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Assessing Public Perceptions and Solutions to Human-Monkey Conflict from 50 Years in Sri Lanka

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Keywords

Primate conservation · Human-monkey conflict · Ethnoprimatology · Long-term field study · Polonnaruwa

Abstract

Sri Lanka is a biodiversity hotspot with high human density that contributes to increasing human-monkey conflict (HMC). In 50 years of primate studies there, the development of HMC has been documented, and many workshops and interventions organized to ameliorate HMC. These activities prompted the present survey. In the extensive lowland dry zone of Sri Lanka, the affected nonhuman primates are the toque macaque, gray and purple-faced langurs and slender loris. We surveyed and evaluated the attitudes of rural residents towards these four species in an effort to contribute to an ethnoprimatological approach to conservation, i.e., promote a coexistence and sharing of habitat between humans and monkeys. We selected 13 villages near Polonnaruwa, located centrally in the dry zone. The four nonhuman primate species differ in their behavioral ecologies, and this influenced how frequently they were thought of as pests. Most HMC was with the macaque and gray langur, less with the purple-faced langur and least with the loris. The underlying sentiment among stakeholders towards monkeys was generally either neutral or positive. Nonetheless, the majority (80%) of people desired a translocation of the troublesome monkeys from their properties to protected areas, which is impractical. Few (<1%) openly wanted monkeys destroyed. While a traditional reverence for monkeys provides a solid basis for science and media-based education, it also contributes to the feeding of monkeys and consequent unnatural population growth, and enhanced HMC. Public understanding of the underlying causes of HMC was poor, hindering effective solutions. A combination of a feeding ban, possibly contraceptive intervention at localized HMC trouble spots, and extensive education may be the only benign alternatives to the destruction of wild primates by a powerful minority. Coexistence through strengthening and expansion of exclusive suitable protected habitats for all wildlife is a priority.

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Introduction

Human expansion into natural habitats worldwide has been the root of an increase in conflict between wildlife and humans. Natural food sources for wildlife are destroyed and replaced by more abundant anthropogenic ones. Wildlife that feeds on such produce is then considered as a pest. Monkeys often have been identified as pest species [Else, 1991]. The global trend towards increasing wildlife-human conflict has brought greater focus by wildlife managers and conservationists on ways to reduce it [Madden, 2004]. Of the more benign options, broadly, two approaches can be considered: either we set aside natural protected areas and reserve them for wildlife, excluding destructive human activity, or we learn to tolerate and share habitat with wildlife. Not all wildlife species lend themselves to sympatry with humans. Most nonhuman primates, however, stand apart from other wildlife species insofar as they share a closer evolutionary history with humans than other faunal groups. In South Asia as well, monkeys have a strong positive cultural and religious significance [Nahallage and Huffman, 2013]. Consideration of cultural differences in developing conservation strategies [Ferraro and Kiss, 2002; Fuentes and Wolfe, 2002; Hill, 2002; Fuentes et al., 2005; Lee and Priston, 2005; Jones-Engel et al., 2011] has given rise to the idea of ethnoprimatology, which is built on the premise that humans have perspectives on nonhuman primates that can contribute positively to their enduring survival [Lee, 2010].

On the Indian subcontinent, the primate species most often cited as pests are the rhesus macaque (*Macaca mulatta*) of northern India and Nepal [e.g., Srivastava and Begum, 2005; Regmi et al., 2013; Chaturvedi and Mishra, 2014; Reddy and Chander, 2016] and the bonnet macaque (*M. radiata*) of southern India [Chakravarthy and Thyagaraj, 2005]. The Hanuman or gray langurs (*Semnopithecus* spp.) have also acquired pest status in some regions of the subcontinent [Chauhan and Pirta, 2010; Habiba et al., 2013].

In Sri Lanka, the cited pests are most often the toque macaque (*M. sinica*) [Nahallage et al. 2008], followed by the purple-faced langur (*Semnopithecus vetulus*) [Dela, 2007; Rudran, 2007; Nekaris et al., 2013] and the gray langur (*S. priam*) [Cabral et al., 2018]. The geographical ranges of these primates fall into the Western Ghats and Sri Lanka biodiversity hotspot [Myers et al., 2000], which, of the 25 such hotspots recognized globally, has one of the highest human population densities in Asia. Hence, the potential for human-wildlife conflict in this region is particularly acute and on the rise [Cincotta et al., 2002]. In Sri Lanka, the biodiversity at risk includes several endemic plant and animal species and many primates [MOE, 2012; Dittus, 2013a, 2017].

The aims of this research were to (1) document stakeholders' perception of their relationship with nonhuman primates in rural villages where the two groups already share habitat, and (2) review a case study of the biological dynamics underlying the development of human-monkey conflict (HMC), and (3) evaluate survey responses in light of a broader experiential perspective (based on 50 years of primate studies in Sri Lanka and participation in numerous workshops with public institutions to ameliorate HMC). Press reports reflect the pulse of public attitudes towards HMC and biodiversity conservation. The survey area selected was located in the center of the extensive lowland dry zone (Fig. 1), which makes up more than 70% of the island's landscape and is home to the four primate species cited above. It was intended that

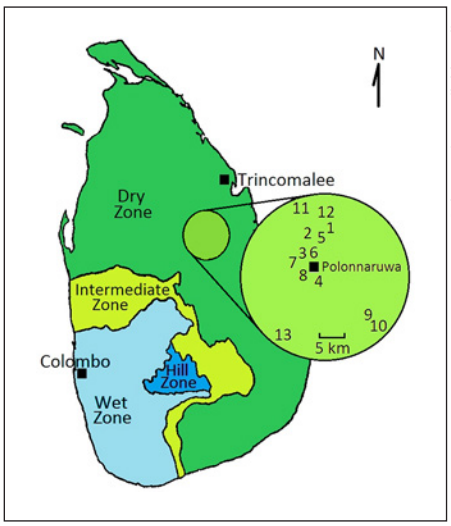

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Fig. 1. Map of surveyed village areas in the dry zone of Sri Lanka within 50 km of Polonnaruwa; Monarathenna (1), Ethumalpitiya-East (2), Ethumalpitiya-West (3), Pothgul Pedesa (4), Sri Nissankamallapura (5), Kuruppu Junction (6), Bandiwewa (7), Pulathisi Pedesa (8), Nelumwewa (9), Aluthwewa (10), Hingurakgoda (11) and Senanayakapura (12) in the Polonnaruwa District and Dambulla (13) in the Matale District.

these diverse observations taken together [e.g., Masood, 2018] might help to chart a way forward in conserving the primates in this much threatened global biodiversity hotspot.

Methods

Characteristics of the Surveyed Area and Its Residents

The survey involved 150 adult respondents from 13 different village areas; there were 1–33 respondents per village. The villages included were Monarathenna, Ethumalpitiya-East, Ethumalpitiya-West, Pothgul Pedesa, Sri Nissankamallapura, Kuruppu Junction, Bandiwewa, Pulathisi Pedesa, Nelumwewa, Aluthwewa, Hingurakgoda and Senanayakapura in the Polonnaruwa District and Dambulla in the Matale District (Fig. 1). These villages were rural, most within a radius of 50 km of the Polonnaruwa Nature Sanctuary and Archaeological Reserve where primate studies have been ongoing since 1962 [e.g., Ripley, 1965; Dittus, 2017].

The survey area was broadly characterized as rural-urban, with tracts of intermingled secondary or primary dry-evergreen forest. These attributes were thought relevant to the study as it was assumed that forest proximity may influence the frequency and degree of monkey visitation, depending on the quality of remaining habitat. Less than half (44%) of respondents had lived from 20 to 50 years in their residence and occupied permanent structures; the remaining "newcomers" had lived from 5 to 20 years on their land, often in makeshift houses. The majority of respondents used at least part of their land for subsistence farming (approx. 36%), usually coupled with coconut (approx. 24%) and vegetable cultivation (approx. 18%), and followed by fruit (approx. 10%) and rice paddies (approx. 7%).

The Survey

The survey was administered by five field staff fluent in the Sinhala language, in the course of about a week, in March 2010. The questionnaire included 22 questions on such topics as: the type, use and extent of land ownership; the type of species having impact on the property; and general opinions on monkeys, as well as experiences with the frequency and purpose of primate visits. Questions also touched on the type of damage caused to property by monkeys, as well as suggestions on approaches to minimizing such damage. The survey results were tabulated and

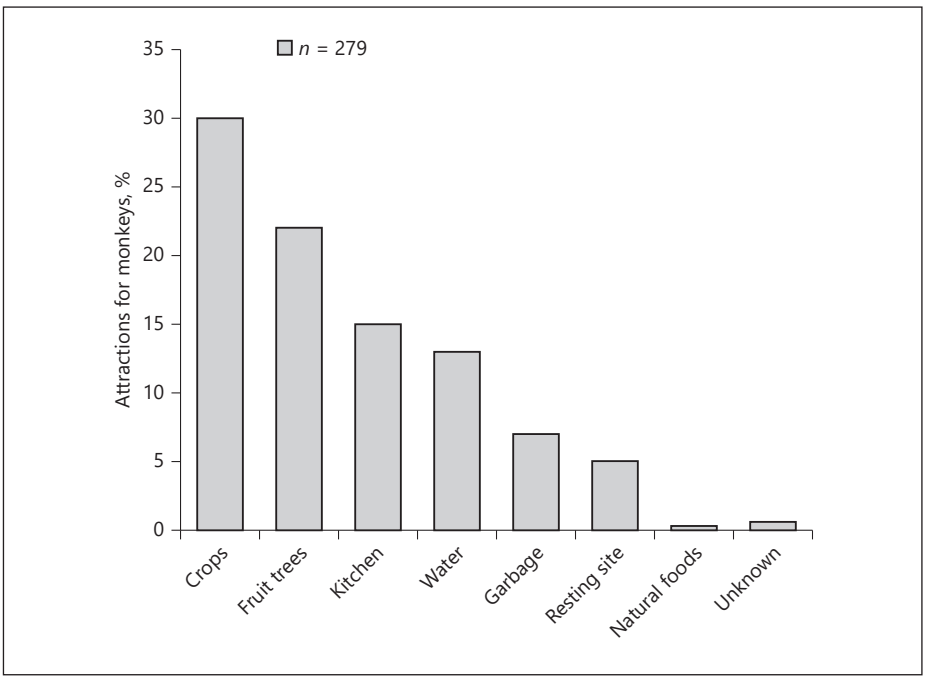

Fig. 2. The relative frequencies that different resources were reported as important in attracting monkeys (mostly macaques and langurs) to survey respondents' properties.

subsequently analyzed using Excel 2010. Graph plots were made using SigmaPlot© v.12.5 software (Systat Software Inc., Chicago, IL, USA). Results were compiled by summarizing the total number of responses for each answer option and expressing this value as a percent of the total number of responses for that question. When more than one option was selected (i.e., the respondent selected two or more responses to a question), these were tabulated as discrete entries (i.e., if a respondent selected both option 1 and 5, this would be counted as two entries, one in each category of 1 and 5). In these cases, the percentage was expressed as a percent of the total responses (as opposed to percent of total respondents).

Workshops and Activities to Reduce HMC

In the period 1998–2018, two of the authors (W.D. and S.G.) participated in many workshops to find solutions to reduce HMC and, to this end, had also planned and implemented a 3-year project to address HMC [Diaz, 2000]. The workshops included the following agencies in Sri Lanka: the Army (2007), Postgraduate Institute of Agriculture (2010), Ministry of Economic Development and World Bank (2010), Ministry of Coconut Development and State Plantations (2011), Ministry of Public Administration and Home Affairs (2011 and 2017), Wildlife and Nature Protection Society (2012), Ministry of Wildlife Resource Conservation (2014), National Science Foundation (2014) and the Veterinary Association (2015). A number of schools, hotels and hospitals were similarly engaged in almost every year during the period (1992–2018). The "Clean Reserve Project" (1998–2001) was executed to remove (and recycle) refuse and prevent littering by visitors to the Polonnaruwa Nature Sanctuary and Archaeological Reserve, with sponsorship from the Ministry of Religious and Cultural Affairs [Diaz, 2000]. Although the lessons from these efforts were not quantified, they provide, together with the primate studies themselves (1968–2018), an important perspective for evaluating the responses of the stakeholders in the survey.

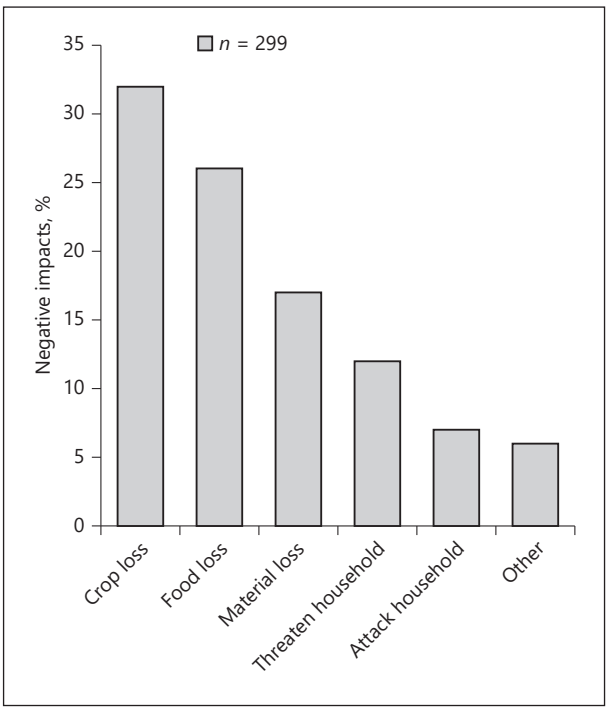

Fig. 3. The relative frequencies that respondents reported different negative impacts on their properties by visiting monkeys.

Population Ecology

The demographic trajectories of the original 18 groups of macaques studied in 1968–1975 at Polonnaruwa [Dittus, 1975] were monitored continuously over five decades in relation to their feeding ecology and habitat use according to methods described in Dittus [1977a] and Dittus and Baker-Dittus [1985]. Diets were distinguished in terms of the duration of time foraging on different food items. The histories of the macaque or langur populations at the other survey sites were not quantified.

Results

Conflict Species and Their Perceived Impact on Humans

Respondents identified five forest-living species that most frequently visited their properties; among these sightings (n = 235) the toque macaque (49%) and gray langur (29%) were the most frequently seen, followed by the purple-faced langur (9%), slender loris (5%), giant squirrel (*Ratufa macroura*) (3%) and others (4%). In responding to other questions, people did not always distinguish between macaques and gray langurs; thus, in our reporting the term "monkeys" refers primarily to the macaques.

When asked what might have attracted wild animals to visit their properties (mostly macaques and gray langurs), more than 85% of respondents listed human-sourced foods (crops, fruit trees, cooked and uncooked kitchen food stores, scraps intended for dogs or cats, edible garbage) and water from open drains, leaky taps or wells. Some macaques were adept at opening taps. Monkeys also used resting sites

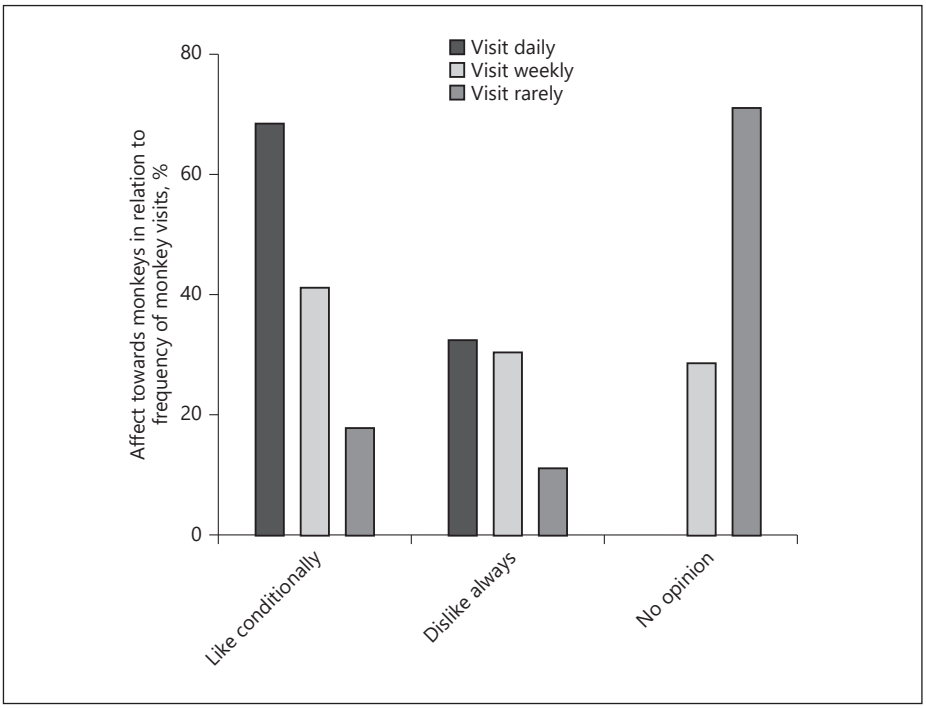

Fig. 4. The relative frequencies that respondents expressed a liking of monkeys, a disliking of them or had no opinion, in relation to how frequently monkeys had visited their properties.

(rooftops, fences, trees) on their properties. Natural food sources, such as fig trees (*Ficus* spp.) were rare on human properties, and the monkeys visited these food sources only if they were bearing young leaves or fruit (Fig. 2).

With regard to negative impacts, about half of the reports indicated loss of crops or kitchen foods, followed by material loss such as roof tiles and clothes hung out for drying. Roof tiles or sheets were damaged mostly when the large-bodied (10–15 kg) gray langurs leaped onto roofs from the branches of high trees during travel or when macaques removed tiles when foraging for insects. Purple-faced langurs were generally not involved. Monkeys, especially macaques, were perceived as threatening and even chasing, hitting or biting (rarely) the domestic-dog or human residents (Fig. 3).

Peoples Affect towards Monkeys

Very few people found monkeys to be desirable as pets (<3%), but nearly 50% expressed a liking for them, their playfulness and ingenuity, but wished them not to visit their properties and cause loss or damage. About 20% of people expressed an outright dislike of monkeys. Peoples' attitude towards monkeys was influenced by how frequently the animals visited their properties. Those who had no strong opinion about monkeys were also the least frequently visited by them (Fig. 4). Households that were visited on a daily basis also had the highest proportion of individuals who expressed a liking for monkeys (Fig. 4).

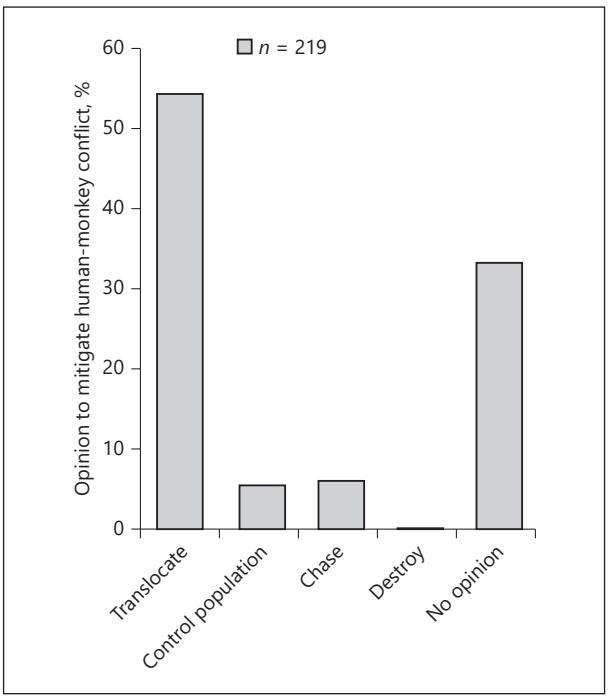

Fig. 5. The relative frequencies that respondents had expressed an opinion on how best to mitigate conflict between humans and monkeys.

Defense against Monkeys

People (231 responses) defended themselves against monkeys in a variety – and through a combination – of actions. The method used most often involved throwing stones or using a catapult (30%), shouting or throwing a firecracker (54%), or encouraging their dogs to chase monkeys (9%). Only about 1% did nothing or tolerated the monkeys. The majority of defensive actions against monkeys was undertaken by men (50%), less frequently by women (23%) or children (20%). Only about one third of respondents had complained to the government authorities with regard to HMC.

Mitigating Conflict

Of the 146 persons who expressed an opinion about how best to mitigate conflict with monkeys (Fig. 5), more than 80% wanted to translocate monkeys away from their properties and into protected natural areas, such as national wildlife parks. Less than 1 in 10 people suggested some form of population control such as reducing monkey numbers through sterilization or the installation of repellents to prevent monkeys' access to their properties. Rarely (<1%) did respondents want monkeys destroyed.

Human Influence on Macaque Population Ecology and HMC

At Polonnaruwa, the original population of approximately 550 macaques, distributed among 18 different groups [Dittus, 1975], has grown over the five decades, having undergone several group fissions [Dittus, 1988] as well as a fusion and group extinctions [Dittus, 1986]. With the expansion of tourism and human encroachment into macaque habitat at the Polonnaruwa site, some groups have had progressively

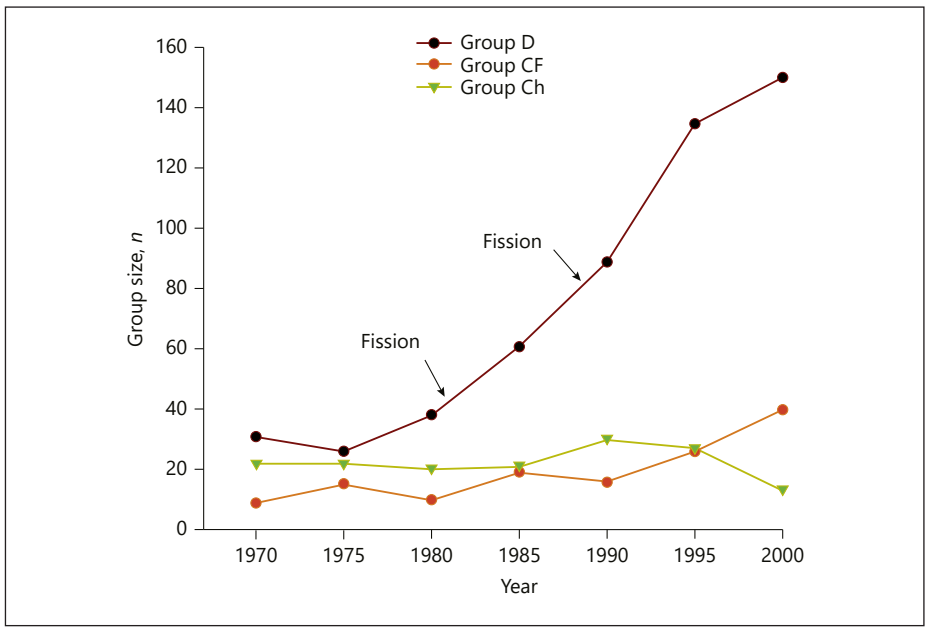

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Fig. 6. Differences in the numerical size of three groups of toque macaques at Polonnaruwa whose home ranges overlapped but diets differed: group D (diet >30% refuse), group CF (diet <5% refuse) and group Ch (diet >98% natural) over a period of 30 years. Adapted after Dittus [2012].

greater access to human food resources, whereas others have retained a natural diet and lean body composition [Dittus, 2013b]. By way of illustrating the effects of this variation in the macaques' diet on population growth, we compared the growth trajectories of three neighboring groups (D, CF and Ch) whose home ranges overlapped, but with only group D having regular access to anthropogenic foods. Over three decades the size of group D grew in numbers at a 12% mean annual rate and involved several group fissions, whereas the size of neighboring group CF (with <5% access to human food sources) grew only slightly since 1980. The size of group Ch (with <2% access) remained unchanged (Fig. 6).

The growth of group D is particularly instructive: not only did its numbers grow leading to 7 group divisions over a 50-year period, but the land area used by this growing subpopulation (all the D subgroups) expanded progressively with a 49% gain in area, mainly by dispersal into human-dominated landscape (32% of area gain), although some (17%) of its newly acquired range was taken over from the natural forest occupied by neighboring groups (Fig. 7).

Discussion

HMC and Monkey Population Dynamics in Relation to Resource Availability

In undisturbed natural forest environments, the availability of natural diet foods for primates, though variable with seasons and years, is ultimately limited. An

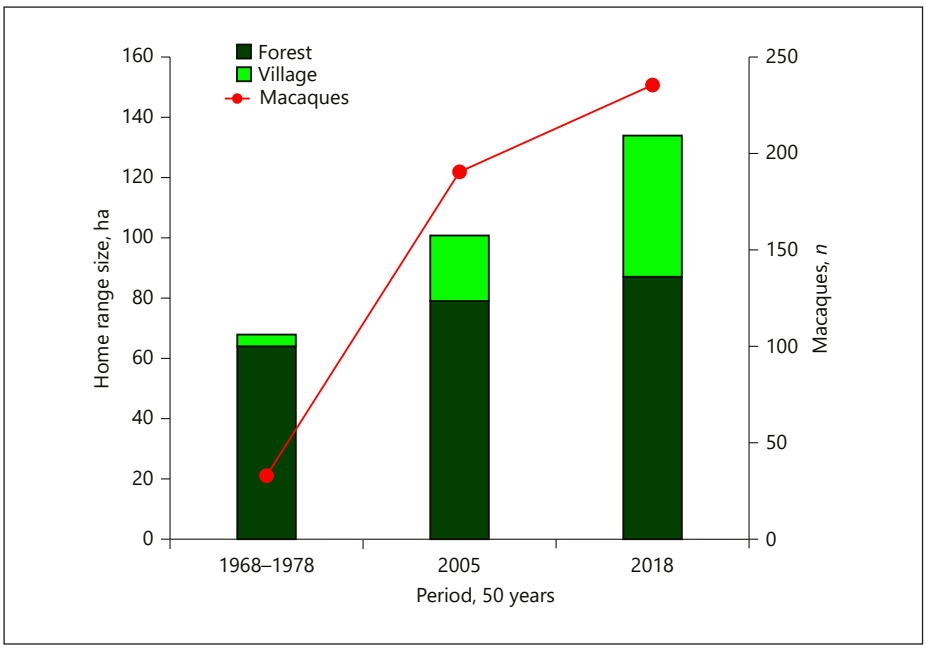

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Fig. 7. The relation between the growth of macaque numbers in the group D set of groups and the size of their expanding cumulative home range, comprising natural forest habitat and village or town areas, over a period of 50 years. The ancestral group D (1968–1980) was one cohesive group with less than 6% of its range into village areas. It fissioned several times; by 2005 there were 4 daughter groups (D1–D4) with 22% of their cumulative range in village areas; by 2018 there were 7 daughter groups (D1–D7) using 35% village areas.

individual monkey's access to food and water sets the limits to its physical growth, fat (energy) reserves and chances of reproduction and survival. Predation and disease normally have a secondary effect on mortality. Survival rates under natural conditions are low and determined primarily by an interplay between environmental resource availability and social behaviors that influence the degree to which different individuals benefit from limited vital resources, i.e., survive and reproduce [Dittus, 2004, 2013b]. The net effect of this dynamic is zero growth at the level of the population, as was the case for groups CF and Ch (Fig. 6). When resource limits are removed, as occurs when monkeys have access to human food sources, monkeys mature faster, accumulate more fat reserves, and reproduce and survive at higher rates – all of which adds up to an overall increase in monkey numbers as in the case of group D (Fig. 6).

The relationship illustrated by these groups (Fig. 6) is reflected among primates generally [Dittus, 2004] and nationwide in Sri Lanka. Monkey densities in the dry zone can vary from less than 1 monkey/km^2 in arid regions of low plant productivity to over 100 monkeys/km^2 where habitats are floristically more diverse, productive and moist. Densities are far greater at sites where monkeys have access to anthropogenic food [Dittus, 2017]. Species and habitat differences in ecology are important considerations when addressing the cause of and solutions to HMC.

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Fig. 8. a Well-intentioned pilgrims feed human food to leaf-eating gray langurs and in this way create a growing population of pests that may be killed by farmers. **b** Poisoned macaques. Photo, courtesy Chameera Pathirathne.

Sri Lankan Primates as Pest Species and Local Differences

The four species of primates relevant to this study differ markedly in their natural dietary adaptations and ecologies [Petter and Hladik, 1970; Ripley, 1970; Hladik and Hladik, 1972; Dittus, 1974; Vandercone et al., 2012] which, consequently, distinguishes them in their predispositions to venture into human-occupied land. The rarely seen nocturnal, arboreal and mainly insectivorous loris cannot be considered a pest. Of the two species of leaf-eating langurs, the purple-faced langur occurs in small single-male harem groups with small defended territories. This species is highly arboreal, occupying the top layer of the forest canopy and rarely venturing to the ground [Rudran, 1973; Manley, 1984]. The gray langur occupies large ranges [Ripley, 1967], has a more catholic folivorous diet than the purple-faced langur and often forages on the ground. The gray langur is also known to raid vegetable plots [Unanthanna and Wickramasinghe, 2010]. Like the gray langur, the macaque forages in extensive home ranges (20–50 ha) in search of a great variety of foods and water and, among the four primate species, adapts most readily to human sources of foods [Dittus, 2012]. The macaque and gray langur are at ease on the ground as well as in the trees, and this flexibility gives them an edge over the more strictly arboreal purple-faced langur in adapting to human-occupied landscapes; the two species comprised 78% of sightings whereas the purple face langur comprised only 9%. Kavanagh [1980] noted similar

contrasting adaptations among some African primates. The differences in the frequencies with which these four species were reported as visitors to the surveyed respondents' properties (macaques being most frequent) are consistent with the ecological and behavioral differences among them.

In the southwestern wet zone of Sri Lanka (Fig. 1), which has the highest population density of humans, the gray langur is naturally absent, and suitable wild-primate habitats are highly fragmented and have been converted in large part for human use [Parker et al., 2008]. In these areas, the macaques (if not already locally exterminated) are also reported as pests, and the purple-faced langur is notorious for causing damage to roofs and home gardens [Dela, 2007; Rudran, 2007, Nahallage et al., 2008; Nekaris et al., 2013; Cabral et al., 2018]. In the dry zone in contrast, sparser human density and greater availability of secondary or primary forest has so far spared the purple-faced langur from extensive conflict with humans, while the macaques are still a common problem there.

Peoples' Perceptions of Monkeys and Their Role in HMC

Survey respondents reported that monkeys were attracted to human properties by sources of food and water (Fig. 2). The resting sites at such times were primarily part of a strategy to observe humans and wait for an opportune moment to forage or raid in safety. The role of kitchen food scraps (garbage) thrown into the garden or intended for domestic animals appears to be underestimated by respondents as a source for attracting macaques. Crops and fruiting trees are available only briefly and seasonally. Food scraps, on the other hand, are discarded daily. Even small amounts of food, and especially water in the dry season, are sufficient to entice the macaques to incorporate a visit to a household into their daily travel route. It is, after all, one of the few predictable constants in location, if not amount as well, in their otherwise very seasonal and scattered natural food supply [Dittus, 1974]. The respondents' perceived importance of loss of crops, kitchen supplies and fruiting trees to their livelihood (Fig. 3) seemingly placed a greater emphasis on these sources as an attractant relative to discarded valueless garbage (Fig. 2).

Differences in the losses felt by respondents to monkey raids is consistent with the value of these resources and their vulnerability to raids (Fig. 3). Cash crops are a source of revenue but spatially scattered and therefore not effectively defendable. Spatially concentrated kitchen supplies can be defended more easily against the fewer, boldest monkeys. Material damage (television antennae, vehicle mirrors, garden taps and clothes) can be substantial, but such damage is incidental to raids for food and water and therefore occurs rarely. Village dogs are often lazy, but in a pack may kill monkeys. Rural villagers generally understand their relation to monkey visitors, and although they are often threatened by monkeys (e.g., during raids for food), most threats are bluff and people heed them. If domestic dogs, or humans, attempt to attack macaques and langurs, the macaques, in particular, can respond aggressively, especially if one of their own is at risk. Such incidents occur in a different context from publicized attacks on tourists or their local agents, who often behave inappropriately in the presence of wildlife [Sharma et al., 2010; Rodrigo, 2011a]. Monkeys in Sri Lanka are not known to bite humans in the absence of strong provocation.

The respondents' low estimation (Fig. 2) of the role of garbage and the feeding of monkeys as an attractant and contributor to HMC is understandable; garbage has no value and feeding of the revered god-like monkeys (at least by some humans) is

considered a meritorious act. Among the general public, however, this sentiment contributes to the "monkey menace phenomenon" because feeding monkeys stimulates the growth of their populations in areas of sympatry. At Polonnaruwa, groups of macaques that had frequent access to human-source foods (mostly refuse) grew at a mean annual rate of 12%, nearly quadrupling their numbers over a 30-year period; this is in sharp contrast to the zero population growth rate of neighboring groups that had little or no access to human foods, their diet being natural forest foods (Fig. 6). Not only have numbers of monkeys increased in the conflict zone, but the monkeys' culture of survival has shifted to a growing dependence upon anthropogenic resources, and their home ranges have expanded primarily by dispersing out of the forest to occupy progressively more human habitation (Fig. 7).

Reducing Monkey Raids on Crops and Buffers

Loss of crops from monkey raids was a major concern to respondents (Fig. 3) and among the public generally. The key to a solution, at least partially, lies in addressing the biological dynamics involved.

Localized rapid growth of macaque populations and expanding ranges, similar to group D at Polonnaruwa (Fig. 6 and 7), has been replicated country-wide to varying degrees in areas near municipal garbage dumps, temples, tourist attractions, roadside fruit and vegetable stands, picnic sites and hotels over the last few decades, as evidenced by personal observations (W.D. and S.G.) as well as numerous news reports [Ladduwahetty, 2012; Somaratna, 2012; Warakapitiya, 2018]. Where these hotspots of growth occurred near crops, the macaques were enticed to feed on them, which in turn promoted their numbers, dispersal into human occupied lands and HMC. On ecological principles alone, it is predictable that if these artificial sites were to be eliminated, the population of crop-raiding monkeys and their prevalence on human properties, too, would be reduced substantially over time as exemplified by macaque groups CF and Ch at Polonnaruwa (Fig. 6). In a similar vein, the elimination of government incentives to grow crops near protected areas would help to reduce HMC; a commonsense approach that applies to human-wildlife conflicts anywhere [Naughton-Treves et al., 2001] including conflict with elephants in Sri Lanka [Fernando et al., 2005].

Crops can be shielded from monkeys by buffer zones [Naughton-Treves et al., 2001; Riley, 2007]. In Sri Lanka, the forest-dwelling toque macaques shun crossing open ground: this reluctance can serve in the defense of crops. To be effective, however, the buffer should be at least 100 to 200 m wide, devoid of trees, shrubs and food sources; pasture could serve this purpose. The suggestion of planting food trees for monkeys in the forests to supplement their diet and in this way prevent crop raids by "hungry" monkeys [Riley, 2007; Pirta et al., 1997] is based on a false premise. Such supplements would serve only to enhance monkey population growth and, in turn, HMC. The buffer should be "no man's land" for monkeys and crop farmers.

Human Behavior Develops New Pest Populations of Gray Langurs

To date, the gray langur has been only slowly converted to anthropogenic food sources, but feeding, especially by growing numbers of well-meaning pilgrims, has changed its ecology and diet (Fig. 8a). In parts of India, gray langurs have developed into serious aggressive pests [Chauhan, 2010; Sharma et al., 2010], a situation that, with effective management of the public, might still be averted in Sri Lanka. Humans

feeding monkeys, or monkeys' unrestricted access to anthropogenic resources, has been recognized as a major contributor to HMC at many other sites throughout Asia; the fining of monkey-feeders has met with variable success in reducing this habit [Fuentes et al., 2005; Sha et al., 2009; Jones-Engel et al., 2011; Chaturvedi et al., 2014].

Defense against Monkeys

Respondents attempted to chase monkeys from their properties in more than one manner (Fig. 5). At about the time of the survey, the Sri Lankan government had encouraged the use of air rifles to deter monkeys and other wildlife [Rodrigo, 2011b]. The resulting numbers of monkeys killed or seriously maimed is unknown. The chasing of macaques and langurs can be effective if done in a consistent and organized way [Dittus, 2012], but it is probably easier to do with toque macaques, whose adult body sizes range from 3 kg to 6 kg [Cheverud et al., 1992] than with larger-bodied primates.

Rural women tend to spend more time at home than men and therefore are likely to have more frequent encounters with monkeys. The fact that men more often than women engage in chasing monkeys runs counter to expectations based solely on who stays at home more often (numbers are lacking). It is consistent, however, with cultural attitudes: in a self-fulfilling prophesy, it is widely accepted that monkeys have a greater respect for men than women when chased; also, it is a man's role to defend the property.

Variable Affect towards Monkeys

The pet trade within Sri Lanka for monkeys is virtually absent, although private ownership, especially of young monkeys, is not uncommon. The positive relation between the frequency of visits to households and proportion of people liking monkeys is counterintuitive (Fig. 4). It would make sense, however, if people who liked monkeys also fed them their kitchen scraps. The feeding of monkeys is a popular pastime, often based on the religious belief of gaining merit in the afterlife. This deeply rooted sentiment poses a serious challenge to conservation management when trying to convince the general public that the feeding of monkeys promotes HMC (discussed above). It is, in fact, also potentially harmful (Fig. 8b) to the habituated monkeys when they encounter persons who do not like them (Fig. 4) and use food as poisoned bait [Singh et al., 2005; Unanthanna and Wickramasinghe, 2012]; monkeys' body parts are used in local folk medicine [Nahallage and Huffmann, 2013].

People who were infrequently visited by monkeys had no strong opinions about them: being deprived of frequent observations these humans possibly had not yet learned to appreciate the monkeys' better qualities or to dislike them as a nuisance (Fig. 4). Human ambiguity towards wildlife has been reported for Sri Lankan elephants, where people who experienced the risk of elephants near their homes disliked them more than urban dwellers far removed from the dangers [Bandara and Tisdell, 2003]. A similar polarity in sentiment in relation to frequency of exposure was shown towards purple-faced langurs in the densely human dominated wet zone [Parker et al., 2008]. Reports of a "love and hate" relationship to monkeys are fairly common in parts of Asia (e.g., India [Chakravarthy and Thyagaraj, 2005; Lee and Priston, 2005; Saraswat et al., 2015], Indonesia [Fuentes et al., 2005], Singapore [Sha et al., 2009]) or globally in countries that harbor these primates [Harcourt et al., 1986].

Respondents' Choices for Mitigating HMC and Practical Limitations

In order to mitigate human conflicts with monkeys, only a small minority (<1%) of respondents wanted the monkeys destroyed; however, given that openly voicing such an opinion would run counter to cultural norms, the high proportion of no opinions may not be truly neutral. An alternative choice for about 10% of respondents was to reduce the monkey population by sterilizing monkeys or simply chasing them. Most (80%) respondents preferred that monkeys be removed from their village and taken to a protected area of natural forest that was thought of as a better home for the monkeys (Fig. 5).

A desire to translocate troublesome wildlife has been expressed almost universally, spurred by misleading press reports, and has been politically promoted [Hettiarachchi, 2008; Dharmasena, 2011]. It is not generally understood at any level of society, however, that translocation invites more economic and biological ills than it solves. This applies to monkeys [Dittus, 2012] as well as elephants [Fernando et al., 2012]. Trapping and transporting animals for release away from an HMC trouble spot has been presented as successful in India [e.g., Iman et al., 2002] but lacks the empirical follow-up about the fate of the translocated monkeys and their impact on humans and indigenous wildlife in the area of offloading. Elsewhere, habituated street-wise macaques removed from towns create havoc when translocated to a rural community where generations of humans and monkeys have coexisted in a makeshift peace [Somaratna, 2012; Govindrajan, 2015]. In such instances the trouble with pest monkeys is not solved, it is merely shifted from an economically and politically strong area and imposed upon poor rural villagers [Pirta et al., 1997; Lohumi, 2004; Ramanayake, 2012] some of whom protest against the practice [Somaratna, 2012]. Furthermore, in Sri Lanka, the several sizable protected areas occur in arid regions whose carrying capacity for primates is low and cannot support the survival of translocated groups of monkeys [Dittus, 1977b, 2017]. Translocation may have limited conservation applications [Strum and Southwick, 1986] but is not a viable solution for reducing HMC, particularly in areas of high human population density, or in general with most wildlife [Craven et al., 1998].

The culling of wildlife classified as pests (wild boar, macaques), though legal and often promoted and carried out, has not yet been adopted widely as an official management strategy to reduce HMC in Sri Lanka, as it has been in some other localities including parts of India [Chakravarthy and Thyagaraj, 2005], Malaysia [Eudey, 2008], Singapore [Koenig et al., 2015] and Japan [Watanabe and Muroyama, 2005].

The Way Forward with an Ethnoprimatological Approach: The Role of Science and the Media

This survey of stakeholders' attitudes towards wild primates points to the directions for further development of conservation strategies. A common thread consistent with the survey results (Fig. 4) and among participants in HMC workshops revealed an undercurrent of positive, if not neutral, attitude towards monkeys. This prevailing sentiment offers a strong foundation for an ethnoprimatological approach to conservation objectives.

The strategy for expanding positive attitudes among the public, over and above the historically religious teachings and humans' generally benign curiosity towards monkeys, invites scientific education about the primate phenomenon and how best to safeguard it. Scientists have a positive role in this at many levels [Chapman and

Peres, 2001], but Washburn's [1973] "promise of primatology" [Higham and Dominy, 2018] must reach beyond science and academia. Documentary film producers, given scientists' support, can contribute substantially to the education of huge audiences through entertaining media. Regrettably, few such films are narrated in the language of the host country or broadcast there. By way of example, more than 30 documentary productions have been made by foreign interests about the toque macaques at Polonnaruwa [www.primates.lk]. The one that was narrated also in the Sinhala language [BBC, "The Temple Troop", Linfield, 1997] has been the most popular locally televised nature program in Sri Lanka for two decades. People can be awed and their attitudes changed towards monkeys with a relatively minor investment in media dissemination.

The Caveat for Loving Monkeys

The same precepts that revere monkeys and leads to tolerance of their potentially destructive habits also encourages people to feed them (Fig. 8a), which in turn, stimulates monkey population growth and hence increased HMC in areas of sympatry. Locally concentrated overpopulations of monkeys, as typically occur at tourist and temple sites, has led, unofficially (and surreptitiously), to their massive destruction (e.g., Fig. 8b) and/or ill-conceived translocations [Hettiarachchi, 2008; Dharmasena, 2011; Dittus, 2012].

Controlling Population Growth

A minority of respondents pointed to methods of reducing monkey populations through sterilization (Fig. 5). For small confined populations of macaques, as occur in Hong Kong, the surgical neutering of females has been successful in reducing population size but only when combined with a ban on the feeding of monkeys [Shek and Cheng, 2010]. In addition, population control of wild animals by any means necessitates the professional hand of wildlife managers balancing demographic efficacy [e.g., Hone et al., 2010; McCarthy et al., 2013] with humane treatment [Hampton et al., 2015]. On a local scale at HMC trouble spots this may be a realistic option, even in larger countries.

Coexisting with Monkeys: How Is It Possible?

Getting people to understand and appreciate monkeys is one thing; a steeper challenge is educating the public about ways to coexist with primates. The respondents in the survey reflected the perceptions of the general public. It was widely appreciated that habitat loss leads to HMC. Nonetheless, people identified the cause of HMC simply as the fault of misbehaving monkeys and advocated their removal [Sunday Times, 2010] (Fig. 5). In the absence of crops, as in larger towns, the magnet that drew monkeys to human properties and led to HMC were the ubiquitous sources of food refuse and water that were easily accessible by monkeys [Diaz, 2000; Dittus, 2012]. The public neither perceived nor willingly acknowledged this cause even when made aware of it, or felt apathetic and helpless to do anything about it because reducing monkey visitations requires coordinated action by the entire community or neighborhood, not merely an individual.

The solution to resolving HMC lies not so much in getting rid of monkeys, but in not attracting them to human habitation in the first place. This is a challenge to conservation activists because it requires a change in human habits, traditional in-

grained ways of thinking and the expenditure of public and private resources. On a local scale, in the schools and hospital at Polonnaruwa we have achieved an elimination or reduction of HMC by instituting refuse controls and a feeding ban.

Traditional village life in Sri Lanka has always dealt with HMC [Knox, 1681], and the survey respondents' methods of defending against monkey raiders by chasing (Fig. 5) have been effective for generations and in a sense offer a model for coexistence in sympatry. Indeed, some hotels hired monkey chasers. What has changed in modern times is more habitat loss and economic development (especially in towns) that brings in its tow an increase in the amount and quality of edible refuse and its wider geographical distribution by local travelers and tourism.

Notwithstanding these obstacles, with a little effort, the sharing of habitat and coexistence is possible in modern times, if correctly orchestrated. By way of an example, for more than 50 years the forests surrounding the Smithsonian Institution Primate Research Station at Polonnaruwa (locally known as the "monkey camp") has been inhabited by two or more groups of monkeys. Some macaques are inveterate raiders in the surrounding village neighborhood, but when the same groups visit the station premises, they find access points to food and refuse screened off. Apart from occasional attempts, macaques have learned that raids are unproductive and may lead to punishment (chasing). They rest, groom, play, socialize, fight and sleep in the tress and on the roofs but have learned not to waste their energies in raiding attempts. The intelligence of monkeys can favor coexistence with humans, or not. The challenge lies in teaching not only humans [e.g., Sha et al., 2009], but also nonhuman primates how to share habitat.

Taking a broader view and cues from human behavior throughout history and current events, coexistence and the sharing of space among different communities of *Homo* is fraught with risks of human-human genocide. In this light, the ideal of humans sharing habitat with monkeys as an approach to primate conservation seems remote. Sentiments supporting efforts for coexistence might be more productively channeled towards setting aside exclusive space and habitat for our primate relations. Enabling coexistence through exclusive habitats might be viewed as a priority over sharing it.

Conclusion

A combination of approaches to reduce HMC should include stringently enforced food and refuse management that prevents monkeys' access, repelling monkeys when necessary, and possibly contraceptive interventions at localities of artificial overpopulation. In the absence of any reduction in HMC by benign approaches, human nature will take its toll in reducing monkey numbers directly; it has already occurred in Sri Lanka, and some politicians have openly encouraged this in their election platforms. Human sympathy towards nonhuman primates might be most productively used to support the strengthening of exclusive protected nature reserves for all wildlife, with habitat-sharing as a secondary and supplemental option.

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The authors have no ethical conflicts to disclose and no conflicts of interest.

Author Contributions

The three authors contributed about equally to the idea of a survey, and M.F., who had prior experience with surveys, drafted the questionnaire with help from W.D. and S.G. The survey villages were selected by S.G. and W.D., the survey itself was supervised in the field by S.G. and M.F., and survey analyses were done by M.F. W.D. drafted the manuscript with feedback from S.G. and M.F.

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