International Journal of Bio-resource and Stress Management https://ojs.pphouse.org/index.php/IJBSM

Crossref

IJBSM December 2024, 15(12): 01-06 **Article** AR5763

Research Article *Stress Management*

DOI: HTTPS://DOI.ORG/10.23910/1.2024.5763

Morphometric Characterization and Haemato-biochemical Profile of Indian Fruit Bats

Dave K. M.[1], Raval S. K.[1], Neha Rao[1], Nayak J. B.[2], Kanani A. N.[3], Beena Patel[3], Panchal M. T.[4] and Patel P. V. [5]

[1]Dept. of Veterinary Medicine, [2]Dept. of Veterinary Public Health, [4]Dept. of Animal Reproduction Gynaecology & Obstetrics, [5]Dept. of Veterinary Parasitology, College of Veterinary Science & A.H., Anand, Kamdhenu University, Gujarat (388 001), India

[3]Dept. of Animal Husbandry, Office of Deputy Director of Animal Husbandry, F.M.D. typing scheme, Ahmedabad, Govt. of Gujarat, Gujarat (380 051), India

Open Access

Corresponding skraval23@rediffmail.com

0009-0007-9676-0926

ABSTRACT

The present study was conducted during January–December, 2022 at the Department of Veterinary Medicine, College of Veterinary Science & A.H., Kamdhenu University, Anand, Gujarat, India to study the normal values of haematological and biochemical parameters in both males and females of *P. giganteus* and *C. spinx*. In the study period, samples were collected from different district of Gujarat *viz.*, Ahmedabad, Navsari and Valsad. In which two species of the fruit bats, *P. gigantus* (n=4) and *C.sphinx* (n=10) were screened for the morphometric identification. Based on morphometry both the species were identified. The haematology was performed in 27 fruit bats (*Pteropus giganteus*, n=13; *Cynopterus sphinx*, n=14) and biochemical analysis was carried out in 28 fruit bats (*Pteropus giganteus*, n=16; *Cynopterus sphinx*, n=12). In haematology, mean Hb, PCV and TLC were observed higher in *P. gigantus* than *C. sphinx*, whereas the value of TEC was lower. Between the species and sexes, hemoglobin and packed cell volume (PCV) values were comparatively equal, indicating similar oxygen-carrying capacity. In serum biochemistry, mean value of Creatinine, ALT, Total protein and BUN was observed higher in *P. gigantus*, whereas the AST was found high in *C.sphinx*. In comparison between male and female, the higher value of Creatinine and Total protein were found in male, whereas ALT, AST and BUN was found higher in female.

KEYWORDS: Bat, morphometry, haematology, biochemical analysis

***Citation* (VANCOUVER):** Dave et al., Morphometric Characterization and Haemato-biochemical Profile of Indian Fruit Bats. *International Journal of Bio-resource and Stress Management,* 2024; 15(12), 01-06. HTTPS://DOI.ORG/10.23910/1.2024.5763.

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

RECEIVED on 06th September 2024 RECEIVED in revised form on 26th November 2024 ACCEPTED in final form on 17th December 2024 PUBLISHED on 21st December 2024

1. INTRODUCTION

Bats are one of the most important and underrated groups of animals. They play an important role in the global balancing act of ecosystems. They are key predators of night-flying insects that burn a big hole in the farmers pocket annually (Kasso and Balakrishnan, 2013). India is renowned for its majestic wildlife but the bats of India are hardly ever mentioned. They are the regenerators of the forest and a key component of biodiversity; however, the fruit bats are listed in schedule V of the Indian Wildlife Protection Act 1972 in India and International Union for Conservation of Nature (IUCN) Red List (Version 2014.1) (Singh, 2023). Bats are widely distributed and useful to humans in pollinating several plants, they also play a great role in pest control (Anonymous, 2015; Narayan, 2019). Chiropteran fauna in India, one of the world's richest countries, plays a crucial role in regenerating forests and contributing to biodiversity (Chakravarthy and Yeshwanth, 2008).

According to Bhandarkar and Paliwal (2014), bats represent 20% of all known mammals and rank second after rodents. Pteropus giganteus, widely known as "Indian flying fox" or "Greater Indian fruit bat," is the second largest order in the class Mammalia. It belogs to the family Pteropodidae and order Chiroptera. The name Pteropus giganteus means "hand-wing." This order has over 1,117 different species of bats. It is further divided into two sub-orders: Microchiroptera, which is made up of smaller, echolocating, and primarily insectivorous bats (Vyas and Upadhyay, 2014), and Megachiroptera, also known as "megabats," which comprises 186 species of frugivorous bats (Simmons, 2005). India has 11% of the world's bat population (Simmons, 2005), with 13 species of fruit bats (Srinivasulu et al., 2010) and 101 insectivorous bats (Bhandarkar and Paliwal, 2014), However only three species viz., Indian flying fox (*Pteropus giganteus*), Fulvous fruit bat (Rousettus leschenaultii), and Greater short-nosed fruit bat (Cynopterus sphinx) were found commonly. The Indian flying fox inhabits a vast area of the Indian subcontinent, spanning from Pakistan to China, Southeast Asia, and the Maldives. As per Molur et al. (2008), this species is found not only in India but also in Bangladesh, Bhutan, Myanmar, Nepal, and Sri Lanka. The Indian flying fox, *P. giganteus* is known to live in close proximity of humans and was observed roosting in botanical gardens, cities, and villages (Chakravarthy and Yeshwanth, 2008; Akbar et al., 2022).

Bats are known to be reservoirs of zoonotic infectious diseases, including high-profile viruses like Rabies, Ebola, SARS, Nipah, Hendra, MERS, and Paramyxoviridae, attracting scientific attention for their role in these infections. (Wang and Anderson, 2019). Bat species identification has progressed from external morphology and geometric morphometry to PCR-based mitochondrial DNA 16srRNA on faecal samples, depending principally on amplification of two mtDNA genes (cyt b and COI) and their sequencing, making bat species identification easier (Vamadevan et al., 2019). The haematological parameters and biochemical profiles are crucial for evaluating the health and physiology of captive and wild animals, aiding in disease diagnosis and understanding their physiological responses to the environment, and are essential for monitoring population health and addressing environmental changes (Paksuz, 2022). Despite numerous studies on haematological and biochemical parameters in mammalian species, the data needed to understand their general health profile and physiological status is insufficient, especially in the order Chiroptera. This study aims to know the normal values of haematological and biochemical parameters in both males and females of *P. giganteus* and *C. spinx*.

2. MATERIALS AND METHODS

The study was conducted at the Department of Veterinary Medicine, College of Veterinary Science & A.H., Kamdhenu University, Anand in collaboration with the Ahmedabad district's non-governmental organizations and the office of deputy director of the F.M.D. Typing Scheme, Ahmedabad. During the study period (January-December, 2022), a total of 42 fruit bats, the blood and serum were collected from the 28 live fruit bats whereas the 14 dead fruit bats were screened for the morphometric measurement. The morphometric measurement was done in *P. gigantus* (n=4) and *C. spinx* (n=10) fruit bats by measuring different parameters *viz.,* body weight, head body length (HBL), ear length (EL), wingspan, canine-condyle length, forearm length (FAL) and hind feet length (HFL). The whole blood was collected in K_3EDTA vial (approx. 1 ml) and different haematological parameter *viz.,* Haemoglobin (Hb; g dl^{-1}), Packed cell volume (PCV; %), Total leukocyte count (TLC; $\times 10^3$ μl^{-1}) and Total erythrocyte count (TEC; $\times 10^6$ μl^{-1}) were analyzed by the manual methods. The serum was harvested from the blood, which was collected in clot activated vial and the biochemical parameter *viz.,* Total protein (g dl^{-1}), Creatinine (mg dl^{-1}), Blood urea nitrogen (BUN; g dl^{-1}), Alanine amino transferase (ALT; U L^{-1}) and Aspartate amino transferase (AST; U L^{-1}) were analyzed by the using automated serum-biochemical analyzer. The data of haemato-biochemical analysis were analysed by using independent sample 't'-test by statistical Package for Social Science (SPSS) version 26.0.

3. RESULTS AND DISCUSSION

During the study period, a total of two species (*Pteropus giganteus* and *Cynopterus sphinx*) of fruit bat were identified based on their morphological characteristics. The

morphological identification was done by measuring the different morphometry. The details of the morphometry of the bats used for species identification are presented in Table 1.

Table 1: Bats and its morphometry

Sl. No.	Morphometry	*Pteropus giganteus* (n=4)	*Cynopterus sphinx* (n=10)
1.	Body weight (g)	539.00±38.34	60.00±1.71
2.	Head body length (cm)	25.90±1.00	9.02±0.14
3.	Ear length (cm)	3.85±0.10	1.59±0.06
4.	Wing span (cm)	112.28±3.98	51.37±0.99
5.	Canine condyle Length (cm)	4.07±0.11	2.34±0.06
6.	Forearm length (cm)	15.40±0.42	6.46±0.13
7.	Hind feet length (cm)	4.25±0.09	1.45±0.03

Pteropus giganteus (n=4) is a colonial species that resides in enormous daytime roosts that may contain hundreds or even thousands of individuals and are typically found in mature trees. This was the biggest bat ever discovered at the study site, with two well-developed nostrils and a long snout. The ears were long, pointed, and black in colour. The tail was not present, but the eyes were big and functional. The cloak was a pale yellow-brown colour, the back was black with light grey streaks, the head was brown, and the underside was buffy brown. The average body weight was 539±38.34 g; head body length, 25.90±1.00 cm; ear length, 3.85±0.10 cm; wing span, 112.28±3.98 cm; Canine condyle Length, 4.07±0.11; forearm length, 15.4±0.42 cm; and hind feet length, was 4.25±0.09 cm. The results of this study, which examines *Pteropus gigantae* externally, are consistent with earlier findings of Srinivasulu and Srinivasulu (2001), Saha et al. (2015) and Vamadevan et al. (2019). In the Indian subcontinent, *Cynopterus sphinx* (n=10) is the most widespread species. The muzzle was relatively short and broad, with an upper half with pelage that ranged from brown to grey-brown and a lower part that was somewhat whiter. Whereas the inter-femoral membrane was hairy above and below, the entire wing membrane was a dark brown colour. The ears have a faint white line on the anterior and posterior sides. The average body weight was 60±1.71 g; head body length, 9.02±0.14 cm; ear length, 1.59±0.06 cm; wing span, 51.37±0.99 cm; Canine condyle length, 2.34±0.06 cm; forearm length, 6.46±0.13 cm; and hind feet length, was 1.45±0.03 cm respectively. The range of accessible specimens' morphometry was found to be consistent with that noted by Bates and Harrison (1998) and Kumar et al. (2015).

Out of 27 blood samples of the fruit bats, 13/27 (48.14%) blood samples were from the *P. giganteus* and 14/27 (51.86%) from the *C. sphinx*. Amongst the 13 blood samples of *P. giganteus,* 7/13 (53.84%) were male and 6/13 (46.16%) were female. Whereas 6/14 (42.86%) were male and 8/14 (57.14%) were female in *C. sphinx*. The samples were subjected to estimate Haemoglobin (Hb; g dl^{-1}), Packed Cell Volume (PCV; %), Total Leukocyte Count (TLC; $\times 10^3$ μl^{-1}) and Total Erythrocyte Count (TEC; $\times 10^6$ μl^{-1}). The comparison between the species and within species was carried out to find out the significant difference.

The values of haematology for two species were estimated and the comparison between the species and pulled male and female were also carried out. The detail of the result is presented in Table 2.

The mean Hb and PCV level were found to be lower in *C. sphinx* in comparison to *P. giganteus,* and the difference was non-significant. Whereas the highly significant difference was observed in the value of TEC and TLC in *C. sphinx* and *P. giganteus,* respectively. While in comparison between pulled male and female the TEC value shows highly significant (<0.01) difference.

The comparison with in the species was carried out and data is presented in Table 3. In *P. giganteus*, the difference was observed non-significant. Whereas in *C. sphinx*, the value of TLC was higher significantly in female. The value of TEC was higher significantly in male in comparison to female.

Table 2: Mean haematological values of fruit bats

Haematological parameter	Pulled values (n=27)	*P. gigantuis* (n=13)	*C. sphinx* (n=14)	Pulled male (n=13)	Pulled female (n=14)
Hb (g dl^{-1})	14.52±0.17	14.59±0.20	14.39±0.27	14.42±0.23	14.55±0.25
PCV (%)	43.57±0.52	43.77±0.62	43.17±0.81	43.27±0.71	43.63±0.75
TLC ($\times 10^3$ μl^{-1})	5.75±0.45	7.42±0.73**	4.78±0.59	5.35±0.90	6.69±0.56
TEC ($\times 10^6$ μl^{-1})	9.46±0.34	8.30±0.22	10.21±0.48**	10.11±0.52**	8.54±0.28

**: Highly significant (p<0.01)

Table 3: Mean haematological values of male and female fruit bat (*P. giganteus*; *C. sphinx*)

Haematological parameter	*P. giganteus*		*C. sphinx*	
	Male (n=7)	Female (n=6)	Male (n=6)	Female (n=8)
Hb (g dl^{-1})	14.51± 0.29	14.68± 0.32	14.32± 0.42	14.45± 0.38
PCV (%)	43.54± 0.87	44.05± 0.97	42.96± 1.25	43.34± 1.14
TLC ($\times 10^3$ μl^{-1})	7.25± 1.31	7.62± 0.65	3.14± 0.20	5.40± 0.27**
TEC ($\times 10^6$ μl^{-1})	8.52± 0.24	8.05± 0.39	11.96± 0.29**	8.90± 0.37

In general, hematological parameters typically vary in response to various types of stress during the capture and handling of bats and other animals. In the present study, stress was reduced by carefully handling and restraining the bats. According to Hossain et al. (2013) bats have greater RBC counts, Hb concentrations, and PCV levels than other mammals because of their distinct energy needs and high weight-specific basal metabolic rates. The higher blood oxygen transport capabilities of bats help them to overcome their flight limitations and high weight-specific metabolism.

The present findings on Hb and TEC concentration are an agreement with those reported by Hossain et al. (2013), Rahma et al. (2017) and Albayrak and Saricam, (2019). The PCV values of the present study was nearer to wild and captive Egyptian fruit bats (*Rousettus aegyptiacus*) (44±2 to 58±4) reported by Van Der Westhuyzen (1988), whereas the higher value (52.2±1.5) was reported by Hossain et al. (2013) in wild-captured Indian Flying Fox (*Pteropus giganteus*). A similar value of TLC counts was reported by Rashid et al. (2016) and the lower values were reported by Kuzel et al. (2020).

During the study period, a total of 28 sera samples were harvested from the blood of the fruit bats. Amongst them, 16/28 (57.14%) of *P. giganteus* and 12/28 (42.85%) of *C. sphinx*. In *P. giganteus,* 8/16 (50.00%) were male and 8/16 (50.00%) were female. In *C. sphinx,* 6/12 (50.00%) were male and 6/12 (50.00%) were female. The samples were subjected for the biochemical parameters, *viz.,* creatinine (mg/dl), Alanine amino transferase - ALT (U/L), Aspartate amino transferase - AST (U/L), Total Protein (g/dl) and Blood Urea Nitrogen- BUN (g/dl). The comparison between the species and pulled male and female was carried out. The data is presented in the table 4.

Table 4: Mean biochemical values of fruit bats

Biochemical parameter	Pulled value (n=28)	*P. giganteus* (n=16)	*C. sphinx* (n=12)	Pulled male (n=14)	Pulled female (n=14)
Creatinine (mg dl^{-1})	0.87±0.04	0.97±0.07**	0.73±0.04	0.88±0.08	0.85±0.05
ALT (U l^{-1})	70.80±4.66	83.12±2.44**	54.55±8.45	66.45±5.07	75.29±7.84
AST (U l^{-1})	106.59±11.63	61.40±3.43	166.83±13.26**	105.01±19.38	108.15±13.63
Total protein (g dl^{-1})	6.12±0.14	6.27±0.25	5.93±0.09	6.39±0.22	5.84±0.17
BUN (g dl^{-1})	26.65±3.50	31.79±5.54	17.46±2.05*	22.41±3.41	28.87±6.13

**: Highly significant (p<0.01); *: significant (p<0.05)

The mean creatinine and ALT values were significantly (p<0.01) higher in *P. giganteus* fruit bat than *C. sphinx*. Where the non-significant difference was observed between the male and female.

The value of total protein was found significant higher in male *P. giganteus* than female, whereas the value of AST was higher in female than male. In *C. sphinx*, the difference was non-significant between the male and female. The serum

Table 5: Mean biochemical values of male and female fruit bat (*P. giganteus; C. sphinx*)

Biochemical Parameter	*P. giganteus*		*C. sphinx*	
	Male (n=8)	Female (n=8)	Male (n=6)	Female (n=6)
Creatinine (mg dl-1)	1.03±0.12	0.91±0.08	0.68±0.05	0.78±0.05
ALT (U L-1)	78.66±3.29	87.59±2.98	50.20±6.61	58.91±16.21
AST (U L-1)	53.33±4.43	69.47±3.49*	173.92±24.09	159.75±13.18
Total Protein (g dl-1)	6.74±0.33*	5.79±0.30	5.93±0.14	5.92±0.14
BUN (g dl-1)	24.92±5.52	38.65±9.35	19.08±3.41	15.84±2.42

**: Highly-significant (p<0.01); *: Significant (p<0.05)

biochemistry gives crucial details about an animal's immune system and health status, which is helpful in a clinical context with captive animals as well as in epidemiologic research for attempting to determine the potential impacts of infection with a specific disease. Further, this study provides an analysis of serum-biochemistry with regards to sex as well as a comparison between two species of fruit bats (*P. giganteus; C. sphinx*). According to Edson et al. (2018) the substantial differences between males and females that have been found are more likely to be physiologic changes that occur during the life cycle than than clinical disparities.

4. CONCLUSION

The investigation reveals the size differences between *P. giganteus* and *C. sphinx*, which are critical for identifying the two species and facilitating their ecological adaptation. The mean haemoglobin value, PCV and TLC were higher in males than females. While TEC is low in males than females. The creatinine, BUN, and ALT levels of *P. giganteus* were greater than those of *C. sphinx*, suggesting that the two species differ in terms of liver metabolism and renal function. A comprehensive study with a large number of samples can aid the scientific community by reducing the margin of error, accounting for demographic variances, and providing the way for future research.

5. ACKNOWLEDGEMENT

The authors express their sincere gratitude to the Director of Animal Husbandry and the Chief Wildlife Warden of Gujarat State for granting permission to conduct this research. They also extend their heartfelt thanks to the Department of Zoology, The Maharaja Sayajirao University of Baroda, Gujarat, for their invaluable assistance with morphometric identification, and to the competent authorities of Kamdhenu University for providing financial support..

6. REFERENCE

Akbar, M.S., Sajawal, M., Bukhari, S.H.A., Ahmad, K., Haq, S.U., Ubaid, M.D., Safi, A.U., 2022. The study of Indian flying fox (*Pteropus giganteus*) in selected areas of Peshawar, KPK, Pakistan. International Journal of Chemical and Biochemical Sciences 21, 237–243.

Albayrak, I., Saricam, T., 2019. Investigation of blood cells of *Miniopterus schreibersii* (Mammalia: Chiroptera) in Turkey. Turkish Journal of Zoology 43(6), 636–640.

Anonymous, 2015. Red list of Bangladesh. Volume 2: Mammals. Available at https://portals.iucn.org/library/sites/library/files/documents/RL-549.3-003-v.2.pdf. Accessed on 10th March, 2024.

Bates, P., Harrison, D., 1998. Bats of the Indian subcontinent. Biodiversity and Conservation 7(10), 1383–1386.

Bhandarkar, S.V., Paliwal, G.T., 2014. Population and conservation status of the Indian flying fox roost in Itiadoh dam, Maharashtra. Small Mammal Mail-Bi-Annual Newsletter of CCINSA & RISCINSA 6, 15–18.

Chakravarthy, K., Yeshwanth, H.M., 2008. Status of roost of Indian fruit bat (*Pteropus giganteus*) in Karnataka, South India. Bat Net-CCISNA Newsletter, 9, 16-18. Available at: https://zoosprint.org/ZoosPrintNewsLetter/Batnet_9_1_Jan_July_2008.pdf#page=18.

Edson, D., Field, H., McMichael, L., Mayer, D., Martin, J., Welbergen, J., Amanda, M., Lauran, H., Joanna, K., George, T., Kirkland, P., 2018. Hematology, plasma biochemistry, and urinalysis of free-ranging grey-headed flying foxes (*Pteropus poliocephalus*) in Australia. Journal of Zoo and Wildlife Medicine 49(3), 591–598.

Hossain, B., Islam, N., Yasin, G., Hassan, M., Islam, A., Khan, A., 2013. Hematological profile of wild-captured Indian Flying Fox (*Pteropus giganteus*) in Bangladesh. International Journal of Natural Sciences 3(1-4), 12–17.

Kasso, M., Balakrishnan, M., 2013. Ecological and Economic Importance of Bats. International Scholarly Research Notice 2013(1), 1–9.

Kumar, M., Satyapriya, Y., Mathur, V., Elangovan, V., 2015. Roost selection and roosting ecology of fulvous fruit bat, *Rousettues leschnaulti* (Pteropodidae). International Journal of Science and Natur 5(1), 62–68.

Kuzel, A., Tavares, A., Amaral Fernandes, P., Alves, B., Costa Neto, F., Lacorte, C., Moratelli R., 2020. Hematological values for free-living great fruit-eating bats, *Artibeus lituratus* (Chiroptera: Phyllostomidae). Brazilian Journal of Veterinary Research and Animal Science 57(3), 1–9.

Molur, S., Srinivasulu, C., Bates, P., Francis, C., 2008. *Pteropus giganteus*. Version 2012.2. IUCN Red List of Threatened Species, IUCN 2012. Available at www.iucnredlist.org. Accessed on 25th March, 2024.

Narayan, V.A., 2019. Nipah virus outbreak in India: is it a bat-man conflict. International Journal of Community Medicine and Public Health 6(4), 1826–1830.

Paksuz, E.P., 2022. Hematology and plasma biochemistry of greater mouse-eared bat, *Myotis myotis* (Borkhausen) (Chiroptera: Vespertilionidae) in Turkey. Trakya University Journal of Natural Sciences 23(1), 37–42.

Rahma, A., Hanadhita, D., Cahyadi, D.D., Supratikno, S., Maheshwari, H., Satyaningtijas, A.S., Agungpriyono, S., 2017. Haematological study of fruit bat, *Cynopterus tithaecheilus*. In 1st International Conference in One

Health (ICOH 2017) (pp. 164-168). Atlantis Press.
Rashid, N., Irfan, M., Nadeem, M.S., Shabbir, A., 2016. Comparative seasonal haematology of two bat species, *Scotophilus heathii* and *Pipistrellus pipistrellus*, in a Subtropical Area of Pakistan. Pakistan Journal of Zoology 48(5), 1503–1510.
Saha, A., Hasan, M.K., Feeroz, M.M., 2015. Diversity and morphometry of chiropteran fauna in Jahangirnagar University campus, Savar, Dhaka, Bangladesh. Bangladesh Journal of Zoology 43(2), 201–212.
Simmons, N., 2005. Chiroptera. In: Wilson, D.E., Reeder, D.M. (Eds.), Mammals of the World- a taxonomic and geographic reference. Johns Hopkins University Press, Baltimore, 312–529.
Singh, R., 2023. Fruit bats: their importance, threats and conservation. International Journal of Bio-resource and Stress Management 14(6), 833–853.
Srinivasulu, C., Racey, P.A., Mistry, S., 2010. A key to the bats (Mammalia, Chiroptera) of South Asia. Journal of Threatened Taxa 2(7), 1001–1076.
Srinivasulu, C., Srinivasulu, B., 2001. Bats of the Indian subcontinent–an update. Current Science 80(11), 1378–1380.
Vamadevan, B., Neelam, T., Saikumar, G., 2019. A report on bat species identified in Bareilly, Uttar Pradesh, India with a brief description of their ecology. International Journal of Ecology and Environmental Sciences 45(2), 229–239.
Van Der Westhuyzen, J., 1988. Haematology and iron status of the Egyptian fruit bat, *Rousettus aegyptiacus*. Comparative Biochemistry and Physiology 90(1), 117–120.
Vyas, R., Upadhaya, K., 2014. Study of the Indian flying fox (*Pteropus giganteus*) colonies of Jambughoda Wildlife sanctuary, Gujarat, India, record of largest roosting congregation at Targol. Small Mammal Mail 6(1), 2–8.
Wang, F., Anderson, E., 2019. Viruses in bats and potential spillover to animals and humans. Current Opinion in Virology 34, 79–89.