

A brief review of Bornean banded langur *Presbytis chrysomelas* (Müller, 1838) of Sarawak

Mohammad Noor-Faezah^{1,2}, Tukiman Nur-Aizat^{1,2}, Tingga Roberta Chaya Tawie^{2,3}, Mohamad Fhaizal Bukhori², Jayasilan Mohd-Azlan⁴, Azroie Denel⁵, Badrul Munir Md-Zain³, Muhammad Abu Bakar Abdul-Latiff⁶, Abd Rahman Mohd-Ridwan^{2*}

¹Animal Resource Science and Management, Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

²Centre for Pre-University Studies, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

³School of Environmental and Natural Resource Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

⁴Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

⁵Sarawak Forestry Corporation, Kota Sentosa, Sarawak, Malaysia

⁶Environmental Management and Conservation Research Unit (eNCORE), Faculty of Applied Sciences and Technology (FAST), Universiti Tun Hussein Onn Malaysia (Pagoh Campus), 84000, Muar, Johor, Malaysia

*Email: armridwan@unimas.my

Received: 26 May 2023 / Revised: 25 August 2023 / Accepted: 29 August 2023 / Published online: 31 August 2023.

How to cite: Noor-Faezah, et al. (2023). A brief review of Bornean banded langur *Presbytis chrysomelas* (Müller, 1838) of Sarawak, Journal of Wildlife and Biodiversity, 7(4), 265-282. DOI: <https://doi.org/10.5281/zenodo.8313172>

Abstract

The critically endangered Bornean banded langur (*Presbytis chrysomelas*) is exclusively found in Borneo. This species is classified among the world's 25 most endangered primate species. The geographical locations and distribution patterns of *P. chrysomelas* remain inadequately understood, and their taxonomic classification remains unclear. Although it was once abundant in Sarawak, the distribution of *P. chrysomelas* has become one of the most restricted among all *Presbytis* species. Presently, documented sightings of *P. chrysomelas* span across five specific locations in Sarawak: Samunsam Wildlife Sanctuary, Tanjung Datu National Park, Gunung Pueh National Park, Similajau National Park, and Maludam National Park. Thus, the purpose of this review is to present previous studies conducted on *P. chrysomelas* in Sarawak, elucidating its taxonomy, characteristics, distributions, important sites, research gaps, threats, and recommendations for further studies. Immediate conservation efforts and attention from the primatologist, relevant authorities and stakeholders are needed to prevent the localized extinction of *P. chrysomelas*.

Keywords: Bornean banded langur, *Presbytis chrysomelas*, Sarawak

Introduction

Borneo is well renowned for being one of the world's primate hotspots (Meijaard & Nijman, 2003; Wolf & Ripple, 2022). Borneo inhabits 17 distinct species of non-human primates, spanning across six families and eight genera, including genus *Presbytis*. The genus *Presbytis* of the subfamily Colobinae is the most widely distributed group among the non-human primates in Borneo and widely studied in Malaysia; however, most investigations focused at species level on *Presbytis frontata*, *Presbytis femoralis*, *Presbytis hosei*, and *Presbytis rubicunda* (Abdul-Latiff et al., 2019; Duckworth et al., 2011; Smith, 2015; Meyer et al., 2011; Miller, 1934; Najmuddin et al., 2020; Najmuddin et al., 2021; Mohd-Hatta, 2013). Other studies focused more on resolving the taxonomic ambiguity of the genus (Aifat et al., 2016; Md-Zain, 2001; Md-Zain et al., 2008; Meyer et al., 2011; Meyer, 2012; Vun et al., 2011). Nevertheless, limited attention has been directed towards the study of *Presbytis chrysomelas*. *Presbytis chrysomelas* or Bornean banded langur is an understudied rare primate and endemic to Borneo. Currently, information on the sites and distribution of *P. chrysomelas* is still scarce, and its taxonomy is still disputed (Brandon-Jones et al., 2004; Meyer et al., 2011). Similar to other *Presbytis*, *P. chrysomelas* is also synonymously known locally as penatat or penyatat by Bidayuh, lutung by Malays, bijit by Iban, and berangad by Kenyah (Mohd-Hatta, 2013). It has the most restricted distribution of all *Presbytis* in Borneo. And globally, it has been categorized as a Critically Endangered species on the IUCN Red List (Nijman et al., 2020a) as it has a very high risk of extinction in the wild due to the continuously reduced populations and requires immediate conservation and proper study approaches. Approximately, the population has decreased by up to 80% during the last 30 years and is expected to do so at the same rate over the next 30 years (Nijman et al., 2020a). The distribution region is quite narrow in comparison with its historical range as it was once widely spread.

Hence, the objective of this current review is to compile the notable existing records concerning *P. chrysomelas* in Sarawak with the intention of enhancing scientific documentation. This comprehensive review covers aspects including taxonomy, characteristics, distributions, important sites, threats, recommendations for future research and the crucial need for prompt conservation initiatives.

Taxonomy of *Presbytis chrysomelas*

The Bornean banded langur has always been the subject of taxonomic confusion. Formerly, it was first described as *Semnopithecus femoralis* (Miller, 1934), *S. chrysomelas* (Kantha &

Suzuki, 2009), *P. melalophos* (Kantha & Suzuki, 2009), *P. melalophos chrysomelas* (Oates et al. 1994), and then as a distinct species of *P. femoralis chrysomelas* (Brandon-Jones et al., 2004). Currently, this species is referred to as *P. chrysomelas* based on updated DNA data (Meyer et al., 2011; Vun et al., 2011) and morphological characteristics (Groves, 2001). Two subspecies comprised under *P. chrysomelas* were found distinct based on the colour morphs variation: the black morph (*P. c. chrysomelas*) and the red morph (*P. c. cruciger*) (Phillipps & Phillipps, 2016).

Characteristics of *Presbytis chrysomelas*

The fur colouration of *P. chrysomelas* is quite variable between subspecies although it is normally jet black with a portion of brown hairs on the dorsum (Mohd-Hatta, 2013). For *P. c. chrysomelas*, the underside is fawn (pale whitish) up to the chin, wrists, and cheek, as well as down to the belly, inner leg, and ventral part of the tail (Rifqi et al., 2019) (Figure 1a). The chest hairs are dark in colour and curly. Small forehead whorls are observable, commonly in pairs, close to the brow, with a crest that is tall, upright, and narrow in between. Nevertheless, Duckworth et al. (2011) recognized the unusual morphological characteristics of *P. c. chrysomelas* in Similajau National Park. The facial skin is greyish to pinkish, with dark cheeks and lighter underparts. Additionally, the hair colour variation for subspecies *P. c. cruciger* is apparent, with red-orange, starting on the head, shoulders, sides of the belly, and toward the thigh and calf (Rifqi et al., 2019) (Figure 1b). The hands, arms, feet, and the rear line of its body, which extends to its tail, are covered in black. The juveniles of both subspecies are either grey/reddish/pale white in colour, with a black cross that runs down over their backs and arms and a pale belly (Phillipps & Phillipps, 2016).



Figure 1. The fur colouration between subspecies of *P. chrysomelas*. **a)** Black morph *P. c. chrysomelas* **b)** Red morph *P. c. cruciger* (source: <http://prcfindonesia.org/lutung-sentaram-hewan-langka-muncul-di-nanga-lauk/>).

Historical distributions

Presbytis chrysomelas is a diurnal and arboreal species that primarily inhabits lowland environments, specifically tropical rainforests, mangrove forests, and swamp forests. This species exhibits the most limited distribution among all members of the *Presbytis* genus, heavily relying on its specific habitat. Typically, *P. chrysomelas* is found in groups of around five to six individuals, consisting of one male, two to three females, and their offspring (Bennett, 1992; Payne et al., 1985). One distinguishing feature is the distinct calls of *P. chrysomelas*, which can be differentiated from those of *P. robinsoni*, *P. femoralis*, and *P. siamensis* through their unique sound "ke-ke-ke-ke-ke" (Phillipps & Phillipps, 2016).

Presbytis chrysomelas was once the most prevalent and widely dispersed species in Borneo (Phillipps & Phillipps, 2016) (Figure 2). The historical distribution of the Bornean banded langur as per the previous name *P. melalophos* recorded in the area extends to the Northwestern of Kalimantan down to Western Sarawak. In Sarawak, it was frequently seen northward extending to Central Sarawak where it meets *P. melalophos cruciger*. Nonetheless, this distribution was omitted by Payne et al. (1985) of the records of *P. c. chrysomelas* in Similajau National Park located northeast of Sarawak.

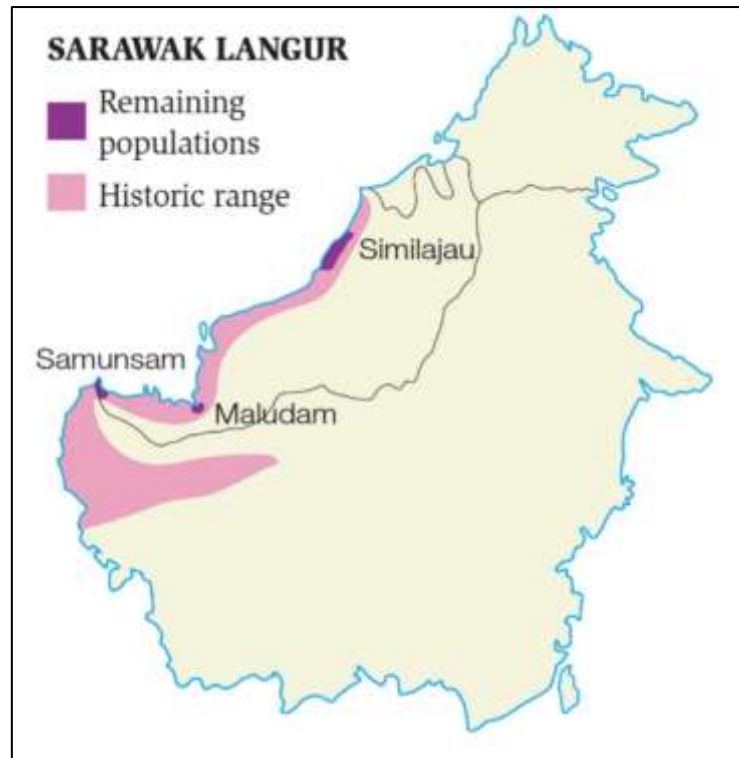


Figure 2. Map of Bornean Island, illustrating the historical distributions and modern distributions of *Presbytis chrysomelas* (Phillipps & Phillipps, 2016)

Modern distributions

Once considered common back in the early twentieth century, the current area of occupancy of *P. chrysomelas* is less than 5% of its historical range with an approximate population between 200 and 500 individuals (Smith, 2015; Nijman et al., 2020a). Five locations in Sarawak have reported recent sightings of *P. chrysomelas* based on direct observation and camera trapping, namely, Maludam National Park, Similajau National Park, Tanjung Datu National Park, Samunsam Wildlife Sanctuary, and Pueh National Park. Since many records are historical, the modern distribution requires further research to be done to depict the accuracy of the existence.

Important sites

With the recent sightings as shown in Table 1, these protected areas are considered important for the conservation of *P. chrysomelas* in Sarawak. The biggest known population was recorded in the Samunsam Wildlife Sanctuary. A total of 17 groups with 8 to 13 individuals of *P. c. chrysomelas* has been encountered via line transect survey between November 2004 and December 2005 (Ampeng and Md-Zain, 2012).

Meanwhile, the Tanjung Datu National Park is one of Sarawak's smallest national parks in Sarawak and is situated at the southwestern point of Borneo. In 2018, eight distinct photos of the *P. c. chrysomelas* were captured during the course of 28 months of camera trapping (Mohd-Azlan et al., 2018). All of the sightings were detected in the beach forest and none in the mixed-dipterocarp forest.

The Similajau National Park is a 90 km² forest consisting of mixed-dipterocarp forest that alternates with kerangas woodland. The Bornean banded langur is considered the most common colobine species found in the park. The first recorded sighting of the Bornean banded langur based on direct observation was back in 1986 in which numerous groups were observed (Duckworth & Kelsh, 1988).

The Gunung Pueh National Park located at the northwestern tip of Borneo. Given its location near the Samunsam and Tanjung Datu National Park, it is realistic to anticipate sightings of Bornean banded langur there. A solitary record of the *P. c. chrysomelas* based on motion-sensor camera trappings of 3,109 trap nights was documented at the lowland forest of Gunung Pueh (Mohd-Azlan, 2022).

Finally, the Maludam peat swamp forest was declared a national park in 2000 by the state government of Sarawak due to the documented presence of the proboscis monkey (*Nasalis larvatus*). Out of the five locations listed, only Maludam reported by Nijman et al. (2020b) has a viable population size of *P. c. cruciger*, but no exact amount has been recorded. The other three exhibit dispersed populations of *P. c. chrysomelas*, despite being protected in the wildlife refuges and national parks.

Table 1. Recorded sightings of *Presbytis chrysomelas* in Sarawak based on the published papers of previous years.

#	Location	Records	Reference
1.	Samunsam Wildlife Sanctuary	17 groups of 8 to 13 individuals were observed via line transect. (December 2004 to December 2005)	(Ampeng & Md-Zain, 2012)
2.	Tanjung Datu National Park	8 individuals based on camera trap images independent detections. (July 2013 to October 2015)	(Mohd-Azlan et al., 2018)
3.	Similajau National Park	Several groups at two sites in 1986, at least five groups at three sites in 1995, and four times in 2005 with other colobines were observed.	(Duckworth et al., 2011) (Duckworth & Kelsh 1988) (Duckworth 1997)
4.	Maludam National Park	No exact recorded sighting but the population was reported to be viable.	(Nijman et al., 2020b)
5.	Gunung Pueh National Park	Solitary image from camera trap recorded in lowland forests of lower than 1,100 m asl. (June 2016 to March 2017)	(Mohd-Azlan, 2022)
6.	The northern part of Borneo (No clear geographical barrier)	26 localities data in the habitat of tropical wet evergreen forest. (1991 to 2001)	(Meijaard & Nijman, 2003)

Comparison with other endangered primates in Sarawak based on research attention

In Sarawak, two endemic species of primates have been classed as Critically Endangered by the IUCN Red List (IUCN, 2022) and listed as Totally Protected under the Wild Life Protection Ordinance (1998): orangutan and Bornean banded langur. Nonetheless, high conservation attention has been given to the orangutan and the endangered proboscis monkey, in comparison with the Bornean banded langur, even though all species are in a dire need of conservation action.

The Bornean orangutan, the charismatic ape species, has drawn significant conservation attention ever since 1958, as a Totally Protected species under the Wild Life Protection Ordinance. The state government of Sarawak had formulated action plans with the relevant Malaysian government stakeholders and agencies to save orangutans from extinction. The latest is the pledge of the Sarawak government on the policy of zero-loss orangutans and their

habitat by 2015 (Ji, 2015). Studies on orangutans also have been done holistically by many researchers. In addition, the proboscis monkey has received extensive conservation and study action in Sarawak as well (Table 2). The recent one is the collaboration between the Sarawak Forestry Corporation and Universiti Malaysia Sarawak for Sarawak Proboscis Monkey Action Plan 2021–2025 (Khan et al., 2021). Moreover, several areas in Sarawak with viable populations of proboscis monkeys had been gazetted as Totally Protected areas, namely, Samunsam Wildlife Sanctuary, Bako National Park, and Kuching Wetland National Park (Kombi & Abdullah, 2016).

On the other hand, the ecology of the *P. chrysomelas*, particularly based on population estimates, is yet unknown. Four studies on the behavior and ecology of *P. chrysomelas* have been conducted, four on genetic studies and two on the threats and conservation. The studies on population, distribution, and abundance are limited on the assessment from the IUCN Red List. The study gap between the Bornean banded langur, Bornean orangutan, and proboscis monkey in Sarawak is depicted in Table 2, while the comparison of the number of studies by species over a decade is illustrated in Figure 3.

Table 2. Comparison of study conducted on *Presbytis chrysomelas*, *Pongo pygmaeus* and *Nasalis larvatus* in Sarawak.

#	Species	IUCN Red List	Behaviour and ecology	Population, habitat, distribution, and abundance	Genetic	Parasite and health	Threats and conservation
1.	<i>Pongo pygmaeus</i>	Critically endangered	Ampeng et al. (2016); Husen (2001); Mohd-Hatta (2005); Mohd-Rahmantullah, (2001); Salina et al. (2004); Wesley (2001)	Ampeng et al. (2016); Ampeng et al. (2021); Blouch (1997); Gurmaya & Silang (2002); Gumal et al. (2021); Pandong et al. (2018); Pandong et al. (2022); Schaller, (1961). Silang et al. (2006)	Kanthaswamy & Smith (2002); Mattle-Greminger et al. (2018); Warren et al., (2001); Zhi et al., (1996)	Teo et al. (2019); Thayaparan et al. (2014)	Pandong & Anak (2019); Gumal (2022); Gumal & (Tisen, 2010); Jonas et al. (2017); Medway (1976); Pandong et al. (2019); Tisen & Silang (2016); Zander et al. (2014)
2.	<i>Presbytis chrysomelas</i>	Critically endangered	Ampeng (2003); Ampeng (2006); Ampeng & Md-Zain (2007); Ampeng & Md-Zain (2012)	Nijman et al. (2020a; 2020b; 2020c)	Abdul-Latiff et al. (2019); Aifat et al (2016); Md-Zain (2001); Vun et al. (2011)		Ampeng (2006); Smith (2015)
3.	<i>Nasalis larvatus</i>	Endangered	Bennett (1986); Bennett (1988); Bennet & Sebastian, (1988); Budeng, (2011); Kombi & Abdullah (2016); Onuma (2002); Salter et al. (1985); Wan-Azman et al. (2022)	Aziz et al. (2015); Azman (2005); Kombi & Abdullah, (2013); Kombi & Abdullah (2016); Laman & Aziz (2019); Tuen & Pandong (2007)	Mazlan et al. (2019)	Adrus et al. (2019); Hasegawa et al. (2003); Khairi (2012); Julian (2015); Lim et al. (2019); Thayaparan et al. (2013); Thayaparan et al. (2014)	Bennett (1986); Kamaruzzaman et al. (2017); Khan et al. (2021)

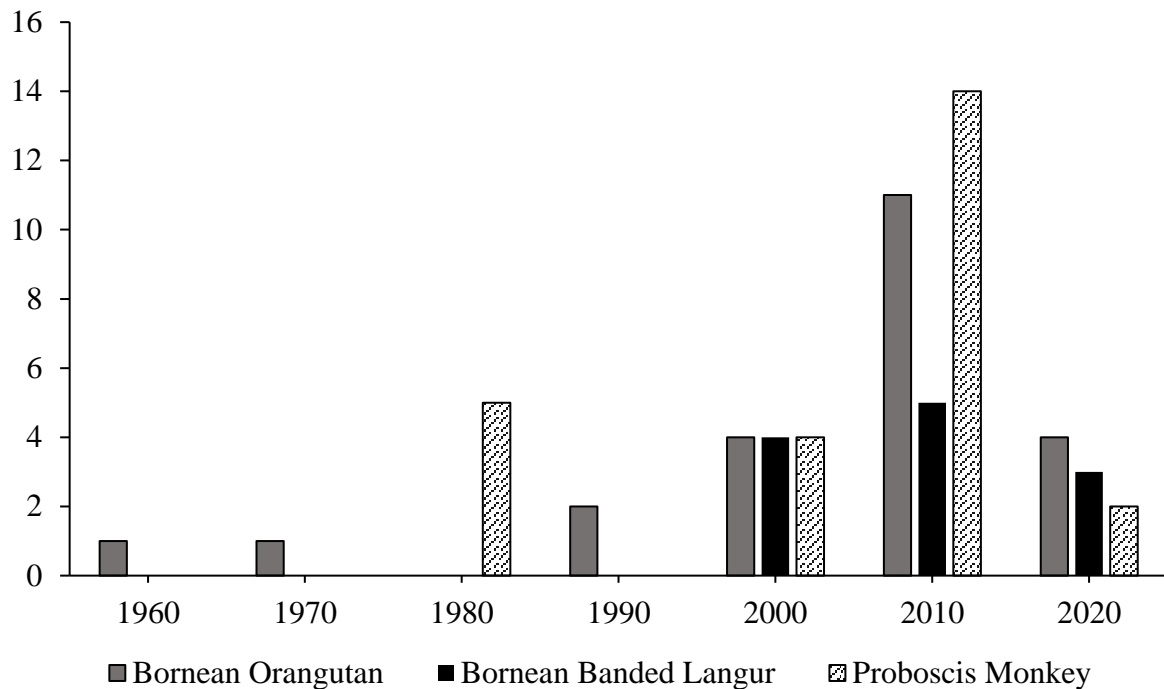


Figure 3. Studies on Bornean orangutan, Bornean banded langur and Proboscis monkey of Sarawak per decade.

Conservation threats

The primary threats to the *P. chrysomelas* in Sarawak include habitat loss and fragmentation and poaching (Ampeng, 2006). As the *P. chrysomelas* is highly dependent on habitat by being arboreal, the conversion of forests into agricultural land, mainly for oil palm cultivation, as well as residential and commercial development has threatened their sustainability. The monoculture farms of oil palms and the construction of the Pan-Borneo Highway-Sarawak further fractured the forest (Alamgir et al., 2020). The severe forest fragmentation heightens the possibility of extinction due to the continuous loss of habitat connectivity and the increment risk of hunting and predation. However, the impact of declining habitat quality on the long-term persistence of species is still unclear.

Previous ecological studies on *Presbytis chrysomelas*

The ecological study of *P. chrysomelas* is limited to the research on ranging behavior done by Ampeng and Md-Zain (2012). They discovered the ranging patterns employed by 17 groups of *P. c. chrysomelas* in Samunsam Wildlife Sanctuary encompass vertical, cross-horizontal, and straight horizontal movements. They have a short daily movement distance (31.8 to 54.3 m). The abundance and distribution of food resources influence the ranging pattern and ranging distance of *P. c. chrysomelas*.

Several samples of *P. c. chrysomelas* were used in the genetic study to reclarify the taxonomic classification of the genus *Presbytis*. Vun et al. (2011) discovered that *P. chrysomelas* is genetically distinct from *P. femoralis* and *P. siamensis*, separating *chrysomelas* at the species level, while the cytochrome b gene revealed that *P. chrysomelas* is the most primitive among *Presbytis*. In contrast, the subspecies *P. c. cruciger* in Kalimantan has received much attention from researchers in recent years. Notable research attention was given to the study of ecology on the *P. c. cruciger* in Taman Danau Sentarum. However, similar to *P. c. chrysomelas* in Malaysia, *P. c. cruciger* in Indonesia is also in need of immediate attention in genetic study.

Research recommendations

It is important to realize that there is a notable gap in the study with a focus on the ecological and genetic studies of *P. chrysomelas* at the species level. Hence, future research should focus on the studies listed in Table 3.

Table 3. Recommended potential future study in resolving the research gap for *P. chrysomelas* in Sarawak.

#	Aspect	Recommendation
1.	Population size and distribution	The population size and density of <i>P. chrysomelas</i> are still in oblivion. The previous study merely documented the frequency and precise distribution (Ampeng & Md-Zain, 2012; Duckworth et al., 2011; Mohd-Azlan, 2022; Mohd-Azlan et al., 2018; Meijaard & Nijman, 2003; Nijman et al., 2020b). Extensive research is required to determine the population size, distribution, and density of both subspecies in Sarawak. Extensive ground sampling should be conducted by returning to the area within its historical distribution.
2.	Daily activity budget	The study is limited to the subspecies <i>P. c. cruciger</i> in Indonesia (Musyaffa & Santoso, 2020). No previous research was done on the daily activity budget of <i>P. chrysomelas</i> in Sarawak. Baseline daily behavioral data of <i>P. chrysomelas</i> in Sarawak is needed to develop a strategic conservation action.
3.	Feeding ecology	Dietary information is still quite limited. Dietary research is necessary to evaluate dietary flexibility and to comprehend the coexistence with other primate species in reducing intraspecific competition through dietary overlap as shown in long-tailed macaque and dusky langur (Ruslin et al., 2019).
4.	Population genetics	Population genetic diversity concentrating on each subspecies in Sarawak is still rare as much focus is on the genus <i>Presbytis</i> (Aifat et al., 2016; Md-Zain, 2001; Md-Zain et al., 2008; Meyer et al., 2011; Meyer, 2012; Vun et al., 2011). Research on population genetics using a molecular technique is essential to determine the genetic diversity of <i>P. chrysomelas</i> in Sarawak. Indeed, the genetic data of both <i>P. chrysomelas</i> subspecies is critical for resolving its taxonomic classification.
5.	Positional behavior	Data on positional behavior is needed to specify the locomotors and postures used in response to habitat structure. It is also essential to acquire a thorough understanding of the mechanisms that link ecology, morphology, and behavior (Saunders et al., 2018).
6.	Metagenomic	Metagenomic studies of <i>P. chrysomelas</i> in Sarawak have not been done before. Metagenomic study based on fecal samples permits the assessment of gut microbial species (Srivathsan et al., 2016) and the identification of the

	species of plant diet consumed via the DNA metabarcoding method (Osman et al., 2020).
7. Mitogenomic	<i>P. chrysomelas</i> has never been the focus subject of mitogenomic research. Genomic data collected from noninvasive fecal samples is a tool for conservation genomics (Taylor et al., 2021). This information can settle the taxonomic disputes between subspecies of <i>P. chrysomelas</i> , which may be different species due to their diverse fur colourations.
8. Conservation management	Effective conservation management focusing on <i>P. chrysomelas</i> species is needed. A continuous monitoring program emphasizing ecological criteria may be used during the conservation planning. This action could be a collaboration between local researchers with local authorities (Sarawak Forestry Corporation and Forest Department Sarawak) and international authorities (Brunei and Indonesia) to conserve this neglected transboundary species.
9. Threats	The threat to this species is limited to the study conducted by Ampeng (2006) and Smith (2015). Hence, in-depth research on the threats is crucial in the work of revising the Wild Life Protection Ordinance (WPO) 1998.

Conclusion

This study contributes to the current knowledge of *P. chrysomelas* in Sarawak. Despite being listed as Totally Protected by Sarawak's Wildlife Protection Ordinance (WPO) and Critically Endangered on the IUCN Red List, this species remains underappreciated. Substantial research efforts are required to enable the implementation of timely and comprehensive conservation actions aimed at preventing the extinction of this species.

Acknowledgements

The authors would like to thank Universiti Malaysia Sarawak for providing the necessary assistance and support. This research was funded by the Ministry of Higher Education Malaysia (MOHE) through the Fundamental Research Grant Scheme (FRGS) (Grant Number: FRGS/1/2022/WAB11/UNIMAS/03/5).

References

- Abdul-Latiff, M. A. B., Baharuddin, H., Abdul-Patah, P., & Md-Zain, B. M. 2019. Is Malaysia's banded langur, *Presbytis femoralis femoralis*, actually *Presbytis neglectus neglectus*? Taxonomic revision with new insights on the radiation history of the *Presbytis* species group in Southeast Asia. *Primates* 60: 63-79.
- Adrus, M., Zainuddin, R., Ahmad Khairi, N. H., Ahamad, M., & Abdullah, M. T. 2019. Helminth parasites occurrence in wild proboscis monkeys (*Nasalis larvatus*), endemic primates to Borneo Island. *Journal of medical primatology* 48(6): 357-363.
- Aifat, N. R., Yaakop, S., & Md-Zain, B. M. 2016. Ancient DNA analyses of museum specimens from selected *Presbytis* (Primate: Colobinae) based on partial Cyt b sequences. *AIP Conference Proceedings*, Vol. 1784, No. 1, p. 060024.
- Alamgir, M., Campbell, M. J., Sloan, S., Engert, J., Word, J., & Laurance, W. F. 2020. Emerging challenges for sustainable development and forest conservation in Sarawak, Borneo. *PloS one* 15(3): e0229614.
- Ampeng, A. 2003. *Densiti dan kepelbagaian primat diurnal di Taman Negara Tanjung, Sematan Sarawak*. B.Sc. thesis, Universiti Kebangsaan Malaysia.
- Ampeng, A. 2006. *A study on ecology and behaviour of Presbytis melalophos chrysomelas in the Samunsam Wildlife Sanctuary, Sematan, Sarawak*. Master dissertation, Universiti Kebangsaan Malaysia.
- Ampeng, A., & Md-Zain, B. M. 2012. Ranging patterns of critically endangered colobine, *Presbytis chrysomelas chrysomelas*. *The Scientific World Journal*.
- Ampeng, A., Shukor, M. N., Sahibin, A. R., Idris, W. M. R., Ahmad, S., Mohammad, H., ... & Md-Zain, B. M. 2016. Patterns of mineral lick use by Northwest Bornean orangutans (*Pongo pygmaeus pygmaeus*) in the Lanjak Entimau Wildlife Sanctuary, Sarawak, Malaysia. *European journal of wildlife research* 62: 147-150.
- Ampeng, A., Liam, J., Simpson, B., Traelholt, C., Nor, S. M., Abdan-Saleman, M. S. B., ... & Md-Zain, B. M. 2021. First Bornean orangutan sighting in Usun Apau National Park, Sarawak. *Biodiversity data journal* 9.
- Ampeng, A., & Md-Zain, B. M. 2007. A short note on methodology of detecting leaf monkeys (*Presbytis melalophos chrysomelas* and *Trachypithecus cristatus*) in Samunsam Wildlife Sanctuary, Sarawak. *The Journal of Wildlife and Parks* 24: 7-9.
- Aziz, A. F., Laman, C. J. M., & Azman, M. S. 2015. Past and present population estimations of proboscis monkeys (*Nasalis larvatus*) at Bako National Park, Sarawak. *Proceedings of The Regional Taxonomy and Ecology Conference 2015*, pp. 341-348.
- Azman, S. A. 2005. *Population estimation of proboscis monkey (Nasalis larvatus) at Bako National Park*. Bachelor thesis, Universiti Malaysia Sarawak.
- Bennett, E. L. 1988. Proboscis monkeys and their swamp forests in Sarawak. *Oryx* 22(2): 69-74.
- Bennett, E. L. 1986. Proboscis monkeys in Sarawak: their ecology, status, conservation and management. Kuala Lumpur: World Wildlife Fund Malaysia.
- Bennett, E. L. 1992. A wildlife survey of Sarawak. New York: New York Zoological Society.
- Bennett, E. L., & Sebastian, A. C. 1988. Social organization and ecology of proboscis monkeys (*Nasalis larvatus*) in mixed coastal forest in Sarawak. *International Journal of Primatology* 9: 233-255.
- Blouch, R. A. 1997. Distribution and abundance of orangutans (*Pongo pygmaeus*) and other primates in the Lanjak Entimau Wildlife Sanctuary, Sarawak, Malaysia. *Tropical Biodiversity* 4(3): 259-274.

- Brandon-Jones, Douglas, A. A. Eudey, Thomas Geissmann, Colin P. Groves, Donald J. Melnick, Juan Carlos Morales, Myron Shekelle, & C-B. Stewart. Asian primate classification. *International Journal of Primatology* 25: 97-164.
- Budeng, B. 2014. Behavioural activities and foraging ecology of proboscis monkey in Sarawak, Malaysia (Borneo). *Final Report* :1-11.
- Diva, A. M. 2022 Perilaku Sosial Langur Borneo (*Presbytis chrysomelas* ssp. *cruciger*) di Resort Lupak Mawang, Taman Nasional Danau Sentarum. Bachelor dissertation, Institut Pertanian Bogor.
- Duckworth, J. W. 1997. Mammals in Similajau National Park, Sarawak, in 1995. *Sarawak Museum Journal* 51: 171-192.
- Duckworth, J. W., Sebastian, A. C., Kelsh, R. N., & Brandon-Jones, D. 2011. On the apparent occurrence of Hose's Surili *Presbytis hosei* in Similajau National Park, Sarawak, Malaysia. *Asian Primate Journal* 2(1): 29-35.
- Duckworth, J. W., & Kelsh, R. 1988. A bird inventory of Similajau National Park. *International Council for Bird Preservation*, No. 31.
- Groves, C. P. 2001. Primate Taxonomy. Washington: Smithsonian Institution Press.
- Gumal, M. 2022. Orang-Utans In Sarawak and the Changing Landscapes Conservationists Find Themselves In. Kuala Lumpur: Malaysian Naturalist.
- Gumal, M., & Braken Tisen, O. 2010. Orangutan Strategic Action Plan: Trans-Boundary Biodiversity Conservation Area. Kuching: Wildlife Conservation Society.
- Gumal, M., Rubis, J., Silang, S., Goyem, C., Juat, N., Simba, P., ... & Pandong, J. 2021. Densities of orang utan nests in Batang Ai National Park, Lanjak-Entimau Wildlife Sanctuary and the proposed Ulu Sebuyau National Park. Kuching: Wildlife Conservation Society.
- Gurmaya, J. K., & Silang, S. 2002. Development of Lanjak Entimau Wildlife Sanctuary as a Totally Protected Area, Phase III. *A Study of Habitat Conditions, Populations, and Distribution of Orangutan in Lanjak Entimau Wildlife Sanctuary and Batang Ai National Park, Sarawak, Malaysia. ITTO Project PD* 16: 99.
- Hasegawa, H., Matsuo, K., & Onuma, M. 2003. *Enterobius* (colobenterobius) *serratus* sp. nov. (nematoda: oxyuridae) from the proboscis monkey, *Nasalis larvatus* (Wurmb, 1787) (primates: cercopithecidae: colobinae), in Sarawak, Borneo, Malaysia. *Comparative parasitology* 70(2): 128-131.
- Hidayat, I. T. 2022. Kohabitasi Ruang Lutung Sentarum (*Presbytis chrysomelas cruciger*) di Kawasan Bukit Semujan Taman Nasional Danau Sentarum. Bachelor dissertation, Institut Pertanian Bogor.
- Husen, A. Z. 2001. *Foraging ecology of semi-wild orangutan at Semenggoh Wildlife Rehabilitation Centre, Sarawak*. Undergraduate Thesis, Universiti Malaysia Sarawak.
- IUCN. 2022. *The IUCN Red List of Threatened Species*. Version 2022-2. <https://www.iucnredlist.org>. [19 December 2022].
- Ji, Y. 2015, July 29). Sarawak to be more ape-friendly. *The Star*. <https://www.thestar.com.my/News/Nation/2015/07/29/Sarawak-to-be-more-apefriendly-Environmental-policy-will-protect-orang-utans/> [12 January 2023].
- Jonas, H., Abram, N. K., & Ancrenaz, M. 2017. Addressing the impact of large-scale oil palm plantations on orangutan conservation in Borneo. London: IIED.
- Julian, B. J. 2015. *Campylobacter jejuni* Detection in Proboscis Monkey (*Nasalis larvatus*). Undergraduate Thesis, Universiti Malaysia Sarawak.
- Kamaruzzaman, M. A., Ismail, M. I., & Tingga, R. C. T. 2017. Ecotourism conservation potential of proboscis monkey (*Nasalis larvatus*) at Samunsam Wildlife Sanctuary, Sarawak, Malaysia. *Ecotourism Potentials in Malaysia*, 59-67.

- Kantha, S. S., & Suzuki, J. 2009. Primate species in Darwin's major books on evolution. *Current Science* 97(5): 715-718.
- Kanthaswamy, S., & Smith, D. G. 2002. Population subdivision and gene flow among wild orangutans. *Primates* 43: 315-327.
- Khairi, N. H. B. A. 2012. *Gastrointestinal Parasites of Free-ranging Primates in Bako National Park, Sarawak*. Doctoral dissertation, Universiti Malaysia Sarawak.
- Khan, F. A. A., Mazlan, N., Aziz, A. F., Adrus, M., Abang-Aimran, A. A., Gumal, M., Zaini, M. K., Silang, S. and Denel, A. 2021. Sarawak Proboscis Monkey Action Plan 2021-2025. Kuching: Sarawak Forestry Corporation.
- Kombi, M. B., & Abdullah, M. T. 2016. A review of the proboscis monkey (*Nasalis larvatus*) in Borneo, with reference to the population in Bako National Park, Sarawak, Malaysian Borneo. *Tropical Natural History* 16(1): 42-56.
- Kombi, M., & Abdullah, M. T. 2013. Ethogram of the free ranging *Nasalis larvatus* in Bako National Park, Sarawak. *Malayan Nature Journal* 65(2&3): 1-21.
- Kushairi, A., 2018. Overview of the Malaysian Oil Palm Industry 2017. *Malaysian Palm Oil Board* 6.
- Laman, C. J. M., & Aziz, A. F. 2019. Population estimation of proboscis monkey, *Nasalis larvatus* with new analysis based on forest types in Sarawak, Malaysian Borneo. *J. Sustain. Sci. Manag.* 14(2): 91-101.
- Laksmitha, N. 2022. *Karakteristik Habitat dan Jenis Pakan Langur Borneo di Resort Pulau Majang, Taman Nasional Danau Sentarum*. Bachelor dissertation, Institut Pertanian Bogor.
- Lim, L. W. K., Chung, H. H., Chong, Y. L., & Lee, N. K. 2019. Isolation and Characterization of Putative Liver-specific Enhancers in Proboscis Monkey (*Nasalis larvatus*). *Pertanika Journal of Tropical Agricultural Science* 42(2).
- Mahesa, R. 2022 *Analisi Tipe Habitat Lutung Sentarum (Presbytis chrysomelas ssp. cruciger, Thomas 1892) di Taman Nasional Danau Sentarum*. Bachelor dissertation, Institut Pertanian Bogor.
- Mattle-Greminger, M. P., Bilgin Sonay, T., Nater, A., Pybus, M., Desai, T., de Valles, G., ... & Krützen, M. 2018. Genomes reveal marked differences in the adaptive evolution between orangutan species. *Genome biology* 19: 1-13.
- Mazlan, N., Abd-Rahman, M. R., Tingga, R. C. T., Abdullah, M. T., & Khan, F. A. A. 2019. Population Genetics Analyses of the Endangered Proboscis Monkey from Malaysian Borneo. *Folia Primatologica* 90(3): 139-152.
- Md-Zain, B. M. 2001. *Molecular systematics of the genus Presbytis*. Doctoral dissertation, Columbia University.
- Md-Zain, B. M., Morales, J. C., Hasan, M. N., Abdul, J., Lakim, M., Supriatna, J., & Melnick, D. J. 2008. Is *Presbytis* a distinct monophyletic genus: inferences from mitochondrial DNA sequences. *Asian Primates Journal* 1: 26-36.
- Medway, L. 1976. Hunting pressure on orang-utans in Sarawak. *Oryx* 13(4): 332-333.
- Meijaard, E., & Nijman, V. 2003. Primate hotspots on Borneo: predictive value for general biodiversity and the effects of taxonomy. *Conservation Biology* 17(3): 725-732.
- Meyer, D. 2012. Taxonomy and phylogeny of leaf monkeys (Colobinae) with focus on the genus *Presbytis* (Eschscholtz, 1821). Doctoral Dissertation, University of Gottingen.
- Meyer, D., Rinaldi, I. D., Ramlee, H., Perwitasari-Farajallah, D., Hodges, J. K., & Roos, C. 2011. Mitochondrial phylogeny of leaf monkeys (genus *Presbytis*, Eschscholtz, 1821) with implications for taxonomy and conservation. *Molecular Phylogenetics and Evolution* 59(2): 311-319.
- Miller, G. S. 1934. The langurs of the *Presbytis femoralis* group. *Journal of Mammalogy* 15(2): 124-137.

- Mohd-Azlan, J. 2022. Community structures of mid-sized to large-bodied mammals in Tropical Lowland and Lower Montane Forests in Gunung Pueh National Park, Western Sarawak, Borneo. *Nature Conservation Research* 7(1): 70-79.
- Mohd-Azlan, J., Lok, L., Maiwald, M. J., Fazlin, S., Shen, T. D., Kaicheen, S. S., & Dagang, P. 2020. The distribution of medium to large mammals in Samunsam Wildlife Sanctuary, Sarawak in relation to the newly constructed Pan-Borneo Highway. *Nature Conservation Research* 5(4): 43–54.
- Mohd-Azlan, J., Nurul-Asna, H., Jailan, T. S., Tuen, A. A., Engkamat, L., Abdillah, D. N., ... & Brodie, J. F. 2018. Camera trapping of terrestrial animals in Tanjung Datu National Park, Sarawak, Borneo. *Raffles Bulletin of Zoology* 66.
- Mohd-Hatta, M. R. 2013. *Distribution, ecology and systematics of Presbytis hosei and other leaf monkey species in North Borneo*. Doctoral dissertation, Australian National University.
- Mohd-Hatta, M. R. 2005. *Activity Patterns and Food Preferences of Orang-utan in Captivity and Semi-wild State*. BSc dissertation, Universiti Malaysia Sarawak.
- Mohd-Rahmantullah, M. H. 2001. *Nesting ecology of semi-wild orangutans at Semenggoh Wildlife Rehabilitation Centre, Sarawak*. Bachelor thesis, Universiti Malaysia Sarawak.
- Musyaffa, M. E. F., & Santoso, N. 2020. Karakteristik habitat dan pola aktivitas langur borneo (*Presbytis chrysomelas cruciger*) di Taman Nasional Danau Sentarum. *Jurnal Penelitian Hutan dan Konservasi Alam* 17(2): 155-172.
- Najmuddin, M. F., Haris, H., Norazlimi, N., Ruslin, F., Matsuda, I., Md-Zain, B. M., & Abdul-Latiff, M. A. B. 2021. Dietary habits of free-ranging banded langur (*Presbytis femoralis*) in a secondary-human modified forest in Johor, Malaysia. *Zoological Studies* 60.
- Najmuddin, M. F., Haris, H., Othman, N., Zahari, F., Md-Zain, B. M., Shahrool-Anuar, R., ... & Abdul-Latiff, M. A. B. 2020. Data on First Record of Brown Morph Banded Langur (*Presbytis femoralis*), Leucistic Dusky Leaf Monkey (*Trachypithecus obscurus*) in Malaysia and Review of Morph Diversity in Langur (Colobinae). *Data in brief* 31: 105727.
- Nijman, V., Cheyne, S., Traeholt, C. & Setiawan, A. 2020a. *Presbytis chrysomelas*. The IUCN Red List of Threatened Species 2020: e.T39803A17955321. <https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T39803A17955321.en>. [19 December 2022].
- Nijman, V., Cheyne, S., Traeholt, C. & Setiawan, A. 2020b. *Presbytis chrysomelas ssp. chrysomelas*. The IUCN Red List of Threatened Species 2020: e.T136857A17987458. <https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T136857A17987458.en>. [19 December 2022].
- Nijman, V., Cheyne, S., Traeholt, C. & Setiawan, A. 2020c. *Presbytis chrysomelas ssp. cruciger*. The IUCN Red List of Threatened Species 2020: e.T39804A17987391. <https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T39804A17987391.en>. [19 December 2022].
- Oates, J. F., Davies, A. G. & Delson, E. 1994. *The diversity of living colobines, in Colobine Monkeys: Their Ecology, Behaviour and Evolution*, A. G. Davies & J. F. Oates (eds.). pp. 45–73. Cambridge: Cambridge University Press.
- Onuma, M. 2002. Daily ranging patterns of the proboscis monkey, *Nasalis larvatus*, in coastal areas of Sarawak, Malaysia. *Mammal study* 27(2): 141-144.
- Sarawak. 1998. *Wildlife Protection Ordinance 1998*. Laws of Sarawak. Forest Department Sarawak.
- Osman, N. A., Abdul-Latiff, M. A. B., Mohd-Ridwan, A. R., Yaakop, S., Nor, S. M., & Md-Zain, B. M. 2020. Diet composition of the wild stump-tailed macaque (*Macaca*

- arctoides*) in Perlis State Park, Peninsular Malaysia, using a chloroplast tRNL DNA metabarcoding approach: A preliminary study. *Animals* 10(12): 2215.
- Pandong, G., & Anak, J. J. 2019. *Conservation Ecology of Bornean Orangutans in the Greater Batang Ai-Lanjak-Entimau Landscape, Sarawak, Malaysia*. Ph.D dissertation, University of Adelaide.
- Pandong, J., Balang, M., Anyie, Y., Manggat, M., Ng, S., Gumal, M., & Rayan, D. M. 2022. Preliminary results of orangutan distribution using occupancy modelling at the Sedilu-Sebuyau-Lesong landscape in Sarawak. *Malaysia Conservation Conference 2022*.
- Pandong, J., Gumal, M., Alen, L., Sidu, A., Ng, S., & Koh, L. P. 2018. Population estimates of Bornean orang-utans using Bayesian analysis at the greater Batang Ai-Lanjak-Entimau landscape in Sarawak, Malaysia. *Scientific Reports* 8(1): 1-11.
- Pandong, J., Gumal, M., Aton, Z. M., Sabki, M. S., & Koh, L. P. 2019. Threats and lessons learned from past orangutan conservation strategies in Sarawak, Malaysia. *Biological Conservation* 234: 56-63.
- Payne, J., Francis, C. M., & Phillipps, K. (1985). *Field guide to the mammals of Borneo*. Kota Kinabalu: Sabah Society.
- Phillipps, Q. & Phillipps, K. 2016. *Phillipps' field guide to the mammals of Borneo and their ecology: Sabah, Sarawak, Brunei, and Kalimantan*. Vol. 105. New Jersey: Princeton University Press.
- Pusparini, S. D. 2012. Population Structure and Conservation Status of *Presbytis chrysomelas cruciger* in Danau Sentarum Forest Area, West Kalimantan. Graduate Thesis, Universitas Negeri Jakarta.
- Rifqi, M. A., Pambudi, T., Khotiem, M., & Gessha A. A. 2019. Bornean Banded Langur *Presbytis chrysomelas cruciger* in Danau Sentarum National Park, West Kalimantan, Indonesia. *Southeast Asia Vertebrate Records* 2019: 56-59.
- Ruslin, F., Matsuda, I., & Md-Zain, B. M. (2019). The feeding ecology and dietary overlap in two sympatric primate species, the long-tailed macaque (*Macaca fascicularis*) and dusky langur (*Trachypithecus obscurus obscurus*), in Malaysia. *Primates* 60(1): 41-50.
- Salina, A., Salim, N. B., Rasedee, A., Senthilvel, K. S. S. N., Iskandar, C. T. N. F., Hassan, L., ... & Khan, M. A. K. G. 2004. A field study on social behaviour, feeding regime and health status in semi-captive and free-ranging orang utans (*Pongo pygmaeus*) undergoing rehabilitation programme. *The 11th International Conference of The Association of Institutions for Tropical Veterinary Medicine*, pp. 378-383.
- Salter, R. E., MacKenzie, N. A., Nightingale, N., Aken, K. M., & Chai PK, P. 1985. Habitat use, ranging behaviour, and food habits of the proboscis monkey, *Nasalis larvatus* (van Wurmb), in Sarawak. *Primates* 26: 436-451.
- Saunders, E. L. R., Roberts, A. M., & Thorpe, S. K. S. 2018. Positional behavior. In *The International Encyclopedia of Biological Anthropology*, pp. 1-7. New Jersey: John Wiley & Sons, Inc.
- Schaller, G. B. 1961. The Orangutan in Sarawak. *Zoologica* 46: 73-82.
- Silang, S., Laman, C.J. & Demies, M. 2006. Orangutan Habitat Monitoring: Fruit Trees for Orangutan in Batang Ai National Park. *Hornbill* 8: 177-189.
- Smith, D. A. E. 2015. The ecology and conservation of *Presbytis rubicunda*. Ph.D. Dissertation, Oxford Brookes University.
- Srivathsan, A., Ang, A., Vogler, A. P., & Meier, R. 2016. Fecal metagenomics for the simultaneous assessment of diet, parasites, and population genetics of an understudied primate. *Frontiers in Zoology* 13: 1-13.
- Taylor, R. S., Manseau, M., Redquest, B., Keobouasone, S., Gagne, P., Martineau, C., & Wilson, P. J. 2021. Whole genome sequences from non-invasively collected caribou faecal samples. *Conservation Genetics Resources*: 1-16.

- Teo, S. Z., Tuen, A. A., Madinah, A., Aban, S., & Chong, Y. L. 2019. Occurrence of gastrointestinal nematodes in captive nonhuman primates at Matang Wildlife Centre, Sarawak. *Tropical biomedicine* 36(3): 594-603.
- Thayaparan, S., Robertson, I. D., & Abdullah, M. T. 2014. Leptospiral agglutinins in captive and free ranging non-human primates in Sarawak, Malaysia. *Veterinary World* 7(6): 428-431.
- Thayaparan, S., Robertson, I. A. N., Amraan, F., Su'ut, L., & Abdullah, M. T. 2013. Serological prevalence of leptospiral infection in wildlife in Sarawak, Malaysia. *Borneo Journal of Resource Science and Technology* 2(2): 71-74.
- Tisen, O. B., & Silang, S. 2016. Orangutan conservation in Sarawak, Malaysia. *15th International Peat Congress 2016*, Abstract No. A-394.
- Tuen, A. A., & Pandong, J. J. G. 2007. Habitat use and population density of proboscis monkeys (*Nasalis larvatus*) at Samunsam Wildlife Sanctuary, Sarawak. *Malayan Nature Journal* 59(3): 269-279.
- Vun, V. F., Mahani, M. C., Lakim, M., Ampeng, A., & Md-Zain, B. M. 2011. Phylogenetic relationships of leaf monkeys (*Presbytis*; Colobinae) based on cytochrome b and 12S rRNA genes. *Genetic and Molecular Research* 10(1): 368-381.
- Wan-azman, N. S., Mazlan, N. & Anwarali Khan, F. A. 2022. Diet Analysis of Sympatric Colobine Monkeys from Bako National Park, Sarawak, Borneo. *Borneo Journal of Resource Science and Technology* 12(1): 157-165.
- Warren, K. S., Verschoor, E. J., Langenhuijzen, S., Swan, R. A., Vigilant, L., & Heeney, J. L. 2001. Speciation and intrasubspecific variation of Bornean orangutans, *Pongo pygmaeus pygmaeus*. *Molecular Biology and Evolution* 18(4): 472-480.
- Wesley, M. N. 2001. Activity budget of mother-infant pairs of semi-wild orangutans at Semenggoh Wildlife Rehabilitation Centre. BSc. Thesis, Universiti Malaysia Sarawak.
- Wicaksana, N. D. 2022. Perilaku Sosial Langur Borneo (*Presbytis chrysomelas* ssp. *cruciger*) di Resort Pulau Majang Taman Nasional Danau Sentarum (Social Behavior of the Bornean Langur (*Presbytis chrysomelas* ssp. *cruciger*) at Majang Island Resort, Lake Sentarum National Park). Bachelor dissertation, Institut Pertanian Bogor.
- Wolf, C., & Ripple, W. J. 2022. Putting a face on carbon with threatened forest primates. *Proceedings of the National Academy of Sciences* 119(28): e2207604119.
- Zander, K. K., Pang, S. T., Jinam, C., Tuen, A. A., & Garnett, S. T. 2014. Wild and valuable? Tourist values for orang-utan conservation in Sarawak. *Conservation and Society* 12(1): 27-42.
- Zhi, L., Karesh, W. B., Janczewski, D. N., Frazier-Taylor, H., Sajuthi, D., Gomber, F., Andau, M., Martenson, J. S. & O'Brien, S. J. 1996. Genomic differentiation among natural populations of orangutan (*Pongo pygmaeus*). *Current Biology* 6(10): 1326-1336.