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Source: Mammal Study, 46(2) : 97-113

Published By: Mammal Society of Japan

URL: https://doi.org/10.3106/ms2020-0062

Mammal Study 46: 97–113 (2021) DOI: 10.3106/ms2020-0062

Review

Special issue **"The Frontline of the Researches on Conservation and Management of Japanese Macaques"**

Studies on primate crop feeding in Asian regions: A review

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Abstract. We reviewed previous literature on primate crop feeding in Asia. We found 134 reports from 14 different countries and regions. More than half of the crop feeding cases involved macaques, followed by colobines, especially common langurs, and to a lesser extent by orangutans. No crop feeding by gibbons, lorises, or tarsiers has been reported. Most reports obtained information about crop feeding through interviews with locals and recorded the crops damaged and troop composition, while a few recorded the activity of the target primates and their population parameters. Crop feeding increased when the field was located near the forest, and when natural food availability decreased. Most farmers used non-lethal countermeasures, while some farmers killed the monkeys, and a few used electrical fences to protect crops. In study sites inhabited by multiple animal species, primates are often the worst crop feeders. Human perception and attitudes toward crop feeding primates were affected by income, residential area, religion, and history of crop feeding. Recent studies have created models based on previous data to clarify the potential risk of crop feeding and to predict the monkeys' ranging patterns. To create models for reducing crop damage and to design conservation strategies, collecting fundamental information is necessary.

Key words: countermeasure, disease, *Macaca*, religion, seed dispersal.

Conflicts between humans and non-human primates (hereafter primates) that arise during crop feeding have become serious problems for farmers because their income decreases, and they are forced to spend extra time and energy to protect their crops (Hill 2004; Riley 2007; Marchal and Hill 2009). In Africa and Central/Southern America, studies aiming to decrease the degree of crop damage caused by primates have been conducted. For example, Naughton-Treves et al. (1998) and Chaves and Bicca-Marques (2017) found a positive correlation between the degree of crop damage by primates and the availability of preferred crops. These findings imply that farmers should intensively protect their crops during the harvest season. Such information is therefore useful for efficient damage control against crop feeding primates. Recent studies have also attempted to analyze the potential risk of crop damage (Siljander et al. 2020) and aimed to create a scenario in which humans and primates can coexist while reducing crop damage (Hockings et al. 2009; Radhakrishna 2013; Taylor et al. 2016).

Primates in Asia are composed of five families, that is, Lorisidae (lorises), Tarsiidae (tarsiers), Cercopithecidae (macaques and colobines), Hylobatidae (gibbons), and Hominidae (orangutans). They inhabit almost every part of East and Southeast Asia, except for the Korean Peninsula and Mongolia (Corlett 2019). Several Asian primates inhabit areas close to human settlements (Aggimarangsee 1992; Watanabe and Muroyama 2005; Sha et al. 2009; Ilham et al. 2017). The close proximity between humans and primates is facilitated by cultural attitudes that imbue monkeys with religious and/or cultural symbolism, which likely translates into tolerance (Priston and McLennan 2013; Dore et al. 2017). However, the primate species in Asia are also known to frequently feed on crops (Chalise

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and Johnson 2005; Priston 2005; Riley 2007; Yamada and Muroyama 2010), and farmers often treat primates as pests (Agetsuma 2007; Nijman and Nekaris 2010b; Anand and Radhakrishna 2017). Depredation of crops by primates adversely affects local farmers, who sometimes respond by injuring or killing the animals (Hill 2004; Nyhus et al. 2005; Strum 2010; Anand et al. 2018). The repercussions of crop feeding are ultimately high for both humans and primates; therefore, aggregating local information and taking efficient countermeasures is necessary to reduce the damage caused by primates. Until recently, systematic reviews of primate crop feeding have been conducted in some countries and regions (India: Mariadoss et al. 2019; Sri Lanka: Cabral et al. 2018; Bangradesh: Uddin et al. 2020; Japan: Enari 2021), but studies covering the entire Asian region have never been conducted.

In this study, we review previous studies on crop feeding by primates in Asia. Specifically, we ascertain the countries that have reported the most intense crop feeding, document the kinds of countermeasures that have been used, and examine how economic, cultural, and religious backgrounds affect local people's perception of crop feeding primates. Gathering information from multiple study sites enables us to identify species-specific and/or site-specific factors causing human-primate conflict and to create models for reducing crop damage. This would be useful to foster the coexistence of humans and primates in a given area. Finally, we discuss the direction of future studies for researchers studying primate crop feeding in Asia.

Materials and methods

We conducted a web-based search and collected case studies on primate crop feeding published since 1960s. We used 1) ISI Web of Science (http://apps.webofknowledge.com/), 2) Google Scholar (http://scholar.google.co.jp/), 3) Japan Science and Technology Information (J-STAGE, https://www.jstage.jst.go.jp/), and 4) Citation Information by the National Institute of Informatics (CINII, https://ci.nii.ac.jp/), and used the following key words: "Asia*", "primate*", "crop raid*", "crop forage*", and "conflict*" (*indicates a wildcard search). Since two out of the four search engines are managed by Japanese institutions, we accept the possibility that a disproportionate amount of the literature detected was written by Japanese researchers. We added information from the literature and books (published after 1960) stored at the libraries of the Primate Research Institute, Kyoto University, and Andalas University. In this study, we extracted only literature accessible to people of all countries and regions: articles, books, theses, and reports written in English. We excluded studies conducted at provisioned sites (Sha et al. 2009; Ilham et al. 2017), university campuses (Md-Zain et al. 2014), and temples (Buddhist and Hindu, Aggimarangsee 1992; Beisner et al. 2015) from the analyses because such "urban monkeys" feed almost entirely on provisioned foods and garbage rather than cultivated plants.

From the contents of the collected literature, we gathered the following information: 1) publication year (divided into ten-year increments for analysis), 2) publication media (categorized into international journals and other journals including reports, theses (both master's and doctoral), and book chapters), 3) primate species involved in the crop feeding, and 4) country where the study was conducted. We defined "international journals" (from step 2) as registered in the Journal Citation Reports (Web of Science JCR).

Besides collecting papers about primate crop feeding, we checked the number of papers (regardless of study field) published each year in the major primatological journals (*American Journal of Primatology*, *Folia Primatologica*, *International Journal of Primatology*, and *Primates*) for reference purposes. We conducted this search using Google Scholar in May 2019.

In order to address taxonomical variation in crop feeding cases, we compared composition of the case reports on the human-primate conflicts and composition of each taxonomic group, and tested by the Chi-square test of independence. Since there were no cases of crop feeding for the three primate groups (lorises, tarsiers, and gibbons), we omitted these groups from the statistical analysis. The analysis was conducted using R version 3.2.3 (R Developmental Core Team 2015). The statistical significance was set at 5%.

Results

Literature on primate crop feeding

We collected a total of 134 studies on primate crop feeding in Asia (Appendix 1). Figure 1 shows the number of publications every ten years. We found that the number of publications has increased rapidly since the 2000s. However, the percentage of publications on primate crop feeding within the broader primatological literature (calculated by the formula: [Number of publications on primate crop feeding]/[Number of papers published in major

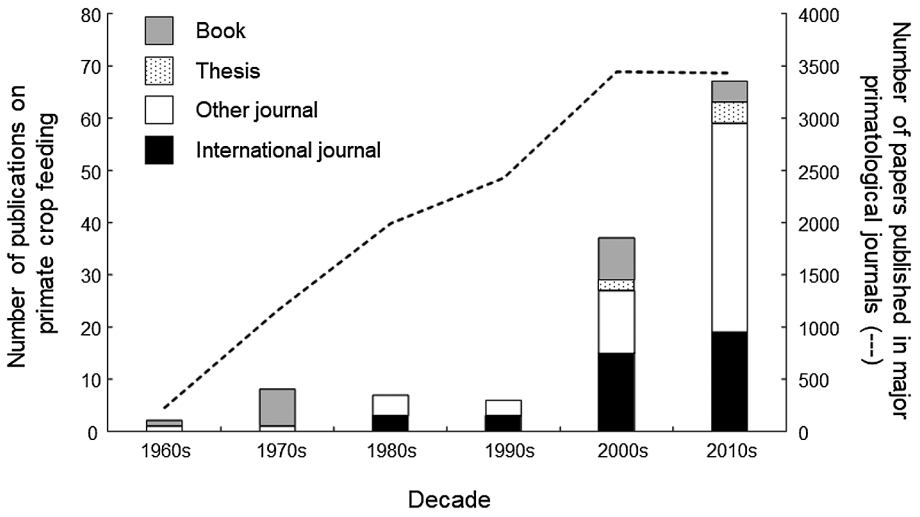

Fig. 1. Temporal change (by ten-year increments) in the number and type of published reports on the conflict between human and non-human primates in Asia. Temporal changes in the number of reports published in the main international primatological journals (*American Journal of Primatology*, *Folia Primatologica*, *International Journal of Primatology*, and *Primates*) (dotted line) are also shown.

primatological journals] * 100) has been consistently low (1.8% in the 1960s, 1.4% in the 1970s, 0.5% in the 1980s, 0.5% in the 1990s, 2.1% in the 2000s, and 3.9% in the 2010s). The percentage of international journals among the collected literature has also risen yearly, but it has remained at less than half of the total publication number. Theses on crop feeding first appeared in the 2000s and increased in the following decade (Fig. 1).

Crop feeding cases were reported from 14 different countries and regions throughout Asia (Fig. 2). The number of publications varied across countries and regions as follows: India had the highest number of reports ($n = 37$), followed by Indonesia ($n = 27$), Japan ($n = 19$), Nepal ($n = 18$), Bangladesh ($n = 10$), Sri Lanka ($n = 8$), and Thailand ($n = 5$). We found no reports from Indochinese countries (Vietnam, Laos, Cambodia, and Myanmar). In Singapore, there were several cases of macaques being a nuisance to people at tourism sites (e.g., Sha et al. 2009; Yeo and Neo 2010), but we found no publications on primate crop feeding.

Primate species involved in crop feeding

Of the 134 studies, macaques ($n = 94$) were the most frequent primate species that fed on crops, followed by colobine monkeys ($n = 10$), such as *Semnopithecus* spp., *Trachypithecus* spp., and *Presbytis* spp. (Fig. 3). Twenty-six studies reported multiple primate species crop feeding (in most cases, two macaque species or one macaque - one colobine species). The number of case studies on crop feeding by orangutans (*Pongo* spp.) was much smaller ($n = 3$) than for macaques or colobines. We found no reports of crop feeding by lorises, tarsiers, or gibbons. Regarding species composition (macaques: 21 species, colobines: 44 species, lorises: 11 species, tarsiers: ten species, and orangutans: three species), the percentage of the crop feeding by macaques were higher, while that of the colobines was lower ($\chi^2_2 = 44.6$, $P < 0.001$).

Contents of the collected articles

a) Information on crop damages: Out of the 134 studies, 54 (41%) obtained information about crop feeding through interviews with local villagers (average number of interviews conducted: 387, range: 39–6983), while only nine studies (7%) conducted behavioral observations of the crop feeding monkeys (Appendix 1 and Supplementary Table S1). Seventeen out of 54 studies were review papers that included information collected from multiple study sites. As primary research articles, 62 studies (47%) listed specific crops damaged by primates. These records were mainly obtained by interviewing the occupants of local households. Chhangani and Mohnot (2004), for example, listed crops damaged by gray langurs (*Semnopithecus entellus*) based on interviews with local people, while Chalise (2003) evaluated the diets of Assamese macaques (*Macaca assamensis*) by behavioral observations (recorded by scan sampling method) and interviews with farmers. Twenty-seven studies (20%) evaluated the crop damage caused by primates. In villages near a protected area in Nepal, the annual crop damage caused by primates was estimated to be about

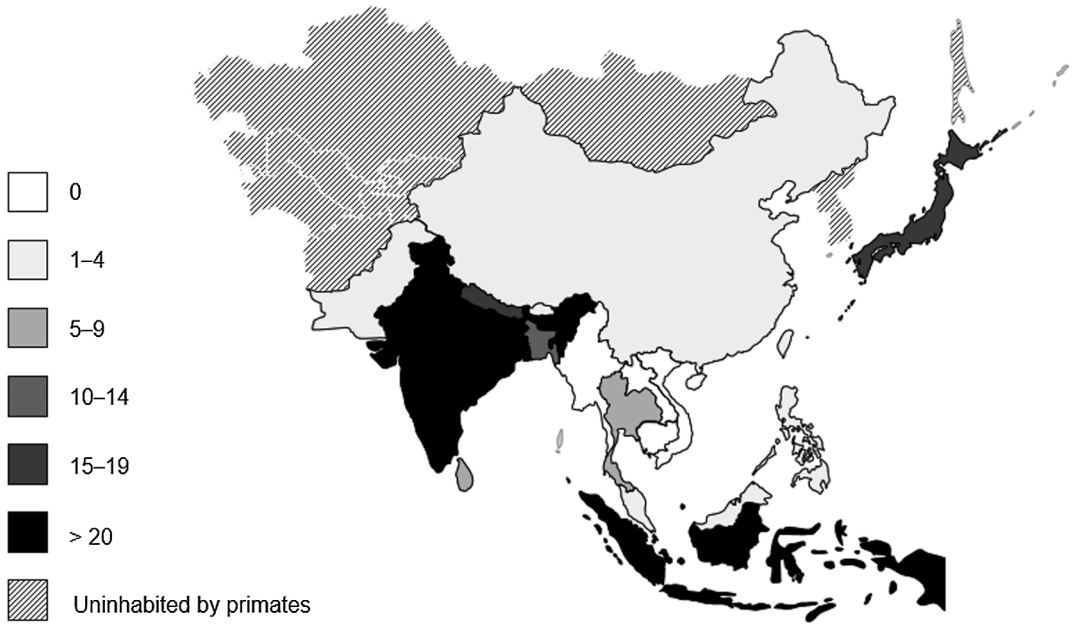

Fig. 2. A map showing the number of case reports on the conflict between human and non-human primates in Asia (n = 128). Saudi Arabia is not shown on the map.

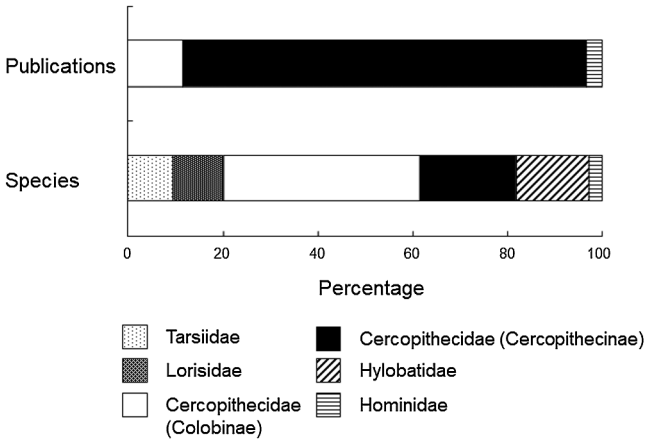

Fig. 3. The top bar represents composition of the case reports on the conflict between human and non-human primates in Asia (n = 128) by primate families. Cases in which multiple species were included in the analyses were omitted. The bottom bar represents the proportion of the number of species in each taxonomic group (Kirkpatrick 2007). We separated Cercopithecidae into two ecologically and morphologically distinct subfamilies (Cercopithecinae and Colobinae).

183 kg/household, worth 75 USD/household (Paudel and Shrestha 2018). In Japan, the total agricultural damage over five years (2003–2007) caused by Japanese macaques (*M. fuscata*) was approximately 17.8 million USD (Suzuki and Muroyama 2010, see also Enari et al. 2021). A majority of these reports pooled the data across the study period, while several studies attempted to find seasonal trends; Chhangani and Mohnot (2004) and Air (2015) conducted a field survey over a period of one year and found that crop feeding by langurs showed clear seasonality: crop feeding was proportional to the availability of crops. On the other hand, clear relationships between crop foraging and food availability in the forest were not always found (Riley 2007; Riley and Priston 2010). Across Asia, the crops damaged were mainly maize, potatoes, bananas, papayas, cacao, rice, and vegetables (Supplementary Table S1).

b) Group composition, home range, and activity of the crop feeders: The number of studies reporting activity budgets of the target primates (nine studies, 7%) or population parameters (such as group composition) (26 studies, 20%) was quite low. In addition, long-term monitoring of female reproductive ratio, infant survival ratio, and rate of natural increase of the target population have not been reported in Asian regions (but see Singh et al. 2016).

Crop feeding sometimes altered the daily travel distance and home-range size of the primates. Chhangani and Mohnot (2006) and Izumiyama et al. (2003) demonstrated that home-range sizes of crop feeding hanuman langurs (*S. entellus*) and Japanese macaques were much smaller than those of non-crop feeding groups, and that the home-range size increased proportionally with the number of group members. The former was attributed to the higher quality of food resources in the cropland, and

the latter was likely due to higher intra-group competition.

Accounts of crop feeding behavior by primates are site-specific and species-specific, and therefore, quantitative evaluation of the crop feeding requires all-day observation (Wallace and Hill 2012). Regmi et al. (2013) found that Assamese macaques visited the crop field in the early morning. Zak and Riley (2017), on the other hand, set camera traps in the farmland and evaluated the time when the moor macaques (*M. maura*) foraged in the crop field. Contrary to the farmers' impression that macaques visited the crop field early in the morning, the macaques entered the crop field in the afternoon and evening. Furthermore, Priston et al. (2012) reported intra-group variations in behavior among group members of crop feeders. They found that the number of co-feeding Buton macaques (*M. ochreata*) had a positive effect on the duration of time spent in the crop field, and the adult and subadult males took the lead when entering farms to forage on crops, while females and the dependent young were more likely to be observed crop foraging when people and dogs were absent from the farm.

c) Evaluation of crop quality: How valuable are crops to monkeys compared to foods in the forest? Several studies have evaluated the nutritional value of crops and compared them with that of natural foods. Riley et al. (2013) found that cultivated cacao fruits contained less fiber and higher energy than wild plants. Regmi et al. (2013) and Frondelius (2010) independently reported that maize and potatoes contained higher protein, lipids, and carbohydrates and deduced that the higher nutritional value of the crop was the main reason for primate crop feeding. At many sites, farmers experienced the highest levels of crop feeding on maize and (sweet) potato crops. It can be inferred that the nutritional value of these crops is likely responsible for attracting crop feeding.

d) Relationship between crop feeding and forest environment: Many studies have shown that crop fields located adjacent to the forest are at a greater risk of being visited by primates (e.g., Priston 2005; Adhikari et al. 2018a). The relationship between the crops' distance from the forest and the degree of crop feeding has been tested by several authors. Frondelius (2010) and Priston et al. (2012) found that papayas and sweet potato crops were mostly fed upon by Buton macaques located less than 10 m away from the forested border of the crop field, and foraging of sweet potatoes declined when the distance from the border increased to 25 m from the edge. Huang et al. (2018) demonstrated that the degree of crop feeding by rhesus macaques (*M. mulatta*) was positively correlated with the number of croplands in the community and negatively correlated with distance from the nature reserve. These results corroborated those of Regmi et al. (2013), Wang et al. (2006), and Honda (2009), who found that crop feeding by Assamese macaques in Nepal, rhesus macaques in Bhutan, and Japanese macaques in Japan, occurred more frequently in crop fields located near the forest. These results imply that the monkeys do not like to stay out of the forest for a long time, and forests serve as their safe sites. In contrast, Air (2015) demonstrated that rhesus macaques fed on all the major crops, regardless of the distance from the national park. Thus, whether the forest serves as a refuge or not appears to be site- or species-specific.

e) Types of countermeasures: Thirty-five reports (26%) described the countermeasures used at the target study site (Supplementary Table S1). A variety of methods for reducing primate crop damage have been proposed by farmers. The most common methods were guarding, using dogs, and setting scarecrows. These are simple, involve low-technology, and do not incur additional costs. However, hunting, killing by poison, and fencing are also employed by some farmers. Rode-Margono et al. (2016) described in detail the protection measures employed by local people in Bawan Island, Indonesia and found that, while people mostly used poison and pesticides to get rid of rats and insects, they resorted to rock throwing, air pump guns, and noise making to protect crops against primates. Paudel (2016) showed that in Nepal, people guarded the crop fields by setting out scarecrows and releasing dogs. Farmers were forced to guard their crops even during the night. Priston (2009) tested the effectiveness of countermeasures (by evaluating the percentage of crops damaged) and found that setting up fences and mesh reduced the damage by up to 50%.

In Japan, electric fencing and population control, conducted by the local government, have been used widely to protect crops against Japanese macaques (Honda et al. 2009; Muroyama and Yamada 2010). Maintenance of the electric fences by farmers, however, is often insufficient due to differences among farmers in their knowledge of the fence management and their willingness and motivation to maintain them (Suzuki and Muroyama 2010).

f) Relative importance of the primates as crop feeders: At many study sites, there are multiple animal species inhabiting there, and farmers need to protect their crops from these animals. Twenty-four studies (18%) have tried to evaluate the ranking of primates as crop feeders by

degree of crop damage. Awasthi and Singh (2015) found that primates (multiple species) were the worst crop feeders compared to other mammalian species (porcupine, goral, deer, jackal, bear, and several mouse species) in the Gaurishankar Conservation Area, Nepal, and Huang et al. (2018) (Daxueshan Nature Reserve, China) and Saraswat et al. (2015) and Anand et al. (2018) (Himachal Pradesh, northern India) found that rhesus macaques were the second-highest crop feeders among sympatric animals (wild boar, bear, porcupine, deer, nilgai, and several bird species). Campbell-Smith et al. (2010) demonstrated that Sumatran orangutans (*Pongo pygmaeus*) were not only ranked as the third most frequent and the fourth most destructive (17%) crop pest entering farmlands, but were also the most feared (31%) species. The damage caused by Japanese macaques was the third largest after sika deer (*Cervus nippon*) and wild boars (*Sus scrofa*) in Japan (Honda 2009; Suzuki and Muroyama 2010). In Kerinci Seblat National Park, Sumatra, crop feeding by southern pig-tailed macaques (*M. nemestrina*) was not as widespread as wild boars, but they caused much greater crop damage (73%) than wild boars (26%), contrary to farmers' perceptions (Linkie et al. 2007). In Lore Lindu National Park, Sulawesi, in contract to farmers' reports, forest mice were more destructive than macaques (Riley 2007). In this way, the relative threat level of the primates is site- and species-specific.

g) Human dimensions: In addition to the ecology of the crop feeding monkeys, 29 studies (22%) have investigated human perceptions of the crop feeding primates. Further, 22 studies (17%) discussed the effects of human activities on primate crop feeding. Aryal and Chalise (2013) and Kumara and Diandra (2018) interviewed the local communities in Nepal and India, respectively, and demonstrated that local people thought that the lack of food resources in the forest and the increasing size of the monkey populations were the proximate determinants of crop feeding. However, these speculations have rarely been confirmed. Nautiyal et al. (2020), on the other hand, argued that the economic background of local people is an indirect factor contributing to crop feeding; farmers with less agricultural productivity depend on livestock for extra income and thus rely on the neighboring forests for grazing and collecting fodder for their cattle. This consequently reduces the availability of natural foods eaten by the Himalayan langurs (*S. schistaceus*), and this consequently induces crop feeding. In Saudi Arabia, a decrease in predators was considered to affect the increase in crop feeding by hamadryas baboons (*Papio hamadryas*) (Biquand et al. 1994). Several researchers have attempted to evaluate the effects of the social background of people on their attitudes toward primate crop feeding. Chauhan and Pirta (2010), for example, showed that residents (people living near a wildlife habitat) felt a greater need for its effective resolution than nonresidents (visitors or tourists). Furthermore, cultural and religious beliefs are likely to generate different perceptions of the crop feeding primates in many parts of Asia (Knight 1999; Khatun et al. 2013). For instance, Anand et al. (2018) compared people's attitudes in two locations in India (Solan and Kasaragod) and found that people in Kasaragod were less tolerant of crop feeding by macaques. This appears to arise from differing cultural backgrounds between the two regions, particularly with respect to perceptions regarding the role of forests and wildlife in human lives. In Bali, long-tailed macaques feed on crops frequently but the local people are relatively tolerant to the monkeys, and Loudon et al. (2006) interpreted this as attributable to Balinese Hinduism. Similarly, Tonkean macaques in central Sulawesi are culturally important to the 1ocal people and are afforded protection, even though they are known to forage on people's crops (Riley 2010).

In Japan, farming near the habitat of macaques is largely conducted as a low-profit, multipurpose activity, in which harvests are used for household consumption, gifts for relatives and neighbors, and a source of small additional income (Suzuki and Muroyama 2010). In such situations, even in the same village, some farmers have little motivation to protect their agricultural products from macaques, while others in the village depend mainly on the income generated from farm production. Suzuki and Muroyama (2010) point out that farmers' awareness of damages significantly affects the proper maintenance of the electrical fence.

h) Experimental and modeling approaches: Modeling is the best way to gauge the potential risk of crop feeding and to predict the home range of monkeys (Honda 2009). Enari and Suzuki (2010) created a risk map and potential habitat of monkeys in northern Japan to identify areas where precautionary actions should be taken to efficiently minimize the overall risk of damage. Linkie et al. (2007) developed models to predict the appearance of the target animals and found that most crop feeding occurred nearest to the forest edge and that the local guarding strategies used were ineffective. Priston and Underdown (2009) predicted the relative risk of primate crop feeding based on crops grown in the field, their availability within individual farms, and patterns of primate selectivity. Recently,

Honda et al. (2019) integrated field experiments and simulations and demonstrated that a high rate of guarding made the macaques less likely to feed crops, which has important implications for mitigating human-macaque conflicts.

Discussion

The number of studies on human-primate conflict is much smaller than that of publications in the field of primatology. Through web-based searching, we collected 134 studies (published between 1960 and 2020) on primate crop feeding in Asia, most of which were published in the past two decades. The rapid increase in publications since the 2000s is likely due to economic developments in Asian countries in the 21st century (Maddison 2009), which have enabled academics to turn their attention towards natural science, including primate ecology. Another likely reason for the recent increase in publications on crop feeding is the rise of "Ethnoprimatology" which examines interactions between humans and primates from biological, cultural, economic, and religious viewpoints (e.g., Knight 1999; Dore et al. 2017). In addition, recognition of the value of studying primate behavior in anthropogenic environments has grown (e.g., Suzuki and Muroyama 2010). The ethnoprimatology has provided the scientific basis for studies on crop feeding in Asia. However, as mentioned above, the percentage of crop feeding studies among primatology is still low. We hope that this applied field will attract the attention of more researchers in the future.

It is noteworthy that the number of theses on primate crop feeding has increased since the 2000s (e.g., Priston 2005; Rijal 2015; Zak 2016). In spite of the limitations of a survey based on a review of published literature, our present results indicate that studies on primate crop feeding have become an important research topic, and such a trend is welcomed. In the next decade, the number of young researchers studying human-primate conflict is likely to increase further. Researchers in developed countries need to train students from developing countries as specialists in human-wildlife conflicts in their respective countries.

The percentage of studies published in international journals has increased; nonetheless, less than 50% of the total number of publications have been on primate crop feeding in Asia. Publishing research in international journals is invaluable as the knowledge gained from the provided research can easily be shared worldwide. In order to publish research in international journals, researchers should collect sufficient high-quality data by using appropriate sampling methods, analyze the data with statistical tools, and prepare manuscripts with clear logic and hypotheses. It may be necessary to unify data sampling and analysis methods among researchers to allow clear comparisons of the results. Collaboration with researchers of fundamental primate ecology and behavior would be a good solution, but there are practical reasons that prevent joint research among researchers from different fields of study. For example, in Japan, countermeasure technology tends to be published with the aim of obtaining patents rather than research papers (Enari 2021). Further, damage management is often implemented with public budgets, requiring researchers to quickly provide results to local communities rather than publishing them in scientific journals. Thus, in order to share information by means of scientific papers, support from local governments would be essential.

In the Asian region, crop feeding is mainly done by macaques and, to a lesser extent, by colobines. The former is unsurprising because macaques are highly tolerant to environmental changes (Nijman and Nekaris 2010b; Tsuji et al. 2013) and even utilize human settlements as their habitats (Richard et al. 1989; Nijman and Nekaris 2010b). For macaques living in forests near human settlements, supplementing their diet with cultivated food is an adaptive strategy. However, it was unexpected that colobines were crop feeders as well. However, most of these cases were caused by *Semnopithecus* monkeys. Compared to other colobines in Asia (genera *Trachypithecus*, *Presbytis*, *Rhinopithecus*, and *Pygathrix*), *Semnopithecus* monkeys have a more omnivorous diet containing a lower proportion of leaves (Kirkpatrick 1999; Tsuji et al. 2013). In addition, *Semnopithecus* spp. have a higher tolerance than other colobines to environmental disturbances and can survive near human settlements (Minhas et al. 2010; Nautiyal et al. 2020). Generalist primates (such as genera *Cercopithecus*, *Papio*, and *Sapajus*) are often the crop feeders in Africa (Naughton-Treves 1998; Hill 2000; Nijman and Nekaris 2010b; Strum 2010) and Central/South America (Spagnoletti et al. 2017). Therefore, crop feeding by generalist primates in Asia is expected. This implies that strategies for the management of primate crop feeding should target *Macaca* and *Semnopithecus* species.

Across Asia, India had the highest number of publications on crop feeding (n = 37), which is likely due to human population growth, deforestation, intense agricul-

tural practices, and urbanization (Mariadoss et al. 2019). In Indonesia ($n = 27$) and Nepal ($n = 18$), a majority of the reports were written by the same research group at the same study sites; thus, information from other groups/study sites is necessary to generalize their findings. The lack of information from Indochinese countries (Vietnam, Laos, Cambodia, and Myanmar) is likely due to the smaller number of researchers and shorter history of primatology in those countries, compared to other Asian countries.

Despite the considerable number of primate researchers and their respective country's economic scale, the number of case reports from Japan ($n = 19$) and China ($n = 2$) was small, because more scholars from these countries are publishing their research on crop feeding in non-English journals. We previously summarized the dietary habits of Japanese macaques feeding on crops (Tsuji et al. 2018) and found that almost all reports (> 90%) were written in Japanese (although several reports contained an English summary). Information written in native languages is useful to share among people within the country and to conduct rapid countermeasures locally. However, considering the globalization of the economy and academic activity, researchers should share with the world the information gained in their own country. This implies that researchers (especially in academia) need to write their reports in English. Reporting more studies from China and Japan on primate crop feeding cases, on effective countermeasures, and on mitigation programs would be useful models for other Asian countries suffering from primate crop feeding.

Crop damage levels depend on season, crop type, size, and location of the crop field, and the primate species involved. Multiple factors make it difficult to predict crop feeding accurately (Linkie et al. 2007; Nijman and Nekaris 2010b). As a next step, what should researchers in Asia do? First, they need to clarify the mechanisms driving the ranging behavior of crop feeding primates. For example, data on the population parameters of crop feeding primates should be systematically collected. Crop feeding often improves the nutritional condition of feeders and consequently increases their population size, which then escalates the crop feeding (Biquand et al. 1994). Collecting demographic data on crop feeders can be challenging and difficult if they are not habituated, and it might be unethical to habituate groups that regularly forage on crops (Riley and Bezanson 2018). Therefore, the use of technology such as sensor cameras (Zak and Riley 2017) and drones (Bonnin et al. 2018) should be considered. Primate crop feeding behaviors cannot be understood solely in terms of animals shifting to crops to compensate for reduced forest food availability. Other possible reasons include the higher nutritional value of crops (Riley et al. 2013), behavioral tradeoff (primates may be weighing the risks and benefits, such that the benefits of crop feeding outweigh the risks) (McLennan and Hockings 2014), and a forest environment adjacent to the crop field (such as abundance and quality of natural foods and landscape structure) (Wang et al. 2006; Regmi et al. 2013; Hill 2017). In addition, extrinsic factors such as temperature, forest productivity, and snowfall also affect the distribution and ranging patterns of the crop feeding primates (Honda 2009). If we can evaluate the relative importance of each factor, we can provide a biological justification for the target primate's preference for crops.

Hill (2017) advocated the idea that crop feeding by primates should be treated as a feeding strategy (Stephens and Krebs 1986; Strum 2010). In this framework, not only crop fields but also the surrounding forest should be evaluated as the habitat of the target primate species, and the potential value of the crop fields (as feeding sites and refuge) should be assessed based on costs and benefits. This knowledge would be useful for controlling the determinants of crop feeding. Data accumulation enables models to simulate the monkeys' ranging and/or potential risk of crop damage, which is useful for both farmers and local governments to prepare countermeasures and to use their budgets and time efficiently. To fully understand why, how, and when primates incorporate crops into their dietary repertoire, researchers need to examine primate crop foraging behavior in the context of their feeding strategies (Strum 2010; MacLarnon et al. 2015; Hill 2017).

Furthermore, researchers should actively employ an experimental approach to confirm the efficiency of target countermeasures; Hill and Wallace (2012), for example, monitored primate crop feeding behavior prior to and after installing locally appropriate countermeasures (fences, alarms, repellents, and systematic guarding), developed by local farmers in Africa, and found that the incidence of feeding and crop loss decreased in almost all cases, often by shifting the feeding to unprotected fields or adjacent farms. Nijman and Nekaris (2010b) tested the applicability of a simple model for calculating the likelihood of crop damage by primates using crop susceptibility to predict the frequency of crop damage for individual farms and found that it works well for predicting crop feeding by langurs. In their study, farmers identified the

pros and cons of each countermeasure and considered which were the most effective and valuable. Unfortunately, such an approach has rarely been used in Asia (only five out of the 134 cases studied here), and many reports are just descriptions of the present situation.

Furthermore, in addition to damage control, researchers also need to evaluate how dependence on crops influences the ecological services of crop feeding primates. The ecological role of Asian primates as seed dispersers and their relationship with forest productivity has been previously revealed (McConkey 2018; Tsuji and Su 2018). Recent studies have shown that the ecological role of primates can be affected by human activity. Sengupta et al. (2015), for example, reported that a dependence on provisioned foods shifted the home range area of rhesus macaques to roadsides and consequently deteriorated their seed dispersal services. In Africa, Hockings et al. (2017) reported that chimpanzees dispersed seeds of cultivated cacao, but the cacao trees that grew in forests did not fruit. These results imply that when the range of primates is affected by human activity, seed dispersal characteristics and effectiveness are also affected. On the other hand, provisioning leads to decreased home range size (Chhangani and Mohnot 2006; Koganezawa and Imaki 1999), which might change the seed dispersal distance and direction. Research on crop feeding hitherto has paid little attention to this ecological perspective.

Additionally, researchers need to accumulate data on the effects of bites and illnesses inflicted upon people during crop feeding (none of the 134 collected studies identified this to be an issue). Engel et al. (2002) studied the infection risk of B virus from provisioned Balinese long-tailed macaques inhabiting a monkey park. Based on their report, more than half of the 105 staff members had been bitten or scratched by the park macaques, and the blood of 33 out of 38 tested monkeys showed a positive reaction to the B virus antibody. This implies that the risk of infection from monkeys to humans is high. At present, however, research on the risk of bite-borne infection is lacking.

It is difficult to balance the lives of farmers with primate conservation (Hockings and McLennan 2012; Hockings et al. 2020). Farmers often distrust local governments (Campbell-Smith et al. 2010; Enari 2021). In order to reach a consensus among stakeholders, researchers first need to show information on the ecological and conservation conditions of the target primate species to local people. Second, researchers need to advise local governments to suggest efficient countermeasures and support local farmers to make them more likely to tolerate the primates (Campbell-Smith et al. 2010). The conservation initiatives provided by scientists would be useful for conducting damage control and environmental education, in terms of coexistence with wildlife.

Promoting research on crop feeding in Asian regions as applied science in the next few decades is the responsibility of researchers who study in Asia where sustainable development is strongly required.

Supplementary data

Supplementary data are available at *Mammal Study* online.
Supplementary Table S1. A summary of previous reports on the details of crop feeding by non-human primates in Asian region.

Acknowledgments: We developed the basic idea for this review through discussions mostly with core members of the Working Group on the Conservation and Management of Japanese Macaques, Japan Mammalogical Society. We sincerely acknowledge this help. Our appreciation also goes to Dr. Hiroto Enari, a joint planner of this special issue, who inspired us to write this article. This study was partly supported by JSPS KAKENHI grant numbers 19K06863 and 19K06837. We would also like to thank the Cooperative Research Program of the Primate Research Institute, Kyoto University, Japan, the library staff of the Primate Research Institute, Kyoto University, and Drs. Chalise M. K., Sugiyama Y., Priston N. E. C., Riley E. P., and Malaivijitnond S. for sending their literature. We would like to thank two anonymous reviewers and Dr. T. Shimada for their constructive comments to our manuscript.

References

Adhikari, J. N., Bhattarai, B. P. and Thapa, T. B. 2018a. Human-wild mammal conflict in a human dominated mid hill landscape: a case study from Panchase area in Chitwan Annapurna Landscape, Nepal. Journal of Institute of Science and Technology 23: 30–38.

Adhikari, K., Khanal, L. and Chalise, M. K. 2018b. Status and effects of food provisioning on ecology of Assamese monkey (*Macaca assamensis*) in Ramdi area of Palpa, Nepal. Journal of Institute of Science and Technology 22: 183–190.

Agetsuma, N. 2007. Ecological function losses caused by monotonous land use induce crop raiding by wildlife on the island of Yakushima, southern Japan. Ecological Research 22: 390−402.

Aggimarangsee, N. 1992. Survey for semi-tame colonies of macaques in Thailand. Natural History Bulletin of the Siam Society 40: 103–166.

Ahsan, M. F. and Uddin, M. M. 2014. Human-rhesus monkey conflict at Rampur village under Monohardi Upazila in Narsingdi District

of Bangladesh. Journal of Threatened Taxa 6: 5905–5908.
Air, A. 2015. Crop-Raiding and Conflict: Study of Rhesus Macaque-Human Conflict in Shivapuri-Nagarjun National Park, Kathmandu Nepal. Master's Thesis, Norwegian University of Science and Technology, Trondheim, 32 pp.
Anand, S., Binoy, V. V. and Radhakrishna, S. 2018. The monkey is not always a god: attitudinal differences toward crop-raiding macaques and why it matters for conflict mitigation. Ambio 47: 711–720.
Anand, S. and Radhakrishna, S. 2017. Investigating trends in human-wildlife conflict: is conflict escalation real or imagined? Journal of Asia-Pacific Biodiversity 10: 154–161.
Aryal, K. and Chalise, M. K. 2013. Human-monkey interface in Arkhale and Nayagaun, Gulmi, West Nepal. Nepalese Journal of Zoology 1: 30–40.
Awasthi, B. and Singh, N. B. 2015. Status of human-wildlife conflict and assessment of crop damage by wild animals in Gaurishankar Coservation Area, Nepal. Journal of Institute of Science and Technology 20: 107–111.
Aziz, M. A. and Feeroz, M. M. 2007. Damage to agricultural crops by mammalian fauna at the fringes of Lawachara National Park, Bangladesh. Tigerpaper 34: 29–32.
Beisner, B. A., Heagerty, A., Seil, S. K., Balasubramaniam, K. N., Atwill, E. R., Gupta, B. K. and McCowan, B. 2015. Human–wildlife conflict: proximate predictors of aggression between humans and rhesus macaques in India. American Journal of Physical Anthropology 156: 286–294.
Bertrand, M. 1969. The behavioral repertoire of the stumptail macaque: a descriptive and comparative study. Bibliotheca Primatologica 11: 1–272.
Biquand, S., Boug, A., Biquand-Guyot, V. and Gautier, J. P. 1994. Management of commensal baboons in Saudi Arabia. Terre et Vie 49: 213–222.
Bonnin, N., Van Andel, A. C., Kerby, J. T., Piel, A. K., Pintea, L. and Wich, S. A. 2018. Assessment of chimpanzee nest detectability in drone-acquired images. Drones 2: 17.
Cabral, S. J., Prasad, T., Deeyagoda, T. P., Weerakkody, S. N., Nadarajah, A. and Rudran, R. 2018. Investigating Sri Lanka's human-monkey conflict and developing a strategy to mitigate the problem. Journal of Threatened Taxa 10: 11391–11398.
Campbell-Smith, G., Simanjorang, H. V. P., Leader-Williams, N. and Linkie, M. 2010. Local attitudes and perceptions toward crop-raiding by orangutans (*Pongo abelii*) and other nonhuman primates in northern Sumatra, Indonesia. American Journal of Primatology 72: 866–876.
Chakravarthy, A. K. and Thyagaraj, N. E. 2005. Coexistence of bonnet macaque (*Macaca radiata radiata* Geoffroy) with planters in the cardamom (*Elettaria cardamomum* Maton) and coffee (*Coffea arabica* Linnaeus) plantation of Karnataka, south India: hospitable or hostile? In (Paterson, J. D. and Wallis, J., eds.) Commensalism and Conflict: The Human-Primate Interface, pp. 276–285. American Society of Primatologists, Norman.
Chalise, M. K. 2000. Crop-raiding by wildlife, especially primates, and indigenous practices for crop protection in Lakuwa Area, East Nepal. Asian Primates 7: 4–9.
Chalise, M. K. 2003. Assamese macaques (*Macaca assamensis*) in Nepal. Primate Conservation 19: 99–107.
Chalise, M. K. and Johnson, R. O. 2005. Farmer attitudes toward the conservation of "pest" monkeys: the view from Nepal. In (Paterson, J. D. and Wallis, J., eds.) Commensalism and Conflict: The Human-Primate Interface, pp. 139–155. American Society of Primatologists, Norman.
Chaturvedi, S. K. and Mishra, M. K. 2014. Study of man-monkey conflict and its management in Chitrakoot, Madhya Pradesh, India. International Journal of Global Science Research 1: 107–110.
Chauhan, A. and Pirta, R. S. 2010. Public opinion regarding human-monkey conflict in Shimla, Himachal Pradesh. Journal of Human Ecology 30: 105–109.
Chaves, Ó. M. and Bicca-Marques, J. C. 2017. Crop feeding by brown howlers (*Alouatta guariba clamitans*) in forest fragments: the conservation value of cultivated species. International Journal of Primatology 38: 263–281.
Chhangani, A. K. and Mohnot, S. M. 2004. Crop raid by hanuman langur *Semnopithecus entellus* in and around Aravallis (India) and its Management. Primate Report 69: 35–48.
Chhangani, A. K. and Mohnot, S. M. 2006. Ranging behaviour of hanuman langurs (*Semnopithecus entellus*) in three different habitats. Primate Conservation 21: 171–177.
Choudhury, A. 2003. The pig-tailed macaque *Macaca nemestrina* in India - status and conservation. Primate Conservation 19: 91–98.
Corlett, R. T. 2019. The Ecology of Tropical East Asia (3rd Edition). Oxford University Press, Oxford, 336 pp.
Crockett, C. M. and Wilson, W. L. 1980. The ecological separation of *Macaca nemestrina* and *M. fascicularis* in Sumatra. In (Lindburg, D. G., ed.) The Macaques: Studies in Ecology, Behavior and Evolution, pp. 148–181. Van Nostrand Reinhold, New York.
Das, D. and Mandal, S. 2015. Man-monkey conflict in Khowai District, Tripura, Northeast India: a case study. Journal of Global Bioscience 4: 3140–3145.
Dela, J. D. S. 2011. Impact of monkey-human relationships and habitat change on *Semnopithecus vetulus nestor* in human modified habitats. Journal of Nature Science Foundation of Sri Lanka 39: 365–382.
Devi, S. N. and Radhakrishna, S. 2013. Attitudes towards primates and primate conservation in Manipur, northern India. Asian Primates Journal 3: 29–36.
Di Bitetti, M. S. 2019. Primates bark-stripping trees in forest plantations – a review. Forest Ecology and Management 449: 117482.
Dittus, W. P. J., Gunathilake, S. and Felder, M. 2019. Assessing public perceptions and solutions to human-monkey conflict from 50 years in Sri Lanka. Folia Primatologica 90: 89–108.
Dore, K. M., Riley, E. P. and Fuentes, A. 2017. Ethnoprimatology: A Practical Guide to Research at the Human-Nonhuman Primate Interface. Cambridge University Press, Cambridge, 308 pp.
Enari, H. 2021. Human–macaque conflicts in shrinking communities: recent achievements and challenges in problem solving in modern Japan. Mammal Study 46: 115–130. DOI: 10.3106/ms2019-0056.
Enari, H. and Suzuki, T. 2010. Risk of agricultural and property damage associated with the recovery of Japanese monkey populations. Land and Urban Planning 97: 83–91.
Engel, G. A., Jones-Engel, L., Schillaci, M. A., Suaryana, K. G., Putra, A., Fuentes, A. and Henkel, R. 2002. Human exposure to herpes virus B–seropositive macaques, Bali, Indonesia. Emerging Infectious Diseases 8: 789–795.
Eudey, A. A. 1987. Action Plan for Asian Primate Conservation: 1987–1991. IUCN Species Survival Commission, Gland, 65 pp.
Fittinghoff, N. A. and Lindburg, D. G. 1980. Riverine refuging and East Bornean *Macaca fascicularis*. In (Lindburg, D. G., ed.) The Macaques: Studies in Ecology, Behavior and Evolution, pp. 182–214. van Nostrand Reinhold, New York.
Fooden, J. 1971. Report on the primates collected in western Thailand, January–April 1967. Fieldiana Zoology 59: 1–62.
Fooden, J. 1982. Taxonomy and evolution of the sinica group of macaques: 3. species and subspecies accounts of *Macaca assamensis*. Fieldiana Zoology 10: 1–51.
Frondelius, L. 2010. Crop Preferences of Buton Macaque (*Macaca ochreata brunnescens*). Master's Thesis, University of Eastern

Finland, Kuopio, 42 pp.
Gamalo, L. E., Baril, J., Dimalibot, J., Asis, A., Anas, B., Puna, N. and Paller, V. G. 2019. Nuisance behaviors of macaques in Puerto Princesa Subterranean River National Park, Palawan, Philippines. Journal of Threatened Taxa 11: 13287–13294.
Ganguly, I. and Chauhan, N. S. 2019. How perception of local people towards rhesus macaque (*Macaca mulatta*) can influence on decision-making of human-macaque conflict mitigation? Journal of Wildlife Biodiversity 3: 52–62.
Ghimire, S. C. 2001. A glimpse of crop-raiding by rhesus monkeys in Bandipokhara, Palpa, Nepal. Nanson Bulletin 10: 12–13.
Ghimire, S. C. and Chalise, M. K. 2016. Status of crop-raiding by Assamese monkeys (*Macaca assamensis*) along the Budhigandaki River, central Nepal. Journal of Natural History Museum 30: 294–305.
Ghimire, S. C. and Chalise, M. K. 2019. Crop-raiding status by Assamense monkeys (*Macaca assamensis*) along the Kaligandaki River, Western Nepal. Journal of Institute of Science and Technology 24: 72–76.
Ghimirey, Y., Acharya, R. and Pokhrel, B. M. 2018. Human-Assamese macaque conflict in Makalu-Barun National Park Buffer Zone, Nepal. Friends of Nature, The Himalayan Naturalist 1: 3–7.
Hadi, I., Suryobroto, B. and Watanabe, K. 2012. Anthropogenic influences on the socioecology of long-tailed macaques (*Macaca fascicularis*) in Lombok Island, Indonesia. Journal Biologi Indonesia 8: 1–7.
Hambali, K., Ismail, A, Zulkifl, S. Z., Md-Zain, B. M. and Amir, A. 2012. Human-macaque conflict and pest behaviors of long-tailed macaques (*Macaca fascicularis*) in Kuala Selangor Nature Park. Tropical Natural History 12: 189–205.
Hanse, R., Tamuli, A. K. and Teron, R. 2015. Human-nonhuman primate conflict: a fallout of environmental degradation. International Journal of Research and Analytical Reviews 2: 122–131.
Hardwick, J. L., Priston, N. E., Martin, T. E., Tosh, D. G., Mustari, A. H. and Abernethy, K. E. 2017. Community perceptions of the crop-feeding Buton macaque (*Macaca ochreata brunnescens*): an ethnoprimatological study on Buton Island, Sulawesi. International Journal of Primatology 38: 1102–1119.
Hill, C. M. 2000. Conflict of interest between people and baboons: crop raiding in Uganda. International Journal of Pest Management 21: 299–315.
Hill, C. M. 2004. Farmers' perspectives of conflict at the wildlife-agriculture boundary: some lessons learned from African subsistence farmers. Human Dimensions of Wildlife 9: 279–286.
Hill, C. M. 2017. Primate crop feeding behavior, crop protection, and conservation. International Journal of Primatology 38:385–400.
Hill, C. M. and Wallace, G. E. 2012. Crop protection and conflict mitigation: reducing the costs of living alongside non-human primates. Biodiversity Conservation 21: 2569–2587.
Hill, W. C. O. 1974. Primates: Comparative Anatomy and Taxonomy, VI1. Cynopithecinae: *Cercocebus*, *Macaca*, *Cynopithecus*. Wiley, New York, 951 pp.
Hockings, K. J., Anderson, J. R. and Matsuzawa, T. 2009. Use of wild and cultivated foods by chimpanzees at Bossou, Republic of Guinea: feeding dynamics in a human-influenced environment. American Journal of Primatology 71: 636–646.
Hockings, K. J. and McLennan, M. 2012. From forest to farm: systematic review of cultivar feeding by chimpanzees-management implications for wildlife in anthropogenic landscapes. PLOS ONE 7: e33391. DOI: 10.1371/journal.pone.0033391.
Hockings, K. J., Parathian, H. Bessa, J and Frazão-Moreira. 2020. Extensive overlap in the selection of wild fruits by chimpanzees and humans: implications for the management of complex social-ecological systems. Frontiers in Ecology and Evolution 8: 1–12.
Hockings, K. J., Yamakoshi, G. and Matsuzawa, T. 2017. Dispersal of a human-cultivated crop by wild chimpanzees (*Pan troglodytes verus*) in a forest–farm matrix. International Journal of Primatology 38:172–193.
Honda, T. 2009. Environmental factors affecting the distribution of the wild boar, sika deer, Asiatic black bear and Japanese macaque in central Japan, with implications for human-wildlife conflict. Mammal Study 34: 107–116.
Honda, T., Kuwata, H., Yamasaki, S. and Miyagawa, Y. 2011. A low-cost, low-labor-intensity electric fence effective against wild boar, sika deer, Japanese macaque and medium-sized mammals. Mammal Study 36: 113–117.
Honda, T., Miyagawa, Y., Ueda, H. and Inoue, M. 2009. Effectiveness of newly-designed electric fences in reducing crop damage by medium and large mammals. Mammal Study 34: 13–17.
Honda, T., Yamabata, N., Iijima, H. and Uchida, K. 2019. Sensitization to human decreases human-wildlife conflict: empirical and simulation study. European Journal of Wildlife Research 65: 71.
Horgan, F. G. and Kudavidanage, E. P. 2020. Farming on the edge: farmer training to mitigate human-wildlife conflict at an agricultural frontier in south Sri Lanka. Crop Protection 127: 104981.
Huang, C., Li, X.Y., Shi, L. J. and Jiang, X. L. 2018. Patterns of human-wildlife conflict and compensation practices around Daxueshan Nature Reserve, China. Zoological Research 39: 406–412.
Ilham, K., Nurdin, J., Rizaldi and Tsuji, Y. 2017. Status of urban populations of the long-tailed macaque (*Macaca fascicularis*) in West Sumatra, Indonesia. Primates 58: 295–305.
Imam, E. and Ahmad, A. 2013. Population status of rhesus monkey (*Macaca mulatta*) and their menace: a threat for future conservation. International Journal of Environmental Science 3: 1279–1289.
Izumiyama, S., Mochizuki, T. and Shiraishi, T. 2003. Troop size, home range area and seasonal range use of the Japanese macaque in the Northern Japan Alps. Ecological Research 18: 465–474.
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.
Jayson, E. A. 1999. Studies on Crop Damage by Wild Animals in Kerala and Evaluation of Control Measures. Kerala Forest Research Institute Research Report 169. Kerala Forest Research Institute, Thrissur, 48 pp.
Khatun, U. H., Ahsan, M. F. and Røskaft, E. 2012. Attitudes of the local community towards the conservation of the common langur (*Semnopithecus entellus*) in Keshabpur, Bangladesh. International Journal of Biodiversity Conservation 4: 385–399.
Khatun, U. H., Ahsan, M. H. and Røskaft, E. 2013. Local people's perceptions of crop damage by common langurs (*Semnopithecus entellus*) and human-langur conflict in Keshabpur of Bangladesh. Environment and Natural Resources Research 3: 111–126.
Kirkpatrick, R. C. 1999. Colobine diet and social organization. In (Dolhinow, P. and Fuentes, A., eds.) The Non-Human Primates, pp. 93–105. Mayfeld Publishing Company, California.
Kirkpatrick, R. C. 2007. The Asian colobines: diversity among leaf-eating monkeys. In (Campbell, C. J., Fuentes, A., MacKinnon, K. C., Panger, M. and Bearder, S. K., eds.), Primates in Perspective, pp. 1186–200. Oxford University Press, New York.
Knight, J. 1999. Monkeys on the move: the natural symbolism of people-macaque conflict in Japan. Journal of Asian Studies 58: 622–647.

Koganezawa, M. and Imaki, H. 1999. The effects of food sources on Japanese monkey home range size and location, and population dynamics. Primates 40: 177–185.

Kumara, V. and Diandra, L. 2018. Study on human-macaque conflict in the Hosanagara taluk of Shivamogga district, Karnataka. International Journal of Life Science 6: 605–614.

Lee, P. C. and Priston, N. E. C. 2005. Human attitudes to primates: perceptions of pests, conflict and consequences for primate conservation. In (Patterson, J. D. and Wallis, J., eds.) Commensalism and Conflict: The Human-Primate Interface. American Society of Primatologists, pp. 1–23.

Lindburg, D. G. 1977. Feeding behaviour and diet of rhesus monkeys (*Macaca mulatta*) in a Siwalik forest in North India. In (Clutton-Brock, T. H., eds.) Primate Ecology: Studies of Feeding and Ranging Behavior in Lemurs, Monkeys, and Apes, pp. 223–249. Academic Press, London.

Linkie, M., Dinata, Y., Nofrianto, A. and Leader-Williams, N. 2007. Patterns and perceptions of wildlife crop-raiding in and around Kerinci Seblat National Park, Sumatra. Animal Conservation 10: 127–135.

Loudon, J. E., Howells, M. E. and Fuentes, A. 2006. The importance of integrative anthropology: a preliminary investigation employing primatological and cultural anthropological data collection methods in assessing human-monkey co-existence in Bali, Indonesia. Ecological and Environmental Anthropology 2: 1–13.

MacLarnon, A. M., Sommer, V., Goffe, A. S., Higham, J. P., Lodge, E., Tkaczynski, P. and Ross, C. 2015. Assessing adaptability and reactive scope: introducing a new measure and illustrating its use through a case study of environmental stress in forest-living baboons. General Comparative Endocrinology 215: 10–24.

Maddison, A. 2009. Statistics on World Population, GDP and Per Capita GDP, 1-2008 AD. Available at http://www.ggdc.net/maddison/oriindex.htm (Accessed 22 July 2020).

Malaivijitnond, S. and Hamada, Y. 2008. Current situation and status of long-tailed macaques (*Macaca fascicularis*) in Thailand. The Natural History Journal of Chulalongkorn University 8: 185–204.

Marchal, V. and Hill, C. 2009. Primate crop-raiding: a study of local perceptions in four villages in north Sumatra, Indonesia. Primate Conservation 24:107–116.

Mariadoss, A., Naresh, B., Sakthivel, P. and Sujeetha, A. R. P. 2019. Damages by non-human primates and management strategies in agroecosystem. Innovative Farming 4: 19–29.

McCann, C. 1933. Notes on some Indian macaques. Journal of Bombay Natural History Society 36: 796–810.

McConkey, K. R. 2018. Seed dispersal by primates in Asian habitats: from species, to communities, to conservation. International Journal of Primatology 39: 466–492.

McLennan, M. R. and Hockings, K. J. 2014. Wild chimpanzees show group differences in selection of agricultural crops. Scientific Reports 4: 5956. DOI: 10.1038/srep05956.

Md-Zain, B. M., Ruslin, F. and Idris, W. M. R. 2014. Human-macaque conflict at the main campus of Universiti Kebangsaan Malaysia. Pertanika Journal of Tropical Agricultural Science 37: 73–85.

Meijaard, E., Buchori, D., Hadiprakarsa, Y., Utami-Atmoko, S. S., Nurcahyo, A., Tjiu, A., Prasetyo, D., Nardiyono, Christie, L., Ancrenaz, M., et al. 2011. Quantifying killing of orangutans and human-orangutan conflict in Kalimantan, Indonesia. PLOS ONE 6: e27491. DOI: 10.1371/journal.pone.0027491.

Miah, D., Rahman, L. and Ahsan, F. 2001. Assessment of crop damage by wildlife in Chunati Wildlife Sanctuary, Bangradesh. Tigerpaper 28: 22–28.

Minhas, R. A., Ahmed, K. B., Awan, M. S. and Dar, N. I. 2010. Habitat utilization and feeding biology of Himalayan grey langur (*Semnopithecus entellus ajax*) in Machiara National Park, Azad Jammu and Kashmir, Pakistan. Zoological Research 31: 177–188.

Mochizuki, S. and Murakami, T. 2011. Change in habitat selection by Japanese macaques (*Macaca fuscata*) and habitat fragmentation analysis using temporal remotely sensed data in Niigata Prefecture, Japan. International Journal of Applied Earth Observation and Geoinformation 13: 562–571.

Mochizuki, S. and Murakami, T. 2013. Scale dependent effects in resource selection by crop-raiding Japanese macaques in Niigata Prefecture, Japan. Applied Geography 42: 13–22.

Muroyama, Y. and Yamada, A. 2010. Conservation: present status of the Japanese macaque population and its habitat. In (Nakagawa, N., Nakamichi, M. and Sugiura, H., eds.) The Japanese Macaques, pp. 143–164. Springer, Tokyo.

Nahallage, C. A. D. and Huffman, M. A. 2012. Macaque–human interactions in past and present-day Sri Lanka. In (Radhakrishna, S., Huffman, M. A. and Sinha, A., eds.) The Macaque Connection: Cooperation and Conflict, pp. 135–148. Springer Science + Business Media, LLC1, New York.

Nahallage, C. A. D., Huffman, M. A., Kuruppu. N. and Weerasingha, T. 2008. Diurnal primates in Sri Lanka and people's perception of them. Primate Conservation 23: 81–87.

Naher, H., Khan, S. I. and Ahmed, T. 2017. Threats and conservation problems of non-human primates in moist deciduous forest of Bangladesh. Journal of Asiatic Society of Bangladesh 43: 11–22.

Naughton-Treves, L. 1998. Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda. Conservation Biology 12: 156–168.

Naughton-Treves, L., Treves, A., Chapman, C. and Wrangham, R. 1998. Temporal patterns of crop-raiding by primates: linking food availability in croplands and adjacent forest. Journal of Applied Ecology 35: 596–606.

Nautiyal, H., Mathur, V., Sinha, A. and Huffman, M. A. 2020. The Banj oak *Quercus leucotrichophora* as a potential mitigating factor for human-langur interactions in the Garhwal Himalayas, India: People's perceptions and ecological importance. Global Ecology and Conservation 22: e00985. DOI: 10.1016/j.gecco.2020.e00985.

Nijman, V. and Nekaris, K. A. I. 2010a. Effects of deforestation on attitudes and levels of tolerance towards commensal primates (Cercopithecidae) in Sri Lanka. International Journal of Pest Management 56: 153–158.

Nijman, V. and Nekaris, K. A. I. 2010b. Testing a model for predicting primate crop-raiding using crop- and farm-specific risk values. Applied Animal Behavior Science 127: 125–129.

Nyhus, P. J., Osofsky, S. A., Ferraro, P., Madden, F. and Fisher, H. 2005. Bearing the cost of human–wildlife conflict: the challenge of compensation schemes. In (Woodroffe, R., Thirgood, S. and Rabinowitz, A., eds.) People and Wildlife: Conflict or Coexistence? pp. 107–121. Cambridge University Press, Cambridge.

Paudel, G. and Shrestha, T. K. 2018. Crop depredation by monkey: outside protected area in Nepal; costs, conditions, and perceptions. Indian Forester 144: 929–935.

Paudel, P. K. 2013. Population Status, Distribution, and General Behavior of Assamense Monkey (*Macaca assamensis* McClelland, 1840) in Kaligandaki River Basin, Baglung and Parbat Districts, Nepal. Master's Thesis, Institute of Science & Technology, Tribhuvan University, Kathmandu, 52 pp.

Paudel, P. K. 2016. Conflict due to Assamese macaques (*Macaca assamensis* McClelland 1840) and crop protection strategies in Kaligandaki River Basin, Western Nepal. Our Nature 14: 107–114.

Peterson, J. V. and Riley, E. P. 2013. Monyet yang dihargai, monyet yang dibenci: the human-macaque interface in Indonesia. In (Radhakrishna, S., Huffman, M. A. and Sinha, A., eds.) The

Macaque Connection: Cooperation and Conflict, pp. 149–165. Springer Science + Business Media, LLC1, New York.

Pirta, R. S., Gadgil, M. and Kharshikar, A. V. 1997. Management of the rhesus monkey *Macaca mulatta* and Hanuman langur *Presbytis entellus* in Himachal Pradesh, India. Biological Conservation 79: 97–106.

Poirier, F. E. 1986. A preliminary study of the Taiwan macaque (*Macaca cyclopis*). Zoological Research 7: 411–422.

Poirier, F. E. and Hu, H. 1983. *Macaca mulatta* and *Rhinopithecus* in China: Preliminary research results. Current Anthropology 24: 387–388.

Priston, N. E. C. 2005. Crop-Raiding by *Macaca ochreata brunnescens* in Sulawesi: Reality, Perceptions, and Outcomes for Conservation. Ph. D Thesis, University of Cambridge, Cambridge, 370 pp.

Priston, N. E. C. 2009. Exclosure plots as a mechanism for quantifying the damage to crops by primates. International Journal of Pest Management 55: 243–249.

Priston, N. E. C. and McLennan, M. R. 2013. Managing humans, managing macaques: human-macaque conflict in Asia and Africa. In (Radhakrishna, S., Huffman, M. A. and Sinha, A., eds.) The Macaque Connection: Cooperation and Conflict, pp. 225–248. Springer Science + Business Media, LLC1, New York.

Priston, N. E. C. and Underdown, S. J. 2009. A simple method for calculating the likelihood of crop damage by primates: an epidemiological approach. International Journal of Pest Management 55: 51–56.

Priston, N. E. C., Wyper, R. M. and Lee, P. C. 2012. Buton macaques (*Macaca ochreata brunnescens*): crops, conflict, and behavior on farms. American Journal of Primatology 74: 29–36.

Radhakrishna, S. 2013. Songs of monkeys: representation of macaques in classical Tamil poetry. In (Radhakrishna, S., Huffman, M. A. and Sinha, A., eds.) The Macaque Connection: Cooperation and Conflict, pp. 53–68. Springer Science + Business Media, LLC1, New York.

Radhakrishna, S. and Sinha, A. 2010. Dr Jekyll and Mr Hyde: The strange case of human-macaque interactions in India (Commentary). Current Conservation 4: 39–40.

Rahman, M. M., Jaman, M. F., Khatun, M. T., Alam, S. M. I., Kayum, A. R. M. R. and Uddin, M. 2015. Substrate utilization by Bengal sacred langur *Semnopithecus entellus* (Dufresne, 1797) in Jessore, Bangladesh: effect of resource type on feeding in urban and rural groups. International Journal of Pure and Applied Zoology 3: 162–172.

Rao, K. S., Maikhuri, R. K., Nautiyal, S. and Saxena, K. G. 2002. Crop damage and livestock depredation by wildlife: A case study from Nanda Devi Biosphere Reserve, India. Journal of Environmental Management 66: 317–327.

Rattan, S. K. 2011. Managing human–macaque conflict in Himachal, India. In (Gunmert, M. D., Jones-Engel, L. and Fuentes, A., eds.) Monkeys on the Edge: Ecology and Management of Long-Tailed Macaques and Their Interface with Humans, pp. 283–292. Cambridge University Press, Cambridge.

R Developmental Core Team. 2015. R: A Language and Environment for Statistical Computing. Version 3.2.3. R Foundation for Statistical Computing, Vienna, Austria. Available at http://www.r-project.org/(Accessed 10 December 2015).

Regmi, G. R., Nekaris, K. A. I., Kandel, K. and Nijman, V. 2013. Crop-raiding macaques: predictions, patterns, and perceptions from Langtang National Park, Nepal. Endangered Species Research 20: 217–226.

Richard, A. F., Goldstein, S. J. and Dewer, R. R. 1989. Weed macaques: The evolutionary implications of macaque feeding ecology. International Journal of Primatology 10: 569–594.

Rijal, B. 2015. Ecological Study of Rhesus and Assamese Macaques and Their Conflict with Humans in Nagarjun Forest, Kathmandu, Nepal. Ph. D. Thesis, Institute of Science and Technology, Tribhuvan University, Kathmandu, 80 pp.

Riley, E. P. 2007. The human–macaque interface: conservation implications of current and future overlap and conflict in Lore Lindu National Park, Sulawesi, Indonesia. American Anthropologist 109: 473–484.

Riley, E. P. 2008. Ranging patterns and habitat use of Sulawesi Tonkean macaques (*Macaca tonkeana*) in a Human-Modified Habitat. American Journal of Primatology 70: 670–679.

Riley, E. P. 2010. The importance of human–macaque folklore for conservation in Lore Lindu National Park, Sulawesi, Indonesia. Oryx 44: 235–240.

Riley, E. P. and Bezanson, M. 2018. Ethics of primate fieldwork: toward an ethically engaged primatology. Annual Review of Anthropology 47: 493–512.

Riley, E. P. and Fuentes, A. 2011. Conserving social–ecological systems in Indonesia: human–nonhuman primate interconnections in Bali and Sulawesi. American Journal of Primatology 73: 62–74.

Riley, E. P. and Priston, N. E. C. 2010. Macaques in farms and folklore: exploring the human–nonhuman primate interface in Sulawesi, Indonesia. American Journal of Primatology 72: 848–854.

Riley, E. P., Tolbert, B. and Farida, W. R. 2013. Nutritional content explains the attractiveness of cacao to crop-raiding Tonkean macaques. Current Zoology 59: 160–169.

Rode-Margono, E. J., Blockland, S., Zahra, S., Rademaker, M. and Semiadi, G. 2016. Crop-raiding and local people's attitudes toward Bawean Island, Indonesia, with a focus on the endangered Bawean warty pig (*Sus blouchi*). Asian Journal of Conservation Biology 5: 16–24.

Roonwal, M. L. and Mohnot, S. M. 1977. Primates of South Asia: Ecology, Sociobiology, and Behavior. Harvard University Press, Cambridge, 421 pp.

Sabic, K. 2011. Human-Wildlife Conflicts in the Nanda Devi Biosphere Reserve, Uttarakhand, India. Undergraduate Thesis, University of Michigan, Ann Arbor, 24 pp.

Saraswat, R., Sinha, A. and Radhakrishna, S. 2015. A god becomes a pest? Human-rhesus macaque interactions in Himachal Pradesh, northern India. European Journal of Wildlife Research 61: 435–443.

Sekhar, N. U. 1998. Crop and livestock depredation caused by wild animals in protected areas: the case of Sariska Tiger Reserve, Rajasthan, India. Environmental Conservation 25: 160–171.

Sengupta, A., McConkey, K. R. and Radhakrishna, S. 2015. Primates, provisioning, and plants: Impacts of human cultural behaviors on primate ecological functions. PLOS ONE 10: e0140961. DOI: 10.1371/journal.pone.0140961.

Sengupta, A. and Radhakrishna, S. 2013. Of concern yet? Distribution and conservation status of the bonnet macaque (*Macaca radiata*) in Goa, India. Primate Conservation 27: 109–114.

Sha, J. C. M., Gumert, M. D., Lee, B. P. H., Jones-Engel, L., Chan, S. and Fuentes, A. 2009. Macaque–human interactions and the societal perceptions of macaques in Singapore. American Journal of Primatology 71: 825–839.

Sharma, G., Ram, C., Devilal and Rajpurohit, L. S. 2011. Study of man-monkey conflict and its management in Jodhpur, Rajasthan (India). Journal of Evolutionary Biology Research 3: 1–3.

Sharma, G., Vijay, P., Devilal, Ram, C. and Rajpurohit, L. S. 2010. Study of the impact of tourists and local visitors/feeders on free-ranging Hanuman langur populations in and around Jodhpur, Rajasthan (India). Journal of Applied and Natural Science 2: 225–229.

Sharma, S. and Acharya, S. 2017. Human-rhesus macaque conflict at Pumdivumdi/Tallokodi, Pokhara, West Nepal. Bangko Janakari 27: 46–50.

Siddiqi, M. R. and Southwick, C. H. 1977. Population trends of rhesus monkeys in the Aligarh district. In (Prasad, M. R. N. and Anand-Kumar, T. C., eds.) Use of Non-Human Primates in Biomedical Research, pp. 15–23. Indian National Sciences Academy, New Delhi.

Siljander, M., Kuronen, T., Johansson, T., Munyao, M. N. and Pellilla, P. K. E. 2020. Primates on the farm – spatial patterns of human-wildlife conflict in the forest-agricultural landscape mosaic in Taita Hills, Kenya. Applied Geography 117: 102185. DOI: 10.1016/j.apgeog.2020.102185.

Singh, H. 2019. A study on man-monkey conflicts in Bir Bara Ban Conservation Reserve Forest in District Jind, Haryana (India). Researcher 11: 73–77.

Singh, M., Kumara, H. N. and Velankar, A. D. 2016. Population Status of Rhesus Macaque (*Macaca mulatta*) in Himachal Pradesh, India. Technical Report: PR-150. Sálim Ali Centre for Ornithology and Natural History, Tamil Nadu, 28 pp.

Singh, V. and Thakur, M. L. 2012. Rhesus macaque and associated problems in Himachal Pradesh, India. Taprobanica 4: 112–116.

Singh, V. and Thakur, M. L. 2017. *Semnopithecus ajax* Pocock, 1928, a critically endangered species struggling for space and survival in nature. Journal of Wildlife Research 5: 32–40.

Southwick, C. H., Malik, I. and Siddiqi, M. F. 2005. Rhesus commensalism in India: problems and prospects. In (Paterson, J. D. and Wallis, J., eds.) Commensalism and Conflict: The Human-Primate Interface, pp. 241–257. American Society of Primatologists, Norman.

Spagnoletti, N., Cardoso, T. C. M., Fragaszy, D. and Izar, P. 2017. Coexistence between humans and capuchins (*Sapajus libidinosus*): comparing observational data with farmers' perceptions of crop losses. International Journal of Primatology 38:243–262.

Sprague, D. S. 2002. Monkeys in the backyard: encroaching wildlife and rural communities in Japan. In (Fuentes, A. and Wolfe, L., eds.) Primates Face to Face: The Conservation Implications of Human-Nonhuman Primate Interconnections, pp. 254–272. Cambridge University Press, Cambridge.

Sprague, D. S. and Iwasaki, N. 2006. Coexistence and exclusion between humans and monkeys in Japan: Is it either really possible? Ecological and Environmental Anthropology 2: 30–43.

Sprague, D. S., Kabaya, H. and Hagihara K. 2004. Field testing a global positioning system (GPS) collar on a Japanese monkey: Reliability of automatic GPS positioning in a Japanese forest. Primates 45: 151–154.

Stephens, D. W. and Krebs, J. R. 1986. Foraging Theory. Princeton University Press, Princeton. 247 pp.

Strum, S. C. 2010. Development of primate raiding: implications for management and conservation. International Journal of Primatology 31: 133–156.

Supriatna, J., Froehlich, J. W., Erwin, J. M. and Southwick, C. H. 1992. Population, habitat, and conservation status of *Macaca maurus*, *Macaca tonkeana*, and their putative hybrids. Tropical Biodiversity 1: 31–48.

Suzuki, K. and Muroyama, Y. 2010. Resolution of human-macaque conflicts: changing from top-down to community-based damage management. In (Nakagawa, N., Nakamichi, M. and Sugiura, H., eds.) Japanese Macaques, pp. 359–373. Springer, Tokyo.

Taylor, R. A., Ryan, S. J., Brashares, J. S. and Johnson, L. R. 2016. Hunting, food subsidies, and mesopredator release: the dynamics of crop-raiding baboons in a managed landscape. Ecology 97: 951–960.

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

Tsuji, Y. and Su, H. H. 2018. Macaques as seed dispersal agents in Asian forests: a review. International Journal of Primatology 39: 356–376.

Tsuji, Y., Takiguchi, M., Ashida, E., Oi, T., Uno, T., Otani, Y., Enari, H., Ebihara, H., Koganezawa, M., Suzuki, S., et al. 2018. Crop species damaged by wild Japanese macaques. Primate Research 34: 153–159.

Uddin, M. M. and Ahsan, M. F. 2018. Do rhesus monkeys (*Macaca mulatta*) damage the unpalatable crops during conflict with humans? A case study from the Rampur village of Narsingdi District in Bangladesh. Journal of Wildlife and Biodiversity 2: 1–5.

Uddin, M. M., Ahsan, M. F. and Lingfeng, H. 2020. Human-primates conflict in Bangladesh: a review. Journal of Animal and Plant Sciences 30: 1–8.

Ueda, Y., Kiyono, M., Nagano, T., Mochizuki, S. and Murakami T. 2018. Damage control strategies affecting crop-raiding Japanese macaque behaviors in a farming community. Human Ecology 46: 259–268.

Wada, K. 1984a. Rhesus monkey distribution in the lower Himalayas and secondary forest succession. Journal of Bombay Natural History Society 81: 355–362.

Wada, K. 1984b. Ecological adaptation in rhesus monkeys at the Kumaon Himalaya. Journal of Bombay Natural History Society 80: 469–498.

Wallace, G. E. and Hill, C. M. 2012. Crop damage by primates: quantifying the key parameters of crop-raiding events. PLOS ONE 7: e46636. DOI: 10.1371/journal.pone.0046636.

Wang, S. W., Curtis, P. D. and Lassoie, J. P. 2006. Farmer perceptions of wildlife crop damage in Jigme Singye Wangchuck National Park, Bhutan. Wildlife Society Bulletin 34: 359–365.

Watanabe, K. and Muroyama, Y. 2005. Recent expansion of the range of Japanese macaques and associated management problems. In (Paterson, J. D. and Wallis, J., eds.) Commensalism and Conflict: The Human-Primate Interface, pp. 313–331. American Society of Primatologists, Norman.

Wheatley, B. P. 1980. Feeding and ranging of the East Bornean *Macaca fascicularis*. In (Lindburg, D. G., ed.) The Macaques: Studies in Ecology, Behavior and Evolution, pp. 215–246. van Nostrand Reinhold, New York.

Yamada, A. and Muroyama, Y. 2010. Effects of vegetation type on habitat use by crop-raiding Japanese macaques during a food-scarce season. Primates 51: 159–166.

Yeo, J. H. and Neo, H. 2010. Monkey business: Human–animal conflicts in urban Singapore. Social & Cultural Geography 11: 681–699.

Zak, A. A. 2016. Mischevious Monkeys: Ecological and Ethnographic Components of Crop-Raiding by Moor Macaques (*Macaca maura*) in South Sulawesi, Indonesia. Master's Thesis, San Diego State University, San Diego, 91 pp.

Zak, A. A. and Riley, E. P. 2017. Comparison of the use of camera traps and farmer reports to study the crop feeding behavior of moor macaques (*Macaca maura*). International Journal of Primatology 38: 224–242.

Received 15 June 2020. Accepted 21 December 2020.
Published online 6 April 2021.
Editor was Hayato Iijima.

Appendix 1.

A list of previous reports on the crop feeding by non-human primates in Asian region

#	Country/ region	Primate species performing crop feeding	a) List up of crops damaged			b) Group composition, home range, and activity of the crop-feeders		c) Evaluation of crop quality	d) Relationship between crop damage and environment	e) Type of countermeasure	f) Relative importance of the primates as crop-feeders	g) Human dimension		h) experiments and models		Type of article[a]	Reference
			Interview (N)	Damaged crops	Evaluation of damage	Population parameters	Activity of the monkeys					Perception/ opinion of local people toward primates	Effects of human characteristics: Age-sex/ Religion/City	Experiments	Model		
1	All Asia	Macaques			*					*		*	*			B	Lee and Priston (2005)
2	All Asia	Macaques														B	Priston and McLennan (2013)
3	All Asia	Multiple species														I	Richard et al. (1989)
4	Bangladesh	*M. mulatta*	* (40)	*												O	Ahsan and Uddin (2014)
5	Bangladesh	*M. mulatta*	* (No data)	*	*						*					O	Aziz and Feeroz (2007)
6	Bangladesh	*M. mulatta*		*		*	*									I	Jaman and Huffman (2013)
7	Bangladesh	*S. entellus*	* (410)							*		*	*			O	Khatun et al. (2012)
8	Bangladesh	*S. entellus*	* (410)									*	*			O	Khatun et al. (2013)
9	Bangladesh	*M. mulatta*	* (70)	*	*											O	Miah et al. (2001)
10	Bangladesh	*M. mulatta*, *Trachypithecus pileatus*		*												O	Naher et al. (2017)
11	Bangladesh	*S. entellus*					*									O	Rahman et al. (2015)
12	Bangladesh	*M. mulatta*, *S. entellus*, *T. pileatus*	* (40)	*												O	Uddin and Ahsan (2018)
13	Bangladesh	*M. mulatta*, *S. entellus*, *T. pileatus*														O	Uddin et al. (2020)
14	Buhtan	*M. mulatta*, *Semnopithecus* sp.	* (274)	*					*	*						O	Wang et al. (2006)
15	China	*M. mulatta*		*					*		*				*	I	Huang et al. (2018)
16	China	*M. mulatta*		*												I	Poirier and Hu (1983)
17	India	*M. mulatta*, *M. radiata*	* (976)									*	*			I	Anand et al. (2018)
18	India	Multiple species (mainly *M. mulatta)*									*					O	Anand and Radhakrishna (2017)
19	India	*M. radiata*		*		*				*						B	Chakravarthy and Thyagaraj (2005)
20	India	*M. mulatta*, *S. entellus*														O	Chaturvedi and Mishra (2014)
21	India	*M. mulatta*	* (400)													O	Chauhan and Pirta (2010)
22	India	*S. entellus*	* (no data)	*	*	*				*						O	Chhangani and Mohnot (2004)
23	India	*S. entellus*		*		*										O	Chhangani and Mohnot (2006)
24	India	*M. nemestrina*		*												O	Choudhury (2003)
25	India	*M. mulatta*	* (no data)			*										O	Das and Mandal (2015)
26	India	Multiple species (mainly *M. mulatta)*	* (120)	*												O	Devi and Radhakrishna (2013)
27	India	*M. mulatta*	* (608)			*				*		*	*			O	Ganguly and Chauhan (2019)
28	India	Multiple species (mainly *M. mulatta)*	* (no data)	*						*						O	Hanse et al. (2015)
29	India	*M. mulatta*	* (300)										*			O	Imam and Ahmad (2013)
30	India	*M. radiata*		*	*					*	*					O	Jayson (1999)
31	India	*M. radiata*, *S. entellus*	* (47)	*	*					*	*	*				O	Kumara and Diandra (2018)
32	India	*M. mulatta*		*												B	Lindburg (1977)
33	India	*M. mulatta*, *M. assamensis*, *M. radiata*, *S. entellus*								*						O	Mariadoss et al. (2019)
34	India	*M. arctoides*		*												O	McCann (1933)
35	India	*Semnopithecus schistaceus*	* (215)						*				*			I	Nautiyal et al. (2020)
36	India	*M. mulatta*, *S. entellus*	* (218)	*		*				*		*				I	Pirta et al. (1997)
37	India	*Multiple species*			*											O	Radhakrishna and Sinha (2010)
38	India	*S. entellus*			*						*					I	Rao et al. (2002)
39	India	*M. mulatta*														B	Rattan (2011)
40	India	*M. radiata*														B	Roonwal and Mohnot (1977)
41	India	*M. mulatta*, *S. emtellus*	* (380)								*	*				T	Sabic (2011)
42	India	*M. mulatta*	* (54)		*					*	*	*				I	Saraswat et al. (2015)
43	India	*M. mulatta*, *S. entellus*	* (180)		*					*						I	Sekhar (1998)
44	India	*M. radiata*, *Semnopithecus hypoleucos*	* (50)			*					*					O	Sengupta and Radhakrishna (2013)
45	India	*M. mulatta*				*										O	Sharma et al. (2011)
46	India	*S. entellus*	* (100)	*								*				O	Sharma et al. (2010)

Appendix 1. (continued)

#	Country/ region	Primate species performing crop feeding	a) List up of crops damaged			b) Group composition, home range, and activity of the crop-feeders		c) Evaluation of crop quality	d) Relationship between crop damage and environment	e) Type of countermeasure	f) Relative importance of the primates as crop-feeders	g) Human dimension		h) experiments and models		Type of article[a]	Reference
			Interview (N)	Damaged crops	Evaluation of damage	Population parameters	Activity of the monkeys					Perception/ opinion of local people toward primates	Effects of human characteristics: Age-sex/ Religion/City	Experiments	Model		
47	India	*M. mulatta*														O	Singh (2019)
48	India	*M. mulatta*		*		*										O	Singh et al. (2016)
49	India	*M. mulatta*, *S. entellus*	* (3243)													O	Singh and Thakur (2012)
50	India	*S. ajax*														O	Singh and Thakur (2017)
51	India	*M. mulatta*														B	Southwick et al. (2005)
52	India	*M. mulatta*		*												O	Wada (1984a)
53	India	*M. mulatta*		*												O	Wada (1984b)
54	Indonesia	*P. abelii*	* (822)								*	*		*		I	Campbell-Smith et al. (2010)
55	Indonesia	*M. fascicularis*, *M. nemestrina*		*		*										B	Crockett and Wilson (1980)
56	Indonesia	*P. pygmaeus*, *P. abelii*		*												I	Di Bitetti (2019)
57	Indonesia	*M. fascicularis*		*												B	Fittinghoff and Lindburg (1980)
58	Indonesia	*M. ochreata*		*				*	*				*			T	Frondelius (2010)
59	Indonesia	*M. fascicularis*				*										O	Hadi et al. (2012)
60	Indonesia	*M. ochreata*	* (no data)			*				*						I	Hardwick et al. (2017)
61	Indonesia	*M. nemestrina*	* (50)	*	*						*					I	Linkie et al. (2007)
62	Indonesia	*M. fascicularis*	* (153)										*			O	Loudon et al. (2006)
63	Indonesia	*M. fascicularis*, *Presbytis. thomasii*, *Pongo abelii*	* (98)	*						*	*					O	Marchal and Hill (2009)
64	Indonesia	*P. pygmaeus*	* (6983)													I	Meijaard et al. (2011)
65	Indonesia	Multiple species										*	*			B	Peterson and Riley (2013)
66	Indonesia	*M. ochreata*	* (155)	*	*	*	*		*	*	*	*	*			T	Priston (2005)
67	Indonesia	*M. ochreata*			*									*		I	Priston (2009)
68	Indonesia	*M. ochreata*													*	I	Priston and Underdown (2009)
69	Indonesia	*M. ochreata*		*			*									I	Priston et al. (2012)
70	Indonesia	*M. tonkeana*			*						*					I	Riley (2007)
71	Indonesia	*M. tonkeana*														I	Riley (2008)
72	Indonesia	*M. tonkeana*											*			I	Riley (2010)
73	Indonesia	*M. tonkeana*, *M. fascicularis*		*	*							*	*			I	Riley and Fuentes (2011)
74	Indonesia	*M. tonkeana*										*				I	Riley and Priston (2010)
75	Indonesia	*M. tonkeana*		*				*								I	Riley et al. (2013)
76	Indonesia	*M. fascicularis*		*						*	*	*				O	Rode-Margono et al. (2016)
77	Indonesia	*M. tonkeana*, *M. maura*		*												O	Supriatna et al. (1992)
78	Indonesia	*M. fascicularis*		*												B	Wheatley (1980)
79	Indonesia	*M. maura*	* (no data)						*		*	*	*			T	Zak (2016)
80	Indonesia	*M. maura*	* (no data)													I	Zak and Riley (2017)
81	Japan	*M. fuscata*			*				*	*		*	*			I	Enari (2021)
82	Japan	*M. fuscata*													*	I	Enari and Suzuki (2010)
83	Japan	*M. fuscata*		*												B	Hill (1974)
84	Japan	*M. fuscata*							*		*				*	I	Honda (2009)
85	Japan	*M. fuscata*								*	*			*		I	Honda et al. (2011)
86	Japan	*M. fuscata*								*	*			*		I	Honda et al. (2009)
87	Japan	*M. fuscata*												*	*	I	Honda et al. (2019)
88	Japan	*M. fuscata*				*										I	Izumiyama et al. (2003)
89	Japan	*M. fuscata*			*								*			I	Knight (1999)
90	Japan	*M. fuscata*							*						*	I	Mochizuki and Murakami (2011)
91	Japan	*M. fuscata*							*						*	I	Mochizuki and Murakami (2013)
92	Japan	*M. fuscata*				*			*			*	*			B	Muroyama and Yamada (2010)
93	Japan	*M. fuscata*														B	Sprague (2002)
94	Japan	*M. fuscata*			*											O	Sprague and Iwasaki (2006)

Appendix 1. (continued)

#	Country/ region	Primate species performing crop feeding	a) List up of crops damaged			b) Group composition, home range, and activity of the crop-feeders		c) Evaluation of crop quality	d) Relationship between crop damage and environment	e) Type of countermeasure	f) Relative importance of the primates as crop-feeders	g) Human dimension		h) experiments and models		Type of article[a]	Reference
			Interview (N)	Damaged crops	Evaluation of damage	Population parameters	Activity of the monkeys					Perception/ opinion of local people toward primates	Effects of human characteristics: Age-sex/ Religion/City	Experiments	Model		
95	Japan	*M. fuscata*														I	Sprague et al. (2004)
96	Japan	*M. fuscata*	∗ (182)		∗					∗		∗	∗			B	Suzuki and Muroyama (2010)
97	Japan	*M. fuscata*								∗			∗			I	Ueda et al. (2018)
98	Japan	*M. fuscata*														B	Watanabe and Muroyama (2005)
99	Japan	*M. fuscata*		∗		∗			∗							I	Yamada and Muroyama (2010)
100	Malaysia	*M. fascicularis*	∗ (46)			∗				∗		∗	∗			O	Hambali et al. (2012)
101	Nepal	*M. mulatta*, *S. entellus*	∗ (100)		∗				∗		∗					O	Adhikari et al. (2018a)
102	Nepal	*M. assamensis*	∗ (100)	∗		∗	∗									O	Adhikari et al. (2018b)
103	Nepal	*M. mulatta*	∗ (100)							∗						T	Air (2015)
104	Nepal	*M. mulatta*, *S. entellus*	∗ (155)	∗		∗				∗		∗				O	Aryal and Chalise (2013)
105	Nepal	Unknown	∗(202)		∗						∗					O	Awasthi and Singh (2015)
106	Nepal	*M. mulatta*, *M. assamensis*, *S. entellus*		∗	∗						∗					O	Chalise (2000)
107	Nepal	*M. assamensis*		∗		∗	∗									O	Chalise (2003)
108	Nepal	*M. mulatta*, *M. assamensis*	∗ (267)									∗				B	Chalise and Johnson (2005)
109	Nepal	*M. mulatta*		∗												O	Ghimire (2001)
110	Nepal	*M. mulatta*	∗ (> 200)	∗	∗											O	Ghimire and Chalise (2016)
111	Nepal	*M. assamensis*		∗												O	Ghimire and Chalise (2019)
112	Nepal	*M. assamensis*	∗ (39)	∗	∗											O	Ghimirey et al. (2018)
113	Nepal	Multiple species?	∗ (100)	∗	∗				∗			∗				O	Paudel and Shrestha (2018)
114	Nepal	*M. assamensis*		∗		∗	∗			∗						T	Paudel (2013)
115	Nepal	*M. assamensis*	∗ (96)	∗	∗					∗						O	Paudel (2016)
116	Nepal	*M. assamensis*	∗ (120)	∗		∗		∗	∗	∗						O	Regmi et al. (2013)
117	Nepal	*M. assamensis*	∗ (375)	∗		∗	∗			∗		∗				T	Rijal (2015)
118	Nepal	*M. mulatta*	∗ (60)	∗	∗					∗						O	Sharma and Acharya (2017)
119	Pakistan	*M. mulatta*		∗												B	Siddiqi and Southwick (1977)
120	Philippines	*M. fascicularis*	∗ (303)	∗						∗						O	Gamalo et al. (2019)
121	Sri Lanka	*M. sinica*, *S. priam thersites*, *T. vetulus*									∗					O	Cabral et al. (2018)
122	Sri Lanka	*S. vetulus*	∗ (110)									∗				O	Dela (2011)
123	Sri Lanka	Multiple species (mainly *M. sinica*, *Semnopithecus* sp.)	∗ (150)	∗		∗				∗		∗	∗			I	Dittus et al. (2019)
124	Sri Lanka	*M. sinica*								∗	∗					I	Horgan and Kudavidanage (2020)
125	Sri Lanka	*M. sinica*	∗ (307)							∗						B	Nahallage and Huffman (2012)
126	Sri Lanka	*M. sinica*, *S. priam thersites*, *T. vetulus*														O	Nahallage et al. (2008)
127	Sri Lanka	*M. sinica*, *T. velulus*	∗ (48)									∗				I	Nijman and Nekaris (2010a)
128	Sri Lanka	*M. sinica*, *T. velulus*							∗							I	Nijman and Nekaris (2010b)
129	Taiwan	*M. cyclopis*		∗												I	Poirier (1986)
130	Thailand	*M. arctoides*		∗												B	Bertrand (1969)
131	Thailand	*M. assamensis*		∗												O	Eudey (1987)
132	Thailand	*M. assamensis*		∗												O	Fooden (1971)
133	Thailand	*M. assamensis*		∗												O	Fooden (1982)
134	Thailand	*M. fascicularis*	∗ (1417)													O	Malaivijitnond and Hamada (2008)

[a] B: book and book chapter, I: international journal, O: other journals including reports, T: theses