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Original Article

Morphology and ectoparasite spectrum of *Pteropus vampyrus* (the flying fox) in different parts of Malakand Division, Pakistan

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Abstract

Three districts *viz*. Lower Dir, Swat and Shangla in Khyber Pakhtunkhwa province, were surveyed for the collection of *Pteropus vampyrus* (the Indian flying fox) in Malakand division, the north western region of Pakistan from February to November 2018. A total of 35 specimens were captured. Out of the examined specimens 22 were found to be infected with ectoparasites. Three types of ectoparasites were observed including flies 20% (n=7/35), mites 28.5% (n=10/35) and bugs 14.2% (n=5/35). Male bats were more infected 57.1% (n=20/35) as compared to females 42.8% (n=15/35), however, no significant difference ($p>0.05$) was noted. Flies were recovered from wings membrane and head region, mites were found on wings, ears and around eyes while bugs were found attached on body surface and neck region. Body weight, circumference and wing span of male bats were greater as compared to female bats and were considered a key factor in clear cut identification of male and female *Pteropus vampyrus* (the Indian flyingfox). It was concluded that *Pteropus vampyrus* from north western part of Pakistan were parasitized by a varied parasite fauna with high infestation rates. We assume that in male bats the number of parasites is generally higher than in females. Our results revealed new insights into parasite fauna of *Pteropus vampyrus*.

Keywords: Pteropus vampyrus, ectoparasite, morphometric analysis, body weight, roosting trees.

Morfologia e espectro ectoparasitário de *Pteropus vampyrus* (raposa voadora) em diferentes partes da divisão de Malakand, Paquistão

Resumo

Três distritos, Lower Dir, Swat e Shangla, em Khyber Pakhtunkhwa, foram pesquisados para a recolha de *Pteropus vampyrus* (raposa voadora indiana) na divisão de Malakand, região noroeste do Paquistão, de fevereiro a novembro de 2018. Foram capturados 35 espécimes, dos quais 22 foram infectados com ectoparasitas. Três tipos de ectoparasitas foram observados: moscas (20%; n = 7/35), ácaros (28,5%; n = 10/35) e insetos (14,2%; n = 5/35). Os morcegos machos foram mais infectados (57,1%; n = 20/35) do que as fêmeas (42,8%; n = 15/35); porém, nenhuma diferença significativa foi observada ($p > 0,05$). As moscas foram recuperadas da membrana das asas e da região da cabeça; já os ácaros foram encontrados nas asas, nas orelhas e ao redor dos olhos; por sua vez, os insetos foram encontrados na superfície do corpo e na região do pescoço. O peso corporal, a circunferência e a envergadura dos morcegos machos foram maiores em comparação aos morcegos fêmeas e foram considerados um fator-chave na identificação dos machos e das fêmeas *Pteropus vampyrus* (raposa voadora indiana). Conclui-se que os *Pteropus vampyrus* da parte noroeste do Paquistão foram parasitados por uma fauna variada de parasitas com altas taxas de infestação. Assume-se que, em morcegos machos, o número de parasitas é geralmente maior que em fêmeas. Os resultados deste estudo revelaram novos insights sobre a fauna parasita de *Pteropus vampyrus.*

Palavras-chave: Pteropus vampyrus, ectoparasita, análise morfométrica, peso corporal, *roosting trees*.

1. Introduction

Bats are among the most successful and diverse mammals on earth. Approximately 1230 chiropteran species are found on every continent except Antarctica and inhabit a multitude of diverse ecological niches (Schipper et al., 2008). Bats play essential roles in maintaining healthy ecosystems, as they act as pollinators, seed dispersers, and predators of populations of insects including harmful forest and agricultural pests (Kunz et al., 2011). Most bat species are listed in the IUCN Red list of endangered species and almost half of these are considered threatened or near-threatened (Mickleburgh et al., 2002). To estimate and prevent further population declines, research has been primarily focused on bat biology, ecology and behavior, while disease aspects were largely neglected (Wibbelt et al., 2010). In the last three decades, the importance of chiropteran species as potential vectors of significant viral diseases especially in regard to zoonoses has received growing attention. Besides bat rabies that has been studied for more than half a century, extensive research efforts identified a large number of microbial agents (Wibbelt et al., 2009) including important emerging zoonotic viruses detected in bats across the world (Halpin et al., 2000; Chua et al., 2002; Leroy et al., 2005; Li et al., 2005; Wong et al., 2007; Towner et al., 2009; Kuzmin et al., 2011). However, most studies are limited to the identification of microorganisms detected and investigations regarding infectious diseases and causes of death in bats are sparse (Simpson, 2000; Daffner 2001; Duignan et al., 2003; Hajkova and Pikula, 2007).

In Pakistan, studies on bats are mainly focused on bat fauna of Peshawar (Perveen and Rahman, 2012), current status of mammals (Akhtar et al., 2014), record of bats (Perveen and Faiz-ur, 2015) *Rhinopoma hardwickii* Gray, 1831 in Northwestern Pakistan (Rahman et al., 2015), *Pteropus giganteus* Brünnich, 1782 in four districts of KPK (Salim and Mahmood-ul-Hassan, 2015) but no work published on parasite fauna of bats in Pakistan. This paper describes morphological features and ectoparasite spectrum of *Pteropus vampyrus* (the flying fox) in different parts of Malakand Division, Pakistan.

2. Material and Methods

2.1. Study sites

This study was designed to investigate the morphometrics and ectoparasite fauna of *Pteropus vampyrus* ((Mammalia:*Chiroptera*) for the first time in three districts of Malakand region, Khyber Pakhtunkhwa, Pakistan (Figure 1.) from March to August 2018. District Swat lies from 34°34° to 35° 55° North and 72° 08° to 72° 50° east, district lower Dir is located approximately 176 km from Peshawar which is the capital of the Province. The climate is dry and rough during summer, while mild cold during winter. Average annual rainfall is 117-242mm, while it is highest during March. However, the temperature falls to -2ºC in the winter season and shoots to 42 °C in the summer. Humidity of these areas are higher throughout the year and the average temperatures of these areas are round about 25°C. These areas experience a rainy season from late December to mid of the February along cooler temperature.

2.2. Data collection

Bat specimens were captured from different regions of Aloch Shangla, Fizagat Swat and Fishinghat chakdara (Dir Lower). These areas contain mostly *Alnus nitida*, *Broussonetia, Pinus roxabergia, Populous nigrus, Morus muccrora* trees to which bats are hanging.

2.3. Trapping of bats

Bats are capture using net and bows and safely brought to the laboratory of Parasitology, Department of Zoology, University of Malakand for examination of ectoparasites. Thick garden gloves were worn while removing bats from net to prevent scratches and bites. Bats killed in vacuum cylinder by using cotton wetted with chloroform, and noted their weight, wing span, body circumference and sexes. Bats were identified with the help of field guide 'Bats of West Africa by Rosevear (1965) and then inspected for parasites.

2.4. Screening of bats for ectoparasites

Individual bats were carefully handled and examined for ectoparasites, the parasites were so small that cannot see with naked eyes. Such parasites were collected by cleaning the whole body surface with cotton wool soaked in 70% ethanol and this will immobilize and pick up any microscopic parasites on surface of bats. The parasites then placed in 70% ethanol and each sample were labelled with number and locality. The ectoparasites were examined under microscope and identified with keys provided by Machado-Allison and Antequera (1971) and Krantz (1978).

2.5. Statistical analysis

The data obtained was analyzed statistically by Graphpad prism 5. The P value was calculated among the host examined and that of infected in male and female bats. One way analysis of variance (ANOVA) was calculated.

Figure 1. The sites encircled with in red represent the localities.

3. Results

3.1. Morphometric analysis

Thirty five specimens of *Pteropus vampyrus* (the Indian flying fox) including 20 (57.1%) males and 15(42.85%) females were captured. The body weight was calculated by electronic digital balance. The average body weight (851.6g) of male bat was higher than that of female (836.93g). Wing span of male and female bats were also measured and calculated through scale in cm. A minute difference between the wing span of male and female sexes as male average wing span was (106.65cm) and female wing span was (104.33cm). Circumference of body was also determined through measuring scale in cm, the average mean circumference of male was (24.115cm) and female was (21.16cm). Male circumference was greater than that of female bat (Table 1). All of the bats (Indian flying fox) have been observed in their natural conditions and habitats (Figures 2 and 3).

Figure 2. *Pteropus vampyrus* (The Flying Fox).

Figure 3. *Pteropus-vampyrus* bats hanging to their roost (trees).

3.2. Prevalence and intensity of ectoparasites

Out of the examined bats 22(13 males and 9 females) were found to be infected with three different types of ectoparasites with overall prevalence of 62.8%. The ectoparasites in male bats was 65% and in female bats was 60% (Table 2). No significant difference (P>0.05) was noted between number of hosts examined and that of infected for both the sex.

Three types of ectoparasites (Figures 4, 5 and 6) were observed including flies 20% (n=7/35), mites 28.5% (n=10/35) and bugs 14.2% (n=5/35). Flies were recovered from wings membrane and head region, mites were found on wings, ears and around eyes while bugs were found attached on body surface and neck vregion. The prevalence and intensity of each parasite are summarized in Table 3.

Figure 4. Bat flies.

Table 1. Morphometric analysis of *Pteropus vampyrus* (flying fox) from different localities in Malakand division.

S. No	Body Weight(gm)	Wing Span(cm)	Circumference of body(cm)	F	R square	P-value
Male mean ± SD	**851±40**	**106±9.98**	**24.1± 1.88**	7292	0.9961	< 0.0001
Female mean ± SD	**836.9±33.0**	**104.3±4.46**	**21.1±1.46**	8116	0.9974	< 0.0001

Table 2. Prevalence of ectoparasitic infection in relation to the sex of hosts studied.

Infection	sex	No. of host examined	No. of host infected (%)	P-value
Ectoparasite infection	male	20	13(65%)	0.8847
	female	15	9(60%)	
Total		35	22(62.86%)	

Table 3. Prevalence and intensity of ecto-parasitic infection in examined bats (N=35).

Parasites	No. of Host infected	Site of recovery	Total no. of Parasite collected	Prevalence (%)	Intensity (%)
Bat flies	7	Wings membrane, head region	21	20	3
Bat mites	10	wings, ear, around eyes	45	28.57	4.5
Bat bugs	5	Body surface, neck region	19	14.28	3.8

Figure 5. Bat bug.

Figure 6. Bat mite.

4. Discussion

A total of 35 *Pteropus vampyrus* samples were examined in three Districts: of Malakand Division, KPK, Pakistan. During morphometric analysis it was found that male bats were large body weight, circumference and wing span as compared to female bats. We also found that 22(62.86%) bats were infected by ectoparasites (mites, bugs and flies). Out of these infected bats 13(65%) were male and 9(60%) were found to be females.

Bats flies closely related to tsetse fly and Hippoboscid flies and all belong to same super family Hippoboscoidae (Dittmar et al.2006). These are obligate ectoparasites of bats (Dick and Patterson, 2006) and are found mostly in tropical areas and a few species also found in sub-tropical and temperate zones (Wenzel et al. 1966). These bats flies were cause disease in animals and humans. A recently study suggested that malarial pathogen is also transmitted by bat flies (Poinar Junior, 2011).

Mites are small in size and freely live in soil or water but mostly lives as parasites on plants and animals (Halliday et al. 2000). These mites' species are found in the ears around the eyes or on the wings of bats (Walter, 1996) and feeds on skin and hair debris of their host. Bats bugs are blood-sucking parasites that feeds directly on blood of bats. Bat bugs are most abundantly found in roosts of colonial bats. Bat bugs are vector of *Trypanosoma spp*. and *Bartonella sp.* (Loftis et al. 2005; Reeves et al. 2007).

Out of 22(62.86%) infected bats 7(20%) were infected by flies, 10(28.57%) were infected by mites and 5(14.28%) were infected by bugs. The intensity of flies, mites and bugs found to be 3, 4.5 and 3.8 respectively. Total of 85 ectoparasites were collected during our research work, out of these 21 were bat flies, 45 were bat mites and 19 were bat bugs, so it means that the mites infect bats at high rate as compared to flies and bugs.

5. Conclusion

This study call for the fact that *Pteropus vampyrus* (Indian flying fox) is an important fruit eating bat species. Male bats have large body weight, circumference and wing span as compared to female ones. Furthermore this bat species harbor different types of ectoparasites (bat flies, mites and bugs). Mites were the most abundant ectoparasites of the examined bats as compared to flies and bugs ($P<0.05$). It was recommended that the ectoparasites of *Pteropus-vampyrus* might be potentially hazardous and pathogenically important which should be considered a risk factor to the human and other animals in the locality.

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