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Long-tailed macaques, *Macaca fascicularis* (Primate: Cercopithecidae): human-monkey behavioural interaction in Botanical Gardens Penang, Malaysia

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ABSTRACT

The interaction between long-tailed monkey, *Macaca fascicularis* Raffles (Primate: Cercopithecidae) and human, *Homo sapiens* Linnaeus has been increased in last few decades due to the tremendous increase in the populations of both species in Botanical Gardens Penang (BGP), Malaysia. They were interrelated in their environment; therefore, *M. fascicularis* has been disturbed due to human activities. In turn, *M. fascicularis* re-emerged with an effective and high-level reaction to human population. The present research was conducted to observe the interaction between *M. fascicularis* and *H. sapiens* by using scan sampling method in BGP, Malaysia during March 2012-February 2013. Their behavioural interactions were found significant ($p < 0.001$) with all aspects. However, the highest behaviour of *M. fascicularis* was attacking (2.2 ± 0.9) and the lowest was vocalization (0.2 ± 0.4) compared with its all activities ($X^2 = 1832.9$; $p < 0.001$; $n = 215$), moreover, the highest behaviour of *H. sapiens* was giving food (2.16 ± 0.8) and the lowest was hand clapping (0.2 ± 0.4) compared with all activities ($X^2 = 927.6$; $p < 0.001$; $n = 119$). The attacking behaviour of *M. fascicularis* was positively correlated with feeding, eating, grooming and snatching, however, it was negatively correlated with running, vocalization, playing and exploiting garbage. From the human activities, the feeding was positively correlated with throwing food, confliction and going close, however, it was negatively correlated with gesture, running, hand clapping and playing. It was concluded that the behaviour of *M. fascicularis* was insecure in BGP where both were coexisted. The management of respective locales were recommended to formulate practical strategies to avoid or decrease the interaction between both.

Key words: Behaviour disturbance, Botanical Gardens Penang (BGP), coexistence, human-macaques interaction, *Macaca fascicularis*, scan sampling.

INTRODUCTION

The Botanical Garden Penang (BGP) is located at $05^{\circ}26'25.80''$ N and $100^{\circ}17'16.56''$ E in Malaysia. It is popular among the visitors due to having numerous plant species and many important places for safety of the wildlife species. There are 2 circles in the garden, one is the lower and another is the upper circle. The lower circle is rounded with total area of 14 hectares and it touches the upper circle to some extent. This circle consists of orchid garden, which is composed of shrubs, plants and trees. A small lake locates inside the lower circle, which has apparent water falling towards lower part of circle to attract the visitors. The upper circle is oval with total area of 11 hectares (Fig. 1) [1].

The macaque, *Macaca fascicularis* Raffles 1821 is also known as the old world monkey. It is a cercopithecine primate native to Southeast Asia. This animal has several common names. It often refers as the long-tailed macaque due to its unusual long tail that is often longer than the body. The species is also known as the crab-eating macaque because it is often seen foraging on crabs. Another common name is the cinomolgus monkey, which literally means dog-milker monkey, commonly used in laboratories. In Indonesia, *M. fascicularis* and other macaque species are

known generically as *kera*, possibly because it gives the high-pitched alarm calls when in danger, i.e., *krra krra*. The body length of adult is 38-55 cm with comparably short arms and legs with tail typically 40-65 cm. The male is considerably larger than the female with 5-9 kg compared to 3-6 kg of female [2].

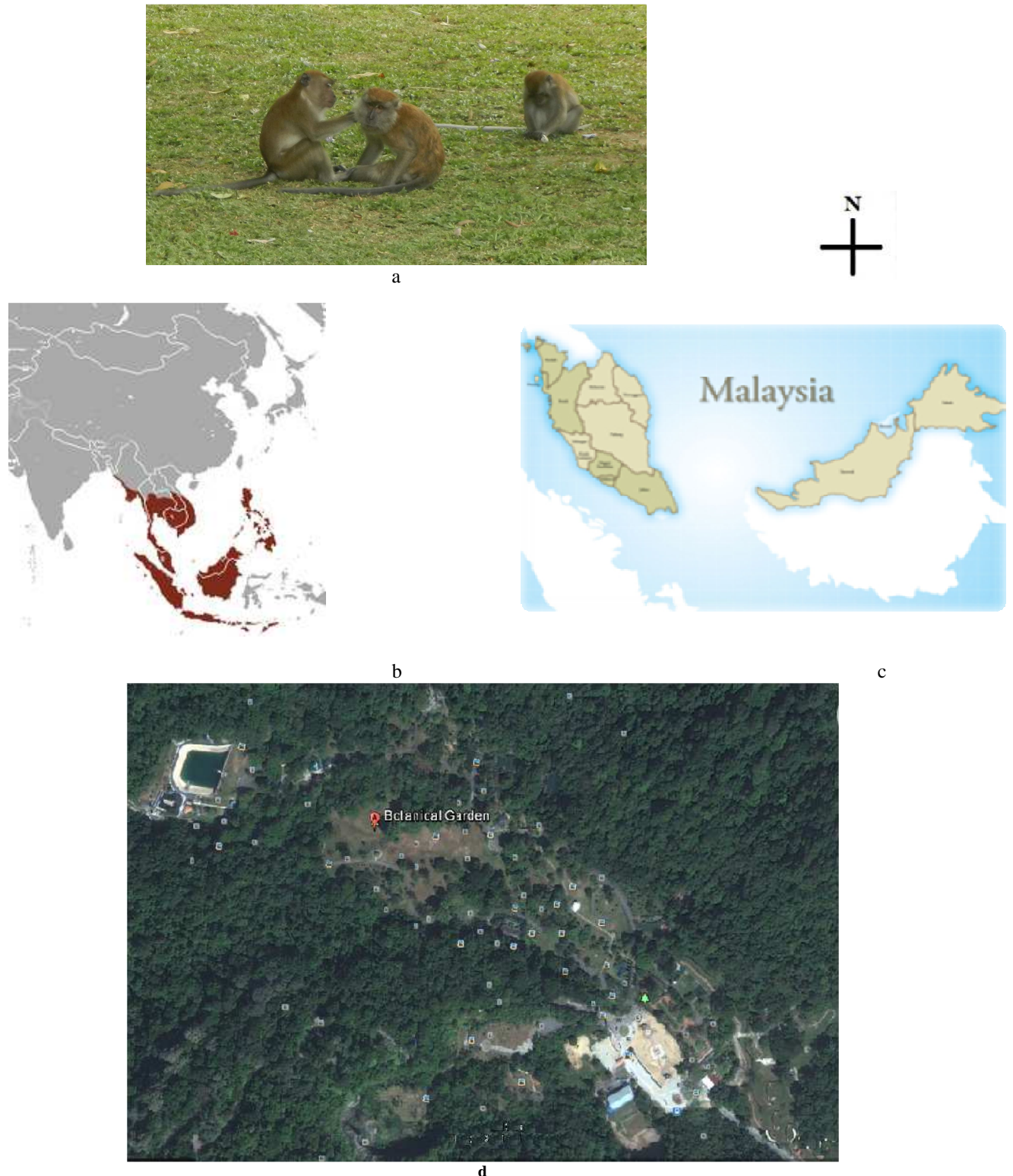


Fig. 1 The map of the study area, Botanical Gardens Penang (BGP) where behavioural interactions between the macaque, *Macaca fascicularis* Raffles (Primate: Cercopithecidae) (a) and human, *Homo sapiens* Linnaeus were surveyed during March 2012-February 2013; worldwide range of *M. fascicularis* (b); the Northern region of Peninsular Malaysia (c); a satellite map of the survey spots of study area, viewing sites of BGP (d) [3].

Macaca fascicularis and Human, *Homo sapiens* Linnaeus, 1758 conflicts increase in last few decades. They are interrelated, both biologically and culturally [4-6]. The importance of social life, reproduction, inside group

relationship and interaction with other groups etc are the ecological factors for the primate's environmental condition [7-10].

It is important to know about primates and human coexistence, i.e., the areas where both of them are sharing resources and their densities occur in abundance [11, 12]. The rise of primates and human interaction, the important influence of parasite-mediated, productiveness, fertility etc require the advance consideration of ecological mechanisms of host-parasite relationship [13, 14]. The behaviours like touching or giving food to *M. fascicularis* are the causes of transmission of viral/bacterial diseases from monkeys to human or vice versa [15].

Further, the present study can be demonstrated the understanding of primates, their connection between the inhabitant's dynamics and their surroundings as well as the social organization of both the host and parasite [16, 17]. Whereas, from long time, in many places of the world human and primates are having sympatric and hate-love association with each other. This association can be described as encounter and competition between them. The crops raiding activity is the main cause between human and primate conflict [18, 19]. Although, many species damage the raised crops, as their creativity, flexibility, cleverness and cunning capabilities etc, therefore, primates can be the majored pests for them [20, 21]. Crops raiding primates belonging to family Cercopithecidae (including macaques, *Macaca* sp Lacépède, 1799; baboons; *Papio* sp Erxleben, 1777 and all species of monkeys etc) are totally depending on type and abundance of crops grown as well as easily picked due to their less weight [22, 23]. In vicinity of human and primates, a right measurement of damages as well as forecasting of up-coming crops raiding action are precisely required [20]. This study is important as to mitigate the effects of crops damaging but it is also important to start a non-harmful procedure of resolving foraging prolem by mentioned primates [24].

In these primates, *M. fascicularis* is the most common species with its great interaction with human in many areas, like agricultural, forests and gardens. This species gives harm to vegetation, rubber farms, rice pitches and orchards. It also survives in residential areas and land farms, for example, rural areas, botanical gardens in Singapore, Penang and Kuala Lumpur. In some occasion, it is dangerous to people and their possessions [25]. *Macaca fascicularis umbrosa* is found in the Nicobar group of Islands and other species are found in Myanmar, Cambodia, Laos, Vietnam, Thailand, Malaysia, Indonesia and Philippines [26].

In Malaysia, *M. fascicularis* is widespread, particularly in the mountainous rainforest running across the islands. In Penang, *M. fascicularis* is abundance in the agricultural forms and botanical gardens. In which, it exhibits its behaviour as their natural habitat and it moves freely along with the visitors, however, no prominent attempt has been assessed to expose their behaviours [27]. Through this survey, the efforts have been made to investigate the human-macaques interaction in BGP, Malaysia.

MATERIALS AND METHODS

The present survey for behavioural interaction of Human, *Homo sapiens* Linnaeus and macaque, *Macaca fascicularis* Raffles was conducted in Botanical Gardens Penang (BGP), Malaysia with its 2 circles, i.e., the lower and upper. The lower circle consists of main gate, orchid garden, palm garden, plant nursery, rubbish side, picnic garden and wide empty grounds. The upper circle consists of sun rockery, Japanese garden, herbal garden and large dam, managed by Water Supply Corporation (WSC) (Perbadanan Bekalan Air: PBA), Pulau Penang Sdn Bhd (PPSB), Malaysia (Fig. 1).

Sampling of the fieldwork about existence of *M. fascicularis* and its behavioural interaction with human was conducted during March 2012-February 2013 daily 9:00 am-7:00 pm. The time-consuming slow walk method for about 50-100 m was used. Sound pitches and feeding by visitors were observed. In some occasion, information was taken from both visitors and gardeners. The observations inside the thick jungle were not taken, as the visitors have rarely gone into the forest; although, data was collected from open grounded census and sufficient places among the trees.

A scan sampling technique was adapted from Altmann [28] with some amendments for facilitation of collection of observational data. The observation on interaction of one group or one individual of *M. fascicularis* was actively prepared with humans, which was taken at a time (15 observations/h).

The following behaviours of *M. fascicularis* were studied: **(1) Attacking:** included slapping, biting, jumping at and pulling [29]; fights, bite and hit [30]. **(2) Feeding:** included reaching for, manipulating, masticating and placing food in the mouth [31, 32]. **(3) snatching:** included taken food by force from each other or from human and running off with it [33]. **(4) Eating:** included eaten from clumped food sources (mainly fruits), handling and eating with dispersed food items (often insects) [34]. **(5) Running:** faster walking on ground or branches of trees. **(6) Playing:**

included social and solitary playing, involving running, climbing or jumping with or without one another and mock fighting [35]. (7) **Grooming:** included referred only to allogrooming [35], grooming in front of human, leaning the body, a monkey picked through the hair of another [30]. (8) **Vocalization:** included high pitched sound like grunts, greeting, contact, mating, distress calls, whistling and screaming etc [36]. (9) **Exploit garbage:** included distribution of food resources [31]. (10) **Feeding by visitors:** included the tourists were given food to them [37]. (11) **Gesture:** included lip smacking, scalp lifting and showing face [38]. (12) **Throwing food:** included the visitors throw the food to them from far away. (13) **Conflicting:** included disagreement among various behaviours of human and *M. fascicularis*. (14) **Hand clapping:** included hand-clapping is a form of gestural communication [39]. (15) **Going close:** included the visitors used to go near around them [40].

Data analysis

Data were analysed by SPSS (Statistical Package for Social Sciences; version 20) and chi-square test at $p < 0.05$. Percentage, correlation and comparisons of variables of behavioural interaction were also calculated [41, 42].

RESULTS

The study was carried out to find out the behavioural interactions between the human, *Homo sapiens* Linnaeus and macaque, *Macaca fascicularis* Raffles in Botanical Gardens Penang (BGP), Malaysia (Fig. 1). *Macaca fascicularis* revealed different behaviours in consequence in the presence of *H. sapiens*/visitors (Fig. 2) who showed altered activities that interacted with *M. fascicularis* (Fig. 3).

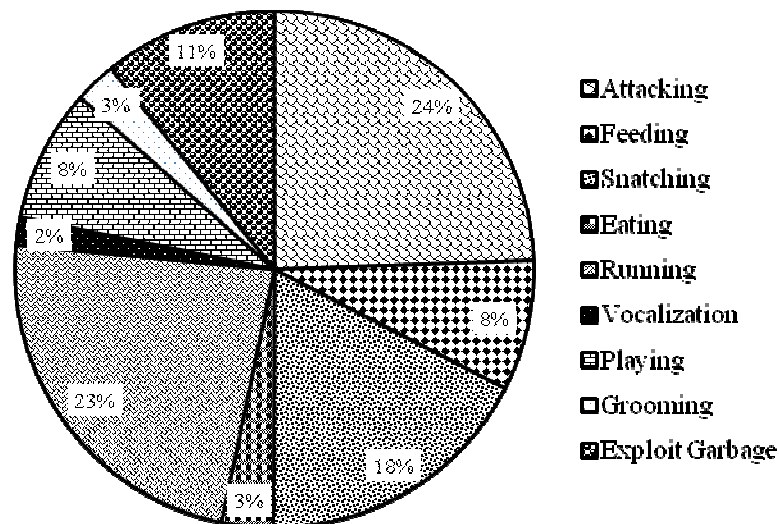


Fig. 2 The behavioural interactions of the macaque, *Macaca fascicularis* Raffles (Primate: Cercopithecidae) (n=215) in the presence of the human, *Homo sapiens* Linnaeus (Primate: Hominidae) were surveyed in Botanical Gardens Penang (BGP), Malaysia during March 2012-February 2013; data (%) were analysed by SPSS (Statistical Package for Social Sciences; version 20) and chi-square test ($X^2=1832.9$) at $p<0.001$, however, they are presented here in percentage (%); Chi-Square values for each behaviour are: attacking: 159.5; feeding: 154.4; snatching: 103.7; eating: 330.3; running: 201.3; vocalization: 289.2.

The coexistence behaviours of *M. fascicularis* (n=215) were found such as: attacking: 24% > running: 23% > snatching: 18% > exploiting garbage: 11% > feeding = playing: 8% > grooming = eating: 3% > vocalization: 2% (Fig. 2); however, the human activities (n=119) were found such as: feeding by visitors: 27% > running: 25% > throwing food: 21% > playing = gesture: 9% > conflicting: 4% > going close: 3% > hand clapping: 2% (Fig. 3).

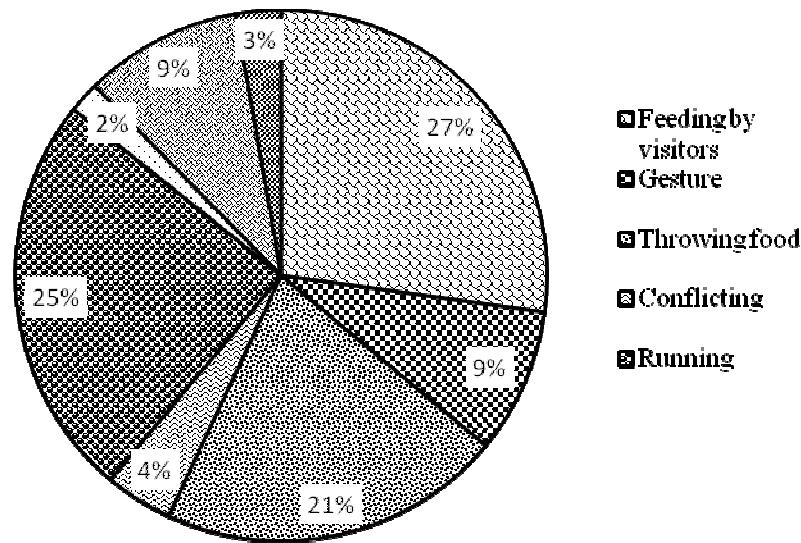


Fig. 2 The behavioural interactions of the human, *Homo sapiens* Linnaeus (Primate: Hominidae) in the presence of the macaque, *Macaca fascicularis* Raffles (Primate: Cercopitheidae) (n=119) were surveyed in Botanical Gardens Penang (BGP), Malaysia during March 2012-February 2013; data (%) were analysed by SPSS (Statistical Package for Social Sciences; version 20) and chi-square test ($X^2=927.6$) at $p<0.001$, however, they are presented here in percentage (%); Chi-Square values for each behaviour are: feeding by visitors: 93.3; gesture: 79.6; throwing food: 52.5; confliction: 161.9; running: 95.6; hand clapping: 161.9; playing: 53.5; go close: 229.4.

All the behaviours of *M. fascicularis* ($p<0.001$; $X^2=1832.9$; n=215) and human/visitors were found significant ($p<0.001$; $X^2=927.6$; n=215) in the areas where the most of interaction occurred between them.

The correlation among coexistence behaviour of *M. fascicularis* and human was calculated. There are 2 types of correlations were found for the behaviour of interaction, i.e., positive and negative correlations. The positive correlation explains the similar direction (i.e., increasing) between 2 behaviours and the negative correlation explicates the opposite direction (i.e., decreasing). For example, attacking behaviour is positively correlated with feeding ($r=0.077$), eating ($r=0.065$), grooming ($r=0.016$) and snatching ($r=0.145$), however, negative correlation was found with running ($r=-0.115$), vocalization ($r=-0.122$), playing ($r=-0.056$) and exploiting garbage ($r=-0.079$) (Table 1).

Table 1 The correlations observed among different behavioural interaction of the macaque, *Macaca fascicularis* Raffles (Primate: Cercopitheidae) (n=215) in consequence of the presence of human, *Homo sapiens* Linnaeus (Primate: Hominidae), surveyed in Botanical Gardens Penang (BGP), Malaysia during March 2012-February 2013.^{1,2}

SNo	Different types of behaviours	Feeding	Snatching	Eating	Running	Vocali-zation	Playing	Grooming	Exploit garbage
1.	Attacking	0.08	0.15 ³	0.07	-0.12	-0.12	-0.06	0.02	-0.08
2.	Feeding		-0.01	-0.11	-0.13	-0.03	0.05	-0.07	0.05
3.	Snatching			-0.08	-0.05	-0.08	-0.01	-0.20 ⁴	-0.09
4.	Eating				-0.12	0.14 ³	-0.06	0.21 ⁴	-0.01
5.	Running					-0.18 ⁴	-0.05	-0.04	-0.03
6.	Vocalization						0.04	0.06	-0.19 ⁴
7.	Playing							-0.19 ⁴	-0.12
8.	Grooming								-0.05

¹values without charge are increasing and with negative charge are decreasing

²Data (%) were analysed by SPSS (Statistical Package for Social Sciences; version 20) and chi-square test ($X^2= 1832.944$) at $p<0.001$

³Correlation is significant at $p<0.05$; ⁴at $p<0.01$

In human activities, the correlation was found in feeding by human, however, this activity is positively correlated with throwing food ($r=0.088$), confliction ($r=0.203$) and going close ($r=0.045$), moreover, it is negatively correlated with gesture ($r=-0.062$), running ($r=-0.014$), hand clapping ($r=-0.068$) and playing ($r=-0.169$) (Table 2).

Table 2 The correlations observed among different behavioural interaction of the human, *Homo sapiens* Linnaeus (Primate: Hominidae) with the macaque, *Macaca fascicularis* Raffles (Primate: Cercopithecidae) (n=119), surveyed in Botanical Gardens Penang (BGP), Malaysia during March 2012-February 2013.^{1,2}

SNo	Behaviours	Gesture	Throwing food	Confliction	Running	Hand Clapping	Playing	Go close
	Feeding by visitors	-0.062	0.088	0.203 ³	-0.014	-0.068	-0.169	0.045
	Gesture		-0.0146	-0.073	-0.147	-0.049	0.028	-0.116
	Throwing food			-0.089	0.088	-0.174	-0.119	-0.138
	Confliction				-0.211 ³	0.253 ⁴	-0.190 ³	0.248 ⁴
	Running					-0.225 ³	0.079	-0.077
	Hand Clapping						0.054	0.133
	Playing							-0.163

¹values without charge are increasing and with negative charge are decreasing
²Data (%) were analysed by SPSS (Statistical Package for Social Sciences; version 20) and chi-square test ($X^2=927.64$) at $p<0.001$
³Correlation is significant at $p<0.05$; ⁴at $p<0.01$

DISCUSSION

Interaction of the macaque, *Macaca fascicularis* Raffles (Primate: Cercopithecidae) with the human, *Homo sapiens* Linnaeus (Primate: Hominidae) has been a significant feature in the daily lives for a number of generations, contritely, these relations conflict the social activities and natural balance of *M. fascicularis* [43]. It appears that the behaviour of *M. fascicularis* has great influence on human population and human disturbed their natural habitat. In the resultant, human-macaques interactions/conflicts occurred [4]. This paper discusses the coexistence behaviours of *M. fascicularis* with human (Figs. 2 and 3).

The present results exhibited, the utmost proportion of interaction of *M. fascicularis* was attacking 24% and human activity was estimated 27% for behaviour of feeding in BPG, as previously described that *M. fascicularis* disturbed the people/visitors 11% [44]. The result given was very less as compare to the present study because a huge population of human were surrounded/visited in BPG and *M. fascicularis* freely/without any threat came down for searching of food, therefore, more interaction occurred here as compare to other places. Previous research described that *M. fascicularis* disturbed the visitors for grabbing/snatching the food [44]. Attacking and feeding behaviours were found significant as interactions occurred in higher numbers and *M. fascicularis* felt angry at the human behaviour. The correlation between attacking and snatching was found significant, as both of behaviours are directly proportional to each other.

The second highest behaviour was running (23%) by *M. fascicularis* and 25% of human as observed by Md-Zain [45] that they moved and ran fast, however, their results were the same as in the present study. This activity was also found significant, however, the correlation was found negative with vocalization, as during threat from human or other animals like dog, they run fast as described by Md-Zain [45]. The snatching food from human was found 18% and conflicting activity was 4%, as described by Fuentes [46], that Monkeys spent the most of their time interacting with tourists, this showed close proximity to behaviour of snatching of *M. fascicularis* in BGP. The correlation of snatching and grooming was found negative with highly significant as snatching was threat able activity and indirectly proportional to grooming behaviour.

The other behaviour such as exploiting garbage was 11% observed by Kamarul et al. [44] that *M. fascicularis* dispersed garbage rapidly, the same behaviour was observed in BGP at the present. The correlation of this behaviour was negative with other behaviours except feeding by human, therefore; during this behaviour, they did not exhibit other activities. Kamarul et al. [44] described that *M. fascicularis* disturbed and exploited the garbage for searching of food. Feeding was 8% by *M. fascicularis* and 27% by human, it was usually happened because visitors once enter to BGP, they habitually fed them as well as their children were also performed this activity, if they were present in BGP [47]. At the present, feeding has positively correlated with playing and exploiting garbage, it depends on food availability that if more food was available then they played around and dispersed the food.

The playing was calculated 8%, it was estimated previously that *M. fascicularis* spent 7% of their time budget in playing [48]; the present finding showed close proximity to previous surveys. The positive correlation was found with feeding and vocalization, as visitors fed them during play, simultaneously, *M. fascicularis* vocalized with a different sound during playing time. Juveniles and infants spent more time as compared to adults of animals [48]. At the present, grooming was calculated 3%, however, it was reported that *M. fascicularis* spent 2% of their total time in grooming [49]; therefore, considerably the findings of Qihai et al. [49] were the same as in the present study. Grooming was found positively high significantly correlated with eating as they eat lice (ectoparasite), *Fahrenholzia pinnata* Haeckel, 1896 (Phthiraptera: Phthirapteridae) during grooming.

At the present, eating was 3%, while previously Charmalie *et al.* [50] and Robert *et al.* [36] discovered that *M. fascicularis* spent more time in eating. Difference could be in the presence of human and their activities. The correlation was found positively significant with attacking and vocalization, however, it was positive highly significant with grooming. Previously, Robert *et al.* [36] described that during eating, some other social behaviours were also taken place like plucking of the flowers, small plants and fruits from the trees were the common behaviours of *M. fascicularis*. Vocalization of *M. fascicularis* was observed 2%, it has negative correlation with the most of other behaviours. It was observed that *M. fascicularis* was the noisiest species among all Primates [51]. Another study found that they spent 2-4% in vocalization [36]; this behaviour was found the same as in the present study. According to Keesing *et al.* [15] the behaviour like touching or giving food to the monkeys was the cause of transmission of virus /bacterial diseases from monkeys to human or vice versa. Such types of behaviours were also observed during the present research. The present survey confirmed that it is not simply the presence of total number of tourists/visitors in BGP was suffering from *M. fascicularis* threats, but relatively human activities were also affected their behaviour.

CONCLUSION

The sharing the same environment was influencing on behaviours of both species. The interfacing behaviours of *M. fascicularis* against human were insecure in BGP where human and *M. fascicularis* coexisted. This study revealed that attacking, running and snatching behaviours of *M. fascicularis* were significantly convinced to human. The behaviours of exploiting garbage and dispersing the dump in clean areas of gardens were common behaviours of *M. fascicularis*. On the other hand, feeding and playing around *M. fascicularis* by human were also found in the open space of BGP, which gave the results of nuisances as well as the disturbance of their natural habitat, it caused the conflicts between both species.

Recommendations

To reduce the stress of interactions and ensure a more enjoyable visit of human in BGP, it is suggested that BGP and Management of Wildlife Department Penang (MWDP) staffs should continuous less restricted methods to provide an advantageous interactions between both species. They should be allocated with more control over places where *M. fascicularis* came near to human. They should have provision of BGP and MWDP staffs and it must be advised by force that they did not allow the public to feed *M. fascicularis*.

The BGP is an accessible place, therefore, the tourists/visitors, wildlife watchers, hunters and trappers have been increasing day by day. Therefore, for their protection, BGP and MWDP staffs should be taken the following steps: 1) BGP should be declared "protected areas" and hunting, killing and capturing of *M. fascicularis* should be completely banned there; 2) hunting, killing or trapping of *M. fascicularis* by means of fire arms or any other device should be prohibited; 3) Dealing with *M. fascicularis* hunting, trade or business should be declared illegal; 4) Trapping should be allowed only in the seasons when observed population abundance by BGP and MWDP staffs; the fee for trapping per animal should be charged; 5) the export of *M. fascicularis* from the province within the country should be charged and it should be double charged for outside the country; 6) to discourage *M. fascicularis* trapping by the young people, trapping licenses are issued only to persons over 18 years of age.

In order to protect *M. fascicularis* population and its habitats, the following specific suggestions for protection at the local level must be taken: 1) the rules regarding tourists/visitors in BGP, Malaysia need to be established and oriented more towards protection. They should be implemented forcedly; 2) *M. fascicularis* breeding places should be established with improve techniques of breeding populations; 3) study the factors of BGP influencing both *M. fascicularis* and human; 4) expand cooperation and collaboration among mammalogists, conservationists and those working in the breeding range of *M. fascicularis* populations; 5) take eco-tourism measures, researches and extend public education programs involving foresters and farmers etc; 6) their habitats should be protected from deforestation and agro-industrial chemical pollution; 7) To control public in BGP, requires additional well-trained BGP and MWDP staffs to protect and manage the BGP; 8) Local committees should be monitored the population, and trapping of *M. fascicularis* in BGP, Malaysia.

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