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Roosting preference of the golden-crowned flying fox, *acerodon jubatus* and large flying fox, *Pteropus vampyrus* (Chiroptera: Pteropodidae) in Mambukal, Negros Occidental, Philippines

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Abstract

Flying foxes, Acerodon jubatus and Pteropus vampyrus are ecologically important species for forest regeneration, plant pollination and seed dispersal. However, these species are declining worldwide due to hunting at roosts and extensive tree cutting for urbanization. Thus, there is a need to preserve the roosting and foraging landscape of these species since bats spend over half of their life in their roost environment. This study aimed to identify and characterize the roosting sites of Acerodon jubatus and Pteropus vampyrus in Mambukal Resort, Negros Occidental. Results showed that there are thirteen (13) roosting tree species preferred by Pteropus vampyrus namely; Pterocarpus indicus, Pterocymbium tinctorium, Zizyphus trinervis, Madhuca betis, Shorea negrosensis, Pometia pinnata, Palaquium luzoniense, Pterospermum obliquum, Swietenia macrophylla, Canarium asperum, Toona calantas, Koordersiodendron pinnatum and Petersianthus quadrialatus. Out of the thirteen species, Koordersiodendron pinnatum was the most preferred roosting site with 175 individuals out of 882. The roosting tree of Acerodon jubatus was Pterospermum obliquum. The preferred roosting trees of Acerodon jubatus and Pteropus vampyrus had an average elevation of 345.4545±18.4203m, mean height was 35.2175±8.444634m, average diameter at breast height (DBH) was 43.75927±11.35574cm, average basal area was 0.1985±0.151448m^2 and the average canopy cover was 79% ± 57%. The measured Diameter at Breast Height of the roost trees in this study may indicate that majority of roosts trees had been occupied by Pteropus vampyrus and Acerodon jubatus for more than 10 years. This may support that flying foxes tend to have high roost fidelity. Thus, forest conservation strategies should be strengthened especially on these preferred roost tree species of Pteropus and Acerodon.

Keywords: *Acerodon jubatus*, *Pteropus vampyrus*, roosting site, flying fox, Mambukal.

Introduction

Flying foxes are considered essential natural resources because it can scatter and disperse seeds up to 1-2km due to its ability to hoard seeds in their gut for several hours[1]. It can also pollinate flowers from about 168 plant species and propagate economically important plant species[1,2]. Flying foxes can also facilitate nutrient transfer within the ecosystem and potential bioindicator to habitat disturbance and existence of contaminants[3,1].

However, despite the importance's of flying foxes, their population is declining worldwide[4]. For instance, the giant golden-crowned flying fox, *Acerodon jubatus* (Eschscholtz, 1831) which is considered endemic from the Philippine Islands during 1831 is classified endangered[5]. The large flying fox, *Pteropus vampyrus*. (Linnaeus, 1758) which is endemic in Southeast Asia is now vulnerable. Pteropus species are also listed in CITES because several species are endangered due to international trade[6]. The main threats facing Pteropus species worldwide are habitat loss and heavy hunting at roosts[5,7]. Roosting sites have important implications on flying foxes as they provide resting habitat, social interactions and protection[7,8]. With the loss of roosting sites, the species may decrease its population or transfer to a different site. This has been reported for many species including *Pteropus vampyrus* in Peninsular Malaysia. In the Philippines, number of roosts containing Acerodon and Pteropus species have declined precipitously over the last century[6]. In the Palawan Island, loss of primary forest, hunting and tourism contribute to the loss of mammalian fauna[9].

Philippines is believed to have the highest endemic mammalian species on a per unit area basis[6]. In Negros, Mambukal Resort is a home to several species protected under Republic Act No. 9147 including endemic bat species such as *Acerodon jubatus* and *Pteropus vampyrus.* However, understanding on the Philippine fauna and its roosting landscape is limited, hence, the nation has limited conservation planning. Therefore, this study aimed to identify the roosting preference of *Acerodon jubatus* and *Pteropus vampyrus* in Mambukal Resort, Negros Occidental, characterize their roosting sites and describe the activities of *Acerodon jubatus* and *Pteropus vampyrus* in the roosting site. Understanding the flying foxes' roosting sites could help the lawmakers in formulating forest management policies that could conserve these animals.

Materials and methods

Acerodon jubatus and *Pteropus vampyrus* were observed and identified in each roosting site. *A. jubatus* and *P. vampyrus* can be distinguished by the pelage on their heads (forehead, crown and nape). *A.jubatus* was distinguished by its golden fur around its head while *P. vampyrus* was distinguished by its fox-like facial features[10].

Species of roosting trees were identified using the "Manual on Native Trees in the Visayas" by Ramon Aboitiz and Co's Digital Flora of the Philippines. Roosting sites of *Acerodon jubatus and Pteropus vampyrus* were characterized by the tree's diameter at breast height (DBH), tree basal area, tree height and canopy of each tree. The diameter at breast height was measured using D-tape at 1.3m breast height above the ground. The tree basal area was calculated using this equation: i. $BA_{(m^2)} = \pi \times DBH_{(cm^2)} / 40000$, ii. (40000 because 10000cm per square metre).

The height of a roosting tree was measured using an improvised clinometer. Percent canopy was estimated visually.

Using a binocular, each flying fox species was observed from 20-25m distance from the roosting tree and their activities were recorded and documented using a 640x480 (Nikon) camera. The activities in the roosting site were classified as: mother-infant interaction (MII), grooming (GR), territorial defense (TD), mating (M), courtship (CO) and resting (R**).** The number of individuals per species present in the roosting tree was then counted. Using a hand-held tally clicker counter, the observer count the individuals by each click of the device. All the records were revalidated and averaged. The total number of each flying fox species per tree was determined, respectively.

Statistical analysis was performed using Paleontological Statistics Software (PAST). Chi-square test was used to determine if the observed number of individuals of each roosting sites by the *Acerodon jubatus* and *Pteropus vampyrus* agreed with the expected number of individuals of each roosting sites.

Results and discussion

The average elevation *Acerodon jubatus* and *Pteropus vampyrus* were found was 345.4545±18.4203m. The mean height of the tree were these species preferred to roost was 35.2175± 8.444634m. The preferred diameter at breast height (DBH) has an average of 43.75927±11.35574cm and the average basal area was 0.1985±0.151448(s^2). The average canopy cover (%) was 79% ±57% (Table-1).

Table-1: Characteristics of the roosting sites of *Acerodon jubatus* and *Pteropus vampyrus* in Mambukal Resort, Negros Occidental, Philippines.

Site Characteristics	Mean ± SD
Elevation (meter)	345.4545±18.4203
Tree Height (m)	35.2175±8.444634
Tree diameter at breast height (DBH) (cm)	43.75927±11.35574
Tree Basal area (m^2)	0.1985±0.151448
Canopy Cover (%)	79% ±57%

Pterospermum obliquum was the observed roosting tree preference of *Acerodon jubatus* in Mambukal Resort with a height of 30m, diameter at breast height (DBH) of 57.3cm, basal area of 0.26 and canopy cover of 85% (Table-2).

On the other hand, the roosting tree preference of *Pteropus vampyrus* belong to thirteen different species namely; *Pterocarpus indicus*, *Pterocymbium tinctorium*, *Zizyphus trinervis*, *Madhuca betis*, *Shorea negrosensis*, *Pometia pinnata*, *Palaquium luzoniense, Pterospermum obliquum*, *Swietenia macrophylla, Canarium asperum*, *Koordersiodendron pinnatum, Toona calantas* and *Petersianthus quadrialatus*.

Out of the thirteen species of roosting trees, it was found out that *Koordersiodendron pinnatum* was the most preferred roosting site with highest number of individuals roosting at 176 out of 882 (Figure-1). It has an average height of 40m, average diameter at breast height (DBH) was 47.20cm, and average basal area was 0.175m^2 and average canopy cover was 82% (Table-3). The 2nd most preferred roosting tree was *Pometia pinnata* with 171 individuals. It has an average height of 30.42m, average diameter of breast height (DBH) was 46cm, average basal area was 0.157m^2 and average canopy cover of 70%. The tree which was least preferred was *Pterocarpus indicus* with only 10 individuals. Its height was 23. 19m, diameter at breast height (DBH) was 41.40cm, and canopy cover was 80%. It was further observed that *Pteropus vampyrus* was associated with *Pteropus hypomelanus* in their roosting trees.

Table-2: Characteristics of the roosting tree preference of *Acerodon jubatus* .

Scientific Name	Tree Location	Elevation (m)	Height (m)	DBH (cm)	Basal Area (m^2)	Canopy cover (%)	Estimated no. of individual
Pterospermum obliquum	N 10°30'41.5'' E 123°06'14.6''	386	30.0	57.3	0.26	85	11

Table-3: The characteristics of the roosting site of *Pteropus vampyrus* in Mambukal Resort, Negros Occidental.

Scientific Name	Tree Location	Elevation	Height (m)	DBH (cm)	Basal Area (m^2)	Canopy Cover (%)
Pometia pinnata	N 10°30'35.2'' E 123°06'16.3''	349m	48.5	47.0	0.138	80
	N 10°30'32.1'' E 123°06'15.5''	350m	40.0	45.0	0.159	85
	N 10°30'39" E 123°06'14"	353m	34.3	45.0	0.173	70
	N 10°30'45.9'' E 123°06'13.8''	324m	26.5	42.0	0.159	70
Koordersiodendron pinnatum	N 10°30'42.2'' E 123°06'12.2''	329m	45.0	46.0	0.166	85
	N 10°30'41.8'' E 123°06'12.6''	340m	26.0	47.6	0.178	80
	N 10°30'41.2'' E 123°06'12.4''	341m	49.0	48.0	0.181	80
Shorea negrosensis	N 10°30'40.2'' E 123°06'12.6''	390m	30.0	47.1	0.174	75
	N 10°30'42.7'' E 123°06'11.6''	325m	24. 7	56.0	0.246	85
Palaquium luzoniense	N 10°30'40.4'' E 123°06'12.1''	341m	33. 7	43.0	0.145	80
	N 10°30'44.4'' E 123°06'13.3''	342m	30.1	41.4	0.135	85
Zizyphus trinervis	N 10°30'35.2'' E 123°06'17.9''	348m	35.0	52.0	0.212	85
	N 10°30'45'' E 123°06'15.4''	324m	24. 4	50.0	0.196	70
Canarium asperum	N 10°30'44.3'' E 123°06'12.7''	347m	25.0	46.2	0.167	70
	N 10°30'42.6'' E 123°06'12.5''	326m	30. 2	45.1	0.159	70
Swietenia macrophylla	N 10°30'43" E 123°06'12.7"	351m	36. 1	40.8	0.130	80
Pterocymbium tinctorium	N 10°30'42.7'' E 123°06'13.0''	327m	36.0	34.0	0.091	85
	N 10°30'38'' E 123°06'13.4''	352m	47.1	17.4	0.850	47
Pterospermum obliquum	N 10°30'40.3'' E 123°06'13.1''	339m	31.0	57.3	0.258	80
Toona calantas	N 10°30'41.5'' E 123°06'13.6''	385m	35.0	53.0	0.221	80
Petersianthus quadrialatus	N 10°30'41.5'' E 123°06'13.6''	376m	25.0	34.0	0.091	80
Madhuca betis	N 10°30'43.5'' E 123°06'13.8''	341m	24. 6	42.0	0.138	80
Pterocarpus indicus	N 10°30'41.5'' E 123°06'11.8''	346m	33.0	42.0	0.032	85

There is a statistically highly significant association between the observed number of individuals of each roosting sites of the *Acerodon jubatus* and *Pteropus vampyrus* with the expected number of individuals of each roosting sites, X^2= 231.44, df=12, P= <0.05.

The activity observed for both *Acerodon jubatus* and *Pteropus vampyrus* in all their roosting sites was resting with minor activities such as courtship and mating (Figure-2).

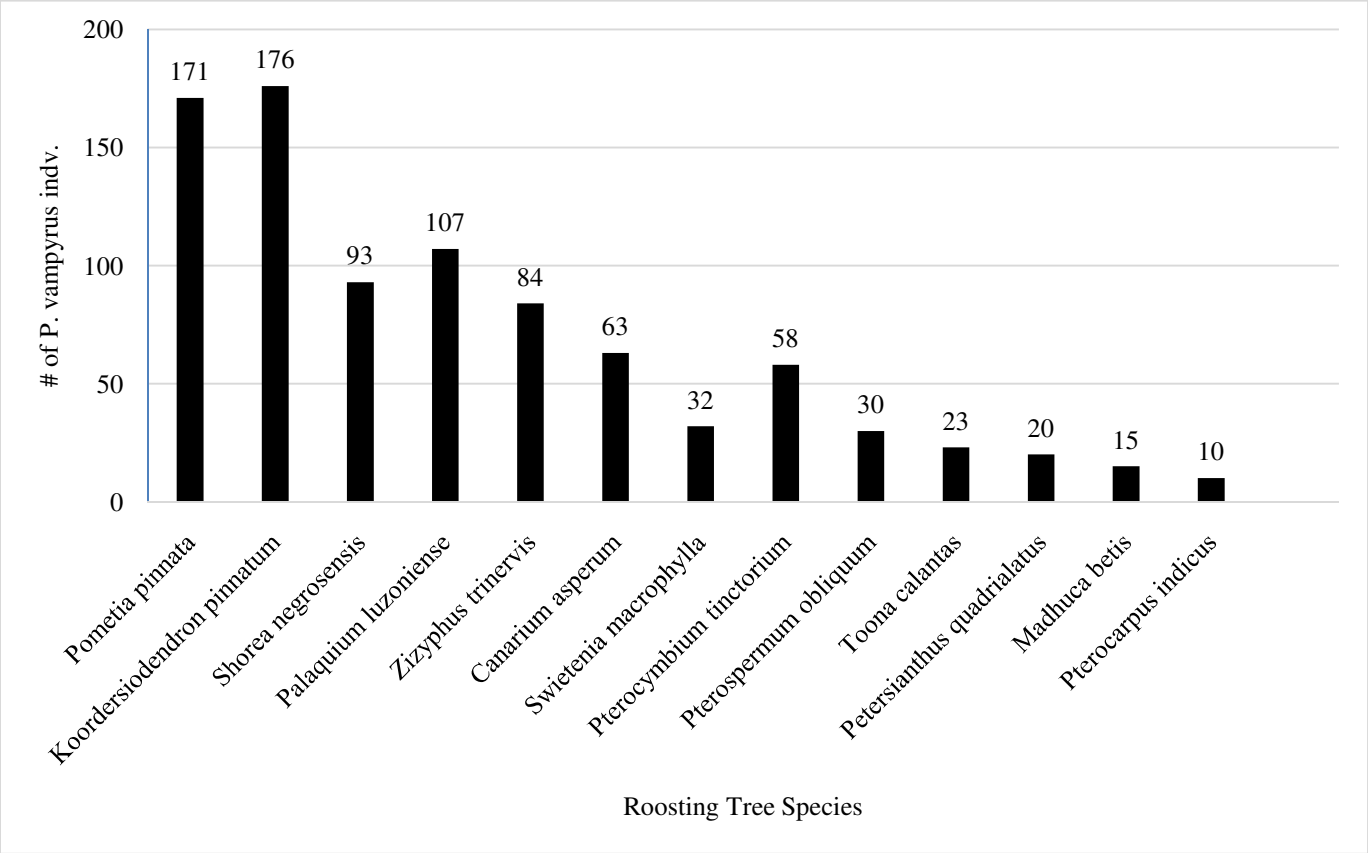

Figure-1: The roosting preference of *Pteropus vampyrus* and the estimated number of individuals present in each roosting tree.

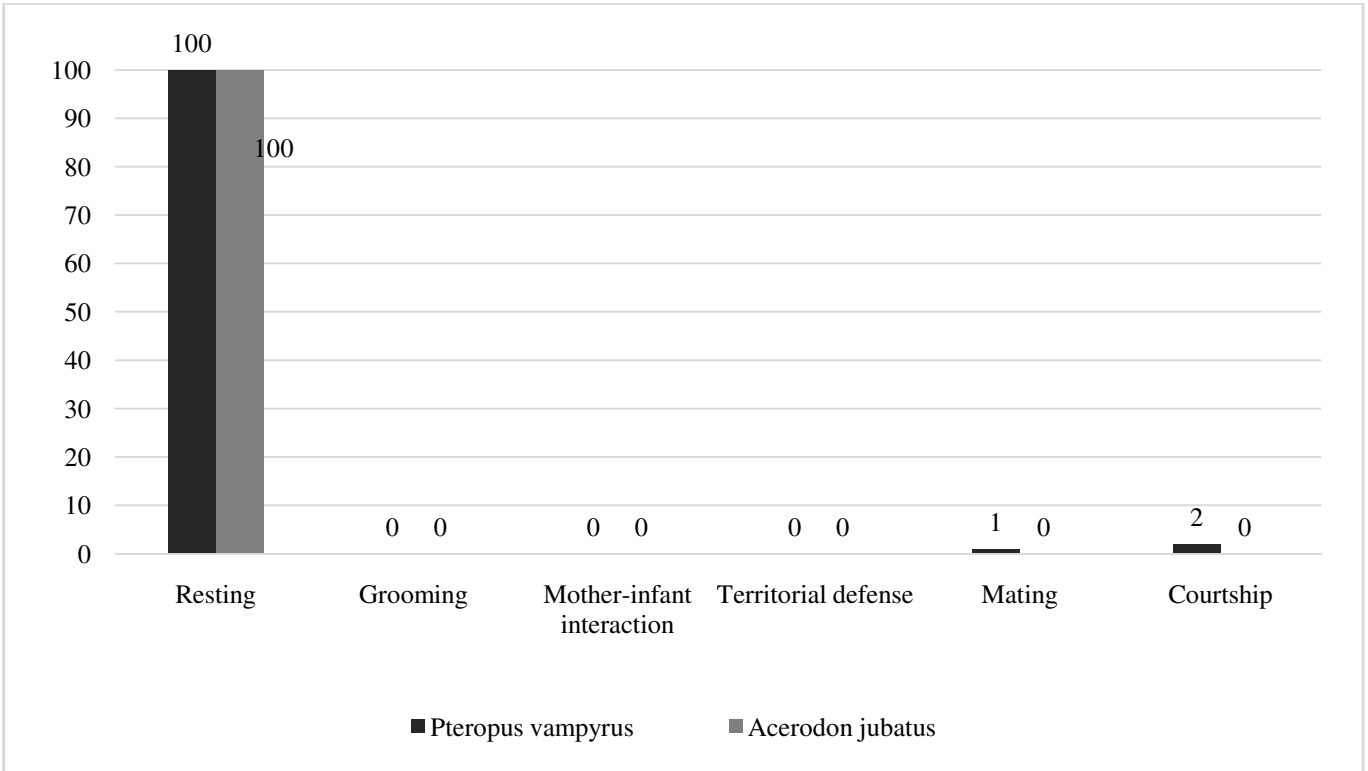

Figure-2: Activities observed in the roosting trees of *Acerodon jubatus* and *Pteropus vampyrus*.

Discussion: The characteristics of roost sites undoubtedly influence bat fitness and survival[11]. Tall trees and snags are preferred by flying foxes because these give them room to free-fall during take off, more space for their large colonies and provide easy access to and from the roost site[8,12]. The species of trees roosted by *P. vampyrus* in the present study ranged from 25 to 49 meters high. Preference of Pteropodid species on tall trees were also observed in *Pteropus giganteus*[12]. However, the trees preferred by *P. vampyrus* in this study were taller than the species of trees roosted by *P. giganteus* in the study of Hahn et al.[12]. The most preferred roosting tree of *P. vampyrus* in our study was *Koordersiodendron pinnatum* which ranged from 26-29m high. The 2nd most preferred was *Pometia pinnata* with an average height 30.42m.Aside from the tree height, the thick foliage of these trees may protect the flying foxes from the heat of the sun[13,14].

In addition, roosting of *Pteropus vampyrus* to several tree species may show that this species is widespread in lowland dipterocarp forests and has wider dietary breadth. It was observed in other studies that *P. vampyrus* and *A. jubatus* used both disturbed and undisturbed areas but prefer lowland dipterocarp forests[15]. However, according to the anecdotal reports in the study of Mildenstein et al.[4], *A. acerodon* mounted to be natural forest obligate and tend to be in or adjacent to understurbed natural forests. A. *acerodon* feeds only on fruits and leaves of plants found in natural forests. This might be one of the reasons why *Acerodon jubatus* was observed to roost in only one tree species in this study. Its reliance on disappearing natural forest may lead to extinction[4]. Thus, with little forest left in the Philippines, *A jubatus* should be a priority for conservation management. An education program is recommended to enlighten the community with the ecosystem services provided by the flying foxes.

The measured Diameter at Breast Height of the roost trees in this study is comparable to the study of Hahn et al.[12]. Results may indicate that majority of roosts trees had been occupied by *Pteropus vampyrus* and *Acerodon jubatus* for more than 10 years. This may support that flying foxes tend to have high roost fidelity. Thus, forest conservation strategies should be strengthened especially on these preferred roost tree species of Pteropus and Acerodon.

The average canopy cover at 79% in the sampling site may support that flying foxes prefer to roost in low canopy cover as observed in the study of Perry et al.[11]. Open forest provides ease of navigation, predator avoidance, roost relocation and thermal regulation[16]. Furthermore, the biotic, abiotic and geographical factors of Mambukal Resort may favor the roosting sites of Pteropus and Acerodon. Mambukal Resort is partly covered by Mt. Kanlaon with an elevation of 1200ft above sea level and cool temperature all year round. In addition, water bodies found in Mambukal Resort may be used as a drinking source for flying foxes as observed in *Pteropus giganteus*[12,14].

Resting was the most frequent observed activity of flying foxes in their roosting sites with minor activities such as courtship and mating parallel to the study of Connel *et al.*[17] and Hengjan *et. al*.[18] Possible reason why bats kept sleeping (resting state) most of its time probably because they conserve their energy for their foraging activity at night[19]. This behavior is particularly true for the flying foxes since they usually have long-distance flights wherein a single flight can reach up to 40km[20]. Additionally, a large body mass of megabats such as *Pteropus vampyrus* requires a lot energy for collection of food at night[21].

Conclusion

The preferred roosting sites of *Acerodon jubatus,* was *Pterospermumobliquum* while *Pteropus vampyrus* preferred to roost on *Koordersiodendron pinnatum*, *Pometiapinnata* and *Palquiumluzoniense*. The roosting sites of *Acerodon jubatus* and *Pteropus vampyrus* species had an average elevation of 345.4545±18.4203 m. The mean height was 35.2175±8.444634 m, diameter at breast height (DBH) was averaged of 43.75927 ±11.35574cm, average basal area was 0.1985± 0.151448m^2 and average canopy cover was 79% ± 57%. Resting was the most frequent observed activity with minor activities such as courtship and mating.

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References

1. Kaaso M. and Balakrishnan M. (2013). Ecological and economic importance of Bats (Order Chiroptera). ISRN Biodiversity.http://dx.doi.org/10.1155/2013/187415.

2. Fujita M.S. and Tuttle M.D. (1991). Flying foxes (Chiroptera: Pteropodidae): threatened animals of key ecological and economic importance. *Conservation Biology*, 5(4), 455-463.

3. Boyles J.G., Cryan P.M., McCracken G.F. and Kunz T.H. (2011). Economic importance of bats in agriculture. *Science*, 332(6025), 41-42.

4. Stier S.C. and Mildenstein T.L. (2005). Dietary habits of the world's largest bats: the Philippine flying foxes, Acerodon jubatus and Pteropus vampyrus lanensis. *Journal of Mammalogy*, 86(4), 719-728.

5. Mickleburgh S.P., Racey P.A. and Hutson A. (1992). Old World fruit bats: an action plan for the family Pteropodidae. *International Union for the Conservation of Nature and Natural Resources*, Species Survival Commission, Gland, Switzerland..

6. Heaney L.R. (1998). A synopsis of the mammalian fauna of the Philippine Islands. *Fieldiana. Zoology. New Series*, 88, 1-61.

7. Kunz T.H. and Pierson E.D. (1994). Bats of the World: An introduction Walker's Bats of the World (ed) Nowak RM. *The Johns Hopkins University Press Baltimore MD London*, 1-46.

8. Pierson E.D. and Rainey W.E. (1992). The Biology of flying foxes of the genus *Pteropus*: A review. in *Pacific Island flying foxes* Proceedings of and International Conference(eds) Wilsona DE and Graham GL United States Department of Interior Fish and Wildlife Service Washington, 1-17.

9. Esselstyn J., Widman P. and Heaney L. (2004). The mammals of Palawan Island, Philippines. *Proceedings of the Biological Society of Washington*, 117(3), 271-302.

10. Ingle N.R. and Heaney L.R. (1992). A key to the bats of the Philippine islands. *Fieldiana Zoology*, 69, 1-44.

11. Perry R.R., Thill D. and Leslie Jr. (2007). Selection of roosting habitat by forest bats in a diverse forested landscape. *Forest Ecology and Management*, 238, 156-166.

12. Hahn M.B., Epstein J.H., Gurley E.S., Islam M.S., Luby S. P., Daszak P. and Patz J.A. (2014). Roosting behaviour and habitat selection of Pteropus giganteus reveal potential links to Nipah virus epidemiology. *Journal of Applied Ecology*, 51(2), 376-387.

13. Gumal M. (2004). Diurnal home range and roosting trees of a maternity colony of *Pteropus vampyrusnaturae* (Chiroptera: Pteropodidae) in Sedilu, Sarawak. *Journal of Tropical Ecology*, 20, 247-258.

14. Gulraiz T.L., Javid A., Mahmood-Ul-Hassan M., Maqbool A., Ashraf S., Hussain M. and Daud S. (2015). Roost characteristics and habitat preferences of Indian flying fox (Pteropus giganteus) in urban areas of Lahore, Pakistan. *Turkish Journal of Zoology*, 39(3), 388-394.

15. Mildenstein T.L., Stier S.C., Nuevo-Diego C.E., Mills L.S. and Nuevodiego C. (2005). Habitat selection of endangered and endemic large flying-foxes in Subic Bay. *Philippines Biological Conservation*, 126**,** 93-102.

16. Vonhof M.J. and Barclay R.M. (1996). Roost-site selection and roosting ecology of forest-dwelling bats in southern British Columbia. *Canadian Journal of Zoology*, 74(10), 1797-1805.

17. Connell K.A., Munro U. and Torpy F.R. (2006). Daytime behaviour of the grey-headed flying fox Pteropus poliocephalus Temminck (Pteropodidae: Megachiroptera) at an autumn/winter roost. *Australian Mammalogy*, 28(1), 7-14. doi: 10.1071/AM06002

18. Hengjan Y., Pramono D., Takemae H., Kobayashi R., Iida K., Ando T., Kasmono S., Basri C., Fitriana Y.S., Arifin E.M.Z, Ohmori Y., Maeda K., Agungpriyono S. and Hondo E. (2017). Daytime behavior of *Pteropus vampyrus* in a natural habitat: the driver of viral transmission. *J. Vet. Med. Sci.,* 79, 1125-1133. doi: 10.1292/jvms.16-0643.

19. Altringham J.D. (1996). Bats: Biology and Behavior. Oxford University Press, London, United Kingdom, 65-139.

20. Heaney L.R. and Heideman P.D. (1987). Philippine fruit bats: endangered and extinct. *Bats*, 5(1), 3-5.

21. Utzurrum R.C.B. (1992). Conservation status of the Philippine fruit bats (Pteropodidae). *Silliman Journal*, 36, 27-45.