The Journal of Animal & Plant Sciences, 24(3): 2014, Page: 955-960
ISSN: 1018-7081

Short Communication

MORPHOMETRICS OF FULVOUS FRUIT BAT (*ROUSETTUS LESCHENAULTI*) FROM LAHORE, PAKISTAN

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ABSTRACT

Present study on Fulvous fruit bat (*Rousettus leschenaulti)* from October 2011 to March 2012 in the vicinity of Lahore, Pakistan took morphometric measurements of 15 (9♂ and 6♀) bat specimens. The average head and body length of all 15 specimens was 99.55 ± 15.035mm, forearm was 77.64 ± 6.373mm long, lengths of 3rd, 4th and 5th metacarpals were 52.73 ± 4.832 mm, 51.56 ± 4.996mm and 49.86 ± 3.998, respectively and the tail length was 11.1 ± 3.072mm. The greatest skull length (n= 9) was 35.89 ± 2.848mm, breadth of braincase was 15.44 ± 1.509mm while bacular length of a male specimen was 3.075mm.

Key words: Fulvous fruit bat, Greatest skull length, Baculum, Badian.

INTRODUCTION

The chiropteran diversity of Pakistan is comparable to any other region of the world with similar climatic conditions and topography. The bat fauna of the country is very diverse and is represented by 50 species, 26 genera and eight families (Roberts, 1997; Mahmood-ul-Hassan and Nameer, 2006) however it is amongst the least studied taxon in Pakistan (Mahmood-ul-Hassan *et al*., 2009). The taxonomy of many chiropteran species is unclear and based on museum surveys, most of which were conducted before partition (Roberts, 1997; Mahmood-ul-Hassan and Nameer, 2006). The bats are given no legislative protection in south Asian countries. Only Sri Lanka legislations fully protect to one sub species *Rousettus leschenaulti seminudus*. Other countries like Pakistan go to the other extreme of exempting bats from wildlife legislation. Bats are exempted from the regulation of international trade (Mickleburgh *et al*., 1992; Sheikh and Molur, 2004).

The Old World fruit bats play important role in pollination, seed dispersal and are important agents for maintaining plant community (Pijl, 1982; Marshall, 1985; Cox *et al*., 1991; Fujita and Tuttle, 1991; Mickleburgh *et al*., 1992; Rainey *et al*., 1995; Eby, 1996; Banack, 1998). More than 114 plant species of world totally depend on Old World fruit bats (Chiroptera: Pteropodidae) for their survival (Mickleburgh *et al*., 1992). Three genera and four species of pteropodids are found in Pakistan (Roberts, 1997; Mahmood-ul-Hassan *et al*., 2009) including short nosed fruit bat (*Cynopterus sphinx*), the Indian flying fox (*Pteropus giganteus*), the Egyptian fruit bat (*Rousettus aegyptiacus*) and the fulvous fruit bat (*Rousettus leschenaulti*). *Rousettus leschenaulti* can be used as a useful non-primate laboratory model to study menstruation and menstrual dysfunctions in human beings as these bats exhibit a human like menstrual cycle both morphologically and physiologically (Zhang *et al*., 2007).

Genus *Rousettus* Gray, 1921 includes 10 species distributed in Sri Lanka, Pakistan, Myanmar, Vietnam, southern China, Java and Bali (Simmons, 2005; Bates and Harrison, 1997). Localized and broad distributions of certain taxa of bats are found in this vast geographical area (Emerick and Duncan, 1982; Nougier *et al*., 1986).

Geoffroy (1810) described the first species presently included in the genus *Rousettus* Gray, I82I, *Pteropus amplexicaudatus* from Timor and the closely related *Pteropus leschenaulti* from South-East India was named by Desmarest (1820). *Rousettus leschenaulti* is distributed in Sri Lanka, Pakistan, Vietnam, S. China, Peninsular Malaysia, Sumatra, Java, Bali, and Mentawai Isles (Indonesia) (Simmons, 2005). This species is rare with erratic occurrence in Pakistan. It migrates to Pakistan during summer season with migration pattern up to 1200 m elevation. It has been reported in Azad Kashmir, Malakand, Peshawer, Sialkot, Lahore and Karachi (Roberts, 1997; Bates and Harrison, 1997). However, its populations at Lahore and Karachi show persistency and do not migrate (Roberts, 1997; Mahmood-ul-Hassan *et al*., 2009).

Geographic variations in organisms have long been a matter of debate. These variations may be due to the geographic factors which play important role in evolution. The variations are associated with genetic variability among populations from different geographical areas which provide basis for speciation, a fundamental prerequisite for evolution. Researchers

interested in geographic variations often search for repeated clines because repeated patterns provide evidence of adaptation, and can be used to deduce possible causes of geographic variation (Endler, 1977). Morphometric studies of bats allow inferences of ecological and behavioral aspects (Mauricio *et al*., 2001). Characters like body mass, wing morphology and forearm length may be designated important parameters for autecological considerations (Aeshita *et al*., 2006).

Although extensive research on bats has been carried out in some parts of Southeast Asia (Francis *et al*., 1996; 1997ab; 1999, Francis and Vonghamheng, 1998; Robinson, 1997; Robinson and Webber, 1998) but in other parts of this region there is shortage of even basic information about bats. Therefore, it is very difficult to describe the status of a species whether abundant or rare (Roberts, 1997; Mahmood-ul-Hassan *et al*., 2009). In Pakistan, the taxonomy, distribution, ecology and biology of most of the chiropteran species is little known. Most of the information is based on the original description of the species since it has not been collected subsequently. Similarly, there are no environmental policies or educational projects for bats. Keeping in mind the scarcity of knowledge about bats in Pakistan present study was conducted to find out bat roosts and elaborate morphological characters of fulvous fruit bat (*Rousettus leschenaulti*) in urban area of Lahore city.

MATERIALS AND METHODS

The study was conducted from October 2011 to March 2012 in Lahore District to find out roosts of *Rousettus leschenaulti* and to note its morphological characteristics.

Sampling Strategy and Species Identification: Exploratory visits were made to the study area to search for potential bat roosts such as old and undisturbed buildings, ruins, abandoned wells, farm houses, tree groves and forest plantations. Local people were also interviewed for gleaning maximum information about the exact location of bat roosts. Mist nets and hand net were used to capture the specimens from the roosts. A day bat roost of *Rousettus leschenaulti* was observed at Badian, Lahore. Mist nets were erected at the point of emergence firstly on January 18, 2012 in evening hours (5:00 PM). This netting effort resulted in capture of 7 (4♂ and 3♀) *Rousettus leschenaulti* specimen and 8 (5♂ and 3♀) specimens were captured in subsequent visit on March 14, 2012.

The species was identified in the field on the basis of external morphology following Bates and Harrison (1997) and brought to laboratory for external body measurements, cranial and bacular analysis.

External Morphology: Each captured bat was placed in a separate cotton bat bag during mist netting and at the completion of a netting session, each bat was weighed up to 0.1 g (Pesola balance 10050, Swiss made) euthanized and preserved in a plastic jar in absolute alcohol. Field number, sex, age and exact locality of each bat were noted on the plastic jar. The external body measurements were taken using a digital vernier caliper (0-150 mm). These measurements included head and body length, ear length, forearm length, claw length, 2nd claw length, thumb length, length of each metacarpal including its phalanges, wing span, penis length, tibia length, calcar length, hind foot, tail length, and free tail length following Dietz (2005).

Cranial Measurements: Skulls were prepared for recording cranial measurements of bat specimens (n= 9) by removing eye balls, tongue and excessive flesh. The brain tissue was macerated and removed using forceps and cotton and cranial cavity was washed with a jet of water. Skulls thus cleaned were kept overnight in a dilute solution (0.2 % of Potassium Hydroxide (KOH)). After being thoroughly washed in tap water again, the skulls were kept in absolute alcohol for a night before being transferred to acetone for another night. Each of the dry skulls was stored in a properly labeled vial padded with cotton. The greatest skull length, condylo-basal length, condylo-canine length, zygomatic breadth, interorbial constriction, postorbital constriction, maxillary toothrow length, mandibular toothrow length, posterior palatal width and anterior palatal width were measured following Bates *et al*. (2005).

Bacular Measurements: Penis of a male bat was cut down as close to the surface of the body as possible so that the baculum is not damaged. The cut penis was placed in a test tube half filled with cold water and boiled for two minutes. The boiled penis was transferred to a plastic tube containing 5% KOH and a pinch of alizarin red powder. After 24 hours, the stained baculum was dissected out of the tissue and stored in glycerin in a labeled test tube following Bates *et al*. (2005). Total length of baculum, shaft length, width of proximal branch and width of distal branch were taken using vernier caliper.

RESULTS AND DISCUSSION

Bat biologists in most parts of the world, especially in the underdeveloped countries, are using characters such as forehead slope, dorsal pelage sheen, and behavior of the bats to discriminate species (Harris, 1974; Nagorsen and Brigham, 1993; Verts and Carraway, 1998). Bat identification on the basis of external morphology and measurements of different skull parameters (Hill and Smith, 1985; Vaughan *et al*., 2000; Jacobs *et al*., 2006) is still a highly reliable technique in most instances. Use of character matrices and identification keys are authentic tools to identify different

chiropteran species (Daniel, 2009; Srinivasulu *et al*., 2010).

The average head and body length of 15 specimens was 99.55 ± 15.035 mm, the ears were 18.27 ± 3.494 mm long, average thumb and claw lengths were 12.43 ± 1.687 mm and 3.47 ± 0.640 mm, respectively (Table 1). Second claw length was recorded 2.73 ± 0.704 mm, the forearm was 77.64 ± 6.373 mm long, length of 3rd metacarpal, 1st phalanx on 3rd metacarpal and 2nd phalanx on 3rd metacarpal were 52.73 ± 4.832 mm, 34.00 ± 3.742 mm and 40.63 ± 4.908 mm, respectively. Length of 4th metacarpal, 1st phalanx on 4th metacarpal and 2nd phalanx on 4th metacarpal were 51.56 ± 4.996 mm, 34.00 ± 3.742 mm and 40.63 ± 4.908 mm, respectively. Length of 5th metacarpal was 49.86 ± 3.998 mm and its 1st phalanx was 49.86 ± 3.998 mm long. Wing span was 398.79 ± 56.771 mm, tibia length 37.24 ± 4.773 mm, calcar length 5.76 ± 1.321 mm, hind foot length 18.07 ± 2.554 mm and tail length was 11.1 ± 3.072 mm. Average penes length of 9 male specimens was 8.22 ± 3.022 mm (Table 1). The data obtained during the present study was compared with earlier studies on this species from India (Bates and Harrison, 1997) and Pakistan (Roberts, 1977) (Table 2). The mean values for head and body length, ear length, forearm length, hind foot length and tail lengths of all 15 *Rousettus leschenaulti* were smaller than recorded by Roberts (1977) and Bates and Harrison (1997) while the upper limits of all these parameters fall within the ranges given by Roberts (1977) and Bates and Harrison (1997).

Combined mean greatest skull length was 35.89 ± 2.848 mm. The Codylo-basal and condylo-canine lengths were 34.67 ± 2.958 mm and 33.50 ± 2.761 mm, respectively. The zygomatic and braincase breadths were 19.78 ± 3.866 mm and 15.44 ± 1.509 mm, respectively. Interorbital and postorbital constrictions were 7.67 ± 0.500 mm and 3.00 ± 0.000 mm, respectively. Maxillary and mandibular toothrow lengths were 13.44 ± 1.667 mm and 14.67 ± 1.785 mm, respectively. The posterior palatal width was 9.33 ± 0.866 mm while anterior palatal width was 6.94 ± 0.635 mm (Table 1, Figure 1).

The data regarding cranial measurements of the species was not previously reported from Pakistan, therefore the cranial parameters were compared only with that of Bates and Harrison (1997). The mean breadth of braincase of nine *R. leschenaulti* captured during the present study was larger while zygomatic breadth and greatest length of skull were smaller than recorded by Bates and Harrison (1997). However, all the other cranial measurements of currently studied specimens were within the ranges given by Bates and Harrison (1997).

Total length of baculum of a single specimen was 3.075 mm. The shaft was 1.275 mm long. The proximal and distal branch widths were 0.925 mm and 0.800 mm, respectively (Table 1, Figure 2). The baculum of a single specimen captured from Sri Lanka was peg-shaped and its length was 3.6 mm (Bates and Harrison, 1997).

Table 1. Mean external body, cranial and bacular measurements (mm) of *Rousettus leschenaulti* captured from Badian, Lahore. (n is the number of specimens).

Body Parameters	**Males (n=9)**	**Females (n=6)**	**Combined Mean ±SD(Range)**
Head and body length	104.68±16.120	91.83±9.908	99.55±15.035(80-125)
Ear length	19.77±2.991	16.00±3.098	18.27±3.494(12-24)
Thumb length	13.04±1.649	11.50±1.378	12.43±1.687(9-16)
Claw length	3.44±0.527	3.50±0.837	3.47±0.640(3-5)
2nd claw length	2.77±0.833	2.66±0.516	2.73±0.704(2-4)
Forearm length	79.14±5.767	75.33±7.062	77.64±6.373(67-85)
Length of 3rd metacarpal	54.22±4.658	50.50±4.550	52.73±4.832(44-60)
1st phalanx on 3rd metacarpal	34.77±3.114	32.22±4.579	34±3.742(27-38)
2nd phalanx on 3rd metacarpal	41.88±4.807	38.75±4.835	40.63±4.908(33-48)
Length of 4th metacarpal	53.22±4.604	49.08±4.862	51.56±4.996(43-60)
1st phalanx on 4th metacarpal	27.50±3.122	25.00±2.683	26.5±3.122(22-33)
2nd phalanx on 4th metacarpal	28.72±4.324	25.00±3.464	27.23±4.305(20-34)
Length of 5th metacarpal	52.00±3.808	48.16±3.971	49.86±3.998(43-56)
1st phalanx on 5th metacarpal	25.88±2.784	23.50±2.665	25±3.998(20-30)
Wing span	421.16 ±54.434	365.23±45.074	398.79 ± 56.771(30-51)
Tibia length	38.90±4.448	35.08±4.779	37.24±4.773(30-43)
Calcar length	5.94±1.333	5.50±1.378	5.76±1.321(4-8)
Hind foot length	19.45±2.126	16.67±1.941	18.07±2.554(13-22)
Tail length	12.16±2.667	10.33±3.724	11.1±3.072(5-16)
Penis length	8.22±3.022	0.00±0.000	8.22±3.022 (4-12)
Cranial Parameters	**Males (n=5)**	**Females (n=4)**	**Combined Mean ± SD(Range)**

Greatest skull length	36.80±2.950	34.75±2.630	35.89±2.848(32-39)
Condylo-basal length	35.80±2.950	33.25±2.630	34.67±2.958(31-38)
Condylo-canine length	34.40±2.702	32.375±2.750	33.50±2.761(30-37)
Zygomatic breadth	21.80±3.834	17.25±2.217	19.78±3.866(15-24)
Breadth of braincase	15.20±0.837	15.75±2.217	15.44±1.509(14-19)
Interorbial constriction	7.80±0.447	7.50±0.577	7.67±0.500(7-8)
Postorbital constriction	3.00±0.000	3.00±0.000	3.00±0.000(3-3)
Maxillary toothrow length	13.80±1.643	13.00±1.826	13.44±1.667(11-15)
Mandibular toothrow length	15.10±1.746	14.12±1.931	14.67±1.785(12-16)
Posterior palatal width	9.60±0.894	9.00±0.816	9.33±0.866(8-10)
Anterior palatal width	7.00±0.707	6.87±0.629	6.94±0.635(6-8)
Bacular Parameters	**n = 1**		
Total length of baculum	3.075 mm		
Length of shaft	1.275 mm		
Width of proximal branch	0.925 mm		
Width of distal branch	0.800 mm		

Figure 1. Cranial features of *Rousettus leschenaulti* captured from Lahore

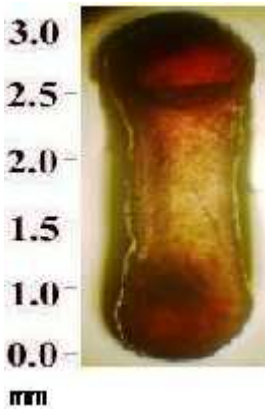

Figure 2. Baculum of *Rousettus leschenaulti* captured from Lahore

Table 2. Comparison of mean external body and cranial measurements of *Rousettus leschenaulti* (I = Roberts (1977; II = Bates and Harrison (1997); III = Present study).

Parameters	**I**	**II n=37**	**III n=15**
		(mm)	
Head and Body Length	131 (120-145)	125.9 (111-147)	99.54 (80-125)
Ear length	21 (19-23)	20.8 (17.5-24)	18.26 (12-24)
Forearm	79	80.6 (75-86)	77.64 (67-85)
Hind foot		18.7 (15-22)	18.07 (13-22)
Tail	14 (10-18)	15.6 (8-21)	11.1 (5-16)
Breadth of braincase	-	15.3 (14.4-16)	15.44 (14-19)
Zygomatic breadth	-	22.5 (20.2-24)	19.77 (15-24)
Greatest length of skull	-	37.3 (34.9-39.4)	35.88 (32-39)

*Range is mentioned in parenthesis.

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