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Bats in Northern Mountain Region of Khyber Pakhtunkhwa, Pakistan

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Abstract

Khyber Pakhtunkhwa (KP) is the North Western Province of Pakistan lying between 31° 15' and 36° 57' North latitude and 69° 5' and 74° 7' East longitude. It covers a land area of 74,521 Km². Great altitudinal range (174–7690 m) diverse temperatures (sub zero to 51°C) and varied rainfall (100–1200 mm) have given rise to a great diversity in habitat with an equally diverse fauna. The Province inhabits 100 species of mammals, 456 species of birds, 48 species of reptiles and 4500 species of plants. Chiroptera is one of the least studied mammalian order in KP. Tall hollow trees, old haunted buildings, inhospitable rock crevices and deep dark caves comprising critical bat habitat are perhaps a valid reason for limited research and studies on bats. Myths and bad omens associated with the nocturnal behavior of bats play an important role in keeping away the non-serious researchers. Literature search reveals that Chiroptera fauna of KP comprises of 4 families, 13 genera, and 29 species. These bats recorded in KP include fruit bats, mouse-tailed bats, vampire bats, horseshoe bats, leaf nosed bats, house bats, serotine bats and pipistrelle bats. This species diversity is a result of diversified habitat and the overlap of Oriental and Palearctic zoogeographic regions in the province. Conservation status of bats in KP is highly unsatisfying. A number of threats loom around bats. These include habitat loss, scarcity of food, slow rate of reproduction, and depredation by animals and birds, killing for medicine, high tension electric transmission lines, killing by fruit farmers, lack of awareness and absence of conducive conservation policy at Government level. The study recommends comprehensive bat research and surveys, habitat analysis, reconfirmation of bat taxonomy, development of bat call library and conservation awareness campaign. The Government of KP should conduct an analysis of the bat distribution, status and adapt a conservation and management policy for bats. The bats should accordingly be listed in the KP Wildlife Law 2015.

Keywords: Chiroptera, diversity, distribution, conservation, Khyber Pakhtunkhwa, Pakistan

1. Introduction to area

The northwestern part of Pakistan that has recently been named by the provincial government as “Khyber Pakhtunkhwa (KP)” possesses a unique physiographic diversity. It lies between 31°15' and 36° 57' North latitude and 69° 5' and 74° 7' East longitude. Afghanistan lies in the North West of the Province. Punjab and Balochistan provinces lie in the south and Gilgit Baltistan, Kashmir and parts of the Punjab Province bound the eastern parts of the Province. KP covers a land area of 74,521 Km² with a population of 30.52 million.

The Province is highly diverse in topography. It comprises of big plains, extensive deserts, low hills and high mountains. The province shares vast stretches of the world-known Karakoram, the Hindu kush and Himalayan Mountain ranges. The altitude ranges from 300 m at Dera Ismail Khan (DI Khan) in the south to 7690 m at Tirich Mir, the highest peak in the Hindu kush Mountain range in the north.

Flora of KP is equally diverse. About nine distinct vegetation types exist in the province. These include Riverain forest, Tropical thorn forest, Mazri palm scrub, and subtropical sub humid forest, subtropical humid Chir pine forest, moist temperate conifer forest, temperate Conifer forest, sub alpine scrubs and alpine meadows [1].

Owing to extraordinary physio-climatic features, the province is rich in wildlife resources. Its broad altitudinal (174–7690 m asl) and climatic range (temperature: –5 to 50°C; average annual precipitation: 1000–1200 mm; rainfall: 230–250 mm; annual average snowfall: 3 ft. (at only Lowari Top)) make it an excellent refuge for country's most prominent wild animal species. The province provides refuge to five out of six wild pheasant species, i.e., the western horned tragopan (*Tragopan melanocephalus*), the Himalayan monal (*Lophophorus impejanus*), the white-crested kalij (*Lophura leucomelanos hamiltonii*), the cheer pheasant (*Catreus wallichii*) and the koklas (*Pucrasia macrolopha*). It is also a home for four sub-species of markhor, i.e., the Kashmir markhor (*Capra falconeri cashmirensis*), the Astor markhor (*C. f. falconeri*), the Kabul markhor (*C. f. megaceros*), and the Suleiman markhor (*C. f. jerdoni*). Two species of urial, the Punjab urial (*Ovis orientalis punjabiensis*) and the Ladakh urial (*O. v. vignei*), two species of bear, i.e., the Himalayan brown bear (*Ursus arctos*) and the Asiatic black bear (*Selenarctos thibetanus*) and one sub-species of the Balochistan black bear (*S. t. gedrosianus*) are also present here. In addition, five species of partridges, i.e., the chukar partridge (*Alectoris chukar*), the snow partridge (*Lerwa lerwa*), the see-see partridge (*Ammoperdix griseogularis*), the gray partridge (*Francolinus pondicerianus*), and the black partridge (*F. francolinus*) are also found in this province [2–4]. Owing to its ornithological importance, the Plass Valley has been designated as one of the global hot spot of biodiversity [5].

In spite of the presence of a rich and diverse wildlife, little attention has been paid to explore bat fauna of the north-western part of the country. Most of the available literature on bat fauna of this region has been contributed by foreigners, before partition of India and Pakistan, during the British reign. Since no comprehensive and updated field study is available, bat biologists still rely on [2, 6–13] for authenticity of their findings.

Literature survey has revealed that bat fauna of the KP consists of four families, 13 genera and 29 species representing more than a half of the bats of the country. These bat families include

Pteropodidae (the fulvous fruit bat *Rousettus leschenaultii*), Rhinopomatidae (the greater mouse-tailed bat *Rhinopoma microphyllum* and the lesser mouse-tailed bat *R. hardwickii*), Rhinolophidae (the greater horseshoe bat *Rhinolophus ferrumequinum*, the lesser horseshoe bat *R. hipposideros*, the Blyth's horseshoe bat *R. lepidus* and the big-eared horseshoe bat *R. macrotis*) and Vespertilionidae (the lesser mouse-eared bat *Myotis blythii*, the whiskered bat *M. mystacinus*, the dark whiskered bat *M. muricola*, the brown long-eared bat *Plecotus auritus*, the gray long-eared bat *P. austriacus*, the Asian barbastelle *Barbastella leucomelas*, the desert long-eared bat *Otonyctris hemprichii*, the Asiatic greater yellow house bat *Scotophilus heathii*, the Botta's serotine *Eptesicus bottae*, the northern serotine *E. gobiensis*, the common serotine *E. serotinus*, the particolored bat *Vespertilio murinus*, the common pipistrelle *Pipistrellus pipistrellus*, the javan pipistrelle *P. javanicus*, the Thomas's pipistrelle *P. paterculus*, the least pipistrelle *P. tenuis*, the coromandel pipistrelle *P. coromandra*, the Leisler's noctule *Nyctalus leisleri*, the mountain noctule *N. montanus*, the common noctule *N. noctula*, the Hutton's tube-nosed bat *Murina huttoni* and the Scully's tube-nosed bat *M. tubinaris*) [2, 13–15]. This diversity of Chiropteran species is a result of the immense diversity of habitat, comprising of old buildings, old trees, mountain caves and cliffs. As far as the status of these bats is concerned, one species is Endangered, two are Vulnerable, six are Near Threatened, 15 are Least Concern and five were Data Deficient [16, 17].

Distribution ranges of most mammals in Pakistan have changed over the past few decades. However, no worthwhile studies documenting these changes except [2, 18–21] are available in the country to show such changes. New mammal species are being explored throughout the world. These discoveries are made especially in those areas which are either poorly surveyed or their mammal fauna is a combination of two or more zoogeographical realms. The north-western part of Pakistan fulfills both these conditions.

It is not only a poorly surveyed, climatically diverse, and habitat rich area, but is also uniquely located on the globe. It forms a buffer zone between Oriental and Palearctic regions and is also connected to Russia and China through land connections. Keeping in mind all these facts, this chapter gives authentic and up-to-date information of bats in the Northern Mountain Region of KP.

2. Diversity, distribution, and conservation status

2.1. Family Pteropodidae

Three species of fruit bats were recorded from Malakand division. These included the Indian flying fox *Pteropus giganteus* Brünnich 1782, the fulvous fruit bat *Rousettus leschenaultii* Desmarest, 1820, and the short-nosed fruit bat *Cynopterus sphinx* Vahl, 1797.

2.1.1. The Indian Flying Fox *Pteropus giganteus* (Brünnich 1782)

The genus *Pteropus* Brisson, 1762, has 65 species and consists of medium to large fruit bats [14]. It is distributed from Mafia and Pemba Islands (off the Tanzania), Madagascar, the Islands of the Indian Ocean, the Indian subcontinent, Southeast Asia, the Philippines, and Australia [13]. Of the 65, five species of the flying foxes are reported from the Indian subcontinent which

include the Indian flying fox *P. g. giganteus* (Brünnich, 1782), *P. g. ariel* (Allen, 1908), *P. g. leucocephalus* Hodgson, 1835, the large flying fox *P. vampyrus* (Linnaeus, 1758), the Nicobar flying fox *P. faunulus* (Miller, 1902), the Island flying fox *P. hypomelanus* (Temminck, 1853), *P. h. satyrus* (K. Andersen, 1908), and the Blyth's flying fox *P. melanotus melanotus* (Blyth, 1863) and *P. m. tytlteri* (Dobson, 1874) [13]. The status and geographical limits of this taxon are still uncertain [13]. *Pteropus giganteus* is included in Appendix II in IUCN SSC Action Plan (1992)-Not Threatened and is Lower Risk-IUCN 2003 [16, 22].

In Pakistan, this species has been reported from Rawal Lake, Saidpur and the Margalla Hills in Islamabad, Sialkot, Lahore, Changa Manga and Renala Khurd in Punjab, and from Jacobabad, Shahpur and Clifton Railway Bridge in Karachi [2, 13, 23]. It has recently been reported from Peshawar and Charsadda districts [20]. The species is widely distributed across India, Maldives, Nepal, Bangladesh, and Sri Lanka [13].

More than 300 bats were recorded roosting in Jrandy (N34° 24.808' E71° 48.202') tehsil Dargai in Malakand district. A single roost of the Indian flying fox was located at Agritech Limited Hazara Phosphate Fertilizer Plant (N33° 58 21.30' and E72° 53 46.04'), Hattar Road, Haripur, during present survey, i.e., May–August 2014. Fifty specimens of the Indian flying fox (*Pteropus giganteus*) were collected from this roost. Ten of them were males while the remaining were females.

2.1.2. The greater short-nosed fruit bat *Cynopterus sphinx* (Vahl, 1797)

The genus *Cynopterus* F. Cuvier, 1824, has seven species [14]. It consists of those species which possess having shorter and broader muzzle with a deep margination between the nostrils. It is distributed from India to Malaysia, Indonesia, Thailand, and the Philippines [13, 24]. Of the 7 species, two species of the short-nosed fruit bats are reported from the Indian subcontinent which include the short-nosed fruit bats *C. sphinx* (Vahl, 1797) and the lesser dog-faced fruit bat *C. brachyotis* (Müller, 1838) [13]. *Cynopterus sphinx* is included in Appendix II in IUCN SSC Action Plan (1992)-Not Threatened, Lower Risk-IUCN 2003 and is Least Concerned-CAMP 2003; CAMP 2002 [15–17, 22].

Typically, this is an Oriental faunal zone species and is confined to warmer sub-tropical areas where there are large numbers of flowering and fruiting trees. This short-nosed fruit bat has been reported from Karachi and Malir by Eates and Murray [23, 25]. No specimen has been collected either by the Zoological Survey of Pakistan or by the Bombay Natural History Society during its mammal survey of Southern Sindh. According to farmers in the Malir area, a small fruit bat does occur which attacks the “chiku” fruit (*Achras sapota*) as well as the custard apple (*Annona squamosa*) hovering near the ground and it seems probable that this is *Cynopterus*. With the spread of banana cultivation in recent decades up to Hyderabad, it is however, likely that this bat is followed as far north as that city [2]. Colonies of up to 25 individuals have been recorded in India by Vasishta and Badwaik [26]. It has been suggested that this species may be beneficial as an agent in seed dispersal (feeding on ripe dates and dropping the pits some distance from the food tree) [27], and in pollinating flowers which produce nectar at night. It is probably not numerous enough in Pakistan to do any considerable damage to the fruit crops.

A skeleton of the greater short-nosed fruit bat was collected from the floor of “Kashmir Smasta” (N34° 25.780' E72° 13.727'), a cave from which 22 *Rousettus leschenaulti* were also

captured. Initially, this skeleton was also thought to be of a *Rousettus* bat, but the dental formula and cranio-morphological measurements confirmed it to be the greater short-nosed bat.

2.1.3. The fulvous fruit bat *Rousettus leschenaultii* (Desmarest, 1820)

The genus *Rousettus* Gray, 1821, includes medium-sized fruit bats that are distributed from sub-Saharan Africa, Arabia and Madagascar to the Indian subcontinent and Southeast Asia [13]. Of the 10 species belonging to this genus, two are reported from the Indian subcontinent which include the fulvous fruit bat *R. leschenaultii* (Desmarest, 1820) and *R. l. leschenaultii* (Desmarest, 1820) and the Egyptian fruit bat *R. aegyptiacus* (E. Geoffroy, 1810) and *R. a. arabicus* (Anderson and de Winton, 1902), [13, 28]. Both are seasonally migratory and colonize Himalayan valleys in summer in the fruit growing districts up to 1200 m (4000 ft.) elevation [2]. *Rousettus leschenaultii* is included in Appendix II in IUCN SSC Action Plan (1992)-Not Threatened, Lower Risk-IUCN 2003 and is Least Concerned-C.A.M.P. 2003 [16, 22].

It is a highly gregarious species and colonies vaulted rooves, natural rock caves and open wells. These roosts were in the more wooded regions in the Himalayan foothill zone and adjacent plains. Being partly migratory, the fulvous fruit bat is mainly a summer visitor to Pakistan with the exception of known Lahore and Malir colonies. It has been recorded near Muzaffarabad in the Jhelum valley of Azad Kashmir, Malakand, the Vale of Peshawar, Sialkot, Lahore, and Karachi [2, 8, 29]. The population of this bat does not seem large enough to have a much effect on the fruit industry in such regions of Peshawar and Mardan. Mirza discovered a colony numbering several 1000 in a rock cave at 1060 m elevation in the Malakand. This was only a summer colony [29] which corroborates their seasonally migratory movements.

A total of 22 specimens of *R. leschenaultii* were captured from Malakand division. Of these 22, seven were captured from Tura Gata (N34° 26.818' E71° 48.973'), five from Cupni (N34° 27.691' E71° 48.220'), seven from Brah (N34° 29.915' E71° 46.822'), and 4 from Daim (N34° 36.647' E71° 47.704').

2.2. Family Rhinopomatidae

Two species of this family were recorded from Malakand division. These included the greater mouse-tailed bat *Rhinopoma microphyllum* Brünnich, 1782, and the lesser mouse-tailed bat *Rhinopoma hardwickii* Gray, 1831. Although both these species have a small dermal ridge on their muzzle, they are distinguishable based on forearm length relative to their tail length. Forearm in *R. microphyllum* is longer than *R. hardwickii*, but tail in *R. microphyllum* is generally smaller than the forearm as compared to *R. hardwickii* which have a longer tail than their forearm.

2.2.1. Greater mouse-tailed bat *Rhinopoma microphyllum* (Brünnich, 1782)

The genus *Rhinopoma* (E. Geoffroy, 1818) has four species worldwide and three of them occur in the Indian subcontinent which include the lesser mouse-tailed bat *R. hardwickii* Gray, 1831, the greater mouse-tailed bat *R. microphyllum* (Brünnich, 1782), and the small mouse-tailed bat *R. muscatellum* Thomas, 1903 [14]. The greater mouse-tailed bat is distributed from Mauritania, Nigeria, Senegal, Arabia, Iran, Afghanistan, Pakistan, India, Sumatra, and Cameroon to Egypt [14]. The species is relatively abundant in the Indian subcontinent with one endemic subspecies (*R. m. kinneari*) and is Least Concerned (South Asian Chiroptera C.A.M.P. Report, 2002; [16, 17].

In Pakistan, the species has been reported from Ara [30], Sakesar, Rohtas [31], Gujrat, Multan, Mailsi, and near Jhelum in Punjab [2]. In Sindh, colonies have been found in Sukkur, Gambat [33]; Hyderabad, Karchat Hills, Karachi [2], and Lasbela (South Balochistan) [7]. The species has also been reported from Sadiqabad and Qutabpur. Mirza found a large summer colony inhabiting a natural rock cave in the Malakand Hills [2]. It is also found in Amb in Khyber Pakhtunkhwa [32].

A total of 58 greater mouse-tailed bats were recorded co-roosting with *R. leschenaultii* in a cave at Tura Gata (N34° 26.783' E71° 49.070') tehsil Dargai.

2.2.2. Lesser mouse-tailed bat *Rhinopoma hardwickii* (Gray, 1831)

R. hardwickii has an average forearm length of 59.2 mm (52.9–64.0 mm) and rarely exceeds 60–67 mm. According to Roberts [2], this is much less common species than *R. microphyllum* in Pakistan. The species has been reported from Amb in Khyber Pakhtunkhwa [34]. It has also been reported from Ara [30], Sakesar, Rohtas in Salt Range and Chitti Dil [31] in Punjab, around Karachi and Karchat Hills near Hyderabad [2] and Landi in southern Sindh [33].

According to Bates and Harrison [13], *R. hardwickii* is widespread and believed to be common in the Indian Subcontinent. Both the species *R. hardwickii* and *R. microphyllum* use the same type of diurnal roosts. The species is considered to be “Least Concerned” (South Asian Chiroptera C.A.M.P. Report, 2002; [16, 17]).

More than 25 bats were recorded roosting in a cave of Tura Gata (N34° 26.818' E71° 48.973') tehsil Dargai in Malakand district.

2.3. Family Megadermatidae

The greater false vampire bat *Megaderma lyra* E. Geoffroy, 1810, is the only species of this family found in Pakistan. One colony of these bats was recorded from the study area.

2.3.1. The greater false vampire *Megaderma lyra* (E. Geoffroy, 1810)

The genus *Megaderma*, E. Geoffroy, 1810, has two species which consists of the greater false vampire *M. lyra* Geoffroy, 1810, and the lesser false vampire *M. spasma* Linnaeus, 1758 [14]. They are large bats without any tail and extensively developed interfemoral membrane. The genus *Megaderma* consists of those species having large oval ears, fold of skin across the crown and have an elongated bifurcated tragus [2, 13]. Megadermatidae consists of four genera and five species, two of which occur in the Oriental Region and one genus and one species in Pakistan [12, 14, 24]. *Megaderma lyra* Geoffroy, 1810, differs from *M. spasma* by its longer forearm, broad and short tragus, smaller postorbital process, and deep prenasal notch. Because of these differences [35], *M. lyra* has been in a separate subgenus, *Lyroderma*. According to Ref. [36], the species (under the generic name *Eucheira*) can be divided into two subspecies, *E. l. lyra* and *E. l. caurina*, both of which are found in and near the Indian Peninsula, and the specimens derived from South China (characterized by larger skull and narrower prenasal notch) belong to a different species, *E. sinensis*. Since the differences are very slight between *E. l. lyra* and *E. l. caurina*, we agree with [37] and [38, 39] who recognized only the nominate subspecies *M. l. lyra* in India, Pakistan, Bangladesh, and Sri Lanka. *E. sinensis* is generally accepted as a

subspecies of *M. lyra* [6] and is distributed in South China, Burma, Thailand, Cambodia, Laos, and Malaysia. The area of *M. lyra* was figured by [35], but with some inaccuracy, since the species is living in Pakistan [40], Afghanistan [7], and Vietnam [41]. The species is “Lower Risk” IUCN, 2003 and IUCN/SSC Action Plan 2001 [13, 14].

The false vampire bat *M. lyra* Geoffroy 1810, is an old world tropical gleaner bat. It detects its prey both via echolocation [42] and based on prey generated rustling noises [43]. *M. lyra* is a large bat with ugly appearance because of their big head, prominent muzzle, huge naked ears, and peculiar nose leaf. The skin of the nose leaf is pink and naked and roughly lozenge-shaped with a narrow vertical ridge running down its center. Ears are bluntly rounded at their tips, sparsely covered with hairs, and pinkish gray color when the animal is alive. The tragus is pinkish brown, long, and slender, being divided into two lanceolate but unequal lobes. The outer lobe is much longer up to 13 mm, and slenderer than the inner lobe which is blunter at its tip. The pelage is fine, soft, and moderately long. The upper surface of the body is a uniform mouse gray faintly washed with brown. The ventral surface is paler, with the hair tips on the throat and belly white; the hair bases are gray. Dorsally the body fur is blue gray and consists of long silky hair. The belly fur is a paler, more yellowish gray. Whitish hairs extend around the posterior ears bases and on to the wing membrane from the axillae to the groin. The upper lip tends to be rather sparsely haired with a fleshy furrow dividing the middle of the lower lip. Female have two pectoral mammae with two more false teats in the pubic region. Juvenile have a comparatively dark pelage. The wings are broad due to the last or fifth digit being relatively long. There is no trace of a tail in this species, but the interfemoral membrane is well developed, stretching from heel to heel and being supported by long but weakly developed calcars. The hind feet that are comparatively large is in the development of the first digit which consists of only two joints while the remaining digits have three joints [2, 13].

In India, the colonies of this species have been observed in man-made structures such as temples, caves, forts, dilapidated old buildings, underground tunnels, old cow sheds, grain godowns, cellars, open walls, and shallow soap stone mines [37, 44, 45]. According to Hill [31], the species has been reported from Murree foothills at Lehtarar at 920 m, while Roberts [2] recorded it from Lahore in old ruined Mughal cellars at Shalimar gardens and from Sialkot. At Sukkur in Sindh, it has been found occupying the hillside caves (these are shallow man-made caves in limestone conglomerate) [2]. The species has been observed entering the verandah of an occupied house in Karachi to devour its prey [23]. The British Museum has one specimen, marked Balochistan and it seems likely that this specimen comes from Lasbela. It has not definitely been recorded anywhere else in Pakistan. In Pakistan, it appears that this bat is rather rare and decidedly local in distribution except in the northern sub-montane zone where it may be more widespread than is presently known. Further collecting will undoubtedly reveal its presence in the valley of Peshawar and possibly Mardan [2].

Twenty bats were recorded in a cave (N34° 26.762' E71° 49.064') at Tura Gata tehsil Dargai in Malakand district along with *R. leschenaultii* and *Hipposideros fulvus*.

2.4. Family Rhinolophidae

The family Rhinolophidae is characterized by a horseshoe-shaped nose leaf on the muzzle which consists of an erect posterior lancet, a lower horizontal horseshoe that surrounds the nostrils, and a perpendicular median sella. The genus *Rhinolophus* Lacepede, 1799, has 76 species

worldwide of which 16 species exist in the Indian subcontinent and five have been recorded in Pakistan. These five species include the greater horseshoe bat *R. ferrumequinum* Schreber, 1774, the lesser horseshoe bat *R. hipposideros* Bechstein, 1800, the Blasius horseshoe bat *R. blasii* Peters, 1866, the Blyth's horseshoe bat *R. lepidus* Blyth, 1844, and the big-eared horseshoe bat *R. macrotis* Blyth, 1844 [2, 13, 14]. This family is distributed from southern England to Caucasus, Iran, Pakistan, India, China, Japan, Morocco, Algeria, and Tunisia. It is considered to be a monogeneric group [12]. The greater horseshoe bat is Least Concerned worldwide [15, 17] and Near Threatened in South Asia (South Asian Chiroptera C.A.M.P. Report, 2002; [16, 17].

Rhinolophidae bats are easily distinguished from the rest of bat families based on a prominent horseshoe-shaped nose leaf apparatus. Two species of this family were recorded from Malakand division. These included the greater horseshoe bat *Rhinolophus ferrumequinum* (Schreber, 1774) and Blyth's horseshoe bat *Rhinolophus lepidus* (Blyth, 1844).

2.4.1. The greater horseshoe bat *Rhinolophus ferrumequinum* (Schreber, 1774)

R. ferrumequinum is widely distributed in northern Himalayan region and extends southwards through the mountains of Waziristan and northern Balochistan. This bat seems to be rare in southern Balochistan because of the lesser supply of suitable insect prey and very dry climate which is unfavorable to the family Rhinolophidae [2]. Specimens have been collected from around Dir town (USNM), Abbotabad (HZM), Karakoram pass (FMNH), Gilgit (type loc. of *proximus*) [13], and Kululai in Swat [2]. These larger greyer specimens have been assigned to the subspecies *R. f. proximus* [2]. Small colonies found in Balochistan near Kalat, Nushki, and Quetta have been assigned to *R. f. irani* [13, 46].

A total of 46 bats were recorded roosting in a cave at Loya Agra (N34° 34.868' E71° 43.114') tehsil Batkhela in Malakand district.

2.4.2. Blyth's horseshoe bat *Rhinolophus lepidus* (Blyth, 1844)

This species is a new record for Pakistan. The first specimen was captured by Mrs. Nora Pendleton from a phosphate mine near Abbottabad [2, 13]. The species has also been collected from Afghanistan [12] and in the dryer parts of Rajasthan, India [9], so the status of this species is unknown in Pakistan [2]. IUCN 2003 and IUCN/SSC Action Plan (2001) declare this species to be Data Deficient. It was in the lower risk (LR/LC) category according to IUCN 2007 report and is a chiropteran of Least Concern according to IUCN [17] Red List of Threatened Animals and C.A.M.P. Report, 2002.

Rhinolophus lepidus shortridgei found in South Asia differs from *R. l. lepidus* in having a longer hind foot (55–63% of the tibia, against 45.8–47.5%) and longer mandible [47].

Bates [13] collected specimens of *R. lepidus* from Nepal, India, and Pakistan. Three bats were captured through mist net in Malakand University (N34° 40.054' E72° 03.653') in Malakand district. Fifty specimens of the Blyth's horseshoe bat (*Rhinolophus lepidus*) were collected from Fizaghat Kaan (N34° 47' 24.42" E 72° 22' 22.16") elevation 3105 ft., Nalai Kaan

(N34° 46'59.17" E72° 22'204.19") elevation 3324 ft., and Gull Dara Kaan (N34° 47'19.66" E72° 22'11.55") elevation 3106 ft. district Swat. Fifteen of them were captured from Fizaghat Kaan (4 male and 11 female), 19 from Nalai Kaan (1 male, 18 female), and 16 from Gull Dara Kaan (5 male, 11 female).

2.5. Family Hipposideridae

2.5.1. *Fulvous leaf-nosed bat Hipposideros fulvus* (Gray, 1838)

Hipposideridae is a family of bats commonly known as the "Old World Leaf-nosed Bats." This large family is characterized by elaborate modifications of the nose and muzzle, forming leaf-like projections that are thought to help focus echolocation signals emitted through the nose. It comprises 80 species in 11 genera throughout the world. In Pakistan, it is represented by three genera and four species. It is a medium small species of *Hipposideros* with characteristically very large ears, the tip of which is broadly rounded off; the feet are small. The nose leaf has a greatest width of about 5 mm; its general morphology is like that of *H. ater* [13]. Adult weigh between 8 and 9 g [48].

The baculum is small and comparable to that of *H. ater*. It has a straight shaft with a simple base and tip [13]. It is closely similar in appearance to *Hipposideros cineraceus* from which it can mainly be distinguished by its slightly greater size and more rufescent dorsal pelage with very pale basal portion to the hairs. The dorsal fur of this species can vary widely in color in parts of western India [37], but in Pakistan, all specimens from the Punjab have long soft fur with the hairs pinkish white basally terminating in dark reddish brown or chestnut tips. Some individuals have more yellowish white fur close to the body with the tips of the hairs gray brown or even golden yellow in specimens from Sindh according to Murray, 1874.

This species seems well adapted to arid regions in the areas having a scattered growth of tropical thorn scrub or dry sub-tropical scrub. It particularly favors the open burrows of Porcupines and Hyenas for its diurnal roost as well as utilizing underground cellars, railway tunnels, and open wells "Kharezes" in Balochistan. They are very susceptible to predation from crows and kites if flying abroad in daylight [49]. Specimens have been collected in the northern Punjab from around Rawalpindi [9] and Chaklala [30] in the salt range. It apparently does not penetrate the foothills in the north and is absent from most of the Indus plain, occurring again in Southern Sindh around Sukkur [33], the Mausoleum of Amir Khan Mono and in Gholam and Gharo, all in Thatta district [50] and Shujawal [34]. In southern Balochistan, it has been collected from Panjgur and Hoshab [2]. The species is least concerned in South Asia [16, 17, 15]; South Asia Bat CAMP, 2002, and is lower risk: Least Concern in Microchiroptera Action Plan [51].

Among the four recorded bat species of this family from Pakistan, only the fulvous leaf-nosed bat *Hipposideros fulvus* Gray, 1838, was recorded from Malakand division.

More than 66 bats were recorded roosting in a cave of Tura Gata (N34° 26.770' E71° 49.090') tehsil Dargai in Malakand district.

2.6. Family Vespertilionidae

Thirteen bat species belonging to seven genera were recorded from Malakand division. These included Hodgson's bat *Myotis formosus* (Hodgson, 1835), Eastern barbastelle *Barbastella leucomelas* (Cretzschmar, 1830/1831), Asiatic greater yellow house bat *Scotophilus heathii* (Horsfield, 1831), Asiatic lesser yellow house bat *Scotophilus kuhlii* (Leach, 1821, Serotine *Eptesicus serotinus* (Schreber, 1774), Botta's Serotine *Eptesicus bottae* (Peters, 1869), common pipistrelle *Pipistrellus pipistrellus* (Schreber, 1774), Javan pipistrelle *Pipistrellus javanicus* (Gray, 1838), Coromandel pipistrelle *Pipistrellus coromandra* (Gray, 1838), Least pipistrelle *Pipistrellus tenuis* (Temminck, 1840), Dormer's bat *Pipistrellus dormeri* (Dobson, 1875), Desert yellow bat *Scotoecus pallidus* (Dobson, 1876), and Schreibers' long-fingered bat *Miniopterus fuliginosus* (Kuhl, 1819).

2.6.1. Hodgson's bat *Myotis formosus* (Hodgson, 1835)

This is geo-graphically widespread but little-known bat [13]. It is apparently common in South Korea [52]. *Myotis formosus* ranges from Afghanistan to China, Taiwan, Korea, Japan, Philippines and Indonesia. Bates and Harrison [13] collected specimens of *M. formosus* from India and Tibet. Five bats were captured through mist net in Wach Khwar (N34° 58.104' E72° 28.270'), Barcharai Daim (N34° 33.737' E71° 44.872'), Chinai Ghaz (N35° 00.850' E72° 03.439'), and Mattak (N34° 59.066' E72° 02.907') in Malakand division.

2.6.2. Asian barbastelle *Barbastella leucomelas* (Cretzschmar, 1830/31)

This is rather a small and delicately built bat with a very striking body color. The dorsal fur is long and silky and of a blackish gray color basally, with the extreme tips of hairs a pale golden brown giving it a hoary appearance. The belly fur is paler grayish brown. The ears are large and conspicuous being rather a squarish in outline and forward slanting.

Present limited evidences indicate that this bat is associated with forests in the northern mountain regions, either Himalayan moist or dry coniferous forest. Since this species is not gregarious in its diurnal roosts, it is never very plentiful throughout its range and the paucity of Pakistan specimens indicates that it is uncommon if not rare [6] include Gilgit and the Punjab within its range based on reports by Blanford, but there are no specimens in the British Museum or Bombay Natural History museum collections from Gilgit. However, a specimen was collected at Dunga Gali in 1907 at 2350 m (7800 ft.) and a second mummified specimen in the same location by the author on 2 May 1980. A third specimen was collected in 1965 by the University of Maryland expedition from Naltar, Gilgit, in spruce forests (*Picea smithiana*), at about 2450 m (8000 ft.) elevation. Siddique does not include this specimen in either of his checklists (1961, 1970). It was collected from Afghanistan in Paktia Province [53] and from several localities in northern Iran [54]. Elsewhere it occurs in Russian Turkestan, Chinese Xinjiang, Transcaucasia [55], southern China, and north to Japan [12]. In India, it occurs in Darjeeling, Nepal, Sikkim, and the Bhutan Duars.

Only one bat was captured through mist net in Lamin Bala (N35° 27.802' E72° 14.310') in Upper Dir district.

2.6.3. Asiatic greater yellow house bat *Scotophilus heathii* (Horsfield, 1831)

Scotophilus heathii is geographically distributed in Afghanistan to South China, including Hainan Island, south to Sri Lanka, Vietnam, Cambodia, Thailand, and Burma. In Pakistan, the species is common and widespread throughout the Indus plains. It has been collected from Kohat (NWFP), Islamabad city, Multan, Lahore and Sialkot districts (Punjab), Kashmoor, Sakkur, Jacobabad, Mirpur Sakro, Dadu, Landi, Malir, Karachi (Sindh) [2, 8, 18, 33, 50]. IUCN categorizes the species as “Least Concern” [17].

Twenty-two bats were captured through mist net in Head Koper (N34°24.454' E71°50.061'), Bazdara Bala (N34° 30.355' E72°04.692'), Malakand Top (N34°34.007' E71°55.736'), Batkhela (N34°36.903' E71°57.768'), and Daim (N34°36.647' E71°47.704') in Malakand district.

2.6.4. Asiatic lesser yellow house bat *Scotophilus kuhlii* (Leach, 1821)

It is uncommon in Pakistan with a very restricted distribution. The species is present only in southern Sindh [2]. Geographically, this species is distributed in Bangladesh, Pakistan to Taiwan, south to Sri Lanka, Burma, Cambodia, W Malaysia, Java, Bali, Nusa Tenggara (Indonesia), southeast to Philippines and Aru Islands (Indonesia) [15]. The species is categorized as “Least Concern” [17].

Two bats were captured through mist net in Head Koper (N34° 24.454' E71° 50.061') and Kot (N34° 29.778' E71° 43.501') in Malakand district.

2.6.5. Serotine *Eptesicus serotinus* (Schreber, 1774)

This species is rare in Pakistan. The only male specimen was collected by Roberts [2] from Dunga gali in Murree Hills. Walker and Molur [16] declare this species to be Data Deficient, Near Threatened (C.A.M.P. Report, 2002), and Least Concern according to IUCN [17] Red List of Threatened Animals.

E. s. pashtomus was described as a new subspecies by Gaisler [7] in his account of bats collected in Afghanistan from Jalalabad district. The zygomatic width of *pashtomus* being 14.5 mm while Felten [56] in describing a further collection of bats from Afghanistan also assigned *E. serotinus* to the subspecies *pashtomus* which was collected from eastern Afghanistan close to the border with Chitral [56].

Fifteen bats were captured through mist net in Head Koper (N34° 24.454' E71° 50.061'), Bakrai (N34° 23.939' E71° 52.202'), Astanadaro Kalay (N34° 24.913' E71° 49.466'), Barcharai Daim (N34° 33.737' E71° 44.872'), Amluk Dara (N34° 43.773' E71° 52.502'), and Pull Saokai (N34° 38.553' E72° 01.749') in Malakand division.

2.6.6. Common pipistrelle *Pipistrellus pipistrellus* (Schreber, 1774)

The taxonomic status of this bat species is unknown from Pakistan. The species is distributed in British Isles, S Denmark, W Europe to the Volga and Caucasus, Morocco; Greece, Turkey,

Israel and Lebanon to Afghanistan, Kashmir, Kazakhstan, Pakistan, Burma, Sinkiang (China), perhaps Korea, Japan, and Taiwan. The British Museum has one specimen that was collected from Kashmir in the beginning of nineteenth century. Two other specimens were collected from Gilgit by an expedition carried out by University of Maryland in 1965 [2]. The species has a restricted range in the Indian subcontinent [13] and seems to be common in Pakistan as there has been no further field studies on bats in Kashmir or Gilgit [2]. The species is “Least Concerned” [17]. Pipistrelles in Europe have recently been shown to comprise two cryptic species *P. pipistrellus* which echolocates with most energy around 45 kHz, and *P. pygmaeus*, with most energy at 55 kHz [57, 58].

Only a single specimen was captured through mist net in Lamin Bala (N35° 27.802' E72° 14.310') in Upper Dir district.

2.6.7. Javan pipistrelle *Pipistrellus javanicus* (Gray, 1838)

Pipistrellus javanicus distributed in East Afghanistan, North Pakistan, North and Central India, South and East Tibet (China), Burma, Thailand, Vietnam, through SE Asia to Lesser Sunda Isles and Philippines; perhaps Australia. No literature is available on the distribution of this species in Pakistan; however, a single specimen was collected from Gharial, Murree Hills [15]. The species falls in “Least Concern” category [17].

Only one bat was captured through mist net in Malakand University (N34° 40.054' E72° 03.653') in Malakand district.

2.6.8. Coromandel Pipistrelle *Pipistrellus coromandra* (Gray, 1838)

Ten specimens of *Pipistrellus coromandra* has been collected from Chitral and 17 specimens from Saidu Sharif in Swat; the mean head and body length was 43 mm. The mean tail length was 35 mm. The mean hind foot and ear length were 7 mm and 11 mm, respectively. The mean forearm length was 32 mm. The Swat specimens averaged 6 g in weight [2]. These Pakistan specimens and also those from Afghanistan (Jalalabad) [7] appear to average slightly larger than the population from central India [59]. The species also has been collected from Dir, Yakh Tangai in Khyber Pakhtunkhwa and from Chakri in Punjab [13]. This is a widely distributed and apparently common species in southern Asia. This species is categorized as “Least Concern” [17].

A total of eight specimens were captured through mist net in Barcharai Daim (N34° 33.737' E71° 44.872'), University of Malakand (N34° 40.054' E72° 03.653'), Koza Agra (N34° 35.171' E71° 41.802') in Malakand district and from Shaheed Benazir Bhutto University, Sheringal (N35° 16.204' E72° 00.172'), Thal (N35° 28.812' E72° 14.588'), Dir (N35° 12.327' E71° 52.540'), and Mian Banda (N34° 50.378' E71° 51.984') in Dir district.

2.6.9. Least pipistrelle *Pipistrellus tenuis* (Temminck, 1840)

Pipistrellus tenuis is the smallest pipistrelle found within the subcontinent with an average forearm length of 27.7 mm. The species is hard to differentiate from smaller individuals of *P. coromandra* based on forearm length. Its body weight averages about 2 g [60]. The species is distributed in

Afghanistan to the Moluccas; S China, Laos, Vietnam, Cocos Keeling, and Christmas Islands (the Indian Ocean). The species has been recorded from Malakand [2], Chitral [9], Multan and Chaklala [30], Chakri, Gambat, Sukkur [34], Karachi, and Malir [8]. The species is considered as "Least Concerned."

Thirty-five bats were captured through mist net in Bakrai (N34° 23.939' E71° 52.202'), Timergara (N34° 49.471' E71° 50.396'), Koz Koper (N34° 24.399' E71° 50.171'), Matkani (N34° 37.380' E71° 51.055'), Head Koper (N34° 24.454' E71° 50.061'), Malakand Tunnel (N34° 33.158' E71° 54.168'), Maina (N34° 29.765' E71° 44.585'), Kot (N34° 29.778' E71° 43.501'), Manzaray Baba (N34° 29.480' E71° 42.353'), Qadar Kalay (N34° 24.076' E71° 50.723'), Shaheed Benazir Bhutto University Sheringal (N35° 16.204' E72° 00.172'), Astanadaro Kalay (N34° 24.913' E71° 49.466'), Thana (N34° 38.334' E72° 04.233'), Daim (N34° 36.647' E71° 47.704'), Tutakan (N34° 36.978' E71° 49.511'), Community Game Reserve Brah (N34° 29.820' E71° 46.327'), Ziarat Kalay (N34° 37.213' E71° 48.715'), Kas kalay (N34° 24.573' E71° 48.978'), Fishing Hut (N34° 38.900' E72° 01.941'), Faqeer Abad (N34° 23.323' E71° 53.324'), Haryan Kot (N34° 29.382' E71° 47.871'), and Mola Misray (N34° 25.251' E71° 49.085') in Malakand division.

2.6.10. *Dormer's bat Pipistrellus dormeri* (Dobson, 1875)

Pipistrellus dormeri is confined to India and Pakistan [13]. It is restricted to the Indian subcontinent where it is an abundant species in areas such as Rajasthan [61]. The species has been collected from Sialkot in Punjab and Shikarpur in Sindh [9]. This species is categorized as "Least Concern" (CAMP, 2002).

Only eight bats were captured through mist net in Dir (N35° 12.327' E71° 52.540'), Fishing Hut (N34° 38.900' E72° 01.941'), Head Koper (N34° 24.454' E71° 50.061'), and Malakand Top (N34° 34.007' E71° 55.736').

2.6.11. *Desert yellow bat Scotoecus pallidus* (Dobson, 1876)

Scotoecus pallidus is endemic to the Indian subcontinent and has a local and restricted distribution in Pakistan. It was first described by Dobson in 1876, from a specimen collected from Mian Mir (Lahore). Further collections were made from different regions of northern Sindh (Kashmore and Mirpur in Jacobabad, Larkana, Sukker and Dadu Districts) and Punjab (Muzaffargarh and Sialkot). Its population status is uncertain and deserves further study [15].

Twenty-two bats were captured through mist net in Manzaray Baba, Dir (N35° 12.327' E71° 52.540'), Jrandy (N34° 24.808' E71° 48.202'), Koz Koper (N34° 24.399' E71° 50.171'), Mola Misray (N34° 25.251' E71° 49.085'), Astanadaro Kalay (N34° 24.913' E71° 49.466'), Malakand Top (N34° 34.007' E71° 55.736'), Badraga (N34° 23.314' E71° 50.295'), Head Koper (N34° 24.454' E71° 50.061'), Pull Saokai (N34° 38.553' E72° 01.749'), Qadar Kalay (N34° 24.076' E71° 50.723'), Kot (N34° 29.778' E71° 43.501'), Fishing Hut (N34° 38.900' E72° 01.941'), and Matkani (N34° 37.380' E71° 51.055') in Malakand division.

2.6.12. *Schreiber's long-fingered bat Miniopterus fuliginosus* (Kuhl, 1819)

It has not been collected from Pakistan up till now, but Gaisler [7] asserts that it is likely to occur in the country as it is present in Afghanistan and Iran, close to the western borders, and

in India, close to the eastern borders of Pakistan [2]. The status of this species is unknown in Pakistan, IUCN 2008-NT.

Six bats were captured through mist net in Barcharai Daim (N34° 33.737' E71° 44.872'), Fatehpur (N35° 04.345' E72° 29.502'), Bahrain Pull (N35° 12.418' E72° 32.963'), Fizagat (N34° 47.586' E72° 23.672'), Fish Hatchery (N35° 08.439' E72° 32.917'), and Baidara (N34° 57.494' E72° 26.635') in Malakand division.

3. Problems of conservation

Bats in the study area are confronted with numerous threats. Some of these threats are highlighted below.

1. Low rate of reproduction

Bats have a low rate of production. Most of the Chiropteran give birth to only one or two pups. Numerous threats to bats' survival compiled with slow rate of reproduction make their survival precarious.

2. Habitat loss

Mountain caves, rocky crevices, old abandoned buildings, and old trees act as favorite roosting places for bats. These places and objects are critically endangered in the study area and are being rapidly destroyed. Caves and rock crevices face destruction on account of use of explosives and dynamites for mining of marble, gem stone, and other minerals. The caves are also excavated for finding archeological artifacts, thus disturbing the bat roost. Tall, old trees are being cut for fuel or for reclamation of land for agriculture and housing. Old dilapidated historic places are being renovated for tourism and the culture of building houses with hollow wooden roofs is being replaced by reinforced cement concrete (RCC) roofs. All these practices lead to destruction of bat habitat, ultimately threatening their survival.

3. Food scarcity

Farmers do not like frugivorous bats because of the damage they do to their fruit orchards. Consequently, the farmers either kill these bats or they change the fruit species composition in the orchards, thus considerably reducing the amount of food available to bats. Reduction in the quantity of food ultimately affects the bat population.

4. Environmental pollution

Every increasing use of pesticides, chemical toxins, air water pollution through industrial wastes and exhausts affects bats as adversely as they do the human beings. Contaminated food and water take a heavy toll on bats and threaten their long-term survival.

5. Natural disasters

Natural disasters such as earthquakes, floods, and fire cause devastation of habitat of bats. Mountain areas of KP, including the study area, are prone to frequent natural disasters.

Earthquakes and landslides result in caving in or closure of cave entrances, thus killing large number of bats inhabiting them.

6. Depredation by birds and animals

Certain birds such as owls and eagles and mammals, including jungle cats, civets, and flying squirrels prey upon bats for food. An abundance of these predators in habitat may result in rapid decline in bat population.

7. Killing for food and medicine

A tribe in Nepal is reported to hunt bats for food. Although, this is not the case in KP, yet people kill bats for use in medicine for curing baldness, rheumatism as aphrodisiacs. Some people also consider bats as a bad omen; therefore, they kill them.

8. Lack of awareness

The bats live in lonely and hidden corner of crevices and they are not known to the common man. Those who know them are not aware of the role they play in the ecosystem. These ugly looking nocturnal creatures play an important role in the ecosystem. They are not only a valuable component of the biodiversity, but also represent a unique mammalian order, Chiroptera. Bats are biological controllers of insects, pests, and some rodents, are crop pollinators, and a source of highly valuable guano.

Being unaware of these values and roles of bats, people do not show any concern about their conservation. The wildlife laws of the country are also silent about bats and no penalties have been prescribed for their illegal hunting, killing or trading. Conservation of bats demands that people, particularly farmers are made fully aware of the importance and role of bats in the country. Besides implementation of an awareness campaign about bats, the bat conservation lessons need to be included in the primary and middle school curriculum.

4. Recommendations for future research guidelines

1. **Bat surveys:** this is the first extensive exploration of that small portion of the KP which comprises of only three districts of Malakand division, i.e., Malakand, Dir, and Swat. Although more focus remained toward Malakand district, 6 families, 14 genera, and 21 species were identified. Moreover, two new country records (*Myotis formosus* and *Miniopterus fuliginosis*) were also made. Further bat surveys in poorly surveyed parts of the country especially in KP and Balochistan may result in identification of some other new bat taxa. More bat surveys involving greater field efforts may also confirm the presence or absence of those already described species from the country.
2. **Distribution ranges and species-specific habitat analysis:** the presence of 13 new locality records (*Pteropus giganteus*, *Cynopterus sphinx*, *Rhinopoma hardwickii*, *Megaderma lyra*, *Rhinolophus lepidus*, *Hipposideros fulvus*, *Barbastella leucomelas*, *Scotophilus heathii*, *Scotophilus kuhlii*, *Eptesicus serotinus*, *Pipistrellus javanicus*, *Pipistrellus dormer* and *Scotoecus pallidus*) and two new country records (*Myotis formosus* and *Miniopterus fuliginosis*) gives credence to

the idea that distribution ranges of most of the bat species have changed over the past 60 years. Thus, serious scientific studies are needed to redefine distribution ranges and identify species-specific habitats using global positioning system and radio-telemetric studies.

3. **Reconfirmation of bat taxonomy:** genetic analysis of none of the bat species of the country has been made using molecular markers thus leaving behind a chance to doubt identification of cryptic bat species. Thus, molecular genetic studies of all the bat species of the country are highly recommended. These could even lead to the discovery of such bat taxa which are new to science.
4. **Bat call library:** There was only one bat detector with my supervisor and he was the only professor in the whole country which was working on bats at that time. He has bought this equipment in his project funded by HEC Pakistan. Under his supervision there were only four students which were working on bats at that time. So, none of the bats could be recorded. Bat call analysis has boosted bat identification throughout the world, but the lack of such sophisticated equipment in the country has become a major bottleneck in the establishment of a bat call library.
5. **Awareness campaigns:** a majority of the countrymen are unaware of the ecological services rendered by bats. Khyber Pakhtunkhwa is the major fruit growing region of the country. Based on misperceptions, the locals consider all bats as vermin and kill them ruthlessly. Conservation education to highlight the significance of bats must be included in the curriculum of children at primary school level so that they may adopt a pro-conservation attitude in the first few years of their personality building.

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