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COVER PAGE

Juvenile Borneon Orangutan *Pongo pygmaeus* at Bukit Merah Orang Utan Island, Malaysia. Photo by Rosimah Roslan.

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GUEST EDITORIAL: PROTECTING WILD PRIMATES DURING THE NOVEL CORONAVIRUS PANDEMIC AND BEYOND

The World Health Organization has declared a global public health emergency in response to the Novel Coronavirus (COVID-19) Pandemic. Wild Western Chimpanzees *Pan troglodytes verus* Schwarz have experienced respiratory outbreaks following infection by human coronaviruses (Patrono et al., 2018) and it is highly probable that other non-human primates are similarly susceptible to SARS-CoV-2, the virus causing the human disease referred to as COVID-19. COVID-19, SARS, Ebola, and Avian Flu are some examples of zoonotic diseases that have jumped from wildlife species into human hosts. This is made possible as wildlife is brought into closer contact with humans through consumption, trade for various purposes, habitat loss, and habitat fragmentation.

Scientific research, nature tourism, and current conservation and management paradigms all have the capacity to subject habituated wild primates to risks of human pathogen exposure. The *IUCN Best Practice Guidelines for Health Monitoring and Disease Control in Great Ape Populations* (Gilardi et al., 2015), were developed in response to a series of mortality events in habituated apes linked to human respiratory virus exposure (Kaur et al., 2008; Köndgen et al., 2008; Palacios, 2019), and a greater recognition of the ease of wild ape exposure to human enteric pathogens (Rwego et al., 2008; Parsons et al., 2015). Fortunately, the majority of these guidelines are broadly applicable to habituated primates and are particularly relevant to the current COVID-19 pandemic.

The current COVID-19 pandemic should be considered a potential threat to the health of wild primates. There is no such thing as zero disease risk and taking measures to prevent or control disease will never eliminate all risks, but implementing these best practices should substantially reduce the risks that human activities pose to primate health and signal a clear commitment to primate conservation.

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AGE-SEX DIFFERENCES IN THE DAILY ACTIVITY AND DIET OF WEST JAVAN LANGUR *Trachypithecus mauritius* IN THE PANGANDARAN NATURE RESERVE, WEST JAVA, INDONESIA: A PRELIMINARY REPORT

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ABSTRACT

In ecology, the study of age-sex-class differences is useful for understanding foraging tactics of target species. However, few studies have addressed this in Asian colobines. In this study, we undertook a preliminary field survey over a period of two months in 2016 in the Pangandaran Nature Reserve, West Java, Indonesia, to compare the activity budget and dietary composition between different age-sex classes of wild West Javan Langur *Trachypithecus mauritius* (Griffith). Our results showed that the langurs spent more than half of the daytime resting. The adults spent a higher percentage of time resting and feeding, while the juveniles spent more time moving and other activities such as play. This could be attributed to age-sex differences in reproductive biology, parental investment, and development. Although the langurs fed on 51 plant species (65 items), a few plant species contributed most to their diet. The item-level dietary overlap (%) was low between adult males and other classes, which may be attributed to age-sex difference in nutritional requirements. There was no clear age-sex difference in the consumption of leaves and fruits.

Keywords: activity, age-sex classes, dietary habits, folivorous, *Trachypithecus*

INTRODUCTION

Colobine monkeys are a major primate group in Africa and Asia which are predominantly folivorous. Studies have shown that the staple diet of many Asian colobines is young leaves, and that their dietary composition changes seasonally (Kirkpatrick, 2007; Tsuji et al., 2013). The percentage of daytime spent resting has been reported to be more than 50% for many colobines (e.g., 76.5% in *Nasalis larvatus* [van Wurmb] [Matsuda et al., 2009], 63% in *Presbytis comata* [Desmarest] [Ruhiyat, 1983], and 62% in *Piliocolobus* spp. [Clutton-Brock, 1974; Marsh, 1981]), which is much higher than that reported for frugivorous primates (e.g. 30-40% in macaques and baboons, 33-54% in apes [Clutton-Brock & Harvey, 1977]). The higher proportion of time spent resting could be related to the special digestive system of the colobines. They have a dual-chambered stomach, similar to ruminants, for digesting cellulose in the foliage (Kool, 1992), and this process requires a longer time for efficient digestion.

Several studies have examined age-sex differences in feeding and other activities of primates. The variation in food habits among individuals can be explained using the Jarman–Bell principle, which states that large-bodied animals require greater amounts of food, but they are capable of tolerating poor-quality food; and in contrast, small-bodied animals require smaller amounts of food, but it should be of high quality (Bell, 1971; Jarman, 1974). Agetsuma (2001), in a study of age-sex differences in the diet of wild Japanese Macaque *Macaca fuscata yakui* Kuroda, found that the adults fed more on lower quality, but more available food items (mature leaves), while the juveniles fed more on insects. Liu et al. (2016) recently found that adult male Sichuan Snub-nosed Monkey *Rhinopithecus roxellana* (Milne-Edwards) ate herbs (low quality diet) more frequently than juveniles and adult females (but see also Hendershott et al., 2016). Regarding activity budgets, Li (2009) found that adult male Yunnan Snub-nosed Monkeys *Rhinopithecus bieti* Milne-Edwards spent more time moving and less time feeding and engaging in social behaviour than adult females, but that adults spent less time moving as compared with juveniles. Similarly, Marsh (1981) reported that adult male Tana River Red Colobus *Piliocolobus rufomitratus* (Peters) spent less time feeding than adult females, and that adults spent less time moving than juveniles. These age-sex differences in diet and activity might reflect fundamental differences in reproductive biology and development among different age-sex classes. Studying such types of intra-group variation in feeding and activity could be useful for understanding the foraging tactics of the target species.

In this study, we analyzed the activity budgets and dietary composition in relation to age-sex difference of wild West Javan Langur *Trachypithecus mauritius* (Griffith), a colobine endemic to Indonesia. Specifically, we tested the following three predictions: 1) adult males spend less time feeding than adult females; 2) adults spend more time resting and feeding, while juveniles spend more time moving; and 3) adults feed more on low-quality diet, such as mature leaves, while juveniles feed more on high-quality diet, such as young leaves, flowers, and fruits.

MATERIALS AND METHODS

Study site

We observed the behaviour of West Javan Langur at Pangandaran Nature Reserve (PNR), West Java, Indonesia (108°40′E and 7°43′S). PNR is located at the top of a peninsula, bordering an isthmus approximately 200 m in width that links the peninsula to the mainland (Tsuji et al., 2015 for details of the site). PNR is divided into two sections, namely, the northern 38 ha forest park (Taman Wisata Alam) where we conducted the study and the southern 370 ha restricted nature reserve (Cagar Alam). The average annual rainfall in the nature reserve between 2005 and 2011 was 3,272 mm. The air temperature and relative humidity were 25–30 °C and 80–90%, respectively (Tsuji et al., 2015).

Animals and data collection

The animals were members of a well-habituated group (Kantor group) of West Javan Langurs. During the study period, this group was composed of 13 individuals: six adult females (body length: 50–70 cm), six juveniles (sex unknown, body length: 30–50 cm), and one adult male (YT, unpubl. data). We observed the behaviour of the langurs in February and March 2016. We were able to observe the study animals from a close distance (<10m). We collected data between 06:00 h and 18:00 h, by scan sampling at 10-min intervals (Altman, 1974), and recorded the activities of visible animals. The activities were classified into (1) feeding (puts food into mouth), (2) resting (sitting, lying, and sleeping on the ground or in trees), (3) moving (moving to another place by leaping, moving quadrupedally in trees, or moving on the ground), (4) allogrooming, and (5) others (including playing, urinating, defecating, self-grooming, and agonistic behaviour). We also recorded the food items eaten by the langurs and classified them into leaves (including leaf buds, young leaves, and mature leaves), fruits (both young and mature), and flowers (including flower buds). We evaluated the activity and dietary composition by calculating the percentage of animals performing the target activity (or part eaten) out of all the scanned animals. We also calculated item-based dietary overlap (%) between three age-sex classes (i.e., adult male vs. adult females, adult male vs. juveniles, and adult females vs. juveniles).

Data analyses

To test the age-sex differences in the activities and dietary composition, we used generalized linear models (GLMs). The dependent (response) variable was the number of scanned animals for the target activity (or number of feeding animals for a specific food part) in a day, and the independent (explanatory) variable was age-sex class (adult male, adult female, and juvenile). The total number of scanned animals (or total number of feeding animals) in a day was set as an offset term. For post-hoc tests, we used the Bonferroni method. We assumed the error structure of the dependent variable would follow a Poisson distribution. All analyses were performed using R.3.2.3. (R Development Core Team, 2015), and the level of significance (α) was set at 0.05 for each analysis.

RESULTS

During the 2-month survey, we collected behavioural data of the langurs for 340 h (30 days: 15 days in February and 15 days in March). The total number of observations was 8,915 (February: 3,865, March: 5,050).

Age-sex differences in activities

Figure 1 shows the percentage of time spent by the study group on the five activity classes during the study period. The proportion of time spent on

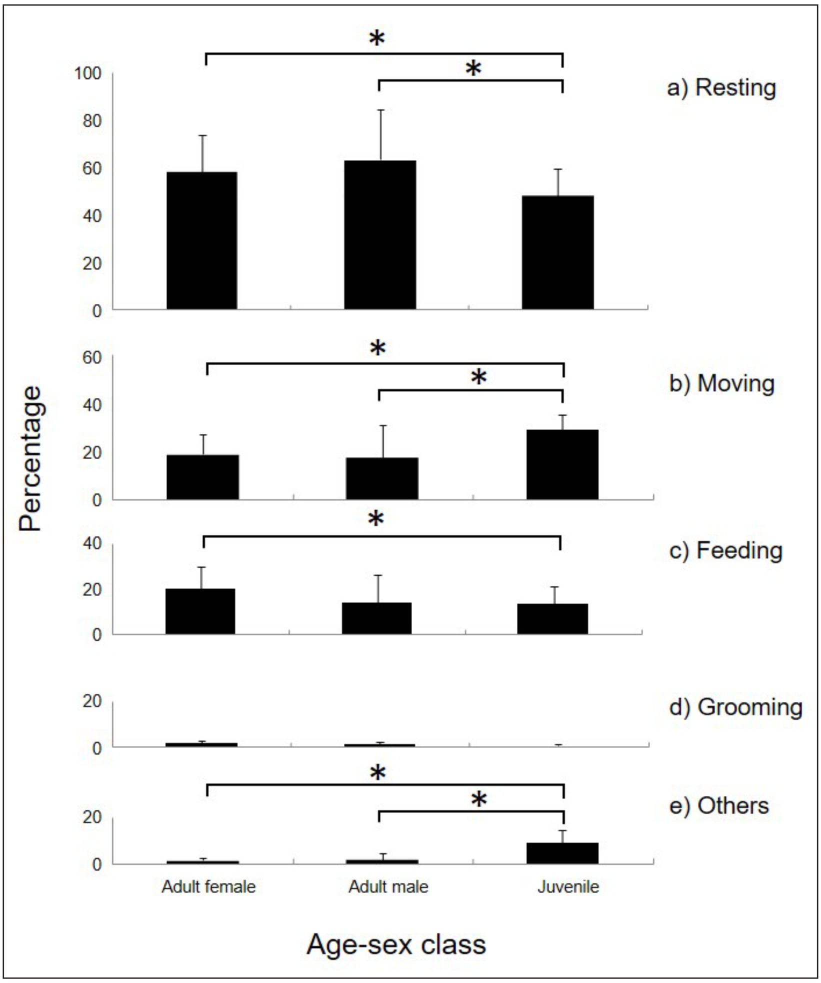

Fig. 1. Mean (±SD) percentages of the main activities of West Javan Langurs by age-sex classes: (a) resting, (b) moving, (c) feeding, (d) grooming, and (e) others. The number of observation days is 30. * represents significant difference ($p<0.017$, Bonferroni adjustment).

grooming and in other activities was much lower (<5%) than that spent on the other three activity classes (Figs 1d and 1e). The GLM analyses showed that all activities differed significantly between the age-sex classes ($p<0.05$ for all, Table 1). The post-hoc tests showed significant differences in the percentage of time spent resting, moving, feeding, and other activities between the adults and juveniles ($p<0.017$): compared with adults, juveniles spent less time resting (58.5%, 63.5%, and 47.6% for adult female, adult male, and juvenile, respectively) and feeding (19.9%, 15.0%, and 13.3%), and more time moving (19.2%, 19.1%, and 29.6%) and other activities (1.0%, 1.5%, and 9.1%). No significant difference in grooming (1.4%, 0.9%, and 0.4%) was observed between the age-sex classes (Table 1). Thus, our prediction 2 was supported, while prediction 1 was not.

Food items of the langurs

The langurs fed on various types of leaves, fruits, and flowers. During the study period, we recorded 51 plant species and 65 items in the diet of the langurs. The top five food items consumed by the langurs in February 2016 were the leaves of *Vitex pubescens* Vahl. (19.0%), *Decaspermum fruticosum* Forest. & Forst. (14.6%), *Cynometra ramiflora* L. (12.8%), *Hibiscus similis* Bl. (9.0%), and *Barringtonia spicata* Bl. (4.1%) (Table 2), while in March 2016 the top food items consumed included the leaves of *Vitex pubescens* (23.6%), *Hibiscus similis* (13.6%), *Cynometra ramiflora* (5.7%), *Croton argyratus* Bl. (4.8%), and *Nauclea orientalis* (L.) L. (4.8%) (Table 3). Adult females and juveniles showed

Table 1. GLM results for the daily activities of the West Javan Langur at study site.

Variable	Estimate ± SE	z-value	p-value	Result of the post-hoc test
Resting				
Intercept	-0.54 ± 0.02	-27.7	<0.001 ***	AF –AM p=1
Adult male	0.08 ± 0.05	1.45	0.147	AM-J p<0.001
Juvenile	-0.21 ± 0.03	-6.76	<0.001 ***	J-AF p<0.001
Moving				
Intercept	-1.65 ± 0.03	-49.03	<0.001 ***	AF-AM p=1
Adult male	-0.00 ± 0.10	-0.02	0.981	AM-J p<0.001
Juvenile	0.43 ± 0.05	-9.59	<0.001 ***	J-AF p<0.001
Feeding				
Intercept	-1.61 ± 0.03	-48.82	<0.001 ***	AF-AM p<0.136
Adult male	-0.28 ± 0.11	-2.51	0.012 *	AM-J p=1
Juvenile	-0.40 ± 0.06	-7.25	<0.001 ***	J-AF p=0.025
Grooming				
Intercept	-4.31 ± 0.13	-33.90	<0.001 ***	AF-AM p<0.289
Adult male	-0.46 ± 0.46	-0.98	0.326	AM-J p=1
Juvenile	-1.15 ± 0.28	-4.09	<0.001 ***	J-AF p<0.054
Others				
Intercept	-4.58 ± 0.15	-31.42	<0.001 ***	AF-AM p=1
Adult male	0.41 ± 0.36	0.36	0.262	AM-J p<0.001
Juvenile	2.18 ± 0.16	0.16	<0.001 ***	J-AF p<0.001

***p<0.001, **p<0.01, *p<0.05

the largest dietary overlap, while the overlap between adult males and females was the least in both the months (February 2016: adult male vs. adult females: 36.0%, adult male vs. juveniles: 47.5%, adult females vs. juveniles: 73.3%; March 2016: 69.1%, 67.4%, and 79.3%, respectively). The adult male fed most on *H. similis* in both the months while it did not feed on *V. pubescens* in February.

Age-sex differences in dietary composition

The langurs, regardless of age and sex, fed mainly on leaves (91.3%, 67.4%, and 87.9%, for adult females, adult males, and juveniles, respectively) (Fig. 2a). We also found that the langurs fed on fruits (5.9%, 0.3%, and 5.2%) and flowers (2.8%, 2.3%, and 6.9%) but their percentages were much lower than that of the leaves (Figs. 2b and 2c). The percentage of food categories fed on, with the exception of flowers, did not differ significantly between the age-sex classes, (Table 4). Thus, our prediction 3 was also not supported.

DISCUSSION

In this study, we showed that the West Javan Langurs, regardless of age-sex class, spent more than half of the daytime resting. This supports previous findings (Ruhiyat, 1983; Matsuda et al., 2009; Smith et al., 2013), and the earlier notion that folivorous primates spend more time resting as opposed to frugivorous primates such as macaques, baboons, and apes (Clutton-Brock & Harvey, 1977).

We found age-sex differences in activity: firstly, we found that adult langurs spent more time resting. Similar results have been reported for Tana River Red Colobus *Piliocolobus rufomitratus* (Peters) (Marsh, 1981). This trend may reflect age-specific digestive physiology: adult animals, which ingest larger amounts of food, would need more time to rest and digest the plant materials. Secondly, we found that adult females spent more time feeding than juveniles. This result is similar to those observed for adult females of the Cat Ba Langur *Trachypithecus poliocephalus* (Trouessart) and snub-nosed monkeys *Rhinopithecus roxellana*

Table 2. List of food items consumed by the West Javan Langur (by age-sex class) at study site for 15 days in February 2016.

Family	Plant species	Local name	Part eaten	Age-sex class (%)			Grand mean (N=621)
				AF (N=393)	AM (N=13)	J (N=215)	
ANACARDIACEAE	*Buchanania arborescens* Bl.	Pohpohan	FO	0.3			0.2
ANNONACEAE	*Cananga odorata* Hook.f. & Thomson	Kananga	FO			0.5	0.2
CANNABACEAE	*Celtis philippensis* Bl.	Kipepetek	FO		15.4	4.2	1.8
COMBRETACEAE	*Terminalia bellirica* (Gaertn.) Roxb.	Jaha	FO	1.5			1.0
EUPHORBIACEAE	*Croton argyratus* Bl.	Parengpeng	FO	3.6	7.7	1.4	2.9
	Suregada glomerulata (Blume) Baill.	Kibeuntur	FO			0.5	0.2
	Alchornea rugosa (Lour.) Mull. Arg.	Burutu	FO			0.5	0.2
FABACEAE	*Cynometra ramiflora* L.	Kateng-kateng	FO	10.2	15.4	16.7	12.8
FLACOURTIACEAE	*Casearia grewiifolia* Vent.	Ki minyak	FO	0.5		0.9	0.7
LAMIACEAE	*Tectona grandis* L.	Jati	FO	3.8		1.4	2.9
LECYTHIDACEAE	*Barringtonia spicata* Bl.	Putat	FO	3.3		5.6	4.1
LYTHRACEAE	*Lagerstroemia speciosa* (L.) Pers.	Bungur	FO	1.8		0.5	1.3
			FR	0.5			0.3
	Lagerstroemia ovalifolia T.& B.	Benger	FO	0.8		0.5	0.7
MALVACEAE	*Hibiscus similis* Bl.	Waru	FO	7.1	30.8	10.7	9.0
			FL	1.8		0.5	1.3
MELIACEAE	*Swietenia macrophylla* King.	Mahoni	FO	1.5		1.4	1.5
MORACEAE	*Ficus annulata* Bl.	Kiara koneng	FO	3.3		1.4	2.8
			FR	1.3		0.5	1.0
	Ficus subcordata Bl.	Kiara kebo	FO	2.8		0.5	2.0
			FR	1.0			0.7
	Ficus sumatrana Miq.	Kiara beas	FO	1.8			1.1
MYRTACEAE	*Syzygium racemosum* (Bl.) DC.	Jambu kopo	FO			1.9	0.7
	Decaspermum fruticosum J.R. Forst. & G. Forst.	Ipis kulit	FO	13.2	23.1	15.8	14.6

	Syzygium antisepticum (Bl.) Merr. & L.M. Perry	Kipancar	FO	1.8		1.9	1.8
	Rhodamnia cinerea Jack	Kibesi	FO	0.8			0.5
			FR	1.3			0.8
	Syzygium sp.	Jambu alas	FO			0.5	0.2
RUBIACEAE	*Nauclea orientalis* (L.) L.	Kelepu	FO	3.8		4.7	4.1
	Psychotria viridiflora Reinw. ex Bl.	Kikores	FO	1.8		3.3	2.3
	Neonauclea excelsa (Bl.) Merr.	Cangcaratan	FR	0.5			0.3
SAPINDACEAE	*Schleichera oleosa* (Lour.) Oken	Kosambi	FO	0.8	7.7		0.7
	Erioglossum rubiginosum (Roxb.) Bl.	Kilalayu	FO	0.5		0.9	0.7
STERCULIACEAE	*Sterculia coccinea* Jack	Hantapheulang	FO	2.5		0.9	2.0
			FR	0.3		0.9	0.5
VERBENACEAE	*Vitex pubescens* Vahl.	Laban	FO	19.6		18.1	19.0
			FR	0.3		0.9	0.5
			FL	1.3			0.8
Unknown	Unknown	?	FO	0.3		0.5	0.3
	Liana sp.	Liana	FO	2.0		1.9	2.0

AF: adult female, AM: adult male, J: juvenile, FL: flower, FO: leaf, and FR: fruit

Table 3. List of food items consumed by the West Javan Langur (by age-sex class) at study site for 15 days in March 2016.

Family	**Plant species**	**Local name**	**Part eaten**	**Age-sex class (%)**			**Grand mean (N=861)**
				AF (N=519)	**AM (N=74)**	**J (N=268)**	
ACHARIACEAE	*Hydnocarpus heterophylla* (Bl.) Shloot.	Buntut lutung	FO	0.8	1.4	0.4	0.7
ANACARDIACEAE	*Mangifera* sp.	Mangga pari	FO	0.2			0.1
BIGNONIACEAE	*Oroxylum indicum* (L.) Benth. ex Kurz	Pongporang	FO	1.0		0.4	0.7
CANNABACEAE	*Celtis philippensis* Bl.	Ki pepetek	FO	0.2		0.4	0.2
EUPHORBIACEAE	*Antidesma bunius* (L.) Spreng.	Huni	FO	4.8	4.1	2.6	4.0

			FR	2.5	1.4	4.5	3.0
	Croton argyratus Bl.	Parengpeng	FO	5.2	9.5	3.0	4.8
	Aporosa sphaeridophora Merr.	Kiendog	FO	1.5	1.4	1.9	1.6
	Suregada glomerulata (Blume.) Baill.	Kibeunteur	FO	0.4			0.2
HERNANDIACEAE	*Hernandia peltata* Meisn.	Borogondolo	FO	0.8	1.4	0.7	0.8
			FL	0.2		0.4	0.2
FABACEAE	*Cynometra ramiflora* L.	Kateng-kateng	FO	4.8	5.4	7.8	5.7
	Trachylobium verrucosum Hayne	Kisapi	FO	0.6		0.7	0.6
	Dalbergia latifolia Roxb.	Sonokeling	FO	0.2			0.1
	?	Kacang-kacangan	FO	2.5	2.7	3.0	2.6
	?	Kacang-kacangan	FL	0.2		0.7	0.3
LAMIACEAE	*Tectona grandis* L.	Jati	FO	3.1		2.2	2.5
LYTHRACEAE	*Lagerstroemia ovalifolia* T.& B.	Benger	FO	1.0		0.4	0.7
	Lagerstroemia speciosa (L.) Pers.	Bungur	FO	0.8		0.7	0.7
MALVACEAE	*Hibiscus similis* Bl.	Waru	FO	12.7	30.8	16.0	13.6
	Schoutenia ovata Korth.	Walikukun	FO	1.2	1.4		0.8
	Pterospermum javanicum	Bayur	FO	3.5	1.4	1.5	2.6
			FR	0.6		1.5	0.8
	Pterospermum diversifolium Bl.	Cerlang	FO	1.2	1.4	2.2	1.5
MORACEAE	*Ficus pubinervis* Bl.	Kopeng	FO	2.3	1.4	1.1	1.8
	Ficus benjamina L.	Beringin	FO	1.2	1.4	1.5	1.3
			FR			1.1	0.3
	Ficus subcordata Bl.	Kiara kebo	FO	0.2			0.1
			FR	1.0		1.1	0.9
	Ficus sumatrana Miq.	Kiara beas	FO	1.2	1.4	0.7	1.0
	Ficus annulata Bl.	Kiara koneng	FO	0.6	1.4	0.4	0.6
MYRTACEAE	*Syzygium aqueum* Alston	Jambu air	FO	1.3	2.7	0.4	1.1

			FR	1.3	1.4	3.0	1.8
	Decaspermum fruticosum J.R. Forst. & G. Forst.	Ipis kulit	FO	1.9	6.8	2.2	2.4
	Rhodamnia cinerea Jack	Ki beusi	FO	1.0		1.9	1.1
	Syzygium racemosum (Bl.) DC.	Kopo	FO	0.2	1.4	0.4	0.3
RUBIACEAE	*Nauclea orientalis* (L.) L.	Kelepu	FO	3.9	6.8	6.3	4.8
			FL	1.0	1.4		0.7
	Ixora paludosa Kurz	Soka	FO	0.8			0.5
SAPINDACEAE	*Erioglossum rubiginosum* (Roxb.) Bl.	Ki lalayu	FO	1.0		1.9	1.1
	Schleichera oleosa (Lour.) Oken	Kosambi	FO	1.2		0.4	0.8
VERBENACEAE	*Vitex pubescens* Vahl.	Laban	FO	26.6	27.0	18.3	23.6
			FL	1.9	1.4	4.9	2.7
UNKNOWN		Kiasahan	FO	2.9		2.2	2.4
		Liana	FO	1.3		1.1	1.1
		Kelor	FO	0.4	1.4		0.3
		Kibaska	FO	0.2			0.1

AF: adult female, AM: adult male, J: juvenile, FL: flower, FO: leaf, and FR: fruit

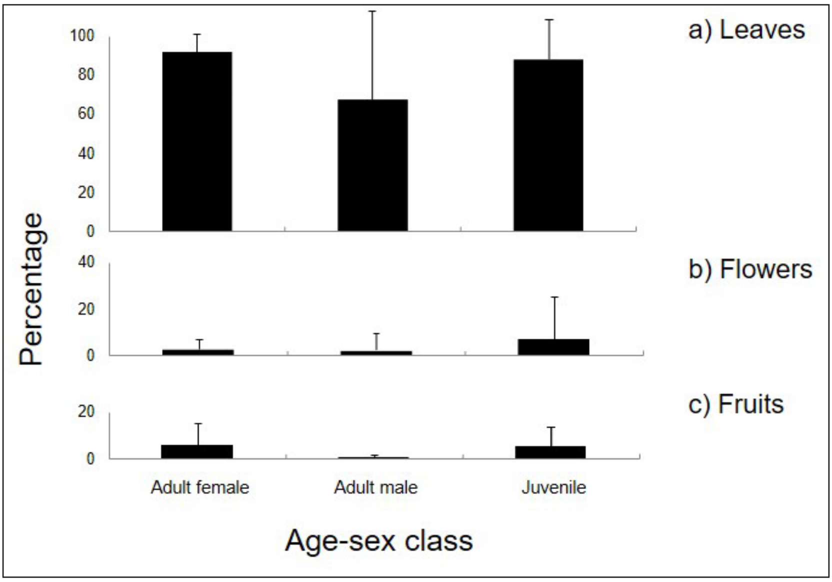

Fig. 2. Mean (±SD) percentages of the staple diets of West Javan Langurs by age-sex classes: (a) leaves, (b) flowers, and (c) fruits. The number of observation days is 30.

Table 4. GLM results for the dietary composition of the West Javan Langur at study site.

Variable	Estimate ± SE	z-value	p-value	Result of the post-hoc test
Leaves				
Intercept	-0.10 ± 0.02	-2.77	0.006 **	-
Adult male	0.05 ± 0.12	0.40	0.692	
Juvenile	-0.09 ± 0.06	-1.49	0.138	
Fruits				
Intercept	-2.81 ± 0.13	-20.87	<0.001 ***	-
Adult male	-1.61 ± 1.00	-1.59	0.112	
Juvenile	0.16 ± 0.22	0.75	0.452	
Flowers				
Intercept	-3.45 ± 0.19	-18.60	<0.001 ***	AF-AM p=1
Adult male	0.13 ± 0.61	0.22	0.826	AM-J p=1.00
Juvenile	1.14 ± 0.23	4.86	<0.001 ***	J-AF p=0.62

***: p<0.001, **: p<0.01

and *R. bieti* (Li, 2009; Li et al., 2014; Hendershott et al., 2016). A probable reason for the lower percentage of juveniles feeding may be the smaller amount of required nutrition and smaller volume of their stomach. Lastly, we found that juveniles spent more time moving and in other behaviour (mainly playing) compared with the adults. This is similar to Sichuan Snub-nosed Monkeys *R. roxellana*, which were observed to spend more time moving than adults (Li, 2009). Brotoisworo (1991), who studied the fundamental ecology of West Javan Langurs in Pangandaran in the 1980s, noted that the juveniles often played and participated in infant transfer; our study supported his findings. White-headed Langur *Trachypithecus leucocephalus* Tan juveniles spent more time playing, while the adults spent more time grooming (Li & Rogers, 2004); thus, age-specific differences in the degree of moving and playing is likely a general characteristic of colobines, and similar to many other mammal species.

During the study period, the primary food item of the langurs was young leaves (Fig. 2a). The staple diet of many Asian colobines is young leaves (Kirkpatrick, 2007; Tsuji et al., 2013) and the present study further corroborates this. However, compared with results from earlier studies conducted at the PNR in the 1980s (30–50%; Brotoisworo, 1991; Kool, 1993), the percentage of young leaves consumed in our study (>80%) was greater. This could be an artifact of the shorter duration of our study, which failed to capture seasonal changes, for example. With respect to dietary composition, the langurs showed no clear age-sex variations. A study on the Cat Ba Langur *T. poliocephalus* also did not find any age-sex differences in the category-level diet composition (Hendershott et al., 2016), which could be the result of higher availability of foliage, which is their staple diet, leading to lower intra-specific competition for this food resource and/or their higher specialization to folivory. We should be careful drawing conclusions on the basis of short-term data, but a probable reason for the lack of age-sex differences in dietary composition is the availability of leaves in PNR. In general, dietary composition of primates is affected by the availability of food (Liu et al., 2016), feeding competition, habitat type, and food abundance and distribution (Jaman & Huffman, 2011). The availability of young leaves in PNR is much greater than that of other food items throughout the year (Tsuji et al., 2018); therefore, the animals can subsist on leaves. Furthermore, intra-specific competition over foliage would be negligible when compared with fruits (limited availability, seasonal, and clumped resource; Koenig, 2002). Another probable reason for the lack of age-sex difference in diet composition is the specialized digestive system of the langurs (Caton, 1999): because langurs are highly adapted to digesting the fibers in leaves, they may not be able to drastically shift their diet composition. We found that at the item-level, dietary overlap between adult females and juveniles was greater than that between adult females and the adult male. This result might also be an artifact of the short-duration of the study, but there is a possibility that this can be attributed to age-sex difference in nutritional requirements. To test this possibility, nutritional analysis of the diet is necessary.

We report preliminary results for age-sex differences in the activity and dietary habits of West Javan Langurs, the ecology and social behaviour of which have been poorly studied. Further longer-term studies on intra-group variation in feeding and activity would contribute to a better understanding of the ecology of the species.

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MENTILIN *Cephalopachus bancanus bancanus* (HORSFIELD, 1821) HABITAT IN BANGKA REGENCY, INDONESIA

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ABSTRACT

The Mentilin *Cephalopachus bancanus bancanus* is a small nocturnal arboreal primate, also known as the Horsfield's Tarsier. It is a flagship species of Bangka Island, listed as Endangered (EN) by the IUCN Red List of Threatened Species. This research was undertaken with the aim to investigate Mentilin habitat in Bangka Regency. The research was conducted in Zed, Kemuja, Paya Benua and Petaling villages in Bangka Regency, Bangka-Belitung Islands Province, Indonesia from December 2015 to February 2016. The methods used to collect vegetation data were strip transect-line plots and strip transects. Across all habitats, we found 33 plant species from 22 families with 488 individuals. In general, the dominant vegetation in the study area was *Hevea brasiliensis* or jungle rubber. Rubber trees, poles, saplings and seedling layers were the main vegetation in all habitats. *Clidemia hirta* dominated ground cover layer in Zed, Kemuja and Paya Benua. In Petaling, *Brachiaria mutica* dominated. The study concluded that Mentilin in Bangka Regency were well adapted to habitat dominated by jungle rubber *H. brasiliensis.* Saplings were used by Mentilin for sleeping and foraging. Mentilin also used four sapling species as sleeping trees; these were *Schima wallichii, Trema orientalis, Ficus annulata and F. aurata*. This study demonstrates that areas dominated by jungle rubber provide important habitat for Mentilin. Consequently, some degree of protection of jungle rubber should be an important element in efforts to assure the conservation of this species in Bangka Regency, possibly along the lines of the IUCN Protected Area Category VI: Protected area with sustainable use of natural resources.

Keywords: Bangka Island, conservation, deforestation, jungle rubber, Tarsiidae, unprotected habitat

INTRODUCTION

Bangka Island is one of the main islands in Bangka-Belitung Islands Province which has an area of 11,330 km^2. Bangka Island consists primarily of secondary forest (WALHI, 2014) and lowland plains and shallow valleys, punctuated by hilly tracts. The highest elevation is 699 m above sea level (asl). The climate of Bangka Island is hot and wet, with an average annual rainfall of approximately 3,000 mm (Gorlinski, 2018).

Deforestation in Bangka Island began in the early 1700s with the advent of tin mining (Heidhues, 1991; Indahnesia, 2012; Kahin, 2015). Habitat loss increased with the introduction of pepper *Piper nigrum* L. in the mid-1800s (Idi, 2012) and rubber *Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg. in the 1920s (van Noordwijk et al., 2008). From 1995 however, oil palm *Elaeis guineensis* Jacq. plantations have started to appear in Bangka Island, becoming a new competitor to the pepper and rubber plantations (Kurniawan, 2005). Deforestation in Bangka Island appears to have worsened in the last two decades, when there has been a significant increase in tin mining and oil palm plantations (Ratno Budi, pers. comm., 2018). According to Supriatna et al. (2017), Bangka-Belitung Islands had the highest deforestation rate in Indonesia during the period 2000-2012.

Of the 6,575.1 km^2 forest cover in the Bangka-Belitung Islands (based on the Decree of Indonesian Forestry Minister No. 357/Menhut-II/2004 about Forest Area of Bangka-Belitung Islands Province), only 28% is relatively undisturbed, while the remaining 72% is degraded (WALHI, 2014). The 32.47 km^2 conservation forest, 298.07 km^2 protected forest and 1,252.24 km^2 production forest in Bangka-Belitung Islands have experienced deforestation and conversion into tin mines and oil palm plantations (Ratno Budi, pers. comm., 2018). The projections show that if current trends continue, the remaining areas of the better forest cover on the islands are at risk of degradation (WALHI, 2014).

Tarsiers are small nocturnal arboreal primates characterized by large round eyes along with long hind legs adapted for vertical leaping (Crompton & Andau, 1986). Tarsiers are found in a wide variety of primary and secondary forests and scrub habitats, and often occur in agricultural areas (Shekelle et al., 2013). They are the only entirely carnivorous primate, preying on insects (e.g., beetles, ants, grasshoppers, locusts, cicadas, cockroaches, moths, butterflies and crickets) and vertebrates (e.g., birds, smaller fruit bats, spider, frogs, lizards, mice and snakes) (Shekelle et al., 2013). Tarsiidae comprises three genera: Western Tarsier *Cephalopachus,* Philippine Tarsier *Carlito* and Eastern Tarsier *Tarsius* (Groves & Shekelle, 2010). *Cephalopachus* comprises one species (i.e., *C. bancanus*) and four subspecies: Horsfield's Tarsier *C. b. bancanus* (Horsfield), Bornean Tarsier *C. b. borneanus* (Elliot), Natuna Islands Tarsier *C. b. natunensis* (Chasen) and Belitung Tarsier *C. b. saltator* (Elliot) (Yustian, 2007; Shekelle & Yustian, 2008a; Roos et al., 2014). The local name of *C. b. bancanus* in Bangka Island is Mentilin.

The IUCN Red List of Threatened Species has determined the conservation status of *C. bancanus* as Vulnerable (VU) (Shekelle & Yustian, 2008a; Roos et al., 2014). However, the subspecies conservation status varies: *C. b. borneanus* is a VU subspecies (Shekelle & Yustian, 2008b; Roos et al., 2014), *C. b. bancanus* and *C. b. saltator* are Endangered (EN) (Shekelle & Yustian, 2008c; 2008d; Roos et al., 2014), and *C. b. natunensis* is Critically Endangered (CR) (Shekelle & Yustian, 2008e; Roos et al., 2014). *Cephalopachus bancanus* (as *Tarsius bancanus*) is classified as a protected species by the Indonesian Government under the Regulation of Indonesian Environment and Forestry Minister No. P.92/MENLHK/SETJEN/KUM.1/8/2018 about Revision of the Regulation of Indonesian Environment and Forestry Minister No. P.20/MENLHK/SETJEN/KUM.1/6/2018 about Protected Plants and Animal Species. Along with other primates, it is listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

The conservation status of *C. bancanus* is based on the impact on their habitat from forest conversion for illegal/unconventional tin mining, large-scale oil palm plantations, settlements, illegal logging, forest fires and flooding (Shekelle & Yustian, 2008a; Yustian et al., 2009). Illegal hunting and wildlife trade are further causes of population decline for *C. bancanus* (Shekelle & Yustian, 2008a; Yustian et al., 2009).

Research on *C. bancanus* has been conducted in Sarawak (*C. b. bancanus:* Niemitz, 1979; 1984) and Sabah (*C. b. borneanus:* Crompton & Andau,1986; 1987), on Belitung Island (*C. b. saltator:* Yustian, 2007; Yustian et al., 2009), and at Muara Enim, South Sumatra (*C. b. bancanus:* Sesa et al., 2014). We were unable to find published research about the habitat and population of *C. bancanus* in Bangka Island (*C. b. bancanus*) and in Serasan and Subi, Natuna Islands (*C. b. natunensis*).

In view of the rapid land use changes and loss of habitats observed in Bangka Regency, this study was conducted to better understand Mentilin occurrence within the remaining habitat types in order to make urgent long-term conservation recommendations for the species.

METHODS

Locations and time of research

We conducted the research from December 2015 to February 2016 in the villages of Zed (2°03'38.99"S, 105°57'19.29"E), Kemuja (2°05'01.80"S, 105°58'17.46"E), Paya Benua (2°06'30.67"S, 105°56'26.90"E) and Petaling (2°08'45.92"S, 105°56'29.16"E), Bangka Regency, Bangka-Belitung Islands Province, Indonesia (Fig. 1). Collectively, the villages cover 224.56 km^2 or 22,456 ha at an altitude of 22-46 m asl, slope of 0-7.7%, temperature of 23.5-30°C and humidity of 70.8-99%. We included these villages in the current research based on interviews with Bangka people about Mentilin encounters. Preliminary surveys were conducted from April 2014 to July 2014 to confirm the presence of Mentilin in the villages.

Data collection

Description of Mentilin habitat

Mentilin habitat description data were obtained using a strip transect-line plots method (Kusmana,

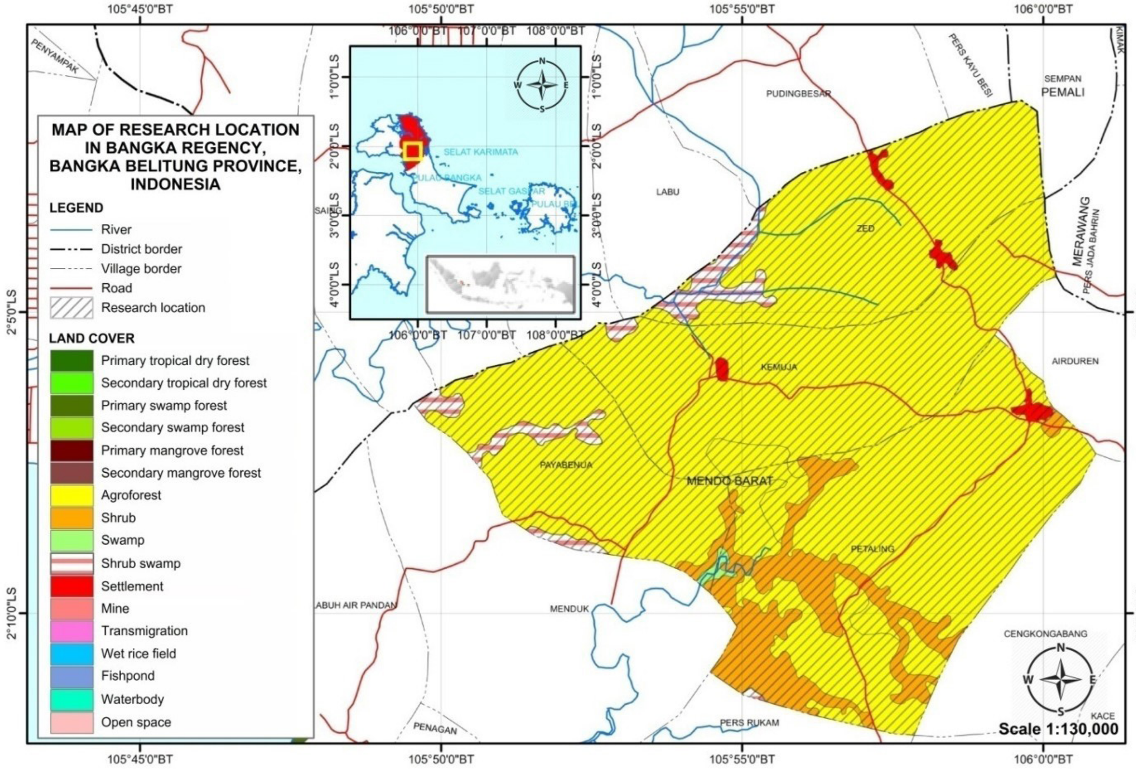


Fig. 1. Map of research location.

1997). Three line plots were placed on a strip transect in each habitat. We collected vegetation data during Mentilin sleeping times, from 09:00 to 15:00 h. The vegetation identified in each line plot included two categories, i.e., ground vegetation (shrubs, herbs and grasses) and tree vegetation. The tree vegetation consisted of four girth levels, i.e., trees (stems ≥20 cm DBH (diameter at breast height), poles (stems ≥10 cm and <20 cm DBH), saplings (>1.5 m tall and stems <10 cm DBH) and seedlings (≤1.5 m tall) (Iskandar, 2007). The strip transect-line plots in each habitat (Fig. 2) were placed on the same line as the line transects to measure Mentilin distribution and population published in Syafutra et al. (2017).

Identification of Mentilin sleeping trees

Mentilin sleeping trees were determined only as those specific trees where we found Mentilin sleeping. We identified Mentilin sleeping trees along the strip transect between 09:00 to 15:00 h.

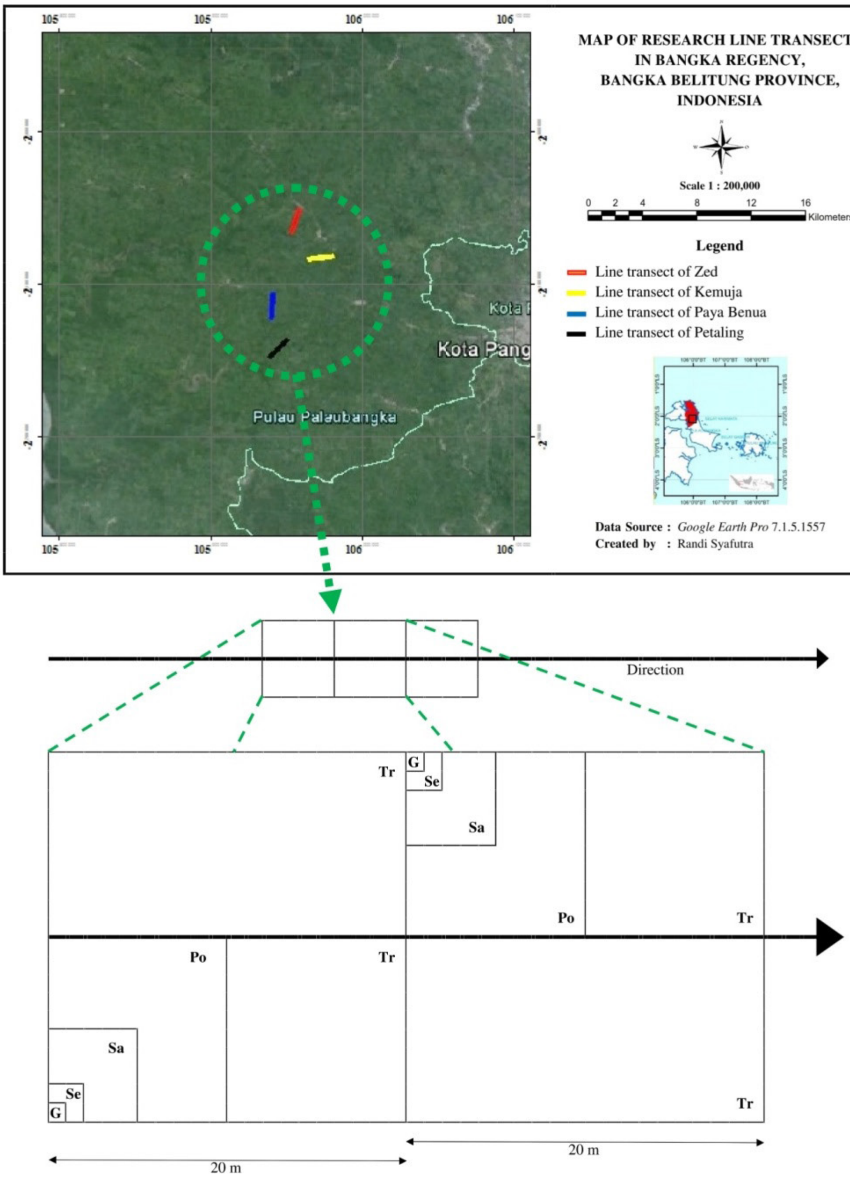
Data analysis

Vegetation data (i.e., relative density, relative frequency and relative dominance) were used to calculate the importance value index (IVI) (Curtis & McIntosh, 1950). After obtaining the IVI, diversity and evenness of vegetation species respectively were analysed by using the indices of Shannon-Wiener (H') (Shannon & Wiener, 1963) and Pielou (E) (Pielou, 1966a; 1966b; 1975). Magurran (1988) stipulated that H'≤1 indicates low species diversity, 1<H'≤3 indicates moderate species diversity, and H'>3 indicates high species diversity. In addition, E≤0.3 indicates low species evenness, 0.3<E≤0.6 indicates moderate species evenness, and E>0.6 indicates high species evenness.

RESULTS

Description of Mentilin habitat

Across all habitats, we identified 33 species of 22 families with 488 individuals. When categorised based on vegetation girth, the tree vegetation (i.e., trees, poles, saplings and seedlings) comprised 21 species from 16 families with 327 individuals, while the ground cover vegetation (i.e., shrubs, herbs and grasses) comprised 12 species from 9 families with 161 individuals. Based on the IVI (Table 1), *H. brasiliensis* dominated tree, pole, sapling and seedling layers in all habitats, except Zed where both of *Trema orientalis* (L.) Blume and



Information:

Tr : Tree (plot 20 m x 20 m)
Po : Pole (plot 10 m x 10 m)
Sa : Sapling (plot 5 m x 5 m)
Se : Seedling (plot 2 m x 2 m)
G : Ground vegetation (plot 1 m x 1 m)

Fig. 2. Design of strip transect-line plots method.

Table 1. The highest IVI in each mentilin habitat.

Location of habitat	Level of vegetation girth	Family	Species		RDE (%)	RFQ (%)	RDO (%)	IVI (%)
			Binomial name	Local name				
Zed	Tree	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	71.43	60.00	36.52	167.95
	Pole	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	65.63	33.33	18.28	117.24
	Sapling	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	35.48	18.75	-	54.23
	Seedling	Cannabaceae	*Trema orientalis* (L.) Blume	Mengkirai	30.77	21.43	-	51.20
		Theaceae	*Schima wallichii* Choisy	Seruk	30.77	21.43	-	51.20
	Ground cover	Melastomataceae	*Clidemia hirta* (L.) D. Don	Kedebik pasir	30.30	17.65	-	47.95
Kemuja	Tree	Poaceae	*Gigantochloa atter* (Hassk.) Kurz	Bambu ater	44.44	28.57	96.91	169,92
	Pole	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	81.25	66.67	40.21	188.13
	Sapling	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	36.00	15.38	-	51.38
	Seedling	Theaceae	*Schima wallichii* Choisy	Seruk	20.00	15.38	-	35.38
	Ground cover	Melastomataceae	*Clidemia hirta* (L.) D. Don	Kedebik pasir	42.50	18.75	-	61.25
Paya Benua	Tree	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	78.57	50.00	25.96	154.53
	Pole	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	100	100	100	300
	Sapling	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	40.63	18.75	-	59.38
	Seedling	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	26.67	25.00	-	51.67
		Theaceae	*Schima wallichii* Choisy	Seruk	26.67	25.00	-	51.67

	Ground cover	Melastomataceae	*Clidemia hirta* (L.) D. Don	Kedebik pasir	32.56	17.65	-	50.21
Petaling	Tree	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	100	100	100	300
	Pole	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	100	100	100	300
	Sapling	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	36.00	17.65	-	53.65
	Seedling	Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	Karet	30.77	20.00	-	50.77
	Ground cover	Poaceae	*Brachiaria mutica* (Forssk.) Stapf	Rumput malela	46.67	27.27	-	73.94

RDE: relative density, RFQ: relative frequency, RDO: relative dominance, and IVI: importance value index.

Schima wallichii Choisy dominated the seedling layer; Kemuja where the Giant Atter Bamboo *Gigantochloa atter* (Hassk.) Kurz and *S. wallichii* dominated tree and seedling layers, respectively; and Paya Benua where both of *H. brasiliensis* and *S. wallichii* dominated the seedling layer. *Clidemia hirta* (L.) D. Don dominated the ground cover layer in Zed, Kemuja and Paya Benua, except Petaling where *Brachiaria mutica* (Forssk.) Stapf dominated. In addition, Shannon-Wiener's diversity (H') and Pielou's evenness (E) indexes (Table 2) showed that all habitats generally have moderate species diversity and high species evenness.

Based on the IVI, H' and E results, Mentilin in Bangka Regency occurred most frequently in habitats where jungle rubber *H. brasiliensis* was the dominant vegetation. This conclusion was strengthened by interviews with villagers around research locations who affirmed that Mentilin in Bangka Regency were generally observed in areas of jungle rubber *H. brasiliensis* aged over 10 years combined with forest of the Giant Atter Bamboo *G. atter* or with abandoned and unproductive pepper *P. nigrum* plantations (Table 3 and Fig. 3).

Identification of Mentilin sleeping trees

Mentilin were observed using four species of plants as sleeping sites, seruk *S. wallichii,* mengkirai *T. orientalis*, bua bulu *Ficus annulata* Blume and bua tupai *F. aurata* (Miq.) Miq. *Schima wallichii* and *T. orientalis* were used as sleeping trees in all habitats, while *F. annulata* and *F. aurata* were only used as sleeping trees in two habitats, i.e., Paya Benua and Petaling (Table 4).

DISCUSSION

Description of Mentilin habitat

According to Beukema et al. (2007), jungle rubber can be regarded as an extensive rubber *H.brasiliensis* agroforest in which wild species are growing between rubber trees. Consequently, it structurally resembles secondary forest. Siregar et al. (2016) found jungle rubber to be dominated by *H. brasiliensis* complemented with other economic plants, such as *Eusideroxylon zwageri* Teijsm. & Binn., *Sloetia elongate* Koord., *S. wallichii, Artocarpus elasticus* Reinw. ex Blume, *Fagraea fragrans* Roxb. and *Parkia speciosa* Hassk.

This study did not record any Mentilin using the well-maintained rubber and oil palm plantations, which were more or less free of undergrowth and other natural vegetation. Yustian (2007) similarly reported that *C.b. saltator* in Belitung Island did not use well-maintained rubber and oil palm plantations, but they were recorded in abandoned pepper and rubber plantations, and in unmaintained oil palm plantations that were abundant with wild shrubs and saplings

We assume that insect availability was not a factor influencing Mentilin's preference for jungle rubber rather than well-maintained rubber and oil palm plantations as its habitat. This is based on the study of Siregar et al. (2016) who reported that the availability of insects (Hymenoptera, Diptera and Lepidoptera) in rubber and oil palm plantations was higher than that

Table 2. H' and E of vegetation of Mentilin habitat.

Location of habitat	Level of vegetation girth	Species number	Shannon-Wiener's diversity (H')		Pielou's evenness (E)	
			Value	Interpretation	Value	Interpretation
Zed	Tree	12	0.6860	Low	0.9896	High
	Pole	13	1.0902	Moderate	0.9924	High
	Sapling	18	1.8849	Moderate	0.9064	High
	Seedling	15	1.5669	Moderate	0.9736	High
	Ground cover	18	1.9495	Moderate	0.9375	High
Kemuja	Tree	15	1.2445	Moderate	0.7732	High
	Pole	12	0.6605	Moderate	0.9529	High
	Sapling	18	1.9232	Moderate	0.9249	High
	Seedling	18	2.0515	Moderate	0.9865	High
	Ground cover	18	1.8705	Moderate	0.8995	High
Paya Benua	Tree	12	0.6927	Moderate	0.9993	High
	Pole	11	-	Low	-	-
	Sapling	18	1.9540	Moderate	0.9397	High
	Seedling	17	1.7874	Moderate	0.9185	High
	Ground cover	17	1.8571	Moderate	0.9544	High
Petaling	Tree	11	-	Low	-	-
	Pole	11	-	Low	-	-
	Sapling	10	2.1398	Moderate	0.9293	High
	Seedling	16	1.7207	Moderate	0.9603	High
	Ground cover	15	1.4217	Moderate	0.8834	High

Table 3. Description of Mentilin habitat in each research location.

Research location	Habitat description
Zed	Jungle rubber *Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg. aged over 10 years.
Kemuja	Jungle rubber *Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg. aged over 10 years + forest of the Giant Atter Bamboo *Gigantochloa atter* (Hassk.) Kurz.
Paya Benua	Jungle rubber *Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg. aged over 10 years.
Petaling	Jungle rubber *Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg. aged over 10 years + abandoned and unproductive plantations of pepper *Piper nigrum* L.

Fig. 3. Mentilin habitats in the villages of (a) Zed, (b) Kemuja, (c) Paya Benua, and (d) Petaling.

in jungle rubber. One likely factor influencing Mentilin's preference for jungle rubber as its habitat was the presence of suitable substrate for its locomotion. In jungle rubber dominated habitats, Mentilin can use the abundant saplings necessary for its specialized mode of locomotion. In Belitung Island, *C.b. saltator* foraged and travelled on branches, trunks and saplings that measure 1-4 cm DBH and ranges 1-5 m height above ground level (agl) (Yustian, 2006; 2007).

Identification of Mentilin sleeping trees

Although its habitat was generally the jungle rubber, we did not observe Mentilin using the rubber trees for sleeping. Mentilin preferred *S. wallichii, T. orientalis, F. annulata* and *F. aurata* saplings for sleeping and travelling when foraging. These saplings have denser crowns and were more suitable as Mentilin sleeping trees (RS, pers. obs., 2016); and are also native to Bangka Island (Yulian Fakhurrozi, pers. comm., 2018). MacKinnon & MacKinnon (1980), Nowak (1999), Meijaard et al. (2006) and Wirdateti & Dahruddin (2006) observed that tarsiers in secondary forest slept during the day in dense vegetation, especially in shady trees with DBH of 4-8 cm, on vertical branches at a height of 3-15 m agl, and rarely in hollow trees. In addition, Dagosto & Gebo (1998), Gursky (1998; 2007), Neri-Arboleda (2001), Wirdateti & Dahrudin (2006), Shekelle et al. (2013), Sandego et al. (2014) and Sesa et al. (2014) reported that tarsiers often use *Ficus* spp. as sleeping trees.

We identified several potential species that could be used as sleeping trees by Mentilin, i.e., *G. atter, Gynotroches axillaris* Blume, *Vitex pinnata* L., *Dillenia suffruticosa* (Griff.) Martelli, *Commersonia bartramia* (L.) Merr. and *F. fistulosa* Reinw. ex Blume; all of which are native to Bangka Island (Yulian Fakhurrozi, pers. comm., 2018). *Gigantochloa atter* was indicated as one of the potential sleeping trees for Mentilin based on Wirdateti & Dahrudin (2008), Amnur (2010), Qiptiyah & Setiawan (2012), Sesa et al. (2014) and de la Cruz & Casas Jr. (2015) who reported that tarsiers use dense bamboo groves with thick undergrowth as sleeping sites and to hide from predators such as

Table 4. Species of Mentilin sleeping trees.

Location of habitat	Level of vegetation girth	Family	Species		IVI (%)	Number of sleeping mentilin
			Binomial name	**Local name**		
Zed	Sapling	Theaceae	*Schima wallichii* Choisy	Seruk	41.33	1
	Sapling	Cannabaceae	*Trema orientalis* (L.) Blume	Mengkirai	34.88	1
Kemuja	Sapling	Theaceae	*Schima wallichii* Choisy	Seruk	35.38	1
	Sapling	Cannabaceae	*Trema orientalis* (L.) Blume	Mengkirai	39.08	1
Paya Benua	Sapling	Moraceae	*Ficus annulata* Blume	Bua bulu	21.88	1
	Sapling	Moraceae	*Ficus aurata* (Miq.) Miq.	Bua tupai	21.88	1
	Sapling	Cannabaceae	*Trema orientalis* (L.) Blume	Mengkirai	21.88	1
	Sapling	Theaceae	*Schima wallichii* Choisy	Seruk	21.88	1
Petaling	Sapling	Moraceae	*Ficus annulata* Blume	Bua bulu	23.76	1
	Sapling	Theaceae	*Schima wallichii* Choisy	Seruk	23.76	1
	Sapling	Moraceae	*Ficus aurata* (Miq.) Miq.	Bua tupai	19.76	2
	Sapling	Cannabaceae	*Trema orientalis* (L.) Blume	Mengkirai	19.76	1

snakes and owls. *Gynotroches axillaris, D. suffruticosa, C. bartramia* and *F. fistulosa* are potential sleeping trees for Mentilin because their crowns are dense as *S. wallichii, T. orientalis, F. annulata and F. aurata* (RS, pers. obs., 2016). *Ficus fistulosa* is also considered a potential sleeping tree because Mentilin is known to use *Ficus* spp.

Conservation efforts

The occurrence of Mentilin in jungle rubber habitats indicates the suitability of the habitat as additional habitat for Mentilin. Currently, jungle rubber dominates unprotected forest areas in Bangka Island (typically associated with local communities and private forest areas). However, due to the low commercial value of rubber, many jungle rubber areas are being converted to the more profitable unconventional tin mines and well-maintained palm oil plantations. This conversion is detrimental to conservation of Mentilin as jungle rubber is clearly an important additional habitat for the species. Hence, the maintenance of jungle rubber dominated agroforest areas will have a positive impact on the conservation of Mentilin. Thus, socio-economic assistance or research activities with financial benefits to the landowners may be an option to encourage the landowners to maintain the jungle rubber. However, Mentilin occurring in jungle rubber areas are vulnerable to capture for trade by the local people. Therefore, awareness programs are needed to highlight the conservation needs and the legal protection status (including penalties and punishments) of the species.

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PRELIMINARY STUDY ON THE DISTRIBUTION AND CONSERVATION STATUS OF THE EAST SUMATRAN BANDED LANGUR *Presbytis femoralis percura* IN RIAU PROVINCE, SUMATRA, INDONESIA

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ABSTRACT

The East Sumatran Banded Langur *Presbytis femoralis percura* is a very little known colobine primate, endemic to Riau Province in Sumatra. Nothing much is known of its population size and distribution, except that it was confined in the area between Rokan and Siak rivers. We carried out an eight-day reconnaissance field trip and determined the presence of *P. f. percura* in seven locations in Riau Province, which extends south of the Siak River, beyond its previously reported range. We also obtained probably the first publicly available full-frontal coloured photos of the taxon in the wild, and photos of the Riau Pale-thighed Langur *P. siamensis cana.* Considering that the known populations of *P. f. percura* are restricted to small and isolated forest remnants, and that the remaining forests are rapidly being converted into oil palm plantations, we propose to change the listing of *P. f. percura* from Data Deficient to Endangered A2c. We recommend an immediate study on its population size and distribution in order to better understand its conservation needs and to protect this taxon. We further urge for more research and conservation attention on the non-human primates in Riau Province, Sumatra.

Keywords: Asian primates, colobine, Indonesia, IUCN Red List, Sumatra

INTRODUCTION

The Banded Langur *Presbytis femoralis* (Martin) is a colobine primate (Cercopithecidae: Colobinae) that is found on the Malay Peninsula and Sumatra (Groves, 2001; Fig. 1). Three subspecies are currently recognised, but the taxonomy is not resolved (Ang et al., 2016): Raffles' Banded Langur *P. f. femoralis* (Martin) in Singapore and southern Peninsular Malaysia; Robinson's Banded Langur *P. f. robinsoni* Thomas in north Malay Peninsula including Malaysia, Thailand, and Myanmar; and East Sumatran Banded Langur *P. f. percura* Lyon in Sumatra, Indonesia. At the Asian Primate Red List Assessment Workshop in Singapore, held from 19-24 November 2015, *Presbytis femoralis* was assessed as Vulnerable, with the nominate subspecies as Endangered due to small and isolated populations with low genetic variability (Ang et al., 2012; Srivathsan et al., 2016), the more widely distributed *P. f. robinsoni* as Near Threatened, and the least known and studied *P. f. percura* as Data Deficient (Ang & Boonratana, in press).

The East Sumatran Banded Langur was formally described by M.W. Lyon, Jr. in 1908 based on specimens collected in eastern Sumatra (Lyon, 1908), specifically from near Siak Kecil River, Makapan, Kompei, Pulau Rupat, and Salat Rupat. Subsequently, field observations delineated the distribution of *P. f. percura* as bounded by the Rokan River in the north and the Kampar River in the south within Riau Province (Wilson & Wilson, 1977; Kawamura, 1984; Aimi & Bakar, 1992). However, Aimi and Bakar (1996) undertook more field surveys in later years and closely examined photographs taken by previous fieldwork and concluded that the southern boundary was in

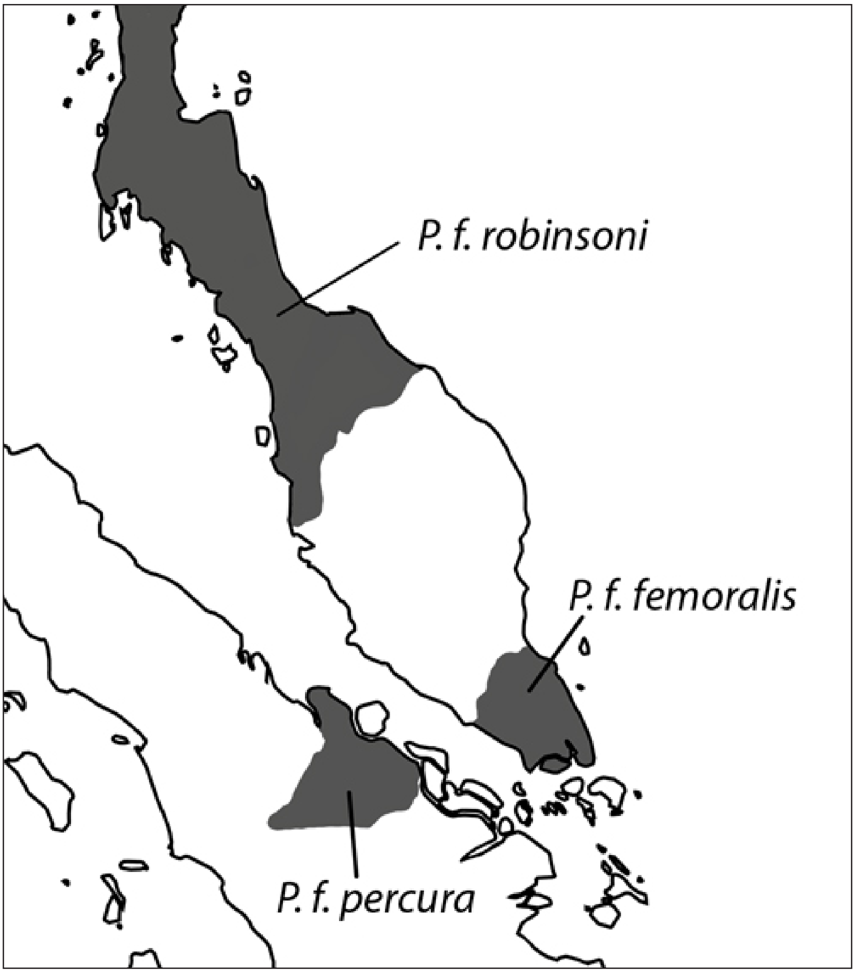

Fig. 1. Distribution of *Presbytis femoralis* (Ang et al., 2012).

fact the Siak River and not the Kampar River (Fig. 2), thus narrowing its known range. This distribution was adopted by Groves (2001)'s seminal primate taxonomy book and *P. f. percura*-related classifications that followed (e.g. Mittermeier et al., 2013; Roos et al., 2014).

With only field observations on its distribution in the 1990s and no data available on population size, *P. f. percura* has been consistently evaluated as Data Deficient for the last 18 years since the first IUCN Red List assessment in 2000 (Nijman et al., 2008; Ang et al., unpublished data from a Red List re-assessment in 2015). Most of the landscape that was previously inhabited by *P. f. percura* and other wildlife in Riau Province has undergone considerable land use changes; among all provinces in Sumatra, the most extensive forest loss occurred in Riau (Uryu et al., 2010). While Riau had the highest amount of natural forest in Sumatra in 1985 (6.9 million ha; 28% of all-natural forest on the island), by 2008 it had lost 63% or 4.4 million ha of forest cover mostly to industrial oil palm and pulpwood plantations (Uryu et al., 2010). Furthermore, preliminary genetic data suggest that at least two of three subspecies of *P. femoralis* may be a unique species (Ang, 2010). If *P. f. femoralis* is indeed a different species to *P. f. robinsoni* and/or *P. f. percura*, then each of them will be an even more threatened taxon than currently recognised (Ang et al., 2016). Therefore, it is urgent and important to better understand the current distribution of *P. f. percura* and to more effectively assess its conservation status.

The objectives of this field reconnaissance were: 1) to provide an updated distribution of *P. f. percura* in Riau Province with notes on habitat characteristics in the area where they were observed; and 2) to assess its conservation status.

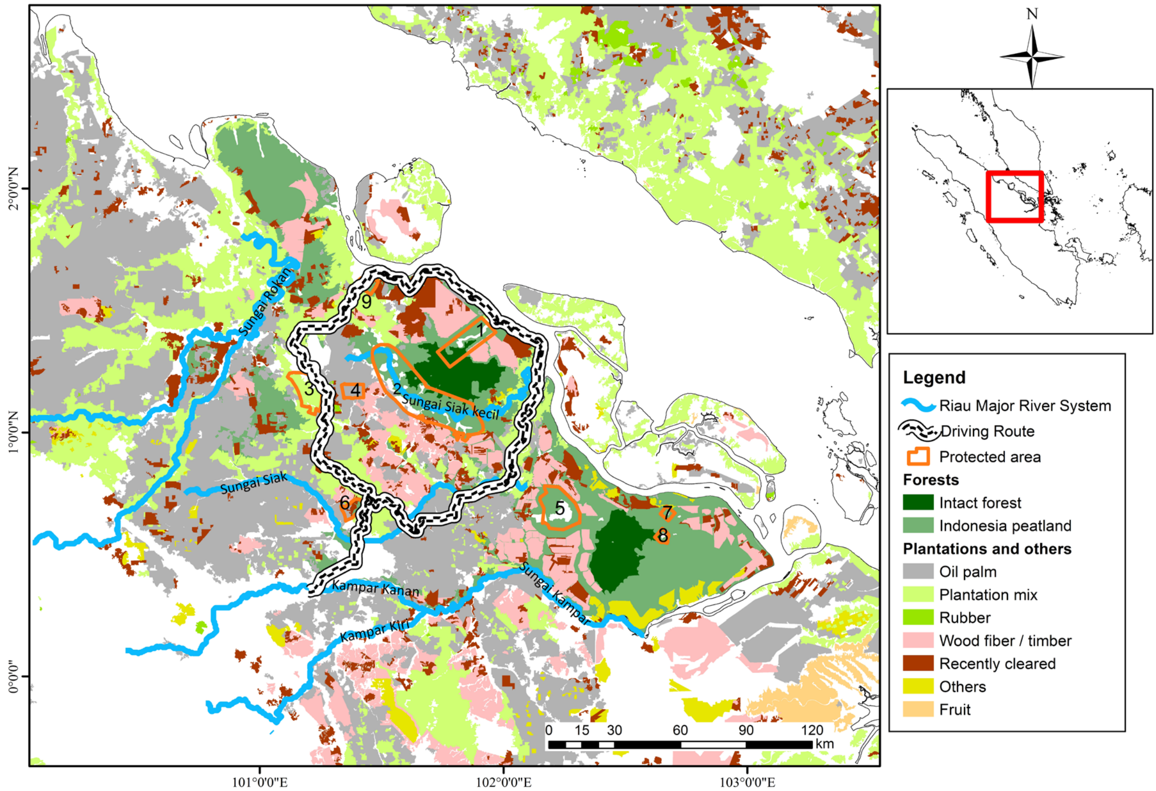

Fig. 2. Landscape map within Riau Province, Sumatra, Indonesia. Major rivers and our driving routes (from west to east, and in clockwise direction) are shown.

METHODS

Study Area

Riau Province is located in the central eastern coast of Sumatra (0°17'36" N and 101°42'24" E; Fig. 2) and is administratively divided into nine regencies (Bengkalis, Indragiri Hilir, Kampar, Kuantan, Singingi, Pelalawan, Rokan Hilir, Rokan Hulu, and Siak) and two cities (Dumai and Pekanbaru). This region has a wet tropical climate with average annual rainfall of 2,000 to 3,000 mm and average temperature of 25°C (daily range of 23 - 32°C). The rainy season typically falls from September to January and the dry season from February to August (www.bmkg.go.id; accessed on 18 July 2018). Originally, most of the vegetation cover in Riau Province consisted of tropical lowland and montane rainforests, peatland and swamp forests; extensive forest loss and fragmentation has occurred due to industrial oil palm and pulpwood plantations, timber logging, clearing for agriculture, roads, and wild fires (see Subiakto et al., 2017).

Land Use Map of Riau Province

We generated a land use map of Riau Province (scale: 4.5 cm – 100 km) based on the latest available dataset from Global Forest Watch (GFW) using ArcMap version 10.5. From the GFW dataset, three land use types were relevant for analyses: "types of plantations" as of 2014 (Petersen et al., 2016); "intact forest landscape" as of 2016 (Potapov et al., 2017); and "Indonesia peatland" as of 2002 (Wahyunto, 2003). "Types of plantations" included monocultures (fruit; oil palm; rubber; wood fiber/timber), mixed agroforest-plantations (fruit mix; oil palm mix; rubber mix; wood fiber/timber mix; others mix), unidentifiable plantations, and bare land (recently cleared; Petersen et al., 2016). "Intact forest landscape" consisted of forest and associated natural landscape with a minimum area of 500 km^2 and no remotely detected signs of human activity (Potapov et al., 2017). As the dataset for "Indonesia peatland" was outdated, we assumed and also cross-checked using high-resolution imagery from Google Earth that some of it had been anthropogenically modified (e.g. into plantations, agroforests, secondary/degraded forests and buildings). The white (blank) areas in the map were likely anthropogenic-related land uses such as roads, residential areas, buildings etc. and also water bodies including lakes and estuaries. The dataset of major river systems in Riau particularly Rokan River, Siak River, and Kampar River was extracted from the river network of HydroSHEDS (Lehner et al., 2006) and validated through Google Earth.

Primates of Riau Province

Based on existing records (Nekaris & Jaffe, 2007; Mittermeier et al., 2013), it is believed that 10 primate taxa occur in Riau Province: Sunda Slow Loris *Nycticebus coucang* (Boddaert), Sumatran Slow Loris *N. hilleri* (Stone & Rehn), Long-tailed Macaque *Macaca fascicularis fascicularis* (Raffles), Southern Pig-tailed Macaque *M. nemestrina* (Linnaeus), Black-and-white Langur *P. bicolor* Aimi & Bakar, East Sumatran Banded Langur *P. f. percura*, Riau Pale-thighed Langur *P. siamensis cana* Miller, Silvered Langur *Trachypithecus cristatus cristatus* (Raffles), Agile Gibbon *Hylobates agilis* Cuvier, and Siamang *Symphalangus syndactylus* (Raffles). *Presbytis melalophos* (Raffles) may possibly be found in Riau Province, but its taxonomy remains unclear and the different colour variants of the species make it difficult to determine the boundaries of its ranges (Groves & Roos, 2013a).

Field Observations

We carried out an eight-day (25 April - 2 May 2018) reconnaissance survey by driving from West Sumatra to Riau Province (Fig. 2). Whenever we came across a habitat appearing suitable for *P. femoralis* (primary and secondary forests, swamp forest, mangrove forest, and rubber forests; Groves & Roos, 2013b), we stopped the vehicle and checked for permission to enter, whether it was a nature reserve, forest park, community forest, coastal forest, forest remnant, or plantation. We carried out field observations along existing trails and along roads that were accessible. Five surveyors were split into two teams of two and three, with the second team heading out approximately 10 minutes after the first team, walking and surveying the same route if there was only one visible trail. The two teams surveyed different routes at the same time if there was more than one trail. We walked each route at the same speed and gathered standard line transect data (Marshall et al., 2014) for all non-human primates (primates hereafter) encountered, e.g., date and time of observation, species observed, observed group size, age and sex composition of the group, GPS coordinates (after the primates left, we went to the location where they were observed), and the forest types. Photographs of the primates were taken whenever possible. During the drive, we also looked out for primates along the roadside and forest edges.

Extent of Occurrence

Based on the information collected during the field survey, we carried out an exercise to assess the conservation status of *P. f. percura.* According to the IUCN Red List, the conservation status of a species can be evaluated using a number of criteria (IUCN, 2017: ver. 13): A. population reduction; B. extent of occurrence (EOO) and/or area of occupancy (AOO); C. small population and decline; D. restricted population and number of locations; E. quantitative analysis (e.g. PVA). With poorly known primate taxa, especially those that are evaluated as Data Deficient (DD) due to a lack of knowledge particularly on population size and distribution, an estimated EOO is one of the most easily quantifiable aspects that can be used to begin preliminary assessment of their conservation status (Gursky et al., 2008). Given that *P. f. percura* was evaluated as DD for at least the last 18 years since its Red List assessment in 2000, we calculated an estimated EOO of *P. f. percura* in Riau Province and also assessed threats based on direct observations and inferences to carry out an assessment of its current conservation status.

Distribution size is classified within one of the four categories (1–100 km^2, 100–5,000 km^2, 5,000–20,000 km^2, and >20,000 km^2). Therefore, following IUCN Red List guidelines, and given that all other necessary conditions are met, the following assessments are recommended:

“Critically Endangered” for EOO: 1–100 km^2

“Endangered” for EOO: 100–5,000 km^2

“Vulnerable” for EOO: 5,000–20,000 km^2

“Near Threatened/Least Concern” for EOO: >20,000 km^2

RESULTS

We located *P. f. percura* in seven of the 25 sites that were surveyed (Table 1; exact locations were withheld due to threats from poaching), covering a total of 58.1 km for the survey period of 1,830 minutes (30.5 hours). The mean distance surveyed and mean amount of time spent per site were 2.32±1.62 km and 73.2±56.5 minutes respectively. We observed nine groups and 75 individuals of *P. f. percura*, with group size ranging from two to 15. Two dependent infants and a few juveniles were seen. They were found in rubber forests, secondary forests, and swamp forest surrounded by oil palm plantations, settlements, and roads; they were never seen in oil palm plantations during our survey. Six groups were seen within rubber forests feeding

Table 1. Survey sites, habitat characteristics, distance covered, time spent, and number of groups and individuals of *Presbytis femoralis percura* observed in Riau Province.

Site #	Location	Habitat	Survey distance (km)	Duration (mins)	# of groups	Group size
1	Bangkinang, Kampar	Oil palm plantation + secondary forest	2.8	48	-	
2	East Kampar, Kampar	Rubber plantation + secondary forest	4.5	133	-	
3	Tambang, Kampar	Rubber plantation	3.5	152	3	10,15,5
4	Minas, Siak	Secondary forest	5.6	196	-	
5	Duri, Bengkalis	Rubber plantation + secondary forest	2.0	134	1	11
6	Duri, Bengkalis	Oil palm plantation + secondary forest	4.0	68	-	
7	Duri, Bengkalis	Oil palm plantation + secondary forest	1.8	44	-	
8	Dumai, Bengkalis	Oil palm plantation + rubber plantation + secondary forest	3.1	60	-	
9	Dumai, Bengkalis	Rubber plantation + swamp forest	5.7	202	1	12
10	Dumai, Bengkalis	Mangroves	1.1	27	-	
11	Dumai, Bengkalis	Secondary forest	0.6	22	-	
12	Bukit Batu, Bengkalis	Secondary forest	0.8	31	-	
13	Bukit Batu, Bengkalis	Secondary forest	2.1	56	-	
14	Bukit Batu, Bengkalis	Secondary forest	1.4	38	-	
15	Bukit Batu, Bengkalis	Rubber plantation + secondary forest	3.0	69	1	7
16	Bukit Batu, Bengkalis	Rubber plantation	2.1	48	-	
17	Bukit Batu, Bengkalis	Secondary forest	0.5	21	-	
18	Bukit Batu, Bengkalis	Secondary forest	1.8	49	1	6
19	Bukit Batu, Bengkalis	Secondary forest	3.3	67	-	
20	Siak, Siak	Oil palm plantation	0.7	16	-	
21	Siak, Siak	Mangroves + rubber plantation	4.6	166	-	
22	Siak, Siak	Oil palm plantation + secondary forest	2.4	111	-	
23	Siak, Siak	Secondary forest	0.3	12	-	
24	Kualang, Perawang	Secondary forest	0.2	38	1	2
25	Tambang, Kampar	Secondary forest	0.2	22	1	7

Fig. 3a. An adult male *P. f. percura* with rubber fruit in the mouth. © Andie Ang

Fig. 3b. An adult male *P. f. percura* after feeding on rubber leaves, leaving latex on the lips. © Andie Ang

on both seeds (Fig. 3a) and leaves (Fig. 3b) of Pará Rubber Tree *Hevea brasiliensis* (Willd. ex A.Juss) Müll. Arg. One adult male was observed to spend 6 min 58 s to extract the seeds from the outer covering (from the moment he obtained the fruit in his hands to the point when he dropped the remainder of the emptied shell). All sighting locations of *P. f. percura* were bounded by the Rokan River in the north and the Kampar River in the south.

We calculated the EOO of *P. f. percura* which was

Table 2. Conservation status of *Presbytis* langurs in Sumatra.

Taxon	Distribution	IUCN Red List Threatened Status*	Menteri LHK RI, 2018**
P. bicolor	EC Sumatra	Data Deficient as *P. melalophos bicolor*	Not included
P. f. percura	CE Sumatra	Data Deficient	Not included
P. melalophos	W Sumatra	Near Threatened as *P. melalophos melalophos*	Included
P. mitrata	SE Sumatra	Endangered as *P. melalophos mitrata*	Not included
P. thomasi	N Sumatra	Vulnerable	Included
P. s. cana	CE Sumatra	Vulnerable	Not included
P. sumatrana	W and NC Sumatra	Endangered as *P. melalophos sumatranus*	Not included

*IUCN SSC PSG Asian Primate Red List Assessment Workshop, November 2015.
**A list of protected plants and animals released by the Ministry of Environment and Forestry of Indonesia.

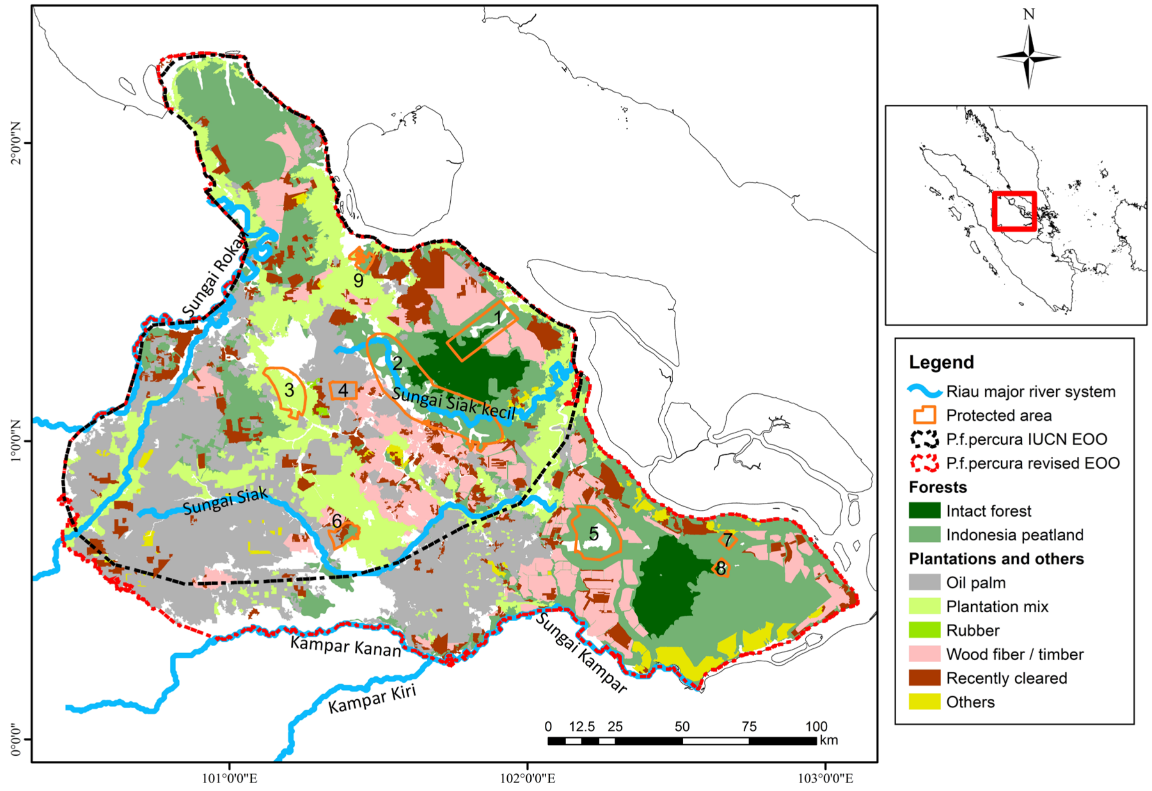

Fig. 4. Revised extent of occurrence (EOO) of East Sumatran Banded Langur *P. f. percura* based on sighting records.

Fig. 5a. An adult Riau Pale-thighed Langur *P. siamensis cana.* © Andie Ang

Fig. 5b. A juvenile *P. siamensis cana.* © Andie Ang

the entire area of Riau Province delimited by the Rokan River and the Kampar River, including forests, oil palm plantations, plantation mixes, recently cleared land, and others (Fig. 4), resulting in an EOO of 28,235.45 km^2 (Table S1). However, we noted that the area of suitable habitat, which excludes monoculture oil palm plantations and recently cleared (bare) land was at most 17,712.84 km^2 (Table S1). See Bernard et al. (2016) on the adverse effects of oil palm plantations on the primate community.

Previously, known photos of *P. f. percura* came from camera trap images (Fujita et al., 2012) and a rescued individual (Asferi Ardiyanto, pers. comm., 2018). Here, we provide coloured photographs of wild *P. f. percura* (Figs. 3a & 3b), probably the first publicly available full-frontal coloured photos of the subspecies, and also one of the first photographs of wild *P. s. cana* (Fig. 5a & 5b) from Riau Province, Sumatra.

DISCUSSION

The East Sumatran Banded Langur (*P. f. percura*) is endemic to Riau Province and its distribution was reported to be bounded by the Rokan River in the north and the Siak River in the south, with the Riau Pale-thighed Langur (*P. s. cana*) being found between Siak River and Kampar River in the south (Aimi & Bakar, 1996). Our preliminary field data demonstrated that the southern limit of *P. f. percura* is at least until Kampar River and not Siak River, supporting earlier reports of a larger distribution (Wilson & Wilson, 1977; Kawamura, 1984; Aimi & Bakar, 1992). We did not find *P. s. cana* north of Kampar River; instead we observed them south of Kampar River. However, due to the preliminary nature of this field survey, we were unable to confirm whether the Kampar River serves as a geographic boundary between *P. f. percura* and *P. s. cana*. Nonetheless, we documented that both taxa occurred further south than previously recorded.

Presbytis f. percura faces a high risk of extinction in the wild. Compared to other provinces in Sumatra, Riau experienced the highest rate of deforestation, and similarly produced more palm oil and paper pulp (Uryu et al., 2010). These land use changes have resulted in highly fragmented forest remnants and degraded habitats that are surrounded by oil palm, rubber, and timber plantations (e.g., *Acacia* and *Eucalyptus*) within the range of *P. f. percura*. Additionally, forest fires due to hot weather conditions and open burning for agricultural purposes destroy millions of hectares of land in Indonesia on an annual basis, and Riau is often one of the worst impacted areas, owing in part to its high concentration of peatland (World Bank, 2016). Based on large scale forest loss which has not ceased (63% of natural forest were lost between 1985 and 2008; Uryu et al., 2010), we inferred that the area of occupancy, extent of occurrence and quality of habitat of *P. f. percura* have declined such that their population size has reduced by ≥50 % over the last three generations since 1989 (30 years approximately; see Nijman & Manullang, 2008 for the closely-related *P. melalophos*), fulfilling the IUCN criteria for Endangered A2c. Even though the extent of occurrence of *P. f. percura* is estimated at 28,235.45 km^2 (>20,000 km^2, i.e. Near Threatened/Least Concern; this study) at the moment, EOO alone might not be a good indicator of its conservation status. Moreover, one or more of the three subspecies of *P. femoralis* may be a unique species based on preliminary genetic information; i.e. each of them might potentially be more threatened than currently recognised (Ang et al., 2016). Hence, we recommend changing the listing of *P. f. percura* from Data Deficient to Endangered A2c. This assessment will be communicated to the Red List Authority for consideration.

It is interesting to note that *P. f. percura* has adapted to feed on non-native rubber trees (*H. brasiliensis*) which were introduced into their habitat nearly 100 years ago. Plantations of fast-growing rubber were first introduced in Jambi, Sumatra in 1904 and subsequently expanded rapidly as a cash crop in the eastern coast from the 1920s (Stoler, 1995). Today, rubber plantations in Sumatra continue to grow in the forms of rubber forest and rubber monoculture. Six out of nine groups of *P. f. percura* were observed in rubber forests and individuals were feeding on rubber seeds and leaves. We recorded one individual spending almost seven minutes to extract the seeds from within the hard woody, 3-lobed capsulated fruit before going for the next rubber fruit, which was a large amount of time spent feeding on a single food item. A rubber seed contains approximately 11.5% crude protein (Narahari & Kothandaraman, 1984). We did not observe another food plant being consumed by *P. f. percura* during our short survey but we would like to put into context their decision to feed on rubber plant. *Parkia speciosa* Hassk. is a native tree in Sumatra and its seeds are a food item of another subspecies, the Raffles' Banded Langur *P. f. femoralis* in Singapore (Ang, 2018). Crude protein in a seed of *P. speciosa* can be up to 27.5% (Kamisah et al., 2013). Note that the same plant food item can contain different nutrient content over different spatial scales and timescales (Lambert & Rothman, 2015) and the amount of secondary compounds such as tannins affects food choice in primates.

In conclusion, we strongly recommend field studies on primates in Riau Province and surrounding areas in Sumatra, especially on *Presbytis* spp. given their high species diversity (*P. bicolor*, *P. f. percura*, *P. melalophos*, *P. mitrata*, *P. s. cana*, *P. sumatrana*, and *P. thomasi*). In the latest list of protected plants and animals released by the Indonesian government, only *P. melalophos* and *P. thomasi* are included (Menteri LHK RI, 2018; see Table 2). No explanation was given in the document on how the list was generated, but we assumed that the other five taxa were not included as an outdated taxonomy was followed (with the exception of *P. femoralis*, the other four taxa were considered subspecies of *P. melalophos* until recently; see Mittermeier et al., 2013). More data on the distribution, population trends, ecology, and population genetics of these taxa are urgently needed to achieve a better understanding of their taxonomy and conservation status in Sumatra. In addition, the Indonesian government's list of protected plants and animals should be updated to include the missing primate taxa.

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FIRST SIGHTING OF PREDATORY ATTACK ON A MALABAR GREY SLENDER LORIS *Loris lydekkerianus malabaricus* BY BROWN PALM CIVET *Paradoxurus jerdoni*

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ABSTRACT

The Malabar Grey Slender Loris *Loris lydekkerianus malabaricus* plays an important role as a predator of insects, but there is little confirmed knowledge of predation on lorises. Several animals are assumed to be their potential predators, but no direct predation on slender lorises has ever been reported. In this paper, we report a direct observation of predation on an adult female Malabar Grey Slender Loris by an adult Brown Palm Civet *Paradoxurus jerdoni*, a species not generally recognised as a predator of lorises. The incident was observed at the Aralam Wildlife Sanctuary, Kerala, India. The predominantly frugivorous Brown Palm Civet apparently includes animal protein in its diet during periods of fruit scarcity.

Keywords: Aralam Wildlife Sanctuary, palm civet, slender loris, predation, Western Ghats.

INTRODUCTION

Prey and predator relationships have always played an important role in every ecosystem, by being the prime movers of energy through food chains and by balancing the ecology of populations in determining the mortality of prey and the birth of new predators (Purves et al., 2004).

Such is the case with the Malabar Grey Slender Loris *Loris lydekkerianus malabaricus* Wroughton (Fig. 1), a nocturnal primate, which plays an important role in its ecology by preying on insects and hence, regulating the insect population in the region (Nekaris & Rasmussen, 2003; Kumara et al., 2005). However, little is known of predation on slender lorises, very likely due to their nocturnal behaviour and that such observations are opportunistic.

A literature search did not yield any confirmed reports of predation on slender lorises. However, potential nocturnal predators of lorises include Jungle Cat *Felis chaus* Schreber and Rusty-spotted Cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire), the domestic cat *Felis catus* Linnaeus, Indian Krait *Bungarus caeruleus* (Schneider) and Common Sand Boa *Eryx conicus* (Schneider), Common Barn-owl *Tyto alba* (Scopoli) and Spotted Owlet *Athene brama* (Temminck) (Bearder et al., 2002; Radhakrishna & Singh, 2002). In addition, the Malabar Pit Viper *Trimeresurus malabaricus* (Jerdon) and Green Vine Snake *Ahaetulla nasuta* (Bonnaterre) have been observed in the trees where lorises were foraging or mating (SDG, pers. obs.). Malabar Grey Slender Lorises, however, did not show any signs of being threatened by them (Bearder et al., 2002; Nekaris et al., 2007). The prior evidence came from dietary studies of Barn Owls and Spotted Owlet, and from the comparisons of the calls of lorises and owlets through the night, but there was no direct evidence of owls preying on lorises (Bearder et al., 2002). Domestic cats have been observed to chase lorises up the trees during which the lorises gave out loud shriek threat calls (Nekaris, 2001).

The sighting of predation reported here is thus the first in more than a century; it has thrown light on one of the predators for the Malabar Grey Slender Loris. The Brown Palm Civet *Paradoxurus jerdoni* Blanford, has not been previously listed as a potential predator for the Malabar Grey Slender Loris. An incident of predation on an adult female Malabar Grey Slender Loris by an adult female Brown Palm Civet took place during our study on relative loris densities in different forest types at the Aralam Wildlife Sanctuary, Kannur District, Kerala, India. The study site, Chullikkandim (11°56’4”N, 75°48’33”E), is a semi-evergreen forest fragment with an area of around 1.5 km^2. Three

Fig. 1. The Malabar Grey Slender Loris *Loris lydekkerianus malabaricus* ©Roshin Tom Chandrankunnel.

species of civets, Brown Palm Civet, Asian Palm Civet *Paradoxurus hermaphroditus* (Pallas) and Small Indian Civet *Viverricula indica* (É. Geoffroy Saint-Hilaire), are found in the Aralam Wildlife Sanctuary.

The following observations were made by the author (SDG). On 7 April 2016, at 23:45 h, four of us (SDG, two volunteers, and one tracker) were surveying one of the line-transects in the Chullikkandim region. The observations were made on foot, using a red light from our red cellophane-covered headlamps. We recorded the incident using *ad libitum* sampling.

Sudden loud loris shrieks were heard 45 minutes after we began our survey. We moved in the direction of the sound and spotted four pairs of eyes on a *Olea wightiana* Wall. ex G.Don tree. The tree was 50 m ahead of us and at a perpendicular distance of 6 m from the line transect. We went closer for a better view of the animals that we sighted. We observed two Brown Palm Civets at a height of about 6 m which were in close proximity to an adult female loris at the same height on a secondary branch. A juvenile loris was about 1 m away at a height of about 9 m from the female loris. The civets had cornered the female loris to the edge of the secondary branch of the tree and surrounded it from both sides (perpendicularly). Soon after, one of the volunteers observed that one of the civets had her mouth gripped around the female loris. It was the bright white light from one of our torches that alarmed them. The civet, distracted by the bright light, lost its grip and the loris fell onto a branch which was situated about 50 cm below. The civet immediately jumped onto the branch below and grabbed the loris at its neck and thorax region, using its sharp teeth, and disappeared into the foliage. The juvenile loris, meanwhile, escaped higher into the foliage. The other civet stared at us from a distance for 38 seconds and then escaped into the foliage. The entire incident took place in the dead of night, giving us no time to focus our white lights or to take pictures.

Brown Palm Civets, being primarily nocturnal, inhabit the dense canopy cover of the rainforests (Mudappa et al., 2010). They are also endemic to the Western Ghats (Ashraf et al., 1993). Food habits of the Brown Palm Civet by previous scat analysis indicated that they are mostly frugivorous, with 97% of scats containing plant matter – mainly fruit (Mudappa et al., 2010). Even though they show such a high level of frugivory, Brown Palm Civet scats contained invertebrate and vertebrate remains during 23 months of 1998 and 1999, with higher proportions in some months when only a few fruit species were consumed (Mudappa et al., 2010). The increase in proportion of non-fruit items in the diet is possibly related to periods of relative fruit scarcity, making civets more opportunistic in their diet, and subsequently dependent on animal matter as a supplement (Mudappa, 2001). It is the usual behaviour of many frugivorous species either to migrate to habitats that have larger food resources during times of scarcity, or to shift to other rarer, aseasonal, or non-preferred fruits (van Schaik et al., 1993) or on animal matter as a supplementary source of nutrition (Ray & Sunquist, 2001; Zhou et al., 2008).

Being mainly arboreal and frugivorous in habit, Brown Palm Civets can survive in areas that contain a relatively undisturbed canopy and adequate food resources, such as in coffee estates which retain most of the natural rainforest canopy tree and liana species. Judging by their requirements, the species is not able to withstand conversion of its rainforest habitat into plantations such as Tea *Camellia sinensis* (L.) Kuntze, eucalyptus *Eucalyptus* spp., and Teak *Tectona grandis* L.f., although they may continue to use patches that have been converted to coffee *Coffea* spp., and Cardamom *Elettaria cardamomum (L.)* Maton plantations, since the large-canopy trees are preserved in such instances (Rajamani et al., 2002). Although mostly solitary (Mudappa et al., 2010), pairs of civets are not uncommon at the Aralam Wildlife Sanctuary (SDG, pers. obs.).

This new sighting opens up a host of possibilities in the study of loris predation, where animals that were not previously considered to be loris predators, can be studied and concentrated efforts to make such sightings can be made.

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EVIDENCE OF PILEATED GIBBONS *Hylobates pileatus* RECOLONIZATION IN AN AREA PROPOSED FOR WATER RESOURCE DEVELOPMENT IN KHAO SOI DAO WILDLIFE SANCTUARY, THAILAND

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ABSTRACT

During 2018 to 2019, at least one group of Pileated Gibbons *Hylobates pileatus* Gray was found in an area proposed for dam construction in Khao Soi Dao Wildlife Sanctuary. This finding suggests recolonization, following a community-based conservation project from 2009 to 2012. However, this recolonization would be jeopardised if the dam construction plan was approved.

Keywords: habitat destruction, *Hylobates pileatus*, Khao Soi Dao Wildlife Sanctuary, Khlong Ta Liu Dam, Pileated Gibbon, re-emergence threat

INTRODUCTION

The Endangered Pileated Gibbon, *Hylobates pileatus* Gray, is one of 20 species of small ape and is found in the remaining forest of central and eastern Thailand and in Cambodia west of the Mekong River (Roos et al., 2014). Like other gibbons Pileated Gibbons are vulnerable to hunting and habitat loss (Phoonjampa & Brockelman, 2008). Since 2008 we have been monitoring the population of Pileated Gibbons in the Ta-riu tributary, Khao Soi Dao Wildlife Sanctuary, Chanthaburi Province, Thailand using auditory surveys. While a community-based conservation project has resulted in the recolonization of once depleted areas (Kolasartsanee & Srikosamatara, 2014), the threat of habitat destruction has re-emerged at the Ta-riu tributary.

The Ta-riu tributary is one of the headwaters of the Chanthaburi River, located on the western side of Khao Soi Dao Wildlife Sanctuary (Fig. 1). The North Ta-riu Watershed is one of the watersheds of the Ta-riu tributary, which in 1979 was the study site for research focused on the ecology and behaviour of the Pileated Gibbon (Srikosamatara, 1984). Comparing with the population data in 1979 (SS, unpublished data), a re-survey in 2008 revealed a decrease in the Pileated Gibbon population (Kolasartsanee & Srikosamatara, 2014), attributed to the main threat from local hunting at that time (Kolasartsanee, 2014). By then the only remaining Pileated Gibbons occupied the mountains around the watershed, while the valley, which suffered high pressure from hunting, was vacated.

In response to this threat, a community-based conservation project employing the *Diffusion of Innovations* (Rogers, 2003) social theory and conservation marketing was initiated in 2009 to mitigate the hunting pressure on the Pileated Gibbon (see Kolasartsanee & Srikosamatara, 2014). This theory essentially investigates and describes the reasons and progression for the dissemination of new ideas and technology (Rogers, 2003). Adapting this, we carried out a series of meetings and activities to facilitate the desired changed in behaviour of key individuals of the focal community towards the Pileated Gibbon, who then later expanded the acquired behavioural change into their community (Kolasartsanee & Srikosamatara, 2014). Although there was no direct evidence of a decrease in hunting pressure after these conservation interventions, an auditory survey in 2012 revealed reoccupation of the valley (Kolasartsanee & Srikosamatara, 2014). Since 2012, the valley of the North Ta-riu Watershed was believed to be the only recolonized area (Kolasartsanee, 2016).

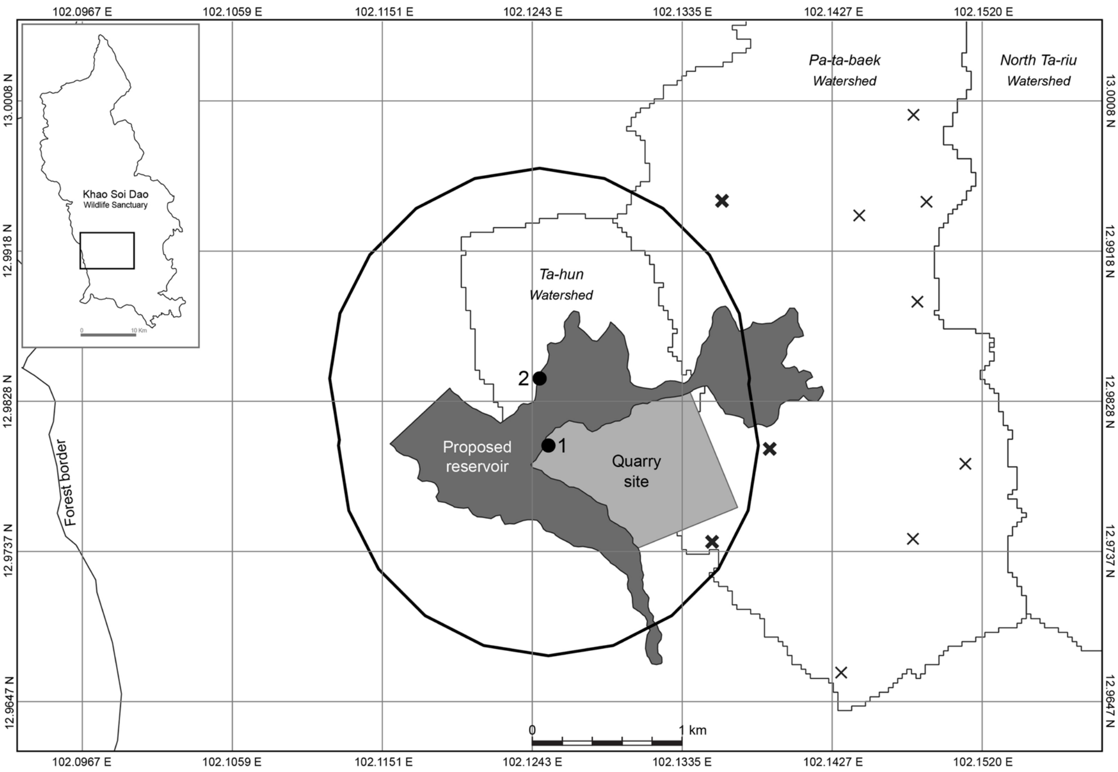

Fig. 1. Map of Ta-riu tributary with boundaries of three watersheds indicated in italics. The proposed Khlong Ta Liu Reservoir is shown in dark grey and the quarry site is shown in light grey (adapted from JICA, 1989). Locations of Pileated Gibbon observations described in the text are shown as black dots. The possible occupied area of the natal groups, based on a 1,400-metres radius from the two new locations, is shown in a thick black circle. Known Pileated Gibbon groups in Pa-ta-baek Watershed are shown as cross marks (Kolasartsanee & Srikosamatara, 2014; Kolasartsanee, 2016). Potential natal groups of the Pileated Gibbons found in locations 1 and 2 are shown as thick cross marks.

FINDINGS AND OBSERVATIONS

In 2018, a camera trap survey of terrestrial mammals at Ta-riu tributary was conducted. Five camera traps were set up from the forest border to the North Ta-riu Watershed. During camera trap maintenance, Pileated Gibbons were encountered twice at the Ta-hun Watershed, located about 3 km from the North Ta-riu Watershed; according to personal communication with local people and personal observations of I. Kolasartsanee since 2008, the Pileated Gibbons had not been found in this watershed for more than 10 years. The first finding was on 14 June 2018 when three consecutive duet calls were heard from Location 1 (Fig. 1). The second finding was on 20 April 2019 when two males with a female were directly observed by one of our local team and I. Kolasartsanee at Location 2 (Fig. 1). We interpret these observations as recolonization.

Using data on sub-adult dispersal in Whited-handed Gibbon *H. lar* (Linnaeus) studied at Khao Yai National Park, the longest natal dispersal distance of a sub-adult White-handed Gibbon was about 1,400 metres from the centre of its natal group (Brockelman et al., 1998). Thus, to estimate the possible occupied area of the natal groups of Pileated Gibbons found in these two locations, we used the buffer tool in the QGIS 3.4.10 program to buffer both locations with a 1,400-metre radius (Fig. 1). Auditory surveys at the North Ta-riu Watershed in 2008, 2012 and 2016 detected Pileated Gibbon groups at the Pa-ta-baek Watershed (Fig. 1) (Kolasartsanee & Srikosamatara, 2014; Kolasartsanee, 2016). The three groups on the west side of Pa-ta-baek Watershed could be the natal groups of Pileated Gibbons found in these two locations, as one group was located in and two groups near the possible occupied area of the natal groups. Pileated Gibbons found in these two locations may be another recolonizing population beside the mountains and the valley of the North Ta-riu Watershed. The valley of the Ta-hun Watershed may currently be a recolonized area for a population that comes from mountains around the watershed and the west side of Pa-ta-baek Watershed. This phenomenon may indicate a lower level of hunting pressure in Ta-hun Watershed. However, this recolonizing area could be destroyed if a dam construction plan at Ta-riu tributary is approved.

Fruit orchards are a significant economic activity in Chanthaburi Province, but require sufficient irrigation to thrive. From the perspective of irrigation engineering, some water resource development projects were planned in the protected areas, but with a lack of concern for biodiversity issues. A feasibility study was undertaken on the agricultural water development project in 1989, and the Khlong Ta Liu Dam was recommended on the Ta-riu tributary (JICA, 1989). It should be noted that Ta Liu and Ta-riu refer to the same tributary and watershed; the Royal Irrigation Department of Thailand uses Ta Liu, whereas the Department of National Parks, Wildlife and Plant Conservation uses Ta-riu.

According to the plan, the rock-filled dam would be built using rocks from the tributary (Fig. 1). However, the dam construction plan proposed by the Royal Irrigation Department of Thailand was rejected at that time. In the 2000s, several floods occurred in Chanthaburi City, so a flood mitigation project was conducted to increase the rate of water drainage from Chanthaburi City out to the Gulf of Thailand by constructing the Bhakti Rambhai Canal at Chanthaburi City. This project has increased the rate of water drainage in Chanthaburi City to more than the average rate over the past 100 years. Although this project has effectively mitigated floods in Chanthaburi City, two dam construction plans in Khao Soi Dao Wildlife Sanctuary were proposed by the Royal Irrigation Department in 2017. One was the Khlong Ta Liu dam and another was on Ta-rong tributary, located about 10 km north of the Ta-riu tributary. The approximate volume of these two reservoirs would be 30 and 60 million m^3, respectively. The purposes of these proposed dams were to increase the ability of flood mitigation in Chanthaburi City by controlling the head waters of the Chanthaburi River, water management for domestic use, and building water security for the production sector (Kateworachai, 2017). All of these purposes were stated under the strategic plan of Thailand's water resource management (2015-2026) (PCWRM, 2015). Although the dam construction plans were rejected, they may be re-proposed, due especially to the increase in demand for water from intense economic development policies and population growth.

Although the high elevation and steep slope of Ta-riu tributary have helped prevent illegal encroachment, this tributary has suffered from local hunting pressure for more than 40 years (Srikosamatara, 1980). This limited the distribution of Pileated Gibbon to high mountains far from the forest edge, which are hard to access by local hunters. After the community-based conservation project from 2009 to 2012, the recolonization of Pileated Gibbons from the mountains to the valley of North Ta-riu Watershed occurred (Kolasartsanee & Srikosamatara, 2014). The recolonized population continued to persist in 2016 (Kolasartsanee, 2016). The Pileated Gibbon group found in this article is evidence of expanded recolonization which may reflect the decrease in hunting pressure at Ta-hun Watershed. Compared with Pa-ta-baek and North Ta-riu Watershed, Ta-hun Watershed is easier to access by hunters in terms of elevation, slope and distance from the forest edge. Thus, this recolonization was beyond our expectation. However, if the plan for developing the reservoir is approved these habitats are at high risk of loss and fragmentation, and potential for recolonization is reduced. Hence, for the synergy between biodiversity conservation and water resource management, we suggest alternatives be sought, such as developing the reservoir be outside the protected area or improve floodway management of the Chanthaburi River.

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Scientific nomenclature should be used at first mention of any species or subspecies. Nomenclature should include taxonomic authority (at first mention) as currently recognised by IUCN (or more recent/authoritative sources), e.g. Northern Pigtailed Macaque *Macaca leonina* (Blyth) (see www.iucnredlist.org). Authors are referred to The Plant List (www.theplantlist.org) for up-to-date plant nomenclature.

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Measurements should always be metric, or where this is inappropriate, the metric equivalents given in parentheses. Time should be designated in the 24-hour system (as e.g. 17:30 h) and date in the European system (e.g. 7 December 2011). Summary statistics should include measures of both central tendency and dispersion where appropriate, e.g. means and standard deviations (SD). Reports of all statistical tests should include the name of the statistical test, the name and value of the test statistic, the degrees of freedom, the probability value used to determine significance and the authors' interpretation. Probabilities should be reported as exact values if not significant, otherwise rounded off to either $p<0.05$, 0.01 or 0.001.

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Acknowledgements

Remember to thank those who have contributed substantially to your paper, not forgetting (in the final submission) the reviewers.

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EDITORIAL

ARTICLES