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POPULATION, BEHAVIOUR AND CONSERVATION STATUS OF LONG-TAILED MACAQUE, M*acaca fascicularis* AND SOUTHERN PIG-TAILED MACAQUE, *Macaca nemestrina* IN PAYA BAKAU PARK, PERAK, MALAYSIA

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ABSTRACT

A study was conducted on the population and behaviour of long-tailed macaque, *Macaca fascicularis* and southern pig-tailed macaque, *M. nemestrina* in Paya Bakau Park, Perak, Malaysia. Direct field observations were taken for 20 non-consecutive days between October and December 2016. One-hour observation session was carried out on daily activity budget for both species during their 'feeding time' between 1700–1900 hour at the main entrance. From the field data, an average group size of 32.75±12.34 individuals of *M. fascicularis* and 22.60±4.84 individuals of *M. nemestrina* was estimated to be present during the 'feeding time'. Resting and locomotion were the most common behaviors performed by both species. There was no significant difference in the behaviours with the exception of resting pattern between *M. fascicularis* and *M. nemestrina* (*p*-value: 0.007, t=2.754, df=158). Due to the 'friendly' and highly tolerated interaction between the individuals of both species observed during the 'feeding time', hybridization of the two species may occur in the future which is of high concern. Conservation measures should be taken to sustain and monitor the status of their population.

Key words: activity budget, hybridization, intra-species, natural history, sex ratio.

INTRODUCTION

Long-tailed macaque (*Macaca fascicularis*) and southern pig-tailed macaque (*M. nemestrina*) are the two most common primate species found in Peninsular Malaysia. Loss of their natural habitat due to anthropogenic activities such as urbanization and land clearing for agriculture have led these primate populations to shift to human settlement areas. However, both species have managed to survive due to their innate ability to adapt to their surroundings. They feed on human food which are easily obtained, energy rich and easily digestible (Sha, 2013). With those adaptations, those monkeys could save time and energy, as well as avoiding high competition for food within their populations.

Long-tailed macaque is native to many parts of South East Asian countries, Bangladesh and India (Malaivijitnond and Hamada, 2008; Ong and Richardson, 2008). In Peninsular Malaysia, the estimated population of long-tailed macaques is about 125,000 to about 135,000 individuals with a population growth rate of 5% per annum (Osman, 1998; Karuppannan *et al*., 2014). They adapt well in a wide variety of habitats including primary and secondary forests, coastal forests, disturbed habitats, agricultural areas including animal farms and within human settlements. They were found at elevations up to 1800 m (Ong and Richardson, 2008; Karuppannan *et al*., 2014). The wide distribution of long-tailed macaques has contributed to their localized differences in their behavior, social organization, habitat usage, morphology and genetic variation (Brent and Viera, 2002; Hamada *et al*., 2006; Hamada *et al*., 2008).

The southern pig-tailed macaque is native to Malaysia, Brunei, Indonesia and Thailand and was introduced to Singapore (Richardson *et al*., 2008). They were found in primary and secondary forests, coastal forests and agricultural lands (Richardson *et al*., 2008). The Southern pig-tailed macaque had been identified to play a key role in seed dispersal of certain plant species (Ruppert *et al*., 2014). Yet, not much information is available for this species.

Numerous field studies have demonstrated that activity budgets, i.e., time spent in activities such as resting, eating and moving, varied according to several environmental factors, distribution as well as abundance of food sources (e.g., Md-Zain *et al*., 2010; Hambali *et al*., 2012). Furthermore, differences in particular behaviors for individuals of different age-class and sex were also noted (Md-Zain *et al*., 2010). This study has estimated the natural population size at the study site and investigated the inter-population behavioural routines during human feeding activities between groups of long-tailed and southern pig-tailed macaques.

MATERIALS AND METHODS

Study area: Manjung Paya Bakau Park is located at 4º12'43.6"N, 100º38'52.7"E, about 5 km off Lumut town, Perak. The park is managed by the Manjung Municipal Council and was officially opened in January 1995. The park has a 370 m long and 2 m wide elevated walkway built through the mangroves. The presence and easy sightings of long-tailed macaques and the southern pig-tailed macaques are the main attractions of this park. Other wildlife that can be encountered in this park are the leaf monkeys (*Trachipitechus obscurus*), monitor lizards, squirrels, crows, pigeons, kingfishers, crabs and mudskippers. The most common species of plants including trees found in this area include *Acrostichum aureum*, *Avicennia* sp., *Bruguiera cylindrica*, *Ceriops tagal*, *Lumnitzera littorea*, *Pluchea indica*, *Rhizophora mucronata*, *Sonneratia alba*, *Talipariti tiliaceous* and *Xylocarpus granatum*.

Population estimation: Direct field observations were conducted for 20 non-consecutive days between October and December 2016 at the main entrance of the park. An hour long observation sessions were carried out between 1700 and 1900 hours. This period was presumably the peak feeding time whereby visitors came to feed the monkeys with various types of food. At this time, the number of individuals for both species were counted based on their age-class for approximately three times i.e., before, during and after the observation period. This would give a rough estimation of the average total number of individuals for each species appeared on site.

The age-class were distinguished according to the body size and secondary sexual characteristics of the monkeys (Oi, 1990): (1) Adult: male with large and muscular body, red-colored penis; female with elongated nipples due to suckling, without carrying any infant (2) Mother: female carrying infant on its body (3) Juvenile: male with slightly smaller body size, female with smaller body size, without elongated nipples. (4) Infant: free-moving, not attached to any individuals i.e., mother.

Behavior observation: Behavioural activities were noted based on direct field observations of 1200 minutes during the feeding time. The time allocation for the behaviour categories were obtained by random scanning on individuals according to their age-class during the same period to reduce biasness. The data collection was taken by two observers, alternately observing the two species of monkeys to achieve a better estimation and an unbiased data set. The behaviours were divided into six categories (1) resting (i.e., motionless, sleeping, staring, observing) (2) moving (i.e., climbing, jumping, running, walking) (3) feeding (i.e., drinking, eating) (4) socializing (i.e., mating, playing) (5) grooming (i.e., grooming, scratching) and (6) others (i.e., fighting, and other activities that do not fall within any of the categories).

Statistical analysis using unpaired *t*-test was performed to determine whether there are significant differences in the behavioral activities between these two species. Comparisons in their behavioural activities according to age-class were also noted. In addition, the age-classes were accumulated based on the behavioural activities and compared between the two species. All graphs and statistical analysis were done using Graph Pad Prism version 5.0.

RESULTS

Population estimation: Number of individuals of *M. fascicularis* that came to the main entrance was approximately 12–65 individuals with an average group size of 32.75±12.34 individuals comprising of 8 infants, 8 juveniles, 4 mothers and 12 adults for each visited day. The population of *M. nemestrina* was estimated at 13–31 individuals with an average group size of 22.60±4.84 individuals comprising of 7 infants, 5 juveniles, 2 mothers and 8 adults for each visited day.

Behavior observation: A total of 1200 minutes of observation period was conducted for this study. Six behavioural activities were successfully identified and described. Based on the age-class, resting constituted the most percentage for the mothers of both *M. fascicularis* (47.25±15.13%) and *M. nemestrina* (58.82±11.09%). Infant portrayed the most socializing behavior among and between both *M. fascicularis* (17.42±20.11%) and *M. nemestrina* (17.17±11.75%). As for the adults, most behavioural actions fell under the 'other' category for both species i.e., *M. fascicularis* (2.25±4.34%) and *M. nemestrina* (3.08±3.76%). The percentage of time spent in grooming, feeding and locomotion were almost similar for both species (Figure 1).

The unpaired *t*-test for all age-classes except for infant showed significant difference on the resting behavior (*p*-value: 0.439, t=0.782, df=18). All age-classes except for adult showed insignificant difference on locomotion (*p*-value: 0.018, t=2.482, df=18). Comparison on behavioural activities among age-classes between the two species are summarized in Table 1.

From the total period of observation, *M. fascicularis* spent most of the time resting (30.56±12.90%) and locomotion (30.83±10.57%) followed by feeding (22.23±11.89%), socializing (9.13±11.91%), grooming (5.65±5.51%), and others (1.60±3.19%) (Figure 2). *M. nemestrina* showed most of the time resting (38.04±10.67%), followed by locomotion (28.29±10.04%), feeding (19.63±12.44%), socializing (6.21±5.61%), grooming (6.04±5.01%), and others (1.79±2.77%) (Figure 2).

When the data were pooled, the unpaired *t*-test indicated no significant difference of behavioural activities between the long-tailed and pig-tailed macaques with regards to their five behavioural categories, i.e., grooming (*p*-value: 0.670, t=0.426, df = 158), feeding (*p*-value: 0.192, t=1.310, df=158), socializing (*p*-value: 0.159, t=1.415, df=158), moving (*p*-value: 0.151, t=1.443, df=158) and others (*p*-value: 0.705, t=0.379, df=158). However, the "resting" behavior was significantly different between them (*p*-value: 0.007, t=2.754, df=158).

Table 1. Comparison of behavioral activities based on age-class between the long-tailed and pig-tailed macaques.

Categories	Behaviours	*p*-value	*t*-value	df	Sig.
Infants	Resting	0.439	0.782	38	No
	Grooming	0.449	0.764	38	No
	Feeding	0.599	0.531	38	No
	Socializing	0.962	0.048	38	No
	Locomotion	0.165	1.416	38	No
	Others	0.494	0.690	38	No
Juveniles	Resting	0.002	3.381	38	Yes
	Grooming	0.246	1.178	38	No
	Feeding	0.886	0.145	38	No
	Socializing	0.055	1.983	38	No
	Locomotion	0.217	1.256	38	No
	Others	0.609	0.515	38	No
Mothers	Resting	0.011	2.662	38	Yes
	Grooming	0.628	0.489	38	No
	Feeding	0.016	2.514	38	No
	Socializing	0.401	0.850	38	No
	Locomotion	0.226	1.232	38	No
	Others	0.798	0.258	38	No
Adults	Resting	0.021	2.409	38	Yes
	Grooming	0.326	0.995	38	No
	Feeding	0.969	0.039	38	No
	Socializing	0.229	1.223	38	No
	Locomotion	0.018	2.482	38	Yes
	Others	0.320	0.649	38	No

DISCUSSION

Population estimation: The group size varied between the long-tailed and southern pig-tailed macaques at the study site. On average, there were at least 40 individuals in a single group of long-tailed macaque. This number is almost equivalent to the number of macaque individuals estimated in the mangrove forest of Kuala Selangor Nature Park (Hambali *et al*., 2012). Study by Md-Zain *et al*., (2010), however, identified nine groups consisting of 20 to 101 individuals of long-tailed macaques in Universiti Kebangsaan Malaysia main campus. In this study, the southern pig-tailed macaques comprised of at least 20 individuals in a single group. However, there is little information on the population status of the southern pig-tailed macaque in Peninsular Malaysia apart from a general remark on the presence of the southern pig-tailed macaques by Karim *et al*., (2014). Intra-specific variations of group sizes were common depending on the habitat occupied or the history of the group (Menard 2004). These species of monkeys have the ability to adapt to any environment and weather conditions that have also given significant impacts on their birth ratios, immigration, emigration and mortality (Karim *et al*., 2014).

Behavior observation: The mangrove forest provided natural food source for these monkeys, though they still prefer to consume foods given by visitors (Hambali *et al*., 2012). During feeding time, groups of long-tailed and pig-tailed macaques would gather at the main entrance of the park. Both species were observed to feed at the same place, with various types of food given by the visitors. These included fruits and vegetables such as apples, bananas, papaya, areca nuts, grapes, corns, guavas, langsat, longan, mangoes, pineapples, oranges, plums, rambutan, star fruits, sugarcane, long beans and turnips. Other food items were fish balls, bread, biscuits, chocolate, pea crackers, cooked rice, *nasi lema*k, *roti canai*, popcorn, peanuts, marshmallow, ice-cream, raisins,

doughnuts, chips, jelly, wafer, bottled mineral water, *teh tarik* and lime juice. Those food items common to human food.

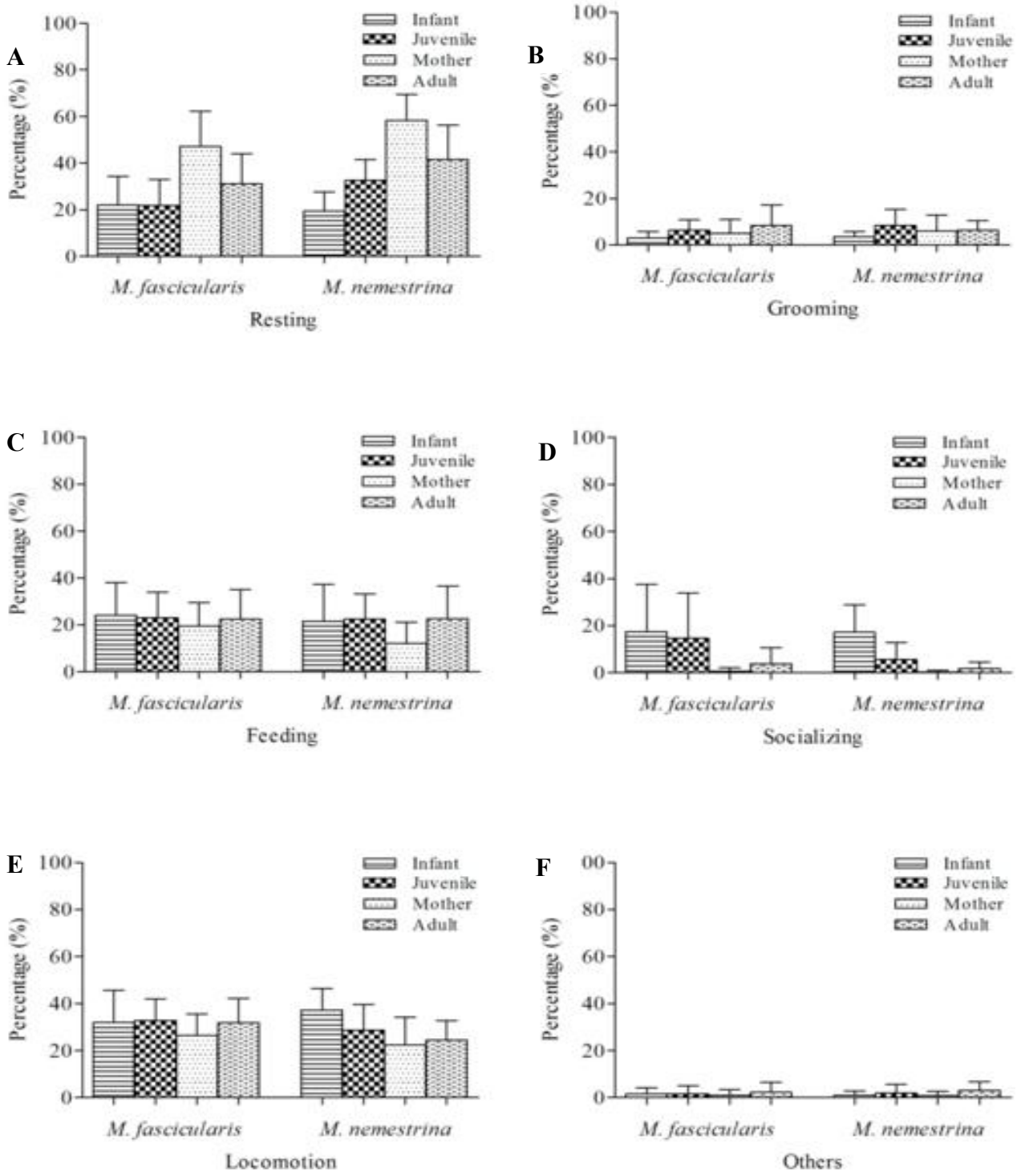

Figure 1: Behavioral activities of Long-tailed and Pig-tailed macaques based on age-class in percentage: (A) Resting (B) Grooming (C) Feeding (D) Socializing (E) Locomotion (F) Others.

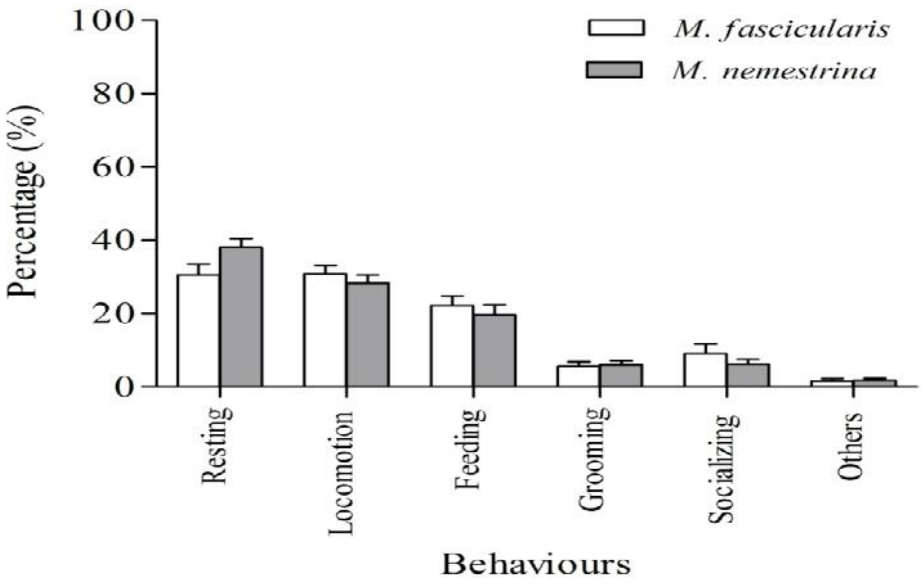

Figure 2. Comparison of behavioural activities between Long-tailed and Pig-tailed macaques.

diets can be correlated to places where the monkeys are usually present (Md-Zain *et al*., 2010). In this study, mutual respect between the two monkey species was observed particularly during feeding periods. Food snatching or fighting over food between individuals of the two species rarely occurred. However, some individuals presumably feeling insecure would bring their food to safer and isolated places. In situations where food was limited, feeding conflicts among the long-tailed and the southern pig-tailed macaques were expected as the two species share the same food source on the same site (Md-Zain *et al*., 2010). The monkeys including mothers would compete and fight for food. In most situations, lower-rank individuals would fight over the food left by the pig-tailed alpha male, which is the larger individual among the two species of monkeys. However, these aggressions seldom occur when there is abundant Both species of monkeys have similar way in handling the food items given by visitors. They either take it directly from the visitors' hands, or from the floor. When handling fruits such as langsat, the monkeys use their hands and teeth to peel the skin off the fruits. Whereas for food items that are grainy and difficult to hold on to such as rice, the monkeys would crouch down with their rear raised up above their bodies and both hands placed on the sides of their heads to support their body weight while they "graze" the rice directly using their mouths. The body postures while drinking were also similar among the two species. The monkeys drink by sucking or licking on liquid spills on ground. For sealed cups, they would hold the cups with both hands and pour the contents directly into their mouths.

Resting normally occurs when the monkeys were waiting for food supply from visitors. These monkeys could be seen sitting, leaning their bodies on tree trunks, lying on their fronts on tree branches with hands supporting their heads or hands hanging freely or lying down sideways on the ground with both eyes closed. They are also considered resting when sitting down, and doing nothing (Hambali *et al*., 2012). Some monkeys that had just arrived on the site would rest for a while before approaching to feed on the available food. When both species groups arrived at the park main entrance for feeding, they can be seen mixing together and not segregated as different groups.

Quadrupedalism locomotion was observed in both species of monkey. Sometimes, some individuals walk using only two hind legs, or two hind legs with one arm. Individuals that preferred to reach to the food more quickly than the others would adopt running which involves both hands and both legs moving simultaneously and gives momentum for the monkeys to force themselves forward. Meanwhile, some individuals use the trees as their mean to move from one point to another. They would jump from one place to another by bending both legs in a squating position, and then push the legs upwards to perform the jump. Their hands are swung from front to the back while the legs are ushered to the front landing first on a surface. The hands are then used to support the impact upon landing. Moreover, climbing involves use of both hands to grab on the tree trunk, bending of both legs followed by straightening of legs creates a force to move upwards, while both hands release the grip and grab on the next upper part of the tree trunk. This repetitive movement is done until the monkeys reach the targeted destination. When coming down tree trunks, the monkeys would hug and grip using both hands and legs with head upright, loosen the grip, and slide down the length of tree trunks. Sometimes, they

might crawl down the tree trunk with the heads facing downwards, and both hands and legs act as brakes.

In this study, there were two long-tailed macaque adult males that were disabled. The one with impaired right arm is large, probably was born that way as scars of past injuries were absent or not visible. It walks using two legs and one arm in normal pace. This individual was also able to climb up and down trees normally like other individuals. The other had an injured leg, was visibly skinny and move from one point to another using both hands and one leg. Both individuals seemed to walk and run on the ground like any other normal individual. Although both individuals were seen tree climbing, the ground seemed to be the best mean of translocation for them.

Auto grooming is often seen in all age-classes for both monkey species. It is defined as repeated rubbing or scratching on any parts of body using its hands or legs. Both monkey species use their hind feet to scratch the head, instead of using their front feet. Although adult males of long-tailed macaque do not auto groom themselves frequently in the wild (Brent and Veira, 2002; Md-Zain *et al*., 2010), other lower age-class individuals often allogroom individuals of higher age-class due to the hierarchical factor. For instance, adult females of long-tailed macaque without infant will allogroom adult males (Md-Zain *et al*., 2010; Hambali *et al*., 2012). This relationship was associated with reward for protection, food sharing and as mating partner (Hambali *et al*., 2012). It has been stated that higher rank age-class of adult female would receive more allogrooming from lower rank age-class (Gumert, 2007), while allogrooming do not occur between males (Brent and Viera, 2002). Adult mother of the long-tailed macaque often groom the infant it carries, to strengthen the relationships between them (Md-Zain *et al*., 2010; Hambali *et al*., 2012). In some occasions, an adult male pig-tailed macaque was observed to groom a mother carrying an infant. In this study, an adult southern pig-tailed macaque male was seen allogrooming an adult female and vice versa. This behaviour could be an initiation of the male to attract the female. On other occasions, both long-tailed and southern pig-tailed macaque juveniles were allogrooming each other. This scenario showed that there is inter-species interaction among these monkeys.

Socializing behaviours such as playing which involve biting mockery, chasing, wrestling and vocalizing often occurs among infant and juveniles at their active age as a form of social relations between them (Md-Zain *et al*., 2010; Hambali *et al*., 2012). Adult individuals especially the mother would monitor the infant to ensure their safety (Md-Zain *et al*., 2010; Hambali *et al*., 2012). Unlike the southern pig-tailed macaques that have short tails, infants and juveniles of long-tailed macaque like to pull the tail of its playmate. Sometimes, the mother itself would grip the tail of the infant so that it is prevented from moving too far away from the mother. In an occasion, an infant long-tailed macaque was seen to carry another infant up a tree, like an adult mother before eventually returning the infant back to the mother. This could probably be that the mother, being up on the tree, might have not noticed that the infant was already on the ground. This is probably a behavioural indicator that each individual plays an important role in looking out for each other.

Playing also involve hanging and swinging on trees for both monkey species. Both playmates will grip the tree branch using both of its hind legs, hanging in inverted position, and using both hands to fiddle with each other. In Thailand, long-tailed macaques often keep their distance from stump-tailed macaque, *M. arctoides*, but as years progress, the two species were able to come close together playing and grooming (Malaivijitnond and Hamada, 2008). In this study, playing involving the infants and juveniles of long-tailed macaques with the southern pig-tailed macaques also occurred. Moreover, the long-tailed macaques like to jump into the water during high tide and swim.

Female individuals that live in a multi-male group focus on copulating with dominant male (Van-Noordwijk and Van-Schaik, 1999). In this study, an alpha adult male of the southern pig-tailed macaque was frequently approached by adult females. The adult female would stand straight with both hands and legs, raising its backside and showing it to the alpha male. Then the alpha male would sniff the genitalia ensuring that the female is ready to mate before mating. The period of mating is very short and takes less than a minute. Similarly, adult female long-tailed macaque would only choose strong and dominant male to mate to ensure the new born infant would be in good health and protected by any rivals (Van-Noordwijk and Van-Schaik, 1999; Md-Zain *et al*., 2010). Most infants of long-tailed macaque within a group are of the dominant male (De-Ruiter *et al*., 1994). Male long-tailed macaque often shows signs of mating more than adult females, and homosexual act between male and male of the long-tailed macaques are often seen (Hambali *et al*., 2012). Mothers of long-tailed macaque often sit close together forming a small group which may be a form of socializing.

Previous studies often relate protection among individuals within the groups from outsiders (Md-Zain *et al*., 2010; Hambali *et al*., 2012). However, there is some exception to this rule. In this study, the juvenile of southern pig-tailed macaque was seen to disturb the juvenile of long-tailed macaque, and trigger the fight between the two individuals. They perform facial threats posture where brows are raised and the eyes are enlarged to the opponent. Sometimes, they would open their mouth wide to display their canine tooth to the opponent. When threatened, the head is lowered to the ground while the faced is aimed directly to the opponent, both hands are

bent and placed on both sides of the head, the backside is raised up, as if it is ready to jump onto the opponent. At one occasion, the adult of the alpha male of southern pig-tailed macaque chases off its own juvenile to break off the fight between the two juveniles. It is unusual to see a behaviour where adults seem to exhibit mutual respect to another species in breaking off a fight by reacting upon its own species.

Conservation status: The long-tailed macaque is classified as Least Concern (Ong and Richardson, 2008) and the southern pig-tailed macaques are classified as Vulnerable by the IUCN Red List (Richardson *et al*., 2008). Wild monkey population that are threatened by genetic pollution causes serious problem for conserving wild and free-ranging monkeys in the future (Malaivijitnond *et al*., 2005). Hybridization between long-tailed and southern pig-tailed macaques have been documented (Groves, 2001). Hybridization have also been recorded between the northern pig-tailed macaques, *Macaca leonina* with southern pig-tailed macaques (Groves, 2001) as well as with pig-tailed macaques and rhesus macaques (Malaivijitnond and Hamada, 2008). These hybrids were fertile, and therefore will influence the following generation (Malaivijitnond and Hamada, 2008). As individuals of long-tailed and southern pig-tailed macaques immigrate-emigrate to and from other groups were tolerated by other male individuals (Oi 1990; Md-Zain *et al*., 2010), possibly to avoid inbreeding for their reproductive success (Oi, 1990), hybridization may occur among the two groups in Paya Bakau Park.

Interspecific hybridization spoils the genetic reliability of the native population (Malaivijitnond *et al*., 2007). Examples for opportunity for inter specific hybridization have been observed before where, a female stumped-tailed macaque, *M. arctoides* with two other females of southern pig-tailed macaques, *M. nemestrina* blends in together with the long-tailed macaque groups (Hamada *et al*., 2004; Malaivijitnond *et al*., 2005). Additionally, a female long-tailed macaque was observed in a stump-tailed macaque group (Hamada *et al*., 2004; Malaivijitnond *et al*., 2005). Malaivijitnond and Hamada (2008) also reported that an adult male southern pig-tailed macaque was observed to mate with a female long-tailed macaque in Thailand. In this study, both long-tailed macaque and southern pig-tailed macaque can be observed mixing together as 'a single species'. Then again, a quick consensual mating between a male juvenile pig-tailed macaque with a female long-tailed macaque was chased by a juvenile male long-tailed macaque. Although there is no evidence on the occurrence of hybridization between these species, we suspect that there a good chance of this taking place in future.

Compared to long-tailed macaques, the southern pig-tailed macaque populations are considered rare, and isolated from each other by forest fragmentation due to agriculture and development. Out breeding depression is becoming more important in small isolated population that is of conservation concern especially as local authority policies and private initiatives result in unwanted animals to be reintroduced into the wild to rejoin their kin (Malaivijitnond *et al*., 2007). As the populations of the southern pig-tailed macaques are decreasing due to habitat loss resulting from expansion of oil palm and agriculture plantations, timber loggings and individuals shot for meat as well as for pest control (Richardson *et al*., 2008), implementing the policies should take into consideration in conserving the genetic and avoid genetic pollution and hybridization of the pig-tailed macaque in protected areas.

The flipside of this situation is that the long-tailed macaque is listed as one of the "100 Worst Alien Invasive Species" by the World Conservation Union. However, they are not a biodiversity threat in their native countries, as sympatric species have adapted well with their presence (Malaivijitnond and Hamada, 2008). However, the long-tailed macaques could be one of potential monkey species that could trigger genetic pollution and hybridization if not properly managed especially in protected areas. Though a castrated male monkey causes more problems, losing their androgen production, aggressiveness and social rank (Malaivijitnond and Hamada, 2008), it might be a necessary step in order to save gene erosion in other monkey species in selected sites (e.g. Malaivijitnond, and Varavudhi, 2002).

Conclusion: Population estimation of the long-tailed macaques in this study was compatible to the natural population of the species in other sites. However, the population status of the pig-tailed macaques in this study could not be compared to other sites as published data of their population size from other areas were not available. Tolerance was observed among individuals of the two species of monkeys that share the same inhabitation area and food source at the park. Interactive behaviours such as playing and grooming were not limited to their own species. However, close inter-species interaction might lead to unfavorable genetic hybridization especially to the southern pig-tailed macaque populations where it may jeopardize conservation efforts in future.

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