Jahangirnagar University J. Biol. Sci. **13**(1 & 2): 1-10, 2024 (June & December)

Food and feeding habits of the Rhesus macaque (*Macaca mulatta*) and their interactions with humans at Charmuguria, Madaripur, Bangladesh

Dipa Baruri*, M. Monirul H. Khan and Jannatul Ferdiousi
Department of Zoology, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh

Abstract

This study explores the food and feeding habits of the Rhesus macaque (*Macaca mulatta*) and their interactions with humans living in the urban landscape of Charmuguria, Madaripur, Bangladesh, from April to October 2023. Transect and scan sampling methods were followed to investigate the diet and feeding habits of Rhesus macaque. Also, a pre-designed questionnaire was used to interview local people and visitors in order to understand their response to macaques. Our study showed that about 70% of the diet came from provisioning, 19% from plants and the remaining 11% was from insects. Secondly, a total of 29.6% of people experienced close contact with the macaque, while about 18.2% people of biting and scratching. About 54.6% of respondents reported property damage to crops, vegetables, fruits and plants. More than half (52.3%) of the people thought that humans are harmful to macaques, while the remaining respondents (47.7%) mentioned that macaques are harmful to humans because of their aggressive behaviour and loss of property. About 88.6% of respondents suggested the need for macaque conservation.

Key words: Diet, provisioned food, positive experience, threats, conservation.

INTRODUCTION

Human and non-human primates' interaction and co-existence are noticeable in many regions and countries. Because they share the same habitat, they even exploit the same food sources for living. For their coexistence, the diet and feeding habits of non-human primates are influenced by food availability, habitat, seasonal variation, temperature, geographic distribution of the area (Jaman & Huffman, 2013). Based on their geographic distribution, non-human primates are categorized into two groups: old-world monkeys and new world monkeys. An Old-World monkey species indigenous to South, Central, and Southeast Asia is the Rhesus macaque (*Macaca mulatta*). Rhesus macaque is the most widespread species in Asia and is *ecologically adaptable to all types of habitats. Their range extends from Afghanistan to India, Thailand,* Vietnam, and China. Among the 522 primate species of the world, 25 species are found in Asia (IUCN, 2000).

All living species require a nutritious diet which is essential for their growth and reproductive success (Jaman *et al*., 2010). All primates have some basic needs for energy, vitamins, minerals, fatty acids, amino acids, and water. Primate populations worldwide are characterized by a diverse range of dietary sources, with particular emphasis placed on plant parts found in particular regions (Gogoi & Das, 2018; Jaman & Huffman, 2008). The food and feeding habits of primates depend on their adaptation to the environment, and is influenced by sex, size, age, seasonal changes etc. (Fuentes & Gamerl, 2005).

* Corresponding author. E-mail: dipabaruri0@gmail.com

Primates use a variable foraging strategy as a key means of adapting to a variety of settings, and diet has a significant impact on primate fitness (Altmann, 1991). The consumption of fruits, seeds and young leaves was the preferred food of Rhesus macaque, and the food availability was positively correlated (Jaman & Huffman, 2013). Rhesus macaques also consume food which is supplied by the local people and wildlife management agencies. Seasonal variations in food availability have an impact on macaques, who favour fruits and tender foliage (Tsuji *et al*., 2013; Tang, *et al.*, 2016).

Complex interaction and challenges influence the coexistence of human and non-human primates in the shared environment. The intersection of natural habitats and human settlements frequently results in these kinds of interactions, creating a special dynamic between humans and wildlife (Hockings, 2016). A well-known example of human-macaque interactions is seen in Charmuguria, Madaripur district. Many non-human primates like Rhesus macaque adjust and adapt their behaviour and thrive in human-altered habitats, including towns and cities. Macaques exploit human-modified environments, developing commensal relationships with humans, but conflicts arise in tourism sites, rural crop-damage, and urban contexts, leaving the future of human-macaque relationships uncertain (Priston & McLennan, 2012).

Understanding the elements influencing interactions and coexistence between humans and non-human primates can help us create sustainable relationships, reduce conflict, and encourage conservation. The objectives of this study were to investigate the food and feeding habits, and human-macaque interaction in human-dominated landscapes in Charmuguria of Madaripur district.

MATERIAL AND METHODS

This was conducted from April 2023 to October 2023 in a local area named Charmuguria in Madaripur district. Madaripur district is located about 63 kilometers northwest of Dhaka, the capital city. It lies between latitudes 23°00' and 23°30' north and longitudes 89°56' and 90°21' east, bordering the districts of Faridpur and Munshiganj to the north; Barisal and Gopalganj to the south; Shariatpur district to the east; and Faridpur district to the west. The Padma, Arial Khan, and Kumar rivers are the three principal rivers in the region. The total area of Madaripur district is 1,144.96 km^2 and the total population is 1,293,027 (Ministry of Planning, 2022). Madaripur Sadar is one of its 5 sub-districts or upazila. The study area, Charmuguria, a small area which is located at Madaripur Sadar upazila in the Madaripur district (Fig. 1).

Field data were collected by direct observation using transect and scan sampling methods. The transect sampling method was applied on a specific route for population estimation. The transect line was about 6.4 kilometers long from Primary Teachers Training Institute (PTI) to Char-Putia in Charmuguria. We walked in a line, intervening every 10 to 20 meters to scan both sides from the transect midline out to 180 degrees to the travel direction. Scan sampling method was used to observe the diet and types of food consumed by the macaques at 5 minute-intervals, maintaining an average distance (d = 2

meters). A total of 300 scans were taken during the study. Data were collected between morning (8.00 am to 12.00 pm) and late afternoon (4.00 - 6.00 pm).

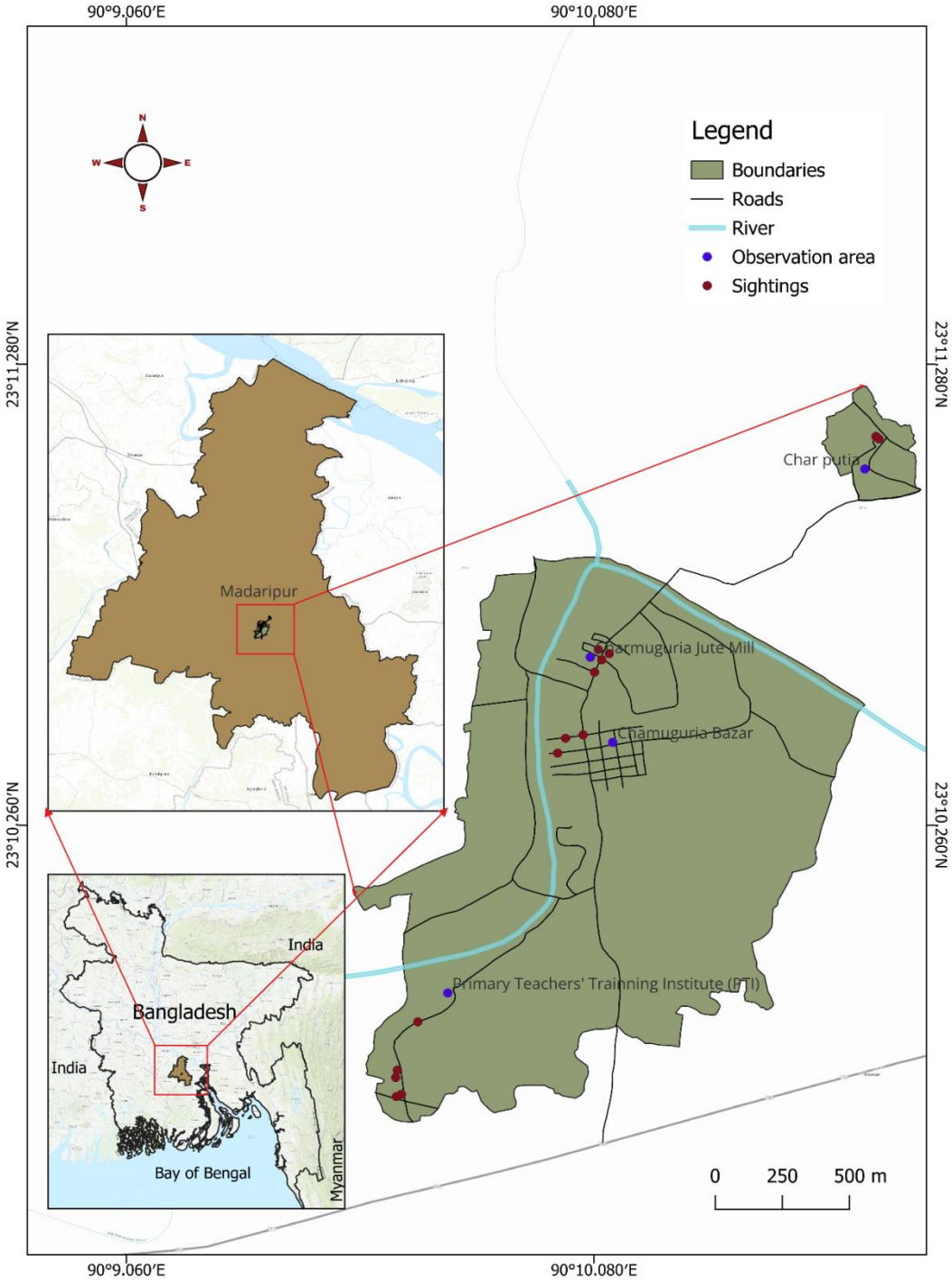

Fig.1. Map of the study area in Charmuguria of Madaripur district, Bangladesh

A set of pre-designed questionnaires were used to assess the opinion of local people as well as the visitors in the area about human-macaque interaction. We interviewed a total of 88 respondents, selected randomly from the community. Microsoft Excel was used for data analysis.

RESULTS AND DISCUSSION

Food and feeding habit: During the survey, macaques were observed at Charmuguria Bazar, Millgate, Primary Teachers Training Institute (PTI) area and Char Putia. About 39% of macaques were found in Charmuguria bazar, 31% in the PTI area, and 15% in both Millgate and Char Putia areas. In the Charmuguria Bazar area, macaque groups were observed mostly on the rooftop of buildings or house roofs and roadside walls, but in the Char Putia and PTI areas, the macaques were found in the upper branches of the trees or in the ground region. In the Millgate area, macaques were seen on the rooftop of the gate (Fig. 2).

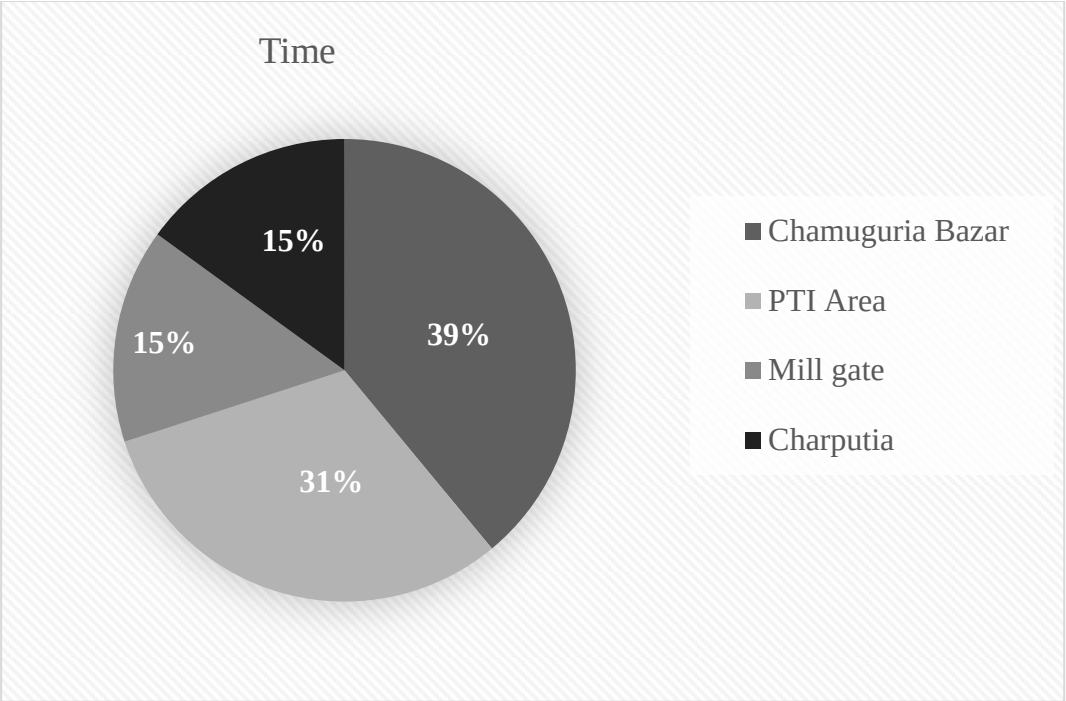

Fig. 2. Observation time in different sites of Charmuguria

The feeding time of the Rhesus macaque was morning and late afternoon. It consumes various types of food, such as natural, supplied, plant food type or provisioned. The major food items include fruits, biscuits, vegetables, burns, insect, leaves, and grains as their foods. The diet and feeding habits varied across the seasons.

Rhesus macaques mostly depended for food on government departments, local people and visitors, which was insufficient. To satisfy their hunger, they stole grains like rice, chickpeas, lentils, fruits, vegetables, provisioned food etc. Besides, they also utilized natural food sources like fruits, young leaves, bark etc. as their food. From the study, it was found that about 56% of food from plant sources were fruits, while the rest of the 44% came from other types of vegetative sources like grain and vegetables.

Only 32% macaque population depended upon natural food sources and 68% of their diet came from supplied sources. We found that about 70% of their food diet was plant-based or vegetative, about 11% was insects and 19% was provisioned by humans.

Table 1. List of food items consumed by Rhesus macaque in Charmuguria

Type of food	Food Items	Scientific Name	Remarks
Natural food	Mango	*Mangifera indica*	
	Papaya	*Carica papaya*	
	Lichi	*Litchi chinensis*	
	Pumelo	*Citrus maxima*	
	Bottle Gourd	*Lagenaria siceraria*	
	Jackfruit	*Artocarpus heterophyllus*	
	Coconut	*Cocos nucifera*	
	Insect		Basically, soft bodied ground insect, some are cutaneous
Provisioned food	Banana	*Musa* sp.	
	Sugarcane	*Saccharum officinarum*	
	Potato	*Solanum tuberosum*	
	Radish	*Raphanus sativus*	
	Peanut	*Arachis hypogaea*	
	Chickpea	*Cicer arietinum*	
	Cucumber	*Cucumis sativus*	
	Carrot	*Daucus carota*	
	Puffed rice		A food item and puffed grain is made from rice
	Bun		A type of round shape bread item which is made of wheat and corn flour
	Biscuit		A flour based baked and shape food item
	Sweet foods		Diverse type of food item which teste sweet

Human-macaque interactions: Four groups of macaques were observed during the field surveys. Two of the groups were found in the Charmuguria Bazar-Millgate area and the remaining two groups were found in the Char-putia and PTI areas. Analysis of interview data showed that about 19.31% (n=17) of people were between 11-20 years of age, 37.5%

(n=33) between 21-30 years of age, and only 2.27% (n=2) were 70+ years. About 63.64% (n=56) were male and 36.36% (n=32) were female.

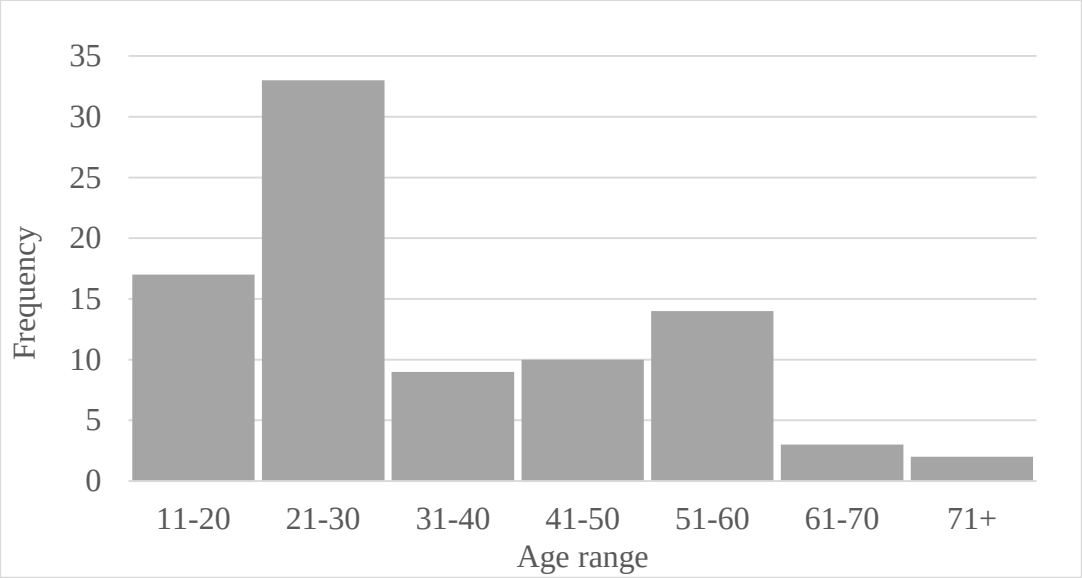

Fig. 3. Age group of participants in the interview

The majority of the participants, 67.05% (n=59), had a positive experience with Rhesus macaques while the remaining faced negative experiences. In particular, 30.68% (n=27) participants stated that they faced minimal contact with macaques, and 10.23% (n=9) didn't have any form of contact or interaction. On the other hand, about 18.18% (n=16) experienced risky contact while 29.55% (n=26) had positive and close contact.

Amongst the people interviewed, 54.55% (n=48) thought that monkeys were a nuisance in the area, while the rest of the people disagreed with that statement. 45.45% (n=40) participants thought that the area was the habitat of the Rhesus macaque since hundreds of years, we are the people came and encroached their natural habitats. Approximately 12% (n=6) of people said that they and their relatives were threatened or chased and 15% (n=7) people said that they were bitten or scratched by the macaques.

The Rhesus macaque damaged plenty of ripened and unripened fruits and also destroyed small vegetation during foraging and play. About 52.27% (n=46) of people thought that humans were harmful to Rhesus macaque, while the rest of the people disagreed with it. Further, 47.82% (n=22) of people said that humans attacked the troops of macaques and 36.96% (n=17) said that humans stole or snatched food items which was supplied by government agencies. 6.52% people thought that humans encroached Rhesus macaque's territory and about 8.70% people gave a clear statement that some people killed macaques by using poison-mixed food.

The majority of the respondents said that the amount of food supplied by government departments was not enough for macaques. Some people said that the government should form a committee to enquire about dishonest people who were involved in killing the macaques. Amongst the people interviewed, 88.64% (n=78) thought that Rhesus macaque should be conserved and required more protection due to balancing ecosystem, religious reasons and aesthetic and entertaining value. An eco-park is under construction which will be used in the future to protect the Rhesus macaque of that area.

Food and feeding habit: Zhang (2023) described that Rhesus macaques prioritized eating young leaves, fruits, and seeds, and there was a positive correlation between the amount of these things consumed and the availability of food for the monkeys. The variations in activity budgets among groups were basically attributed to differences in food types and their availability across habitats, and they preferred ripe fruits to immature, developing, and unripe ones (Jaman *et al*., 2010). The primates lived in fruit-bearing trees, and they consumed the fruit as well as the leaves for 78% of the morning. According to Bernard (1997), diverse invertebrates are important suppliers of fat and protein nutrients, and their digestion depends on a short, simple gut. According to our findings, we found out that Rhesus macaque of Charmuguria, Madaripur, also consumed fruits, seeds, grains, young leaves etc as their primary food diet and most of the time, the groups of macaques spent their morning time with foraging and feeding behaviour. Natural and supplied plant-based food sources contain various vegetative food items like sugarcane (*Saccharum* sp.), banana (*Musa* sp.), potato (*Solanum tuberosum*), radish (*Raphanus sativus*), chickpea (*Cicer arietinum*), mango (*Mangifera indica*), papaya (*Carica papaya*), jackfruit (*Artocarpus heterophyllus*), lichi (*Litchi* sp.), insects, etc. During the field survey, it has been noticed several times that Rhesus macaque preyed on ground insects and consumed it like other food sources. Insects are staple foods in primate diets, providing protein, essential nutrients, vitamins, and fatty acids, especially during abundant periods, and can be supplemented or replaced during outbreaks (Rothman *et al*., 2014). This study found that Rhesus macaque consumed insects from ground and it occupied a large portion of their protein diet as insects contained large amount of protein nutrient.

A study on the Rhesus macaque at Navagraha Temple in Kamrup district, Assam which was conducted by Gogoi & Das (2018) stated that those primates had specific dietary preferences, and they particularly enjoyed the seeds, leaves, and bulbs of monocotyledon plants. But in our study, it was found that the Rhesus macaque could not have that kind of food preference as there was a lack of food resources compared to the population of macaque in Charmuguria, Madaripur, whereas the Rhesus macaque living in the Navagraha Temple, Assam didn't face the food scarcity. So, the Rhesus macaque in Charmuguria preferred a different food diet compared to Navagraha Temple's Rhesus macaque. A study was conducted at the Asola-Bhatti wildlife sanctuary in India where the Rhesus macaque's provisioned food was supplied by the forest department and the macaques adopted different foraging strategies based on the availability of resources (Ganguly & Chauhan, 2018). The findings of this study reveal that the Bangladesh government, local people and visitors supplied food for the Rhesus macaque, but this

amount of food is not enough for them, whereas the supplied food is also stolen by some local people.

Human- macaque interactions: According to Fuentes (2005), aggression tendencies, food availability or lack thereof, and demographic data on both permanent macaques and human guests were some indicating factors for human-Rhesus macaque interaction. We found that macaques' responses to humans varied depending on the age and sex classes of the parties involved. We found the reasons of monkey's aggression and also agreed with that statement that the main reason of monkey's aggression was food scarcity. Age and sex differences of Rhesus macaque also played an important role in their aggression. These aggressive monkeys often attacked locals and visitors.

Ilham (2023) described that food provisioning was seen to be one of the main reasons of conflicts between monkeys and humans, and it might affect the demography, behaviour, and ecology of monkeys (Sha & Hanya, 2013; Sengupta, *et al*., 2021). Most of the participants during the interview said that local people provided enough amount of food to the Rhesus macaque before, that became their habit then. But nowadays they didn't provide that much food, so the monkey species stole food from local people's houses to suppress their hunger. Several questionnaires stated that they were bitten or scratched by the aggressive male monkeys.

According to a study on Human-Long-tailed monkey conflict (Fitria *et al*., 2020), it found that monkeys entered into settlement and even the damaged the crops, and they created disturbance in central Java, Indonesia. From our study, some participants also mentioned that monkeys in that area were a nuisance, and they damaged the plant species, cultivated crops etc. Sometimes they also steal food from the passers-by.
Rhesus macaque is hunted in several ways by local people. Sha (2009) described that humans are responsible for human-monkey conflicts. People said that local people attacked the troops of Rhesus macaque. According to a statement during the study, macaques encountered by humans were primarily caused by actions taken by humans. Local people encroached on the Rhesus macaque territory and tried to eradicate them from the area by their action.

According to Duarte (2011), one of the main threats to living conditions in and around cities was urban encroachment, the Rhesus macaque terrorization and noise pollution. From our finding, local people stated that humans destroyed the natural habitat of Rhesus macaque. For that reason, many monkey groups leaved the area in search of food and shelter. A group of people tried to eradicate the Rhesus macaque from the area. In total, three individuals of Rhesus macaque had been killed using poison. They were hunted by children who used stone and pebbles to hit the Rhesus macaque troops. But most people thought that Rhesus macaque should be conserved due to balancing ecosystem and religious purpose, and macaques also attracted visitors to the area. The government should be aware of Rhesus macaque conservation.

Conclusion: Macaques play a vital role in our environment and enrich our biodiversity. Besides this, it has a religious value for Hindu religious people. The Rhesus macaque is suffering from a scarcity of food in Charmuguria, Madaripur. Mostly the Rhesus macaque in the area depended on provisioned food rather than natural food sources as their natural habitat is encroached by humans. So, humans should take proper steps to repel their hunger and otherwise restore their natural habitat so that they can consume natural food to relieve their hunger. The government provides provide food for the Rhesus macaques, but that is not enough for them and the local people steal their food from the supplied area. If the government and local people can provide enough amounts of food to the Rhesus macaque in the area, the negative interaction and conflict between humans and the Rhesus macaque will be minimized as most of the conflicts occur due to the hunger issue of the Rhesus macaque. Therefore, the government should take proper steps to eradicate the problem. People who are involved with the killing and hurting Rhesus macaques should bring them under law.

REFERENCES

Altmann, S. A. 1991. Diets of yearling female primates (*Papio cynocephalus*) predict lifetime fitness. *PNAS*, **88**(2): 420-423.

Bernard, J. B., Allen, M. E., and Ullrey, D. E. 1997. Feeding captive insectivorous animals: nutritional aspects of insects as food. *NAG*, *Fact Sheet*, **3**: 1-7.

Duarte, M. H., Vecci, M. A., Hirsch, A., and Young, R. J. 2011. Noisy human neighbours affect where urban monkeys live. *Biol. Lett.*, **7**(6): 840-842.

Fitria, W., Bambang, A. N., and Hidayat, J. W. 2020. Human and long-tailed macaque conflict in Central Java, Indonesia. *EDP Sciences; E3S Web Conf.* **202**: 06011.

Fuentes, A., and Gamerl, S. 2005. Disproportionate participation by age/sex classes in aggressive interactions between long-tailed macaques (*Macaca fascicularis*) and human tourists at Padangtegal monkey forest, Bali, Indonesia. *Am. J. Primatol.*, **66**(2): 197-204.

Ganguly, I., and Chauhan, N. 2018. Dietary preference and feeding patterns of the urban Rhesus macaque *Macaca mulatta* (Mammalia: Primates: Cercopithecidae) in Asola-Bhatti Wildlife Sanctuary in India. *JoTT*, **10**(15): 12907-12915.

Gogoi, S., and Das, A. 2018. Diet and Feeding Behaviour of Rhesus Macaque at Navagraha Temple, Kamrup district of Assam. *Period. res.*, **7**(2): 93-98.

Hockings, K. J. 2016. Mitigating Human-Nonhuman Primate Conflict. *In:* Agustín Fuentes. **The international encyclopedia of primatology**, vol. I, 1st edn. pp. 1-2. Wiley-Blackwell, New Jersey, USA.

Ilham, K. 2023. Roadside provisioning threatens both humans and monkeys. *Anim. Conserv.*, **27**(2): 146-147.

Jaman, M. F., and Huffman, M. A. 2008. Enclosure environment affects the activity budgets of captive Japanese macaques (*Macaca fuscata*). *Am. J. Primatol.*, **70**(12): 1133-1144.

Jaman, M. F., and Huffman, M. A. 2013. The effect of urban and rural habitats and resource type on activity budgets of commensal rhesus macaques (*Macaca mulatta*) in Bangladesh. *Primates*, **54**: 49-59.

Jaman, M. F., Huffman, M. A., and Takemoto, H. 2010. The foraging behavior of Japanese macaques Macaca fuscata in a forested enclosure: effects of nutrient composition, energy and its seasonal variation on the consumption of natural plant foods. *Curr. Zool.*, **56**(2): 198-208.

Ministry of Planning, Government of Bangladesh 2022. *Bangladesh Bureau of Statistics*. Retrieved from www.bbs.gov.bd.

Priston, N. E., and McLennan, M. R. 2012. Managing humans, managing macaques: Human–macaque conflict in Asia and Africa. *In:* Radhakrishna. S., Huffman. M. A., & Sinha.A. (eds.). **The macaque connection: Cooperation and conflict between humans and macaques**, 1st edn. pp. 225-250. Springer New York, New York.

Rothman, J. M., Raubenheimer, D., Bryer, M. A., Takahashi, M., and Gilbert, C. C. 2014. Nutritional contributions of insects to primate diets: Implications for primate evolution. *J. Hum. Evol.*, **71**: 59-69.

Sengupta, A., Widayati, K. A., Tsuji, Y., Yanti, R., Rahman, M. F., Balakrishna, N., and Radhakrishna, S. 2021. Why do people visit primate tourism sites? Investigating macaque tourism in Japan and Indonesia. *Primates*, **62**: 981-993.

Sha, J. C., and Hanya, G. 2013. Diet, activity, habitat use, and ranging of two neighboring groups of food-enhanced long-tailed macaques (*Macaca fascicularis*). *Am. J. Primatol.*, **75**(6): 581-592.

Sha, J., Gumert, M., Lee, B., Jones-Engel, L., Chan, S., and Fuentes, A. 2009. Macaque–human interactions and the societal perceptions of macaques in Singapore. *Am. J. Primatol.*, **71**(10): 825-839.

Tang, C., Huang, L., Huang, Z., Krzton, A., Lu, C., and Zhou, Q. 2016. Forest seasonality shapes diet of limestone-living rhesus macaques at Nonggang, China. *Primates*, **57**(1): 83-92.

Tsuji, Y., Hanya, G., and Grueter, C. C. 2013. Feeding strategies of primates in temperate and alpine forests: comparison of Asian macaques and colobine. *Primates*, **54**: 201-215.

Zhang, K., Karim, F., Jin, Z., Xiao, H., Yao, Y., Ni, Q., and Xu, H. 2023. Diet and feeding behavior of a group of high-altitude rhesus macaques: high adaptation to food shortages and seasonal fluctuations. *Curr. Zool.*, **69**(3): 304-314.