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LONG-TAILED MACAQUES OF THE BATU CAVES, PENINSULAR MALAYSIA: POPULATION ESTIMATE, NUISANCE BEHAVIORS, AND HUMAN PERCEPTION

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ABSTRACT

The presence of long-tailed macaques (*Macaca fascicularis*) in tourism sites such as the Batu Caves results in frequent interactions with a high number of visitors. The survey of current population estimation, nuisance behaviors, and visitor's perception are important for determining the potential of the Batu Caves as a ecotourism site. The main objectives of this study were to estimate the long-tailed macaque population size in the Batu Caves, identify macaque nuisance behaviors, and determine the visitor's perception of *M. fascicularis*. A census walk was performed to know the current population size. A scan sampling technique was used during intensive observation and questionnaire surveys were conducted to evaluate visitor's perceptions. Four distinct groups of *M. fascicularis* with a total of 132 individuals were identified in the Batu Caves. Five categories of nuisance behaviors were identified: littering, disturbing visitors, damaging facilities, stealing, and messing up garbage cans. The questionnaire results revealed that local visitors and foreign tourists have different perceptions of the macaques in the Batu Caves. However, the majority of respondents agreed that the Batu Caves have potential as a site for primate tourism. Population censuses and nuisance behavior identification are important for the Batu Caves management authority and the Department of Wildlife and National Parks to improve nuisance management. Our research findings could also assist government and related organizations to develop strategies for improving ecotourism planning and conservation management of *M. fascicularis* in the Batu Caves.

Keywords: long-tailed macaques, *Macaca fascicularis,* nuisance, ecotourism, primate tourism

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INTRODUCTION

The Batu Caves are a famous tourism site in Malaysia that has attracted many local visitors and foreign tourists over the years. The Batu Caves are located about 13 km northeast of Malaysia's capital city, Kuala Lumpur. The karst development of the limestone hill extends over 2.59 km². The Thaipusam festival is held at the Batu Caves, which attracts many Hindu worshipers at the temple of Sri Subramaniar Swamy each year (Kiew, 2014). The Batu Caves draw many tourists due to the cultural and religious significance of the site (Kasim, 2011). Long-tailed macaques (*Macaca fascicularis*) are often seen foraging in the main entrance of the temple and wandering on the cliffs of the Batu Caves. The long-tailed macaques frequently interact with visitors; the Batu Caves attract approximately 3,500 to 4,000 people daily (Marty *et al.,* 2019).

Generally, long-tailed macaques are considered a pest primate in most habitats (Md-Zain *et al.,* 2014; Abdul-Nasir *et al.,* 2021). Macaque's behaviors often create nuisances to people who share environments with them (Md-Zain *et al.,* 2011). Long-tailed macaques that reside in areas close to human settlements are often observed littering, stealing goods, damaging facilities, and showing aggressive behaviors toward humans (Gamalo *et al.,* 2019). These pest behaviors are closely associated with the food requirements of long-tailed macaques (Sha *et al.,* (2009). In addition, food provisioning by humans has led to the habituation of long-tailed macaques (Hambali *et al.,* 2012).

Despite being depicted as a nuisance, long-tailed macaques have also successfully drawn many tourists to attractions throughout Southeast Asia. Macaques that live in the temple area of Bali Island are thought to possess both spiritual and financial value to the local community (Schilaci *et al.,* 2010). In several locations in Malaysia, visitors come to enjoy tourism sites and experience interactions with primates, such as Bukit Malawati (Md-Zain *et al.,* 2009), Penang Botanical Garden (Md-Zain and Ch'ng, 2011), Gunung Keriang (Taufet-Rosdi, 2020), Pantai Teluk Cempedak (Zulkifli, 2020), Tawau Hill Park (Mohd-Hashim *et al.,* 2015) and Batu Caves (Marty *et al.,* 2019).

The current population size of *M. fascicularis* in Batu Caves needs to be updated. There were frequent complaints from visitors and nearby local sellers at the Batu Caves regarding the nuisance behaviors of long-tailed macaques. However, public perceptions toward *M. fascicularis* around the Batu Caves have never been

formally explored. The Batu Caves are visited by a large number visitors with various ethnic backgrounds and purposes. As such, visitors might have different perceptions of macaques. Thus, in this study, we evaluated the population size and pest behaviors of long-tailed macaques. In addition, we surveyed people on their perception of *M. fascicularis* and determined the potential of the Batu Caves as a primate tourism attraction.

MATERIALS AND METHODS

Study Area: The study was conducted in the Batu Caves tourism area (Figure 1). The Batu Caves contain many vertebrate and invertebrate species that play important roles in the ecosystem. The Batu Caves support various types of fauna, including 310 invertebrate species (172 invertebrate families) and more than 59 species (30 vertebrate families) (Moseley *et al.,* 2012). Long-tailed macaques around the Batu Caves have frequent interactions with visitors. The research was conducted along the staircases of the Batu Caves and at the main entrance where visitors assemble around the gold Hindu God statue and potential human-macaques conflicts are likely to occur.

Population Estimation and Nuisance Observation: A census walk was carried out to determine the current long-tailed macaque population size in the Batu Caves temple area. Observer walked each group at least one time a day to count group members. The primate observation was conducted from 0800 h to 1700 h from July 2019 to Sept 2019 with the total of 171 hours of observation. At 0800 h each day, observer arrived at the study site and followed the groups until most visitors left Batu Caves temple areas at 1700 h. The location of the observation was along the 272-step staircase of the Batu Caves and around the main entrance since these were the long-tailed macaque roaming areas. The group census involved direct counting of long-tailed macaque numbers and categorization according to age structure, sex class, and groups (Md-Zain *et al.,* 2010a; Abdul-Latiff *et al.,* 2019; Ruslin *et al*., 2019). Individual macaques were identified and categorized based on characteristics such as body size, facial hair, and reproductive organs (Fittinghoff, 1972). In addition, individual characters such as the shape of the face, nose, eyes, any visible of defects or injuries, were used to differentiate among individuals and between one groups to another. Each individual can also be categorized as a member of a specific group, when its movement in line with the group's movement.

Nuisance behaviors of the long-tailed macaques in Batu Caves were observed using a scan sampling technique (Md-Zain *et al.,* 2010a; Hambali *et al.,* 2012). Pest behaviors were rapidly scanned for 10 minutes intervals with 5 minutes rest between them. The frequency of nuisance behaviors during the scanning period was recorded. The direct nuisance behavioral observation was only focused on ME group, as this group was easy to be identified and human-macaques conflict is likely to occur here.

Figure 1 The Batu Caves site attracts tourists to visit the temple, staircase, and cave.

Questionnaire: Questionnaire surveys were conducted at the main entrance of the Batu Caves. Surveys questionnaires were designed and constructed by referring to previous related studies on people's perception of macaques and the potential of primate tourism (Md-Zain *et al.,* 2014; Gamalo *et al.,* 2019). A set of 100 questionnaires were randomly distributed to visitors adapted to previous studies by Hambali *et al*. (2012). These respondents composed of local visitors, foreign tourists and seller in nearby stalls. The questionnaires were categorized into four sections: Section A, respondent details; Section B, visitor's rationale for visiting Batu Caves; Section C, respondent's perception toward long-tailed macaque and Section D, the potential of primate tourism in Batu Caves. Each statement was rated using a five-point Likert scale (Joshi *et al.,* 2015). The Likert scale was used to determine the respondent's agreement with each statement from "highly agree" (score 5) to "highly disagree" (score 1). The low interquartile range (IQR) indicates the level of consensus among respondents, while the median (Mdn) represents the most common response.

Data Analysis: The Kruskal–Wallis test was conducted to determine significant differences between the frequency of nuisance behaviors across the category of nuisances (Nahm, 2016). In addition, the questionnaires were analyzed using Cronbach's alpha reliability test to verify the consistency and accuracy of the survey (Tavakol and Dennick, 2011). The possible reliability test scores range from 0 (not reliable) to 1 (extremely reliable).

RESULTS

Population Estimation: Four distinct groups of long-tailed macaques were identified in the Batu Caves tourism area (Table 1). These groups were named based on their primary locations, ME, main entrance; T, Hindu temple; ST, staircase; PT, public toilet. Based on population estimation, it is estimated that the total average of long-tailed macaque identified at selected sites were 132 individuals. Among 132 individuals counted, 27 (20.45%) were adults (11 males; 16 females), 47 (35.61%) were sub-adults (17 males; 30 females), 51 (38.64%) were juveniles, and 7 (5.30%) were infants. The largest group was the ME group with a total of 38 individuals, and the smallest group was the T group with 23 individuals.

Table 1. *Macaca fascicularis* individual ages in four groups around the Batu Caves.

Group	Adult male	Adult female	Sub-adult male	Sub-adult female	Juvenile	Infant	Total
ME	4	5	4	9	13	3	38
T	2	4	4	7	6	0	23
ST	2	2	2	8	20	2	36
PT	3	5	7	6	12	2	35

ME = Main entrance, T = Hindu temple, ST = Staircase, PT = Public toilet

Nuisance Behaviors: Based on intensive direct observation, there were five types of nuisance behaviors made by long-tailed macaque in Batu Caves. These nuisance behaviors were categorized as littering, disturbing visitors, damaging facilities, stealing, and messing up garbage cans (Table 2). The data was obtained from the direct observation of ME group, as this group was easy to be identified and human-macaques conflict is likely to occur here. The frequency is referring to the number of occurrence of nuisance behaviors that were identified during the direct observation (Table 2). The most common nuisance behavior was littering (34%) followed by messing up garbage cans (24%), disturbing visitors (22%), stealing (12%), and damaging facilities (8%). The Kruskal–Wallis test showed that the frequency of nuisance behaviors was significantly different ($p < 0.05$) among the five categories.

Demographic Profiles of the Respondents: Demographic data of respondents were collected and analyzed. Distributed survey questionnaires consisted of male respondents with 68%, meanwhile 32% of the respondents were females. While for the respondent's age, the analysis indicated that the highest participants were in the age of 25-44 with 51% respondents, followed by age range of 45-60 with 30% respondents and 15% of respondents were in age range of 18-24. The least respondents participated were in the age range of above 60 with 4% participants. For the respondent's origin, 73% of participants were Malaysians and 27% of the respondents were foreigners. In addition, most of the respondent's religion were Muslim with the total of 45% participants. This followed by Hindu devotees with 31% respondents, Christians with 20% respondents and the lowest were Buddhist with 4% respondents. Furthermore, respondent's race were composed of Malay (37%), Indian (31%), Chinese (6%) and others (26%).

Visitors Rationale for Visiting Batu Caves: The majority of respondents (46%) stated their rationale for visiting the Batu Caves was because of the unique culture and Thaipusam festival followed by limestone rock scenery sighting (39%), free-ranging macaque

observation (12%), and outdoor activity purposes (3%) (Figure 2).

Table 2. Frequency of long-tailed macaque nuisance behaviors.

Type of nuisance behaviors	Frequency	Percentage %
Littering	772	34
Messing up garbage cans	538	24
Disturbing visitors	495	22
Stealing	267	12
Damaging facilities	170	8

Survey Questionnaires

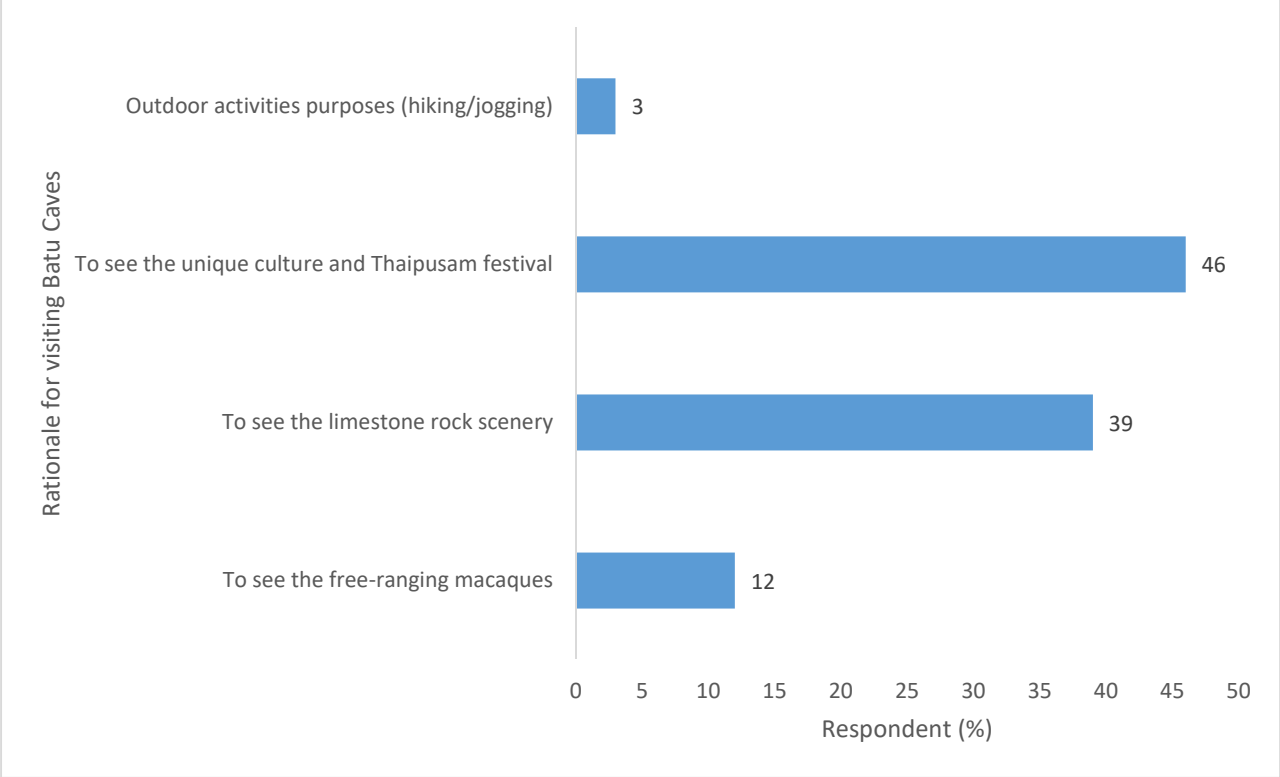

Figure 2 Respondent's rationale for visiting Batu Caves

Respondent Attitudes and Perception towards Macaques: Our descriptive analysis indicated that respondents were divided in their attitudes and perception towards macaques in the Batu Caves. The majority of respondents (65%) were aware of the presence of macaques in the Batu Caves, while only 11% of the respondents disagreed with this statement. Descriptive analysis of the median and interquartile range also showed that the majority of respondents indicated strong agreement with the statement (Mdn = 5, IQR = 1). In addition, 63% of respondents agreed with the statement that they enjoy the presence of macaques in the Batu Caves. Meanwhile, 29% of the respondents, stated their disagreement (Mdn = 4, IQR = 3). The large IQR of 3 indicates divided opinions among the respondents. Opinions were also polarized regarding the feeding activities of macaques in the Batu Caves. Most of the respondents (54%) were in strong agreement with the idea; however, 41% of respondents indicated strong disagreement. In addition, most of respondents (47%) were not afraid of the macaques in Batu Caves, however a roughly equal number (43%) indicated that they were afraid of macaques (Mdn=4, IQR=3). Furthermore, 52% from total respondents stated that macaques in Batu Caves were savages, which majorly answered by local visitors. Conversely, about 32% of respondents disagreed with this statement (Mdn = 2, IQR = 3). About 85% of local visitors indicated that the macaques in the Batu Caves were savages.

Potential of Primate Tourism in the Batu Caves: The majority of respondents (62%) highly agreed that the presence of macaques in the Batu Caves did not spoil the

view; only 4% highly disagreed with this statement (Table 3). A high percentage of respondents (73%) indicated agreement that it is worthwhile to visit the Batu Caves to see the macaques. Most respondents (83%) stated that they will visit the Batu Caves again in the future.

Respondent's Perception of Macaques as Sacred Animals: The majority of respondents who identified themselves as Hindu (81%) viewed macaques as sacred animals that have significant roles in their religion (Table 4). In contrast, all Buddhist respondents (100%) disagreed with the statement that they view macaques as sacred animals. Muslim respondents (98%) and Christian respondents (95%) also did not view macaques as sacred animals.

Table 3. Respondent's perception of the potential for primate tourism in the Batu Caves.

Statement(s)	Respondent answers (%)				
	1	2	3	4	5
The presence of macaques does not spoil the view at Batu Caves	4	5	9	20	62
It is worth visiting Batu Caves to see the macaques behavior	4	9	14	25	48
I will visit Batu Caves again in the future	3	2	2	10	83

1 = Highly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 =Highly Agree

Table 4. Relationships between respondent religion and the perception of macaques as sacred animals.

Religion	Number of respondents that agree macaques are sacred	Number of respondents that do not agree	Grand total
Buddhist	0	4	4
Christians	1	19	20
Hindu	25	6	31
Muslim	1	44	45

DISCUSSION

The results of our population census indicated that three macaque groups (ME, ST, and PT) had relatively similar numbers of members (35-38 individuals). Only group T had a relatively low number of macaque members at 23. This may be due to this group aggregating close to the temple as compared to the ME group, which is the earliest to encounter visitors to the Batu Caves and the food resources are more abundant at the main entrance. The groups of long-tailed macaques identified in the Batu Caves area showed similar patterns of social organization as those reported in a previous study, consisting of multi-male and multi-female groups (Md-Zain *et al.,* 2010a). The Batu Caves macaques population has a sex ratio of 0.61 adult males per female. Our findings were consistent with Riley *et al.* (2015) who reported a sex ratio of 0.54 adult males per adult female of *M. fascicularis* in Singapore. However, Universiti Kebangsaan Malaysia has lower number of male ratio per female (0.39). Long-tailed macaques in the Batu Caves were composed of fewer overall males as compared to females. In addition, each of the identified groups exhibited similar patterns of member composition, which consisted of mostly juvenile individuals with a few infant individuals, with mean values per group of 12.75 and 2.25, respectively. Kamarul *et al.* (2014) also reported that the group composition of *M. fascicularis* individuals in Kuala Selangor Nature Park was mostly juvenile individuals, with infants accounting for the fewest individuals per group.

The most common nuisance behavior recorded was littering (34%). Long-tailed macaques were observed littering around the ME and along the staircase of the Batu Caves. Macaques were seen taking food packaging, water bottles, and leftover food from the garbage cans, sometimes carrying it away to the staircase. This behavior causes the staircase of the Batu Caves to look dirty and gives a bad impression to tourists. In addition, littering behavior such as throwing plastic bags and banana peels on the staircases has the potential to cause injury to the visitors. Additionally, macaques on the staircase were also seen grabbing water bottles from tourists' bags and throwing them at people. The situation could cause injuries to visitors climbing the staircases. Macaques were also seen throwing other objects such as coconut shells that were used for religious activities. Gamalo *et al.* (2019) stated that littering was the most common nuisance behavior observed in Puerto Princesa Subterranean River National Park (PPSRNP), Palawan, Philippines. Macaques in PPSRNP were observed littering around the park area while rummaging for leftover food.

Messing up garbage cans contributed to 24% of the total observed nuisances. Macaques in the Batu Caves often foraged and get inside the garbage cans to find

leftover food. They were seen eating leftover food inside garbage cans and discarding food wrappers, plastic bags, and mineral water bottles outside the trash bins. Most of the garbage bins in the Batu Caves were not properly secured and many were left uncovered, providing easy access for the macaques. This situation has caused the surrounding area to look dirty and smell unpleasant, which was also observed in Kuala Selangor Nature Park (Hambali *et al.,* 2012). According to Gamalo *et al.,* (2019), macaque rummaging behaviors could be stopped or reduced by the installation of garbage bins with properly secured lids. In addition, effective garbage management practices, such as the frequent collection of trash, can reduce littering by long-tailed macaques (Md-Zain *et al.,* 2014).

Macaca fascicularis in the Batu Caves also disturbed visitors, accounting for 22% of nuisance behaviors. These nuisances include aggressive behavior, such as lunging in front of people on the staircase, showing teeth toward people, and biting and chasing visitors as indication of aggressive behaviors. The biting incidents often occurred due to physical contact by visitors, such as hugging or grabbing the macaque's tail during food provisioning. During the observation period, there was one incident where a child tourist was bitten by a macaque during food provisioning. Paniandi *et al.* (2018) found that feeding macaques in the Batu Caves might cause serious biting accidents, especially among kids, resulting from aggressive interactions. Biting incidents have the potential to transmit zoonotic diseases to visitors. Gamalo *et al.* (2019) stated that long-tailed macaques are responsible for the transmission of zoonotic diseases, including Macacine herpesvirus 1, which is transmitted through infected macaque body fluid contact. Md-Zain *et al.* (2014), found that macaques in UKM (Universiti Kebangsaan Malaysia) displayed several aggressive behaviors toward students, often involving physical attacks such as biting and chasing. Sha *et al.* (2009) also reported aggressive behavior toward people by macaques in Singapore, including biting, chasing, and scratching incidents.

Macaque stealing behavior in the Batu Caves accounted for 12% of the nuisance behavior observed. Long-tailed macaques were seen stealing personal belongings and food from visitors. Stealing behavior was usually associated with food cues, such as exiting from nearby restaurants and food packaging. Md-Zain *et al.* (2014) indicated that macaques have a strong sense of smell, allowing them to locate food from a distance. Macaques were also observed grabbing personal belongings such as plastic bags containing food, sunblock cream, and flower decorations from tourists. During our observations, there was an incident where macaques tried to steal a tourist's spectacles. Macaques were also seen disturbing customers who eat in nearby restaurants by stealing food and making messes on the tables. These findings were consistent with a report by Sha *et al.* (2009), who observed macaques in Singapore stealing food and personal belongings from nearby residential areas. Meanwhile, at UKM, macaques were observed stealing students' personal belonging such as notes and books, as well as food and beverages (Md-Zain *et al.,* 2014).

Damaging facilities was the least frequent nuisance behavior by long-tailed macaques in the Batu Caves, accounting for 8% of incidents. Long-tailed macaques were observed damaging lamp posts, rooftops, and electrical wires and shaking signboards. Property-damaging behaviors were also observed in previous studies at PPSRNP (Gamalo *et al.,* 2019) and a student residential college (Md-Zain *et al.,* 2011).

A difference in the perceptions reported by foreign tourists and local visitors to the Batu Caves was detected on questionnaire surveys. The majority of foreign tourists were excited to see macaques and had positive perceptions of their presence in the Batu Caves. Among foreign respondents, 81% agreed that the presence of macaques did not spoil the view in the Batu Caves. Foreign tourists enjoyed feeding macaques and were unafraid to approach macaques during food provisioning. Gamalo *et al.* (2019) revealed that tourists in PPSRNP also like to feed macaques and did not make any complaints regarding nuisance behaviors. In contrast, local visitors had more negative perceptions of long-tailed macaques in the Batu Caves. Fifty-two percent of local respondents stated that macaques in the Batu Caves were pests. Similarly, Sha *et al.* (2009) reported that tourists perceived macaques more positively compared to local respondents, who mostly had negative perceptions toward the presence of macaques in Singapore. Hambali *et al.* (2012) also indicated that the majority of residents in nearby residential areas of Kuala Selangor Nature Park did not like the presence of long-tailed macaques as they often create nuisances.

The majority of Hindu respondents perceived macaques as sacred animals that play important roles in Hinduism. Despite the nuisance behaviors exhibited by the macaques in the Batu Caves, Hindu respondents stated that macaques must be protected against any violence, citing that the nuisance behaviors of long-tailed macaques are a part of nature. In contrast, the majority of non-Hindu respondents disagree with the statement that macaques are sacred animals. Saraswat *et al.* (2015) indicated that most farmers in India viewed macaques as the defense force of Hanuman and refused to kill them, despite the crop destruction done by macaques. The ambivalent attitudes of farmers can be attributed to religious influences. In addition, Schilaci *et al.* (2010) mentioned that Balinese people also perceived macaques that coexist with them in temple areas as sacred animals that are crucial for their culture and religion. In contrast, macaques that caused crop destruction on Bali Island

were perceived as pest animals or even demonic by the Balinese people.

Despite the nuisances created by macaques, the results of our questionnaire survey indicated that the majority of respondents agreed with the idea of primate tourism in the Batu Caves. Most of the respondents (73%) indicated agreement with the statement that it is worth to visit the Batu Caves to see macaques behaviors. Foreign tourists were fascinated to see the long-tailed macaques in the temple area and around the cliffs of the Batu Caves. Schilaci *et al.* (2010) stated that the presence of macaques in temple areas had become a significant tourist attraction on Bali Island. Fuentes (2010) found that the influence of macaques in Balinese culture and religious activities have successfully attracted many tourists, which financially benefits the island. Our results show that the Batu Caves have the same potential to become a primate tourism destination, as macaques reside around the temple area and also play crucial roles in Hinduism beliefs. The Hindu beliefs surrounding macaques could be incorporated into a religious tourism aspect in the Batu Caves. In addition, the presence of macaques on the surrounding cliffs and cave entrance might attract visitors seeking nature-based tourism. Local respondents also agreed with the idea of primate tourism in the Batu Caves as it can bring potential financial benefits to the tourism sector. However, human-primate interactions in the Batu Caves must be under the provision of temple authority, as aggressive has been previously observed in many tourism sites (Md-Zain *et al.,* 2015).

Conclusion: Long-tailed macaques surrounding the ME and staircase area of the Batu Caves have frequent interactions with visitors. Four different groups of long-tailed macaques were identified with a total of 132 individuals. Macaque nuisance behaviors were observed, such as littering, disturbing visitors, damaging facilities, stealing, and messing up garbage cans. The questionnaire survey results indicated differences in perceptions between foreign tourists and local visitors. Tourists perceived macaques more positively compared to local residents, who mostly viewed macaques as pests. However, the majority of respondents agreed with the idea of primate tourism in the Batu Caves. Future studies should be continued, especially during the Thaipusam festival, to compare the frequency of nuisance behaviors created by long-tailed macaques during religious ceremonies. Genetic analysis is also warranted to reveal the current phylogenetic structure (Md-Zain *et al.,* 2010b; Abdul-Latiff *et al.,* 2017) and population genetic aspects (Zainudin *et al.,* 2010; Ang *et al.,* 2011; Karuppannan *et al.,* 2020) of the long-tailed macaque population in the Batu Caves. These molecular studies are important in aiding the conservation management and translocation process of *M. fascicularis* populations in Batu Caves.

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