

MORMOPHOMETRIC CHARACTERS AND DISTRIBUTION OF BAT (Mammalia: Chiroptera) FAUNA IN NORTHWESTERN PAKISTAN

F. U. Rahman^{1,2*}, F. Perveen², T. Rauf², M. Salim³, Z. Ali⁴, M. N. K. Khattak¹

¹Department of Zoology, Faculty of Science, Hazara University, Garden Campus, Mansehra, Pakistan

²Department of Zoology, Faculty of Science, Shaheed Benazir Bhutto University, Sheringal, Dir (Upper), Pakistan

³Department of Forestry and Wildlife Management, University of Haripur, Khyber Pakhtunkhwa, Pakistan

⁴Environmental Health and Wildlife, Department of Zoology, University of the Punjab, Lahore, Pakistan

*Corresponding Author's Email: faizkhan046@gmail.com

ABSTRACT

Bats (Mammalia: *Chiroptera*) are significantly important as seeds dispersal, pollinators and biological pest control agents. The present study was conducted to explore the diversity of bats in districts Charsadda, Kohat, Mardan, Nowshera and Peshawar, Khyber Pakhtunkhwa (KP), Pakistan from July 2011 to May 2013. During the present study 10 bat species belonging to 5 genera and 4 families were recorded. Bat species recorded were *Pteropus giganteus* Brunnich with body mass (BM) 1121.9±38.9 gm; forearm length (FA) 174.10±1.7 mm; *Hipposideros fulvus* Gray with BM: 8.67±0.98 g; FA: 42.0±0.1 mm; *Pipistrellus ceylonicus* Kelaart BM: 8.90±0.99 g; HBL: 8.90±0.99 g; FA: 95.95±1.33 mm; *Pipistrellus coromandra* Gray BM: 5.95±0.80; FA: 29.14±0.89 mm; *Pipistrellus tenuis* Temminck BM: 5.56±0.65 g; FA: 28.99±0.94 mm; *Pipistrellus javanicus* Gray BM 7.6±0.5 mm; FA: 31.8±0.6 mm; *Rhinopoma hardwickii* Gray BM: 26.8±1.96 mm; FA: 54.18±0.86 mm; *Rhinopoma microphyllum* Brunnich BM: 19.09±1.36 mm; FA: 68.71±1.05 mm; *Scotophilus heathii* Horsfield BM: 36.60±3.80 g; FA: 61.9±1.4 mm; *Scotophilus kuhlii* Leech BM: 21.5±1.29 mm and FA: 53.77±1.53, respectively. This paper documented new information about bat fauna, their morphometry, habitats, conservation, threats and distribution map to the bats in Pakistan. Detail information about their status and biology may be needed.

Key words: *Chiroptera*, Bat, Habitat, Morphology, Khyber Pakhtunkhwa.

INTRODUCTION

Bats (Mammalia: *Chiroptera*) are found everywhere except few regions of the world included Arctic, Antarctica and some islands (Hutson *et al.* 2001). They have adopted diverse feeding, roosting habits, social behavior and reproductive strategies as well (Jones *et al.* 2009). Micro-bats are tolerant to optimum temperature of 30°C (Geiser and Brigham, 2000), therefore, in the temperate zones of the world, they undergo a long hibernation period during the entire winter (Park *et al.* 2000). Bats are also considered as environmental indicators (Jones *et al.* 2009), and forecast habitat deterioration and climatic changes as well. *Pteropus giganteus* assess pollination and seed dispersion of more than 163 plant species (Micklenburg *et al.* 1992; Fujita and Tuttle, 1999). Two families including New World Phyllostomids and Old World Pteropodids in addition to pest controlling agents, also play their role as pollinators (Kunz *et al.* 2011).

Bats cover 28% mammalian fauna of Pakistan including 50 species, 26 genera and 8 families (Mahmood-ul-Hassan *et al.* 2009). They have not been studied yet completely as they are considered as non-

significant by many biologists (Mahmood-ul-Hassan *et al.* 2006). However, deforestation, urbanization and human influence in the tropical regions of the world are the factors responsible for their habitat loss and reshaping of their distribution pattern (Lane *et al.* 2006; IUCN, 2009). Moreover, the irrigation through the canal system, agro-forestry and road side plantation have altered the landscapes that benefited bats and their habitats (Taber *et al.* 1967).

Pakistan is an agricultural country with a variety of crops and fruit orchards, where the *P. giganteus* is considered as one of the fruit pests. Here local farmers dislike and kill them in order to save their orchards (Perveen and Rahman, 2012). Peshawar is a large valley, located 34° 0' 28" North and 71° 34' 24" East and surrounded by districts Charsadda, Mardan, Nowshera and Kohat, which are comprised of diverse topography, i.e., tropical, sub-tropical, plain, arid, semi-arid, deserts and mountainous areas. As bats are pre-dominant in the tropical and sub-tropical regions of the world, where maximum arthropods and plant diversity exists. Therefore, pre-dominant crops of the tropical and sub-tropical zones of the present study area were included; major crops as *Triticum aestivum*, *Zea mays*, *Saccharum officinarum* and plant species *Eucalyptus globules*; *Melai azedarack*, *Dalbergia sisso* and *acacia* species. While,

Dyosporus kaki, *Prunus persica*, *Prunus armeniaca*, *Psidium guava* and *Phoenix dactylifera* are the major fruits of the area.

Roberts (1997) recorded a total of 13 bat species representing 4 families and 7 genera from Malakand Agency and Gilgit-Baltistan (northern areas) excluding present study areas i.e., Charsadda, Kohat, Mardan, Nowshera and Peshawar (Figure-1). Therefore, diverse bat fauna is expected in these areas due to different

geographic landscapes and climatic variations as well as various natural and cultivated floras. Therefore, following hypothesis were predicted to conduct this study (a) What will be the bat fauna of the present study areas (b) Will these areas have some new bat species. In addition to above some morphometric characters, habitat analysis and distribution map of the bat fauna of the present study area will also be recorded.

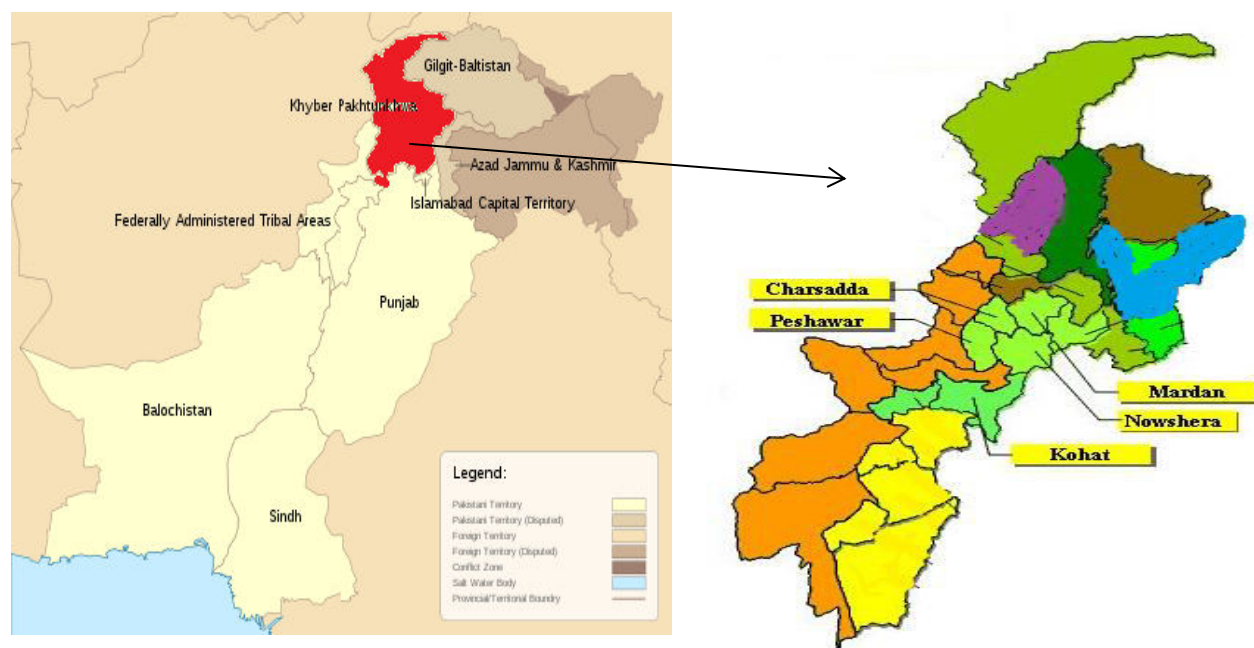


Figure.1: Map of the Peshawar and its adjacent areas, Khyber Pakhtunkhwa (KP), Pakistan where the present research was conducted for determining the bat (Mammalia: Chiroptera) diversity during July to May 2011-2013 (Census, 1998).

MATERIALS AND METHODS

Study area: The present research was carried out on bat (Mammalia: *Chiroptera*) in Peshawar and its adjacent areas in KP, Pakistan for the first time. Study area was divided into 5 quadrates, viz., Peshawar ($34^{\circ} 10' 11''$ E and $72^{\circ} 03' 59.32''$ N), Mardan ($34^{\circ} 10' 23' 75''$ E and $71^{\circ} 54' 03.89''$ N), Charsadda ($34^{\circ} 04' 57' 51''$ E and $71^{\circ} 51' 33.98''$ N), Nowshera ($33^{\circ} 57' 43' 85''$ E and $71^{\circ} 52' 25.47''$ N) and Kohat, where average rainfall ranges from 500-1750 mm in all these areas. However, in Peshawar, there is the highest rainfall during February-April. Moreover, winter starts in mid-November and ends in February with temperature $4-18^{\circ}\text{C}$ in these areas. Further, summer starts from May and ends in August with temperature $25-40^{\circ}\text{C}$ in these study areas (Census, 1998).

Sampling strategy: In order to find maximum bat roosts various sites included; buildings, crevices in walls and ceiling, tree trunks and foliage were explored. Local

people in the study areas were also interviewed to collect maximum information. Mist nets of various sizes viz i.e., 6 m, 9 m and 12 m were used to collect bats. Mist nets were erected before sunset and each session was comprised of 120 m^2 .

Maximum bats collection was made from plain areas, where mist nets were erected on the water bodies and narrow ways where bats could be passed easily. In Frontier Region (FR) Peshawar *Rhinopoma microphyllum* was collected from a diurnal roost inside a cave. Of these 15 (10♀ and 5♂) samples of *Pteropus giganteus* were collected from tree canopy from a forest plantation with mist nets erected at emergence point, while *Rhinopoma hardwickii* 10 specimens (10 ♀) from a tree cavity within the forest, *Scotophilus heathii* were collected from three sites; Syedabad and Ghanu Deri District Mardan and Ajun Garhi District Peshawar. All these were compared with keys proposed by Bates and Harrison (1997), Roberts (1997) and available literature.

Study of habitats and distribution of bat fauna: First of all exploratory visits were made to locate as many as possible potential bat roosts in the study area. Distinct roosts sites such as tree cavities, fissures and cracks in buildings, crevices under roof of the verandas, suitable water bodies were explored and their locations were recorded by using Garmin etrax H Global Positioning System (GPS).

Bats preservation and identification: Specimens recorded from various study sites were given number; locality, collector's name and sex on a tag, being weighed by Pesola balance (up to 0.1 g). They were preserved in absolute ethanol (100%). Morphometric measurements were compared with available literature and Bates and Harrison (1997) and available literature.

External body measurements: Various body and cranial parameters of the various measured; body mass; head and body length (HBL); forearm length (FA) and tibia length (TB) were measured.

Study of bats conservation and threats: In the present study areas extensive surveys regarding bats habitats, their ecological role significance harms to the local people. Besides, various threats and stresses to the bats and their habitats were also recorded.

RESULTS AND DISCUSSION

The present research was conducted to record morphometry, their habitats, distribution, threats and conservation of the bat fauna in Peshawar and its adjacent areas, KP, Pakistan during July 2011 to May 2013. A total of 188 (N) bats were collected belonging to 4 families 5 genera and 10 species.

Morphometric measurements of the bat fauna: Bats collected from the various habitats were morphometrically measured (Table-1 and Figures 2 and 3-14) and identified by recording various body parameters. Bat species recorded were *Pteropus giganteus*, *Hipposideros fulvus*, *Pipistrellus ceylonicus*, *Pipistrellus coromandra*, *Pipistrellus tenuis*, *Pipistrellus javanicus*, *Rhinopoma hardwickii*; *Rhinopoma microphyllum*, *Scotophilus heathii*, and *Scotophilus*

kuhlui. Three bat species including *S. heathii*, *Nyctalus noctule* and *R. microphyllum* previously reported from Kohat were not found during the present study. However, *P. tenuis* was recorded for the first time from Kohat while *R. aegyptiacus* previously recorded from Peshawar was not found during this study.

Habitat and distribution of bat fauna: *Rhinopoma microphyllum* was collected from Peshawar (71°37'14.11''E, 33° 54'40.86'' N) and Mazdurabad (71°56'45.09'' E 34° 19'14.85'' N and Mardan. Moreover, *P. coromandra*, *P. ceylonicus* and *P. javanicus* were recorded from Peshawar (34° 10'11' 71'' E and 72° 03' 59.32'' N). *Pipistrellus ceylonicus* was also reported from Thatta, Karachi; Khanewal and Lyallpur (Faisalabad), Punjab, while *P. javanicus* recorded from Karakar and Murree as least abundant species, Javed (2011). *Pipistrellus coromandra* was reported by Roberts (1977) from Saidu Sharif, Swat and Dir in Khyber Pakhtunkhwa. *Pipistrellus ceylonicus* was recorded from Karachi and Punjab by Roberts (1977) and Javid (2011) from PMNH (Islamabad). Further, *S. heathii* was collected from Syedabad and Ghanu deri, Mardan and *H. fulvus* from Sher Gar near Malakand (34° 10'23' 75'' E and 71° 54' 03.89'' N). Furthermore, *P. giganteus* and *R. hardwickii* from Menawrai Baba Forest (71° 51'33.98''E 34° 09' 12.39'' N). Mahmood-ul-Hassan *et al.* (2009) recorded *P. giganteus* from Lahore. *S. kuhlui* was recorded from Nowshera (33° 57'43' 85'' E and 71° 52' 25.47'' N). Javid (2011) recorded *S. kuhlui* from Punjab while *P. tenuis* were also recorded from Kohat (71° 26' 44' 55'' E 33° 31' 23.45''N), while *P. tenuis* was common of all.

Study of conservation and threats to bats: Till now no any national and International Organizations were working for the protection and conservation of bats in the study areas. While, their roosts have been destroyed by the people at their houses and reconstruction of the old buildings. Bats populations are declining throughout the globe due to habitat loss, deteriorations, hunting for medicine and food (Schipper *et al.*, 2008). Therefore, for monitoring of bat populations a global conservation network may be needed (Jones *et al.*, 2009).

Figure 2. Distribution map of 10 bat species recorded from five quadrates in Khyber Pakhtunkhwa, Pakistan from July 2011 to May 2013

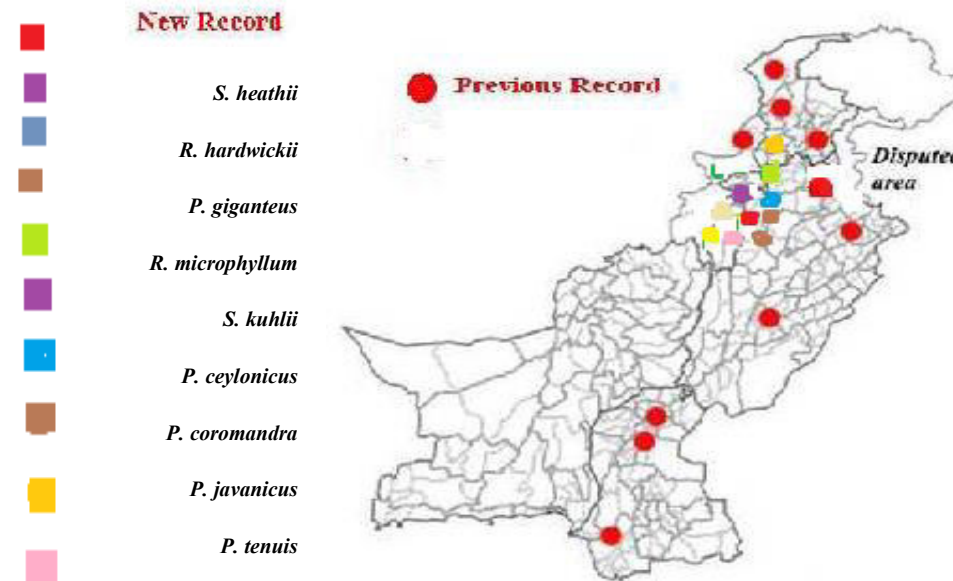


Table 1. Morphometric comparison of bats (Present study=I with Bates and Harrison= II) recorded from Peshawar and its adjacent areas in Khyber Pakhtunkhwa, Pakistan during May 2011 to July 2013

Family	Scientific names	n ¹	BM (I)	II	HBL (I)	II	FA (I)	II	TB (I)	II
Pteropodidae	<i>P^a. giganteus</i>	15	1121.93±38.87	-	270.87±6.01	268 (198-300)	174.10±1.73	168 (198-300)	50.17±1.58	-
Vespertilionidae	<i>S. kuhlii</i> ¹	43	36.60±2.10	-	65.29±2.20	69.8 (60.0-78.0)	61.86±1.04	49 (44.0-56.4)	13.05±1.15	-
	<i>S. heathii</i>	04	38.60±3.80	-	80.35±3.35	82.5 (67.0-93.0)	61.9±1.04	60.7 (55.4-65.8)	24.97±1.33	-
	<i>P^b. ceylonicus</i>	10	8.90±0.99	-	47.91±1.16	53.5 (45.0-64.0)	35.95±1.33	37.2 (33.0-42.0)	7.03±0.49	-
	<i>P^b. coromandra</i>	17	5.59±0.80	-	37.58±1.96	42.3(34.0-49.0)	29.14±0.89	30.0 (25.5-34.3)	6.56±0.38	-
	<i>P^b. javanicus</i>	08	7.6±0.5	-	49.6±2.7	47.1 (40.0-55.0)	31.8±0.6	33.2 (30.0-36.0)	8.2±0.2	-
	<i>P^b. tenuis</i>	40	5.56±0.65	-	37.99±1.58	39.1 (33.0-45.0)	28.99±0.94	27.7 (25.0-30.2)	6.05±0.48	-
Rhinopomatidae	<i>R. hardwickii</i>	10	26.60 ± 1.96	-	73.17±1.46	66.6 (55.0-73.0)	53.06± 0.76	59.2 (52.0-59.0)	12.61±0.52	-
	<i>R. microphyllum</i>	38	19.09±1.36	-	80.35±3.	75.3 (60.0-84.0)	68.71±1.05	68.0 (59.5-74.6)	15.93±0.43	-
Hipposideridae	<i>H. fulvus</i>	03	8.67±0.58	-	49.67±1.53	47.0 (40-50)	42.00±1.00	40.4 (38.4-44.0)	8.98±0.88	-

¹n: number of species collected; *H*: *Hipposideros*; *P^a*: *Pipistrellus*; *P^b*: *Pteropus*; *R*: *Rhinopoma*; *S*: *Scotophilus*; BM: body mass measured in gm; HBL: head and body length; FA: forearm; TB: tibia; HBL, FA and TB: measured in (Mean±SD) mm



-a

Figure 3. Skull of the *Pipistrellus tenuis* Temminck, 1840 recorded from all quadrates; Charsadda: (SA1); Kohat: (SA2); Mardan: (SA3); Nowshera: (SA4); Peshawar: (SA5) from July 2011 to May 2013.



-b

Figure 4. Lower jaw (mandible) of the *Pipistrellus tenuis* Temminck, 1840 recorded from all quadrates; Charsadda: (SA1); Kohat: (SA2); Mardan: (SA3); Nowshera: (SA4); Peshawar: (SA5) from July 2011 to May 2013.



-c

Figure 5. Dorsal view of the skull of the *Scotophilus heathii* Horsfield, 1831 recorded from Mardan (SA3) and Peshawar (SA5) from July 2011 to May 2013.



-d

Figure 6. Ventral view of the skull of *Scotophilus heathii* Horsfield, 1831 recorded from Mardan (SA3) and Peshawar (SA5) from July 2011 to May 2013.



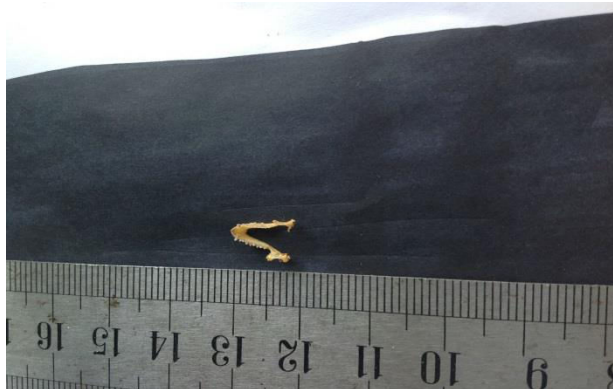
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Figure 7 Dorsal view of the skull of the *Pipistrellus coromandra* Grey, 1838 recorded from Peshawar (SA5) from July 2011 to May 2013.



-f

Figure 8. Ventral view of the skull of the *Pipistrellus coromandra* Grey, 1838 recorded from Peshawar (SA5) from July 2011 to May 2013.



-g

Figure 9. View of the lower jaw (mandible) of the skull of the *Pipistrellus coromandra* Grey, 1838 recorded from Peshawar from July 2011 to May 2013.



-h

Figure 10. Dorsal view of the skull of the fulvus roundleaf-nosed, *Hipposideros fulvus* Gray, 1838 recorded from Mardan (SA3) from July 2011 to May 2013.



-i

Figure 11. Ventral view of the skull of *Hipposideros fulvus* Gray, 1838 recorded from Mardan (SA3) from July 2011 to May 2013.



-j

Figure 12. View of lower jaw (mandible) of *Hipposideros fulvus* Gray, 1838 recorded from Mardan (SA3) from July 2011 to May 2013.



-k

Figure 13. Dorsal view of the *Scotophilus kuhlii* Leech, 1821 recorded from Mardan (SA3) recorded from Nowshera (SA4) from July 2011 to May 2013



-l

Figure 14. Ventral view of the *Scotophilus kuhlii* Leech, 1821 recorded from Mardan (SA3) recorded from Nowshera (SA4) from July 2011 to May 2013

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REFERENCES

- Bates, P. and D. Harrison (1997). Bats of the Indian Subcontinent. Harr. Zol. Mus. Harrison. 123-258.
- Census. (1998). Pakistan Bureau of Statistics, Islamabad. Census Report. 234 p
- Fujita, M. S. and M. D. Tuttle (1999). Flying foxes (Chiroptera: Pteropodidae). Threatened animals of key ecological and economic importance. Con. Bio. 4(2): 455-463.
- Gieser, F. and R. M. Brigham (2000). Torpor, thermal biology, and energetic in Australia long-eared bats (Nyctophilus). J. Com. Phy. 170(2): 153-162.
- Gieser, F. and G. Kortner (2000). Hibernation and daily torpor in Australian mammals. Aus. Zol. 35(1): 204-215.
- Hutson, A. M., S. P. Mickleberg, and P. A. Racey (2001). Microptern bats: global status survey and conservation action plan. IUCN/SSC Chiropteran specialist group. Swi and Cam. 3(2):11-25.
- Javid, A. (2011). Bat biodiversity (Vespertilioniformes: Order Chiroptera) in some tropical and arid-subtropical regions of Pakistan. 73 p
- IUCN. (2009). IUCN Red List of Threatened species. www.iucnredlist.org. 12(3):21-54.
- Jones, G., D.S. Jacobs, T.H. Kunz, M.R. Wilig and P.A. Racey (2009). Carpe Noctem the importance of bats as bio indicators. End. Spe. Res. 8(5): 93-115.
- Kunz T.H., E.B. Torrez, D. Bauer, T. Lobova, and T. H. Fleming (2011). Ecosystem services provided by bats," Ana. New. Acad. Sci. 3(3): 1-38.
- Lane, D.J., W.T. Kingston, B. and Y.H. Lee (2006). Dramatic decline in bat species richness in Singapore, with implications for Southeast Asia. Bio. Cons. 131(4): 584-593.
- Mahmood-ul-Hassan, M.M., G. Jones, C. Dietz (2009). The Bats of Pakistan, the least known creature. Dr. Mul. Ger. 1-168.
- Mahmood-ul-Hassan, M. and P.O. Nameer (2006). Diversity role and threats to the survival of bats in Pakistan. J. of Plant and Animal Sciences. 16: 38-42.
- Micklenburg, S.P., A.M. Hutson, and P.A. Racey (1992). Old world fruit bats an action plan for their conservation. IUCN/SSC Chiroptera specialist Group. IUCN. Gla. Swi. 16(2): 23-29.
- Park, K. J. Jones, G. and R.D. Ransome (2000). Torpor, arousal and activity of hibernating Greater horse shoe bats. Fun. Eco. 14(12): 580-558.
- Perveen, F. and F. Rahman (2012). Checklist of first recorded bat species of Peshawar and its adjacent areas in Khyber Pakhtunkhwa, Pakistan. Intl. J. Farm. & Alli. Sci. 1 (4): 97-100.
- Roberts, T.J. (1977). Mammals of Pakistan. Ernest Benn Limited. 361 p
- Roberts, T.J. (1997). Mammals of Pakistan. Revised Edition Oxford University Press. 1-56 p
- Schipper, J.J., F. Chanson, N.A. Chiozza, N.A. Cox, A. Hoffman, V. Katariya (2008). The status of the World's marine mammals: diversity, threat, and knowledge. J. Sci. 32(3): 225-230.
- Schipper, J., J. S. Chanson, F. Chiozza, N.A. Cox, M. Hoffmann, and V. Katariya (2008). The status of the World's land and marine mammals: diversity, threat, and knowledge. Science. 322: 225-230.
- Jones, G., D.S. Jacobs, T.H. Kunz, M.R. Wilig and P.A. Racey (2009). Carpe noctem: the importance of bats as bioindicators. End. Spec. Res. 8: 93-115.
- Srinivasulu, C., P.A. Racey, and S. Mistry (2010). A key to the bats (Mammalia: Chiroptera) of South Asia. J. Thr. Tax. 2(1): 1001-1076.
- Taber, R.D., A.N. Sheri, and M.S. Ahmad (1967). Mammals of the Lyalpur region, West Pakistan. J. mam. 48(22): 392-407.