megachiroptera. Based on molecular studies bats are now divided into Yinpterochiroptera and Yangochiroptera. Yangochiroptera includes most of the microbat families except the Rhinopomatidae, Rhinolophidae and Megadermatidae. These three families and the megabats are placed in the suborder Yinpterochiroptera.

Yangochiroptera are the only night flying insect eaters. They maintain population of insects and mosquitoes and help farmers save billion of rupees annually which were to be spent on pesticides. They are an essential part of the ecosystem and regulate forest community. They provide a good amount of fertilizers in the form of bat guano that is a more powerful fertilizer as compared to urea and other chemical fertilizers. Some of fruit trees like banana and avocados depend only on bats for pollination, and one African tree species, the baobab, fully depends on fruit eating bats for pollination. While eating fruit they attach some pollen grain on their body and after reaching to other flowers they spread pollen on them. After eating fruit they spread seed and help trees regenerate.

Study Area. Bikaner (28°11'22 N and 73°19'13 E) occupies the north western part of Rajasthan State in India (Fig. 1). During summer, temperature ranges from 27°C to 45°C and it may rise to as high as 49-50°C, and contrary to this it dips to freezing point and sometimes drop down to as low as -2°C. After the arrival of Indira Gandhi Canal (I.G.C.), the climate of this area has changed and the insect population has increased manifold and many of these newly immersed insect species are pests. Rainfall amount is very poor in Bikaner. The average rainfall here is 270 mm. This condition makes day temperature very high and nearly 90% of the rainfall is received during the monsoon season, which usually lasts from July to September. New species of bats extend their distribution range in the zone due to the ecological changes brought by I.G.C. in the region. The climate has become humid and because of this plenty of insect-food for insectivorous bats is now available and due to this reason the population of insectivorous bats is increasing and not only the population, but the diversity is also increasing at a very rapid pace. The frugivorous bats find plenty of fruit trees as a food source, which are planted in this area.



Figure 1. Location map of study area (by Vivek Mittal).

The plants of the Thar Desert that always persist here are *Prosopis juliflora* (Vilayati Babul), *Salvadora persica* (Pillu), *Calotropis procera* (Aak), *Prosopis Cineraria* (Khejari), *Anogeissus pendula* (Kardhai or Dhok), *Calligonum polygonoides* (Phog), *Commiphora wightii* (Guggul) and *Capparis decidua* (Kair). Some of the important crops of Bikaner area are *Pennisetum typhoides* (Bajra), *Vigna radiata* (Mung), *Vigna mungo* (Urad), etc. For irrigation, the canal water is now perpetually available and to enhance cropping more tube-wells are dug in this area. Some crops in Bikaner, which have recently been introduced, are: *Hordeum vulgare* (Barley), *Sorghum vulgare* (Jowari), *Triticum aestivum* (Wheat), *Brassica rapa* (Mustard) and *Cicer arietinum* (Bengal Gram). Some new agriculture pests, which were until now unreported in the region, can now be seen here. The mosquitoes were not present in the desert before the construction of I.G.C. and it is conjectured that the vector of cerebral malaria was introduced here by the workers coming from Bihar and other states to dig the canal. Many new diseases have emerged here and are now spreading in the whole desert region.

MATERIAL AND METHODS

We made an exhaustive survey in Bikaner and its adjoining areas for bat population dynamics. This survey was done from October 2010 to September 2012 for roost site and species identification. After identifying important roosting sites, a yearlong ecological study on the selected insectivorous bat species was carried out to collect the relevant data. Specimens were carefully collected with the help of insect nets and after the determination of their morphometry they were immediately released in their natural habitat. These measurements of the body and its parts were used for the identification of the species. Identification was further confirmed with the help of BATES & HARRISON (1997). Body temperature of bats was taken with the help of a laser thermometer. A digital minimum and maximum thermo-hygrometer was used to record daily minimum and maximum temperature and humidity. A digital

lux meter was used to record light intensity and microclimate of the roost site. Light intensity was noted when the group started to leave the roost and the activity patterns were also recorded. Direct counts for population dynamics was not an useful method as bats keep on moving from one place to another as they get disturbed by human presence, so still pictures and video were taken using a Canon EOS 500D SLR digital camera and a Sony HD Video camera for the total count. Evidences of birth and mortality, mating behaviour and maternal care were also recorded.

RESULTS AND DISCUSSION

In the study area no major work on bat ecology has been carried out. PRAKASH (1961) was the first to work out the bat diversity of Bikaner area and his report include two species of microchiropterans viz., *Rhinopoma hardwickii* Gray 1831 and *Rhinolophus lepidus* Blyth 1844 from the deep and dark tunnels. From 1963 to 2003 a sort of torpor existed in Bikaner region as far as bat studies were concerned. After 40 years, Prof. Ashok Purohit of JNV University, Jodhpur and his team reassessed the chiropteran diversity of Bikaner. They located new roosting sites of four Microchiropterans viz., *R. hardwickii*, *Rhinopoma microphyllum* Brünnich 1792, *R. lepidus* and *Pipistrellus tenuis* Temminck 1840 (Table 1). They added two new species to the earlier studies viz., *R. microphyllum* and Indian pygmy bat *P. tenuis* (*P. mimus*) to the earlier report. Almost a decade after his valuable study on the Chiropterans of Bikaner area no further study has been done and no new roost site has been located. PUROHIT & SENACHA (2003) added two species to the checklist of bats after four decades and we report three more additional species (Table 1 and 2), which is a clear indication that bat diversity of the region is increasing. The three new species that we report for the first time in the area are – *Pteropus giganteus* Brünnich, 1782, *Hipposideros fulvus* Gray 1838 and *Taphozous perforatus* É. Geoffroy 1818.

Table 1. Fluctuations in bat diversity during various years in Bikaner.

Species	Prakash (1961)	Purohit & Senacha (2003)	Present study (2012)
<i>Rhinopoma hardwickii</i>	Present	Present	Present
<i>Rhinopoma microphyllum</i>	-	Present	Present
<i>Rhinolophus lepidus</i>	Present	Present	Present
<i>Pipistrellus tenuis</i>	-	Present	Present
<i>Pteropus giganteus</i>	-	-	Present (New addition)
<i>Hipposideros fulvus</i>	-	-	Present (New addition)
<i>Taphozous perforatus</i>	-	-	Present (New addition)
Total Species	02	04	07

Table 2. Major location of bats species with their relative number of individuals.

Location/ Species	<i>Rhinopoma hardwickii</i>	<i>Rhinopoma microphyllum</i>	<i>Rhinolophus lepidus</i>	<i>Pteropus giganteus</i>	<i>Pipistrellus tenuis</i>	<i>Hipposideros fulvus</i>	<i>Taphozous perforatus</i>
Junagarh fort	1000±70	200±10	-	-	-	-	-
Annapurna mata temple	3000±150	50±06	-	-	-	-	-
Harloi Hanuman temple cave	2700±90	125±05	-	-	-	-	-
Patel Nagar	93±04	-	-	-	-	24±2	-
Public Park	423 ±07	80±04	-	230±20	-	-	-
Devikund Sagar Tunnel	372±15	43±03	74±07	-	17±02	-	-
Laleshwar Mahadev temple	20±01	-	-	-	32±02	-	-
Ranorao Pond caves (Nokha)	7430±70	1025±50	341±18	-	413±25	-	740±30
Doordarshan relay center cave (Nokha)	3070±35	2050±55	-	-	507±08	-	70±09
Veterinary University	50±12	-	-	70±05	-	-	47±09
Dada badi temple	201±15	48±3	-	-	22±2	-	-
Total number	18359	3621	415	300	991	24	857

Important roosting sites

1. Temple of Annapurna Mata (27°59'33N, 73°20'19 E) is very old and famous (Photo 1a, 1b). This temple is situated near Nagnechi Mata temple, which is *Kuldevi* of Rathores (former rulers of Bikaner State). A very long “L” shaped tunnel is present just adjacent to Annapurna Mata temple, which is 6.5 feet high and 4 to 6 feet wide. There are two openings of the tunnel – one of which has a wooden door and the other opens near two temples of Shiva and Hanuman. We found a mix roost of *R. hardwickii* and *R. microphyllum* here in the cave. The previous study of PUROHIT & SENACHA (2003) indicates that the bats disappear from site in winter but our study shows that not the whole population disappears, though it declines greatly. The maximum population recorded here was 1,000+ during breeding period and the minimum was during winter, slightly less than 200. The people of Bikaner are quite orthodox and many come here to perform witchcraft with the help of the priest of temple, by holding the bat on a wooden stick and then keeping the stick at the place of worship as it is supposed to help in getting blessed with a son (Photo 2a).

2. Hurloi Hanumanji's temple (28°00'05N, 73°28'58E). This is a very old temple of Bikaner, which is situated in Nathusar gate area. Here, old gravel caves are present and we found mix roosts of 2 Microchiropteran species viz., *R. hardwickii* and *R. microphyllum*. They has roosted here for 50 years (as told by the residents of the area). They appear at the time of sunset and this is a permanent roost site, where these can be seen throughout the year.

3. Patel Nagar (28°00'28N, 73°33'69 E). This area is situated near Dungar College. Here also we observed a mixed roost of *R. hardwickii* and *H. fulvus*. The latter species is reported for the first time in Bikaner. Earlier studies have not reported the species here. The roost of *H. fulvus* was in a wall of a house and as many as two dozen of them lived in the small crevices between the bricks of the wall. They used to leave the roost exactly at sunset, when light intensity was 01lux. This site is the winter roosting site of the species that uses to settle somewhere else during the summer months when the temperature of the wall rises to 50°C or even more. *R. hardwickii* is the other species that roosts regularly in Patel Nagar.

4. Public Park (28°01'91N, 73°32'30E) is situated in the centre of Bikaner city. Here, large trees of Ashoka (*Saraca indica*) were planted on both sides of the road. Collectorate and many other state Government offices are also situated in this historical building built by His Highness. In this park we observed *P. giganteus* (flying fox) roosting on the trees of Ashoka. They are reported for the first time in Bikaner area. This is the only Pteropodidae bat species of the Thar Desert and here it has interesting migration patterns. This species arrives here with the Monsoon (when temperature starts subsidizing) and leaves the area during the extremely cold months of December and January. They consume fruits, figs and other vegetation present in the region. The total population of *P. giganteus* that has been observed here is 230±20. Two species of Rhinopomatidae bats viz., *R. microphyllum* and *R. hardwickii*, have been found roosting on the ceiling and corners of the gallery of the collector office. *P. tenuis* was also found to be present in the crevices between the stones of this building.

5. Laleswar Mahadave Temple (28°00'05N, 73°35'40) is situated in Shiv-badi area of Bikaner. The temple was established by the Royal family of Bikaner and is one of the oldest temples of the town. The area of the temple is huge and cenotaphs was constructed all around the temple. These cenotaphs and the crevices in stone wall provide ideal roosting site to the microchiropterans. A mixed roost of *R. hardwickii*, *P. tenuis* and *R. microphyllum* was observed here.

6. Devikund Sagar Tunnel (28°02'05N, 73°39'16E). Sagar is a small village situated on the outskirts of Bikaner city and is a picnic spot. Two large ponds are situated near the village and cenotaphs (made of marble) built in the memory of the Royal family members are located here. Many tunnels are present under these monuments for easy flow of rain water. These tunnels are dark and remain undisturbed and provide ideal habitat to microchiropterans. A mixed roost of *R. hardwickii* and *R. microphyllum* was identified here, while *P. tenuis* lives in the houses of the nearby village.

7. Ranorao Pond caves (Nokha) (27°55'63N, 73°46'28E). This area has been surveyed for the first time for bats and we have discovered a large bat roost of more than 10,000 specimens. These caves are abandoned mining sites, which are almost undisturbed. Gravel was earlier excavated from the caves and due to the Government strictness, mining has been stopped here and moreover these long caves have become unsafe for mining activities. These caves are multi-layered i.e. many tunnels are one above the other. On the second and the third levels we found a big cluster of bats, which were hibernating (Photo 2b). These deep tunnels provide a hibernacula site as temperature here is a bit above the outside temperature and, moreover, close clusters of thousands of bats help in maintaining the temperature. It also indicates that bats which roost in short tunnels during summer migrate to these deep tunnels and hence the winter population declines in the shallow caves. We found a mix roost of *R. hardwickii*, *R. microphyllum*, *T. perforatus*, *P. tenuis* and *R. lepidus* here.

8. Gravel Caves near Doordarshan Relay Centre (Nokha) (27°55'09N, 73°46'26E). This area is situated in the corner of the town, where old gravel mines are present. It was very difficult to get near the bat colony because sewage water mixed with bat guano was present at the base of cave. This water was not only foul smelling but also made the access to the roost site difficult. The tunnel system was almost identical to that of Ranorao Pond caves. A mixed roost of *R. hardwickii*, *R. microphyllum* and *P. tenuis* was located here. The total number of bats here was near about 50,000 specimens. All bats were hibernating at this place in many large clusters. Temperature was very cosy as compared to other caves. According to local residents, these tunnels are one kilometre in length and nearly 50 such tunnels are present here and all these are interconnected with each other. A rough estimate puts the total wintering population here to more than 50,000 specimens. According to the denizens of the area, this site is a permanent roost and bats have roosted here from the last 200 years. This is one of the biggest roosts not only in Bikaner district, but of the whole Thar Desert.

9. Veterinary University Campus (28°03'35N, 73°32'90E). The Veterinary University was established in a historical building of His Highness time. In this campus, both Microchiropterans and Macrochiropterans are present. We could record *T. perforatus* for the first time in Bikaner. *P. giganteus* regularly visit the area during their stay here as the campus provides fruits and flowers to them. They also roost near the hostel dome on the trees of Ashoka (*Saraca indica*). *T. perforatus* was reported for the first time in the area and was observed on the window mesh of the main library.

10. Dada badi temple village Udairamsar (28°11'73N, 73°40'21E). This is the one of the oldest temple of Bikaner district. Its structure looks like a fort and it has some pillar like structure that are hollow inside and bats roost inside these structure. We found three species of microchiropterans present inside and these were *R. hardwickii*, *R. microphyllum* and *P. tenuis*. Most of these keep hanging on the wall and the roof. According to local residents, they have been present here from quite a long time and always come out after sunset.

11. Junagarh Fort (28°02'15N, 73°31'85E). This is symbol of bravery for Bikaner. The fort construction started under the supervision of Karan Chand, the Prime minister of Maharaja Sh. Rai Singh. This Historical monument is very big and is made up of small and big rooms and galleries, some of which not opened for visitors and tourists. These closed undisturbed rooms are roosting sites of different bats species. *R. hardwickii* is a common bat of the fort. *R. microphyllum* and *R. lepidus* also roost here. This area is also a hibernating site for these species. This fort provides permanent roosting site for different bat species as certain areas are forbidden for tourists and are undisturbed.

In addition to these sites, many other roost sites have been spotted in Bikaner and its adjoining area, like Laxminath temple, the private campus on Dauji road, Pili Haveli in Rani Bazaar area, Rampuria and Surana Havelis.

The roosting sites may be even more numerous than what we have identified. This whole area of Bikaner region harbours a huge population of bats. They represent an important part of the biodiversity of the area and also affect crops by keeping insect pest population under control. If we compare Bikaner area with other areas of the Thar Desert, the population of bats is slightly less numerous here. Earlier studies reported the presence of eight species in Jodhpur area viz. *P. giganteus*, *R. hardwickii*, *R. microphyllum*, *Taphozous nudiventris* Cretzschmar 1830, *T. perforatus*, *R. lepidus*, *Scotophilus heathii* Horsfield 1831 and *P. tenuis* (PUROHIT & SENACHA, 2002; PUROHIT & VYAS, 2006). Earlier studies of PRAKASH (1961) and later of GAUR (1979, 1981) reported three chiropteran species in the region, which indicates that Jodhpur area has also become richer in species. A similar kind of observation has been recorded in Bikaner area as well. Since we started work on bats in the year 2011, we have come across three new species roosting in the region viz., *P. giganteus*, *T. perforatus* and *H. fulvus*. We have recorded some more new permanent roosting sites in Bikaner city and its adjoining area.

All these seven species of Microchiroptera viz *R. hardwickii* (Photo 3a), *R. microphyllum* (Photo 3b), *H. fulvus* (Photo 3c), *R. lepidus*, *P. tenuis*, *T. perforatus*, and one Megachiroptera *P. giganteus* (Photo 3d) are listed under the least concern category of IUCN. Bikaner is a very vast area and forms the core of the Great Indian Desert. The region is under the process of ecological transformation partly due to Global Climate Change and partly due to mighty Indira Gandhi Canal Project. Since the incoming of the canal water, the region has witnessed huge changes in floral and faunal composition (IDRIS et al., 2009). There is no doubt that the diversity of the Thar Desert is increasing but this increase is at the cost of desert-adapted species. Like all other vertebrate groups, the Chiroptera fauna is also increasing not only in Bikaner but throughout the Thar Desert. This change is due to the changing floral composition, changing crop patterns, planting of fruiting trees, emergence of new insect pests and more conducive climatic conditions. Due to the presence of fruit trees, the frugivorous *P. giganteus* finds a perpetually available food resource. But, the species has some interesting migration patterns here; it is observed from July to mid-December only and avoids extreme high temperature of summers and extremes of winter months by migrating to some unknown areas. Likewise, due to the irrigated crop-fields and introduction of new crops in the region, new insect pests emerge and they form important food base of these insectivorous bat species. The population of different bats also face several threats like the construction of houses around caves; moreover, many caves are used by people for garbage dump and municipality also dumps household garbage near the roosts, for example the caves of Ranorao Pond, Nokha, and the cave near Doordarshan relay station Nokha, is used by municipality as a dump yard and once these cave systems are filled, these species have to abandon this roosting site. These two cave systems provide very large roosting site (Photo 2b) and when these caves will be filled then no place will be left for the bats to move in or out. Another important threat to these secluded creatures is the witchcraft that is performed by the priest of the bat temple. Uneducated people from all around come here to get their wish of a son fulfilled by forcing the bat to sit on a stick. The stress of capture and physical injuries, while holding bats, prove fatal to these small creatures.

If we look at the comparative abundance of the seven species found in the area, it becomes evident that *R. hardwickii* is the most abundant species in the region (Fig. 2). Following it were, *R. microphyllum* and *P. tenuis*. *R. lepidus* was the least abundant species. Ranorao Pond caves and Doordarshan relay centre caves at Nokha are the most preferred caves followed by the Annapurna Mata Temple cave of Bikaner, which has a peak population of $\approx 3,000$ *Rhinopoma* sp. If we look at the previous studies carried out by PRAKASH (1961), and later by PUROHIT & SENACHA (2003), it becomes evident that chiropteran diversity of Bikaner is increasing. As discussed earlier, this increase is because of the ecological change induced by Indira Gandhi Nahar Pariyojna in the Thar Desert and the Global Climate Changes. The bat diversity has increased from two species in 1961 (PRAKASH, 1961) to seven species (present study) during these last 52 years.

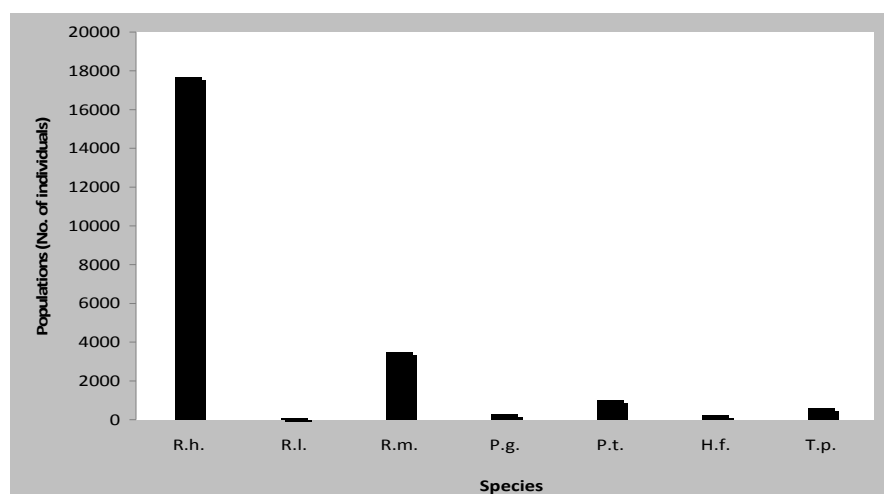


Figure 2. Peak population of different species of bats in a Roosts site of Bikaner district.

Abbreviations = R.h.- *Rhinopoma hardwickii*, R.l.- *Rhinolophus lepidus*, R.m. - *Rhinopoma microphyllum*, P.g. - *Pteropus giganteus*, P.t. - *Pipistrellus tenuis*, H.f. - *Hipposideros fulvus*



Photo 1a, b. Temple of Annapurna Mata (Partap Singh).



Photo 2a. Priest of bat temple performing witchcraft (Partap Singh).



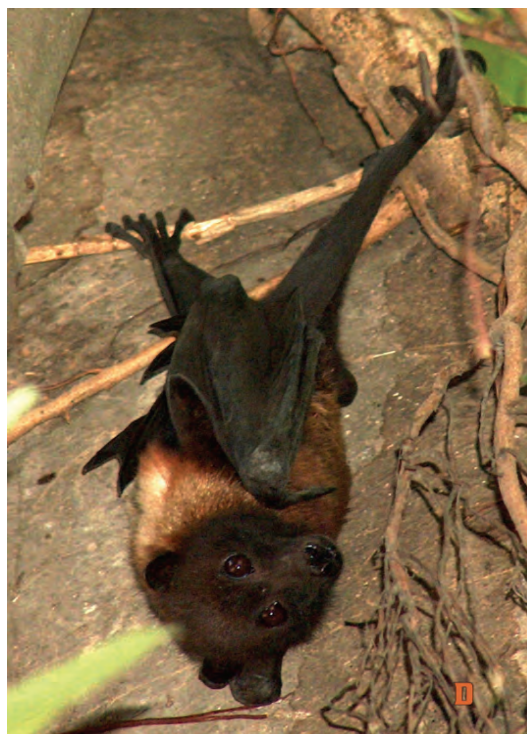
Photo 2b. A winter hibernaculum of mixed population of bats (Partap Singh).



Photo 3a. *Rhinopoma hardwickii* (Partap Singh).



Photo 3b. *Rhinopoma microphyllum* (Partap Singh).

Photo 3c. *Hipposideros fulvus* (Partap Singh).Photo 3d. *Pteropus giganteus* (Partap Singh).

CONCLUSION

Almost all the habitats of world are disturbed by various anthropogenic activities and the Desert Ecosystems are much more fragile than any other. The Thar Desert, one of the smallest deserts of the world, is witnessing large scale ecological transformation as the canal water has been brought here for cultivation to feed the burgeoning human population. As a consequence of the changing floral composition, faunal composition is also changing. Many new species of mammals invade the zone from the southern Aravalli hill range and the northern fertile Gangetic planes. Chiropterans are more susceptible to a slight change than other hardy mammal species. Many bat species invade the zone and some expand their range of distribution. The flying fox, *P. giganteus*, exclusively feeds on fruits, figs and other vegetal matters and its presence in the area indicates the changing floral composition. It also indicates that the fruit trees are now available in the desert, which provides food to these creatures. Two species which are reported for the first time in the region are *H. fulvus* and *T. perforatus*. Due to the changing agriculture practices, new insect pests appear in the area, which serves as food base of these insectivorous creatures. It is certain that bat diversity increased here, but the increased use of pesticides, developing industries, newly established refinery at Barmer and other anthropogenic activities have deleterious effects not only on bat fauna but other faunal elements. Slow moving invertebrates, amphibians, lizards and small mammals will be the most affected species due to these changes.

The population of almost all the species of bats in and around Bikaner is almost stable and there is no eminent threat to them. However, major threats the bats of the region face are habitat destruction, pollution, increased use of pesticides, increasing human and livestock populations, diseases, ectoparasites, predators and many myths prevailing in the society. If we look at the threats to these nocturnal creatures, it becomes evident that most of these threats are anthropogenic in origin. If we leave these creatures without disturbance, they can survive and flourish in number and can easily handle the natural stresses. We must make every effort not to disturb their natural roosting site.

ACKNOWLEDGEMENTS

We are grateful to Dr. Krishna Rathore Tomer, Principal, Dungar College, Bikaner for the carefully guided working environment and the encouragement she has always provided. Laboratory facilities offered by Head, Department of Zoology, are also acknowledged. We also thank UGC for providing funds to carry out the work. Field assistance supported by many of our students is also gratefully acknowledged.

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Received: March 31, 2014.
Accepted: June 10, 2014.