

History of Coffee Farm Development with Local Communities and Wildlife in Ulu Baram, Sarawak

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ABSTRACT

In the upper reaches of the Baram River (hereafter Ulu Baram) in the central highlands of Borneo, there is a movement to conserve biodiversity effectively and sustainably in areas outside national parks and wildlife reserves. This initiative is led by local communities with cooperation from the state government. This study examines a coffee farm in Ulu Baram as a case study, analyzing the impacts of the farm's development strategies on the local community from both socio-economic and ecological perspectives. The owner has maintained operations for 20 years, keeping revenues just above breakeven. Coffee cultivation requires a certain level of labor, making it a space for community-building and enabling different ethnic groups to collaborate. The coffee farm caused limited environmental disturbance and did not lead to a decline in wildlife or significant changes to the forest landscape. The presence of medium-to-large animals, including rare species, and the documentation of their reproduction in the adjacent secondary forest suggest that farm development and wildlife survival can coexist under sustainable management.

Keywords: Ulu Baram; coffee farms; mammal conservation; community-level initiatives; mountain science

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INTRODUCTION

National parks and other nature reserves are crucial mechanisms for preserving biodiversity, yet they can also threaten the livelihoods of the indigenous peoples who originally lived there. There are many precedents in which people who are deeply involved with local forests have been excluded from using those forests due to the establishment of national parks (Neumann 1998; Robbins 2004). Therefore, in recent years, the importance of areas where nature has been protected because of the livelihoods and voluntary efforts of local communities has been reviewed (Berkes, 2021; Charles, 2021).

In March 2023, the International Tropical Timber Organization's Executive Director, Sheam Satkuru, and Sarawak Forest Department Director, Hamden bin Haji Mohamad, signed an international cooperation agreement to effectively conserve biodiversity in areas outside of nature reserves. The target area is the Upper Baram basin in the central highlands of Borneo (Fig. 1A).

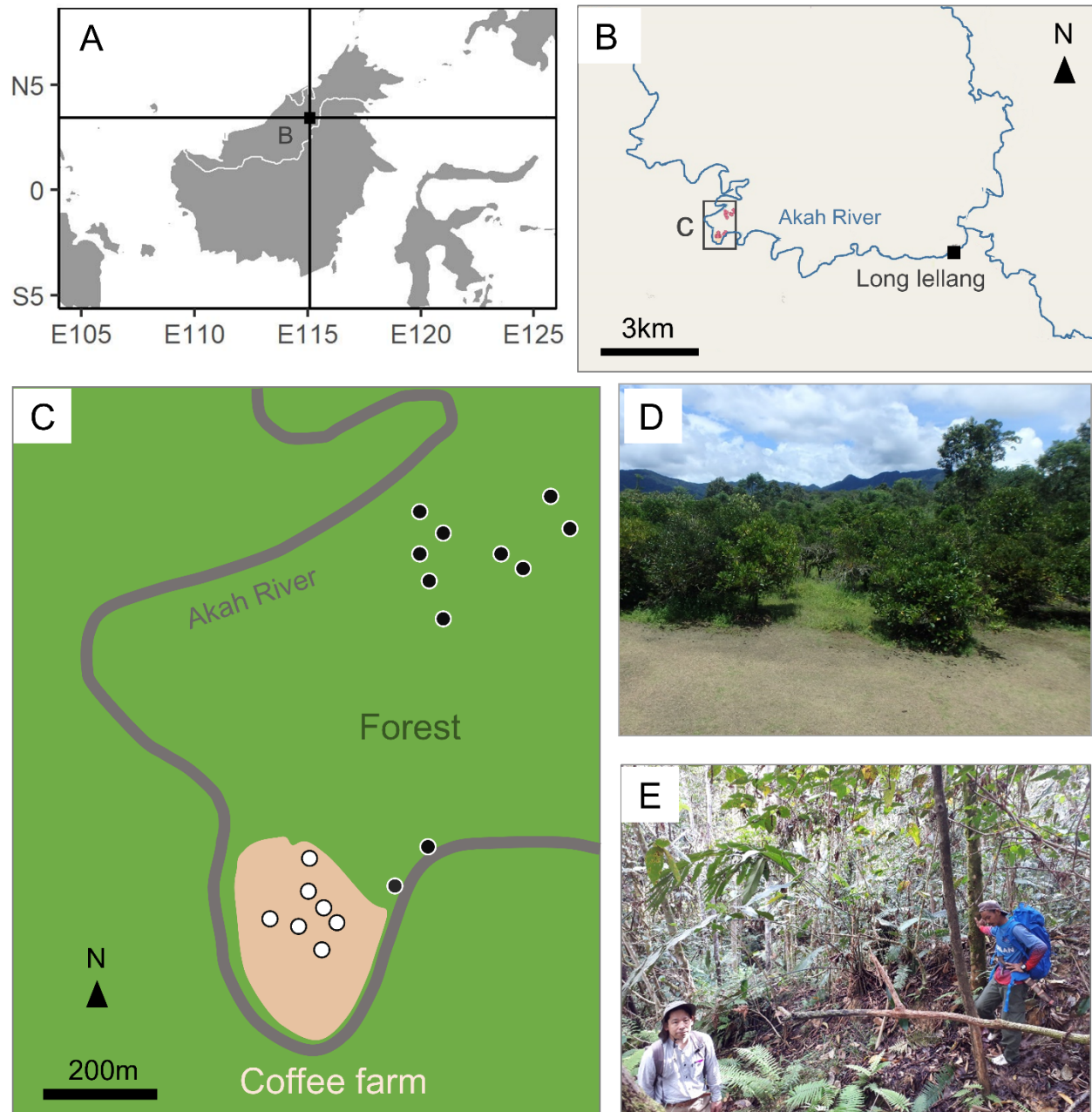


FIGURE 1: A, B. Location of the survey site. C. The black circles in the secondary forests. The white circles indicate the locations of cameras installed in the coffee farm. D. Setting up the cameras. E. Coffee farm landscape.

This area is known as Ulu Baram in Malay, meaning “upstream” or “inland.” It is the only area outside protected zones like national parks where substantial stretches of primary forest remain (International Tropical Timber Organization 2021). Nearly all other primary forests in Sarawak have been depleted by commercial logging. The people who lived in and protected the forest were an indigenous people called the Penan. In late 2011, 18 Penan communities in Ulu Baram announced a concept called the Penan Peace Park (TPPP; Penan, 2011). In 2016, the Sarawak state government agreed to negotiate with Penan representatives. The government expanded the designation to include areas inhabited by twenty-four other indigenous communities—the Kenyah, Kelabit, and Saban—and adopted the name Upper Baram Forest Area (UBFA).

How can biodiversity conservation and autonomous survival of indigenous communities be balanced in the conservation and utilization of their sites? The impact of human activities on tropical rainforests varies depending on the scale of land use, the species involved, the habitats affected, and methods of alteration (Gerder et al., 2009). For example, the loss of canopy habitats due to tree cutting can have a negative impact on the occurrence of arboreal animals, while the improvement of light conditions due to cutting can have a positive impact on herbivores that feed on understory vegetation (Malhi et al., 2022). It has also been reported that bat diversity in forests following shifting cultivation was lower than in primary forests, while the species richness of small mammals and herbivorous scarab beetles was equal to or even higher than in continuous primary forests (Kishimoto-Yamada et al., 2011; Takano et al., 2014). Some studies have demonstrated that forests managed by Indigenous peoples have both high biodiversity and economic value (Mulu et al., 2020; Leo et al., 2022).

This study used a coffee farm within the UBFA as a case study to examine the impacts of the farm’s development on local communities from both ecological and socio-economic perspectives. Mr. Francis Aran (hereinafter referred to as Mr. F), a Kelabit man, pioneered coffee farming in this area. He began seedling cultivation on 0.3 hectares of land in 2007 and expanded to 6.9 hectares by November 2009. His farm is located outside the residential village of Long Lellang. Focused on Mr F’s farm management, the research questions (RQs) for this study were:

RQ1: How has a locally managed coffee farm been maintained over the past 20 years?

RQ2: What kinds of relationships between Kelabit and Penan have emerged through the development of the coffee farm?

At the same time, understanding the effects of coffee farm management on forest biodiversity is essential. Regarding biodiversity conservation in the coffee farm, the study focused primarily on terrestrial mammals and birds. These taxonomic groups not only occupy a high trophic level in the local food web but also provide a source of protein and cash income for residents. However, their habitats are modified by farm development, which can affect their availability. Furthermore, animals are closely related to plants, contributing to material cycles and ecosystem function. Therefore, the RQs related to biodiversity were:

RQ3: What is the fauna of the farm and the surrounding forest?

RQ4: How does the coffee farm affect mammal and bird faunas?

METHODOLOGY

Study Site

Mr F's coffee farm is located along the Akah River, a tributary of the Baram, and are about a 40-minute ride by outboard motorboat from Long Lellang (Fig. 1B). The farm is adjacent to the river and forest, and the boundary between the farm and forests is covered with young trees and ferns. The forests designated as the target area were adjacent to the farm, and their distance from the farm was about 700 m (Fig. 1C). These forests are secondary forests that have been logged, still retaining tall trees exceeding one meter in diameter at breast height. Primary forests without a history of commercial logging also extend across the river.

Economic and Social Survey

The authors have visited Long Lellang for a few days or weeks every year since 2009. During these visits, they have conducted participant observation and interviews within the village and on the farm. Some interviews with Mr F have been previously documented in Japanese (Bundo, 2025). Kelabit people traditionally make their living through farming. As of 2021, Long Lellang's population was around 100, but many have now moved outside the village, such as to the coastal town of Miri. The aging population is progressing along with this depopulation. Residents use the forest near the settlement for timber and collect non-timber forest products (rattan, fish, terrestrial vertebrates, wild edible plants, etc.).

In the surrounding areas of Long Lellang, several Penan communities live in scattered settlements, each comprising several dozen people. Many live in primary forests, where they gather various forest products, hunt, and cultivate rice (Kanazawa, 2021). Although timber companies have repeatedly attempted to enter this area, the Penan communities oppose commercial logging and have protected the primary forest from logging operation through road blockades.

Natural Ecological Survey

For the fauna survey, a total of 39 camera traps (Bushnell Trophy Cam E3) that recorded video in response to movement were installed on the coffee farm (20 cameras) and in the forest (19) from March 25 to October 23, 2023. Cameras were spaced 50–80 meters apart. However, due to theft and humidity-related malfunctions, the final count was seven cameras on the farm and ten in the forest (resulting in 1,245 camera days on the farm and 1,896 in the forest). Cameras were mounted on tree trunks approximately 100 cm above ground level, angled downward at 20 degrees (Fig. 1D). No bait or lures were used to attract animals. The cameras were set to operate 24 hours a day. The cameras recorded 10 seconds of video per trigger, with a 15-minute lag between triggers to reduce battery consumption.

The date, time, and species of the animals were recorded from each video. They were identified to the species level, focusing on birds and medium-to-large ground-dwelling mammals. However, due to difficulties in species identification, mouse-deer were recorded to the genus level (genus *Tragulus*), although some individuals were identified as *Tragulus napu* based on chest patterns. As the site was located near the equator at 3°N latitude, the period from 6:00 to 18:00 was considered daytime throughout the study period, with all other times considered nighttime. To assess sampling completeness (i.e., evaluating whether camera trap sampling reflected the local fauna), species accumulation curves were generated from the dataset of capture locations, times, and animal species obtained. The species accumulation curve was created using R (ver. 4.2.2) and the Began package. To examine whether animal occurrence numbers were influenced by differences in land use, the number of animal detections was compared between the farm and forest areas. For species considered to have a minimum sample size ($n = 10$), Fisher's exact test was performed, with $p < 0.05$ indicating a statistically significant difference. The null hypothesis was that "the number of detections is not influenced by the detection site," assuming that in this case, the number of

animal detections would be proportional to the ratio of operational days between survey sites. It should be noted that during the period from 2000 to 2024, wild boars, the main terrestrial mammal species on Borneo (Shanahan et al., 2000), were absent due to African swine fever (Erik et al., 2024).

RESULTS

Coffee Farm Development

Mr. F, who was a businessman until his thirties, led a busy life in the city. After his health deteriorated, he quit his corporate job and returned to his hometown, Long Lellang. Once he recovered, he began farming rice and coffee on his own land alongside his father, Mr. Amat Aran. A 2009 report on the coffee farm stated that the purpose of the development was to set a precedent for appropriate land use in the region by introducing coffee, a cash crop (Manit & Sedau, 2009). It would also provide opportunities for the Penan people living in the vicinity to earn monetary income and improve their community's economic situation. Around the farm, within a 30-minute boat ride or walking distance, are the Penan villages of Long Benali, Ba Pengaran Iman, and Ba Pengaran Kelian, each with a population several times larger than that of Long Lellang.

The main coffee varieties cultivated industrially worldwide are Arabica and Robusta. Arabica, the most widely produced variety, is grown in high-altitude, cool climates. Robusta, whose flavor is less prone to change, is frequently used for instant and canned coffee. In the 1880s, British Malayan administrators began cultivating the Robusta variety, but it suffered devastating damage from leaf rust disease and defoliation caused by moth flights (Omar et al., 2022). Liberica is a minor variety, accounting for less than 1% of the global coffee industry, but it is more heat-tolerant than Arabica and resistant to leaf rust. Mr F has focused on cultivating Liberica while also working with Robusta and Arabica varieties.

Initially, the coffee farm began with the cooperation of two Penan families and had expanded to 20 families by November 2009. Wages were RM 15 for youth and RM 20 for adults for the actual work done that day. Tasks included planting seedlings, weeding, pruning, and fertilizing. According to interviews conducted by Manit and Sedau (2009), the Penan welcomed the farm's labor system as clear and understandable, viewing it as a valuable source of income that significantly improved the community's economic situation. The buyer for the farm's coffee beans is an individual operating a cafe in Kuching, the capital of Sarawak. This buyer roasts the beans and sells them as coffee beans.

The total expenses from 2007 to 2009, including wages, equipment purchases, and fuel costs, came to RM 42,000, to the extent that records exist, and were covered entirely by Mr F and his father. Records indicate that in 2008, a total of 7,480 seedlings of Liberica and Robusta were planted across 6.7 hectares of farmland, with harvest expected by mid-2010. Coffee trees are said to bear fruit three to five years after planting, meaning that the trees planted in 2008 were able to produce fruit around 2011.

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TABLE 1.

Class	Order	English name	Scientific name	Number of videos		<i>P</i> *
				Coffee farm	Forest	
Mammalia	Carnivora	Bornean sun bear	<i>Helarctos malayanus</i>	0	6	—
		Banded civet	<i>Hemigalus derbyanus</i>	0	4	—
		Binturong	<i>Arctictis binturong</i>	0	1	—
		Malay civet	<i>Viverra zibethica</i>	14	16	0.795
		Masked palm civet	<i>Paguma larvata</i>	0	2	—
		Domestic cat	<i>Felis catus</i>	1	0	—
		Domestic dog	<i>Canis lupus</i>	3	0	—
		Yellow-throated marten	<i>Msrtis flavigula</i>	2	1	—
		Short-tailed mongoose	<i>Urva brachyurus</i>	0	1	—
	Artiodactyla	Sambar deer	<i>Rusa unicolor</i>	7	29	0.019
		Red muntjac	<i>Muntiacus muntjak</i>	0	23	0.001
		Mouse deer	<i>Tragulus sp.</i> **	0	4	—
	Primates	Pig-tailed macaque	<i>Macaca nemestrina</i>	0	107	< 0.001
		Long-tailed macaque	<i>Macaca fascicularis</i>	0	8	—
	Rodentia	Long-tailed porkpine	<i>Trichys fasciculata</i>	0	3	—
	Pholidota	Sunda pangolin	<i>Manis javanica</i>	5	5	1.000
Aves	Galliformes	Crested fireback	<i>Lophura ignita</i>	0	13	0.039
		Great argus	<i>Argusianus argus</i>	0	5	—
	Gruiformes	White-breasted waterhen	<i>Ameurornis phoenicurus</i>	2	0	—

*Calculated by Fisher's exact test. The procedure is described in the method section.

** At least include *Tragulus napu*

In 2016, the Malaysian federal government launched a program to encourage coffee cultivation in Long Lellang. This development support began because Mr F's farm was recognized by the government as a successful business model (Bundo, 2025). The government provided RM 3,000 per person to plant Liberica coffee on one hectare of land. This aid led some villagers who had left to return and start cultivation, sparking disputes over land ownership. Additionally, some of those who started farming due to this aid knew nothing about the long, arduous process from cultivation to sale, or had no real interest in it. Indeed, some cleared land, planted seedlings, received the subsidy, and soon abandoned their farms. Administrative officials involved in development assistance conducted inspections but did not provide cultivation guidance or establish sales channels. As a result, almost none of those who started coffee farming using the government assistance continue to do so as of the writing of this article.

At the time of the 2023 survey, Mr F's farm measured approximately 6.7 hectares, maintaining the same size as when it was first developed (Fig. 1E). The quantity of beans sold to roasters was 1,496kg per month, with the purchase price offered by local roasters for high-quality beans being RM 40 per kg. Transportation costs from the village amounted to RM 4, and expenses for processing and bean sorting were about RM 10, leaving RM 25. According to Mr F, this is used to pay workers' wages, meaning his business is operating at a level that does not result in a loss (Bundo, 2025).

The typical way to drink coffee in Malaysia involves adding milk and sugar or consuming it as instant coffee. Consequently, the domestic market in Malaysia was stagnant until recently. In addition to coffee, Mr F's farm therefore also cultivates pineapple (*Ananas comosus*), dragon fruit (*Selenicereus undatus*), and durian (*Durio zibethinus*), practicing coffee agroforestry.

The fruit that grows on the coffee tree is called a coffee cherry, and the coffee bean is the seed inside this fruit. Processing and refining are necessary to remove the pulp from the fruit and extract only the seed, or "bean." The flavor of the bean changes depending on the refining method. Mr F experiments with three methods (Bundo, 2025). One is the "natural" method, where the fruit is dried whole and then the seeds are extracted. The second is the "washed" method, where the pulp is removed before drying. The third is the "honey process," where the seeds are dried while leaving the mucilage around them intact. As of 2024, he also began cultivating new seedlings and experimenting with a processing method involving slow indoor drying. As for the writing of this article, plans are underway to use the coffee pulp and skin to make tea. Mr F has thus shown dedication to producing high-quality beans and improving his cultivation, harvesting, and processing methods.

Mammal and Bird Fauna

Camera traps captured 12,931 videos. Of these, 262 captured images of medium- and large-sized vertebrates, including sixteen mammal species and three terrestrial bird species (Table 1). Nine of these species were listed on the IUCN Red List (IUCN 2024): Bornean sun bear (vulnerable), banded civet (near threatened), binturong (vulnerable), sambar (vulnerable), pig-tailed macaque (endangered), long-tailed macaque (endangered), Sunda pangolin (critically endangered), Bornean crested fireback (vulnerable), and great argus (vulnerable). Bornean sun bears and pig-tailed macaques were photographed with their young (Fig. 2). The breeding of medium-to-large-sized animals, including rare species, was photographed in the secondary forest adjacent to the farm.

The species accumulation curves, which indicated the completeness of sampling, passed an inflection point and were approaching an asymptote in both environments (Appendix 1). Comparing the vertebrates photographed between environments, the forest yielded fourteen mammal species and two bird species, while the farmland yielded fewer species: six mammal species and one bird species (Table 1). The number of photographs per species and the photograph frequency (number of photographs/100 camera-days) are shown in Table 1 and Fig. 3. While the photographs of sambar deer, barking deer, pig-tailed macaques, and great argus were fewer on the farm, some species, such as the Malaysian civet and Sunda pangolin, were photographed relatively frequently. However, since the sensors installed in cameras were easily affected by the surrounding environment, it is also necessary to be cautious in interpreting the shooting frequency. Although the ground is covered with herbs, these are regularly removed by mowing and herbicides, particularly around the base of the coffee trees.

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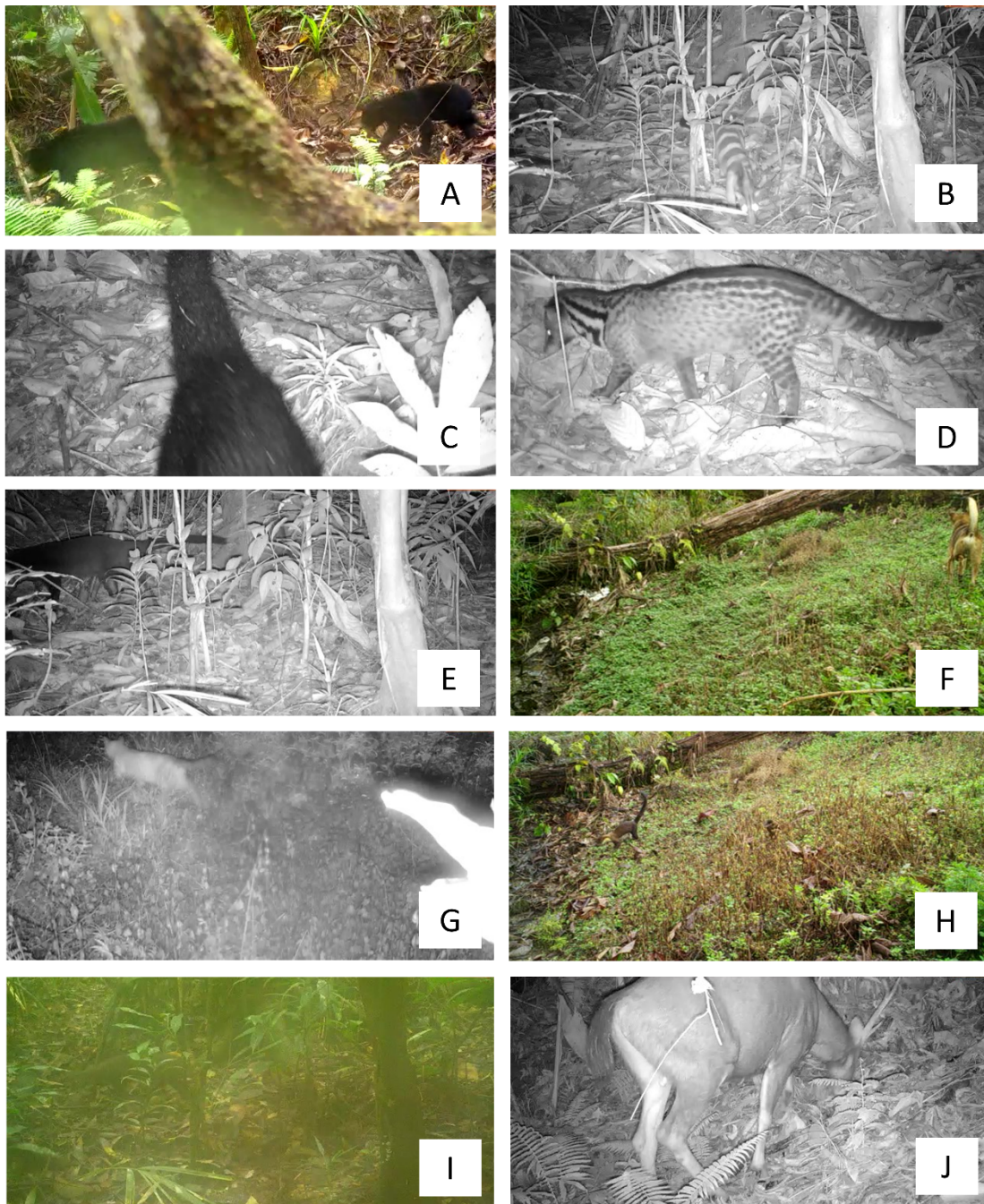


FIGURE 2.

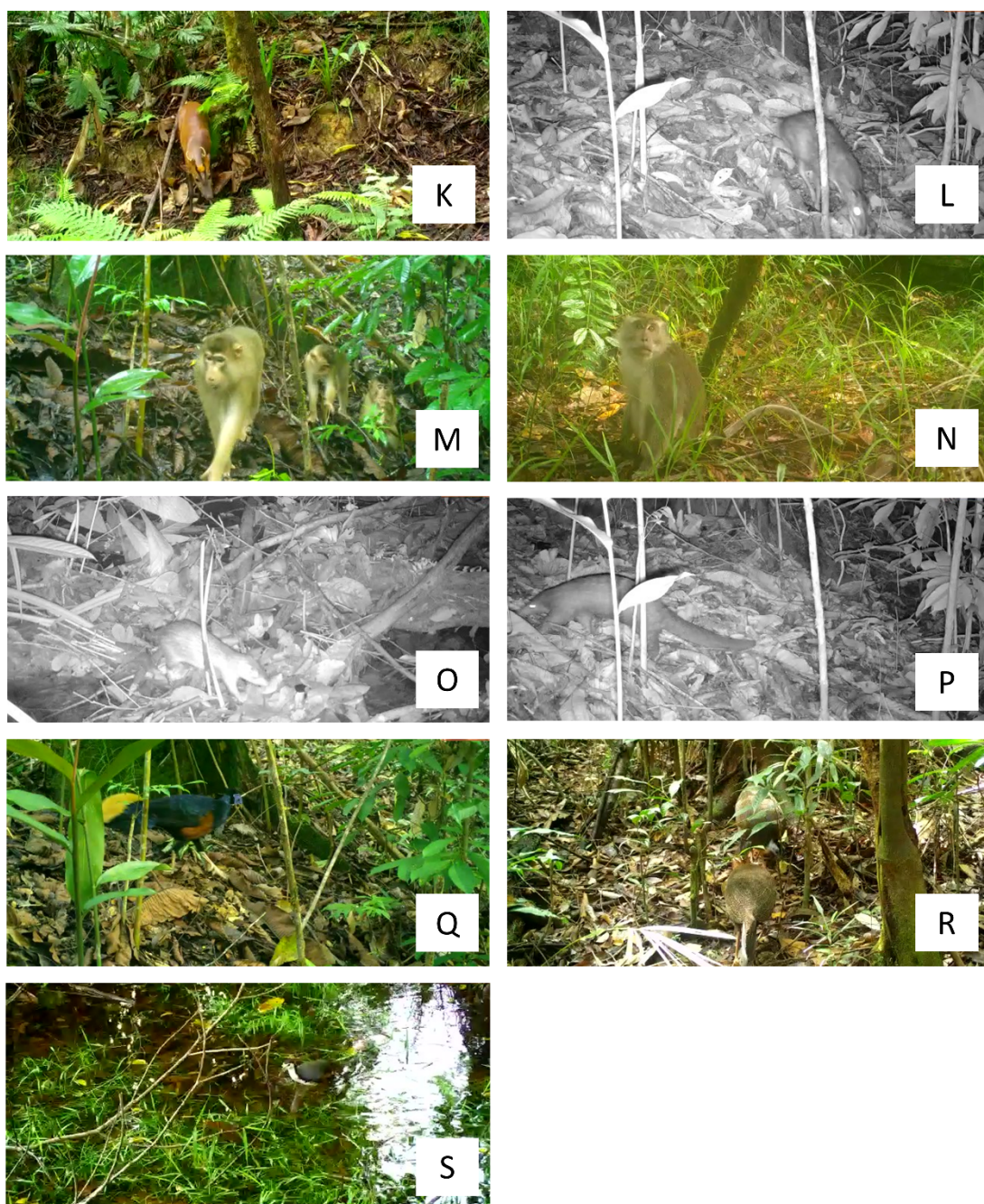


FIGURE 2 (*continued*).

(A) Bornean sun bear, (B) banded civet, (C) binturong, (D) Malay civet, (E) masked palm civet, (F) domestic dog, (G) domestic cat, (H) yellow-throated marten, (I) short-tailed mongoose (not captured in the video), (J) sambar deer, (K) red muntjac, (L) mouse-deer, (M) pig-tailed macaque, (N) long-tailed macaque, (O) long-tailed pork pine, (P) Sunda pangolin, (Q) Bornean crested fireback, (R) great arguments, (S) white-breasted waterhen.

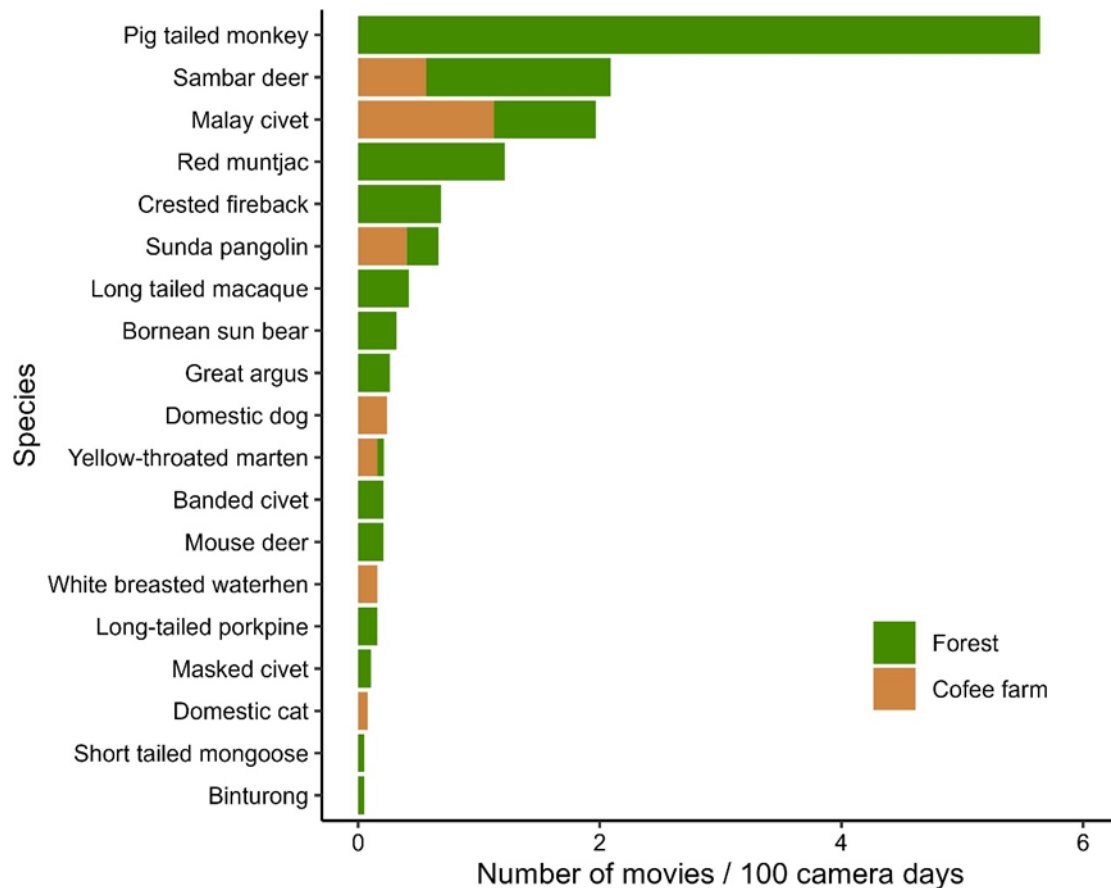


FIGURE 3: Frequency of animal photography

Consequently, despite the presence of adjacent forest, wild vertebrate appearances are infrequent. Nevertheless, animals moving between the secondary forest and coffee farm farms were also confirmed, including Malayan civet, sambar deer, and Sunda pangolin.

The vertical axis shows the cumulative number of animals photographed; the horizontal axis shows the number of cameras installed; the solid line represents the forest; the dashed line represents the value of the coffee farm were confirmed, including Malayan civet, sambar deer, and Sunda pangolin.

DISCUSSION

A small coffee farm was established by a Kelabit family in 2007. The owner, Mr F, has been running the farm for 20 years, maintaining a steady income and a reasonable budget. Surrounding the coffee farm are secondary forests and, beyond them, primary forest areas inhabited by the Penan. The diverse plant and animal resources in the primary forest have formed the basis of the Penan's traditional livelihood. Some non-timber forest products are a source of cash income, but they are becoming difficult to secure as the quality of forests deteriorates (Kanazawa, 2017). Meanwhile, farming communities like the Kelabit must secure alternative income sources, such as cash crop cultivation. Mr F hoped that introducing coffee, a cash crop, would establish a precedent for appropriate land use in the area. At the same time, the coffee farm's management could not be conducted solely within the Kelabit community; it also required labor from the Penan. Developing the coffee farm was therefore an effort to create a local community project in which different ethnic groups could cooperate and coexist.

Conversely, the coffee farm impacted wildlife, as evidenced by the low frequency of herbivore sightings. One reason for this is hunting. According to Mr F, the openness of the farm makes it easy to hunt, and the Penan visit the farm and surrounding forest for these purposes, which are separate from farm management. This may have caused herbivores to become wary and not approach the farm. However, a few sambar deer have been photographed on the farmland (Table 1), and deer species also come to eat the cultivated foliage.

Nevertheless, Mr F's farm has not experienced the type of conflict or damage between wildlife and humans seen on large-scale farms like those of oil palms. While there has been some limited environmental disturbance, it has not led to a decline in wildlife or significant changes to the forest landscape. In the secondary forest adjacent to the farm, medium-to-large animals, including rare species, were photographed breeding. This suggests that, depending on the degree of forest use, forest utilization and wildlife survival can coexist. In locations adjacent to primary or secondary forests, agroforestry land use practices—planting various fruits alongside coffee—can also function as wildlife buffer zones and biological corridors.

Malaysia's coffee culture is currently undergoing a transformation, with demand increasing, especially among young people. Going forward, if the Liberica variety cultivated at Mr F's farm gains higher recognition and its purchase price increases, his business will become more stable. In recent years, Long Lellang has organized agricultural experiences for tourists, which are expected to contribute to revitalizing the local economy as part of the tourism industry. Tourists are already coming to the village for trekking and ecotourism, and visitors have also begun seeking out the coffee farm. The sustainable development of coffee farms within UBFA thus represents an opportunity to balance biodiversity conservation with the autonomous survival of the local community, and it is crucial to further improve these capabilities.

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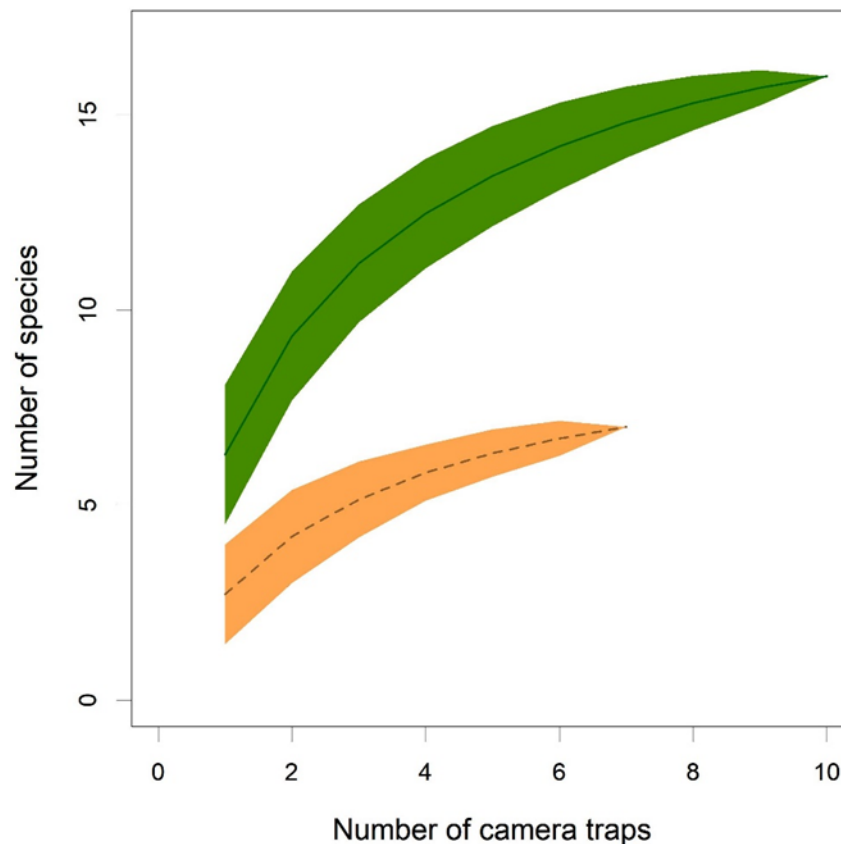
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APPENDIX



APPENDIX 1: Completeness of sampling by camera traps

The vertical axis shows the cumulative number of animals photographed; the horizontal axis shows the number of cameras installed; the solid line represents the forest; the dashed line represents the value of the coffee farm; the bands indicate the 95% confidence interval.