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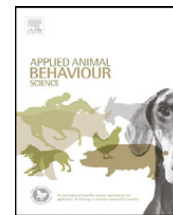
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Testing a model for predicting primate crop-raiding using crop- and farm-specific risk values

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ABSTRACT

Crop-raiding by primates is increasingly known to cause conflict between humans and primates, and due to their opportunism, adaptability, intelligence and manipulative abilities, primates can be significant agricultural pests. Levels of crop-raiding are dependent on time of year, crop type, size and location of the farm, and primate species involved, making it difficult for farmers to predict susceptibility to crop-raiding accurately. We use a simple method for calculating the likelihood of crop damage by primates using crop susceptibility to predict the frequency of crop damage for individual farms. The method relies on calculating incidence rates of crop-raiding for individual crops using pooled data from all farms in the sample, and summing these rates as to reach a farm's risk value (RV) to primate crop-raiding. From 273 farms in southwestern Sri Lanka data were collected on crop-raiding by two species of primate, the arboreal folivorous purple-faced langur and the terrestrial frugivorous toque macaque. Data from 93 farms were used to calculate crop-raiding incidence rates for seven commonly grown crops, and we tested the applicability of the model using the remainder of the dataset. Incidence rates of raiding for crops differed for the two species of primate, albeit not in a uniform manner. Farms appear to be more susceptible to crop-raiding by langurs than by macaques, with higher RVs for langurs than for macaques: this is not related to the behaviour of the farmer as for both species four-fifth of the farmers that experience crop-raiding actively chase primates away. Our model using RVs works well for predicting crop-raiding in langurs as crop-raided farms have significantly higher RVs. It works less well for macaques, which may be related to their terrestriality allowing them to range over larger areas and raid farms opportunistically.

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1. Introduction

While having lived sympatrically in many parts of the world for thousands of years, humans often have a love–hate relationship with the primates living in their proximity. This relationship is often best explained by invoking competition, with the human and primate niche overlapping to a larger or smaller degree, and conflict. Of the conflicts between humans and other pri-

mates, primate crop-raiding is one that has received the most attention to date (Chhangani and Mohnot, 2004; Forthman et al., 2005; Pirta et al., 1997; Naughton-Treves et al., 1998; Riley, 2007; Saj et al., 2001; Strum, 1994). While many species raid cultivated crops (insects, rodents, birds, and herbivores) because of their opportunism, adaptability, intelligence and manipulative abilities, primates can be significant pests (Naughton-Treves, 1998; Sillero-Zubiri and Switzer, 2001; Warren et al., 2007).

Probably the most reliable predictor for crop-raiding is the type of crop grown, with high levels of crop-raiding associated with easily picked crops with high caloric con-

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tents (Naughton-Treves et al., 1998; Saj et al., 2001) or crops with high levels of simple mono- and disaccharides compared to other carbohydrates (Horrocks and Baulu, 1994). Size and location of the farm relative to where primates are and the species of primate are important factors as well. Linkie et al. (2007), Naughton-Treves (1998), Saj et al. (2001), and Warren et al. (2007), amongst others, have found that proximity of the farm to the forest edge and the presence or absence of neighbouring farms best explain the likelihood of any farm sustaining crop damage from primates. With respect to the different primate taxa that are engaged in crop-raiding, but more so in the Old World compared to the New World, the terrestrial frugivores and omnivores are the primary culprits, with the Cercopithecidae (baboons, macaques and to a lesser extent colobines) topping the list (e.g. Cowlshaw and Dunbar, 2000; Sillero-Zubiri and Switzer, 2001; Linkie et al., 2007). With humans and primates living in ever-closer proximity, a proper understanding of crop-raiding is needed, including understanding interspecific differences in patterns of crop-raiding, as well as way to predict future crop-raiding events accurately (cf. Sillero-Zubiri and Switzer, 2001). Not only is this knowledge vital as to mitigate the effects of crop-raiding but also to initiate non-lethal methods of resolving foraging (e.g. Baker et al., 2005, 2007).

Recently Priston and Underdown (2009) presented a simple method for calculating the likelihood of crop damage by primates using crop susceptibility to predict the frequency of crop damage for individual farms. Working on the Indonesian island of Buton, they collected data on farms situated <1 km from forest that were subject to crop-raiding by booted macaques (*Macaca ochreata*). They determined susceptibility to crop-raiding of 15 crop species, and used these data to predict the susceptibility to crop-raiding of farms based on the crops cultivated. These data were subsequently compared to the actual damage levels recorded 2 years later. They found a very high degree of accordance between the predicted and observed levels of crop-raiding, and advocated the use of the method as a simple and rapid device to be used in other parts of the world.

We here use a modification of their method to assess its usefulness in predicting the likelihood of crop-raiding by two species of primate in Sri Lanka. We expect crop-raiding on any given farm to be (a) positively correlated to its predicted susceptibility to crop-raiding, (b) negatively correlated to the distance from the farm to the forest edge, (c) to be more pronounced by the terrestrial macaque than for the arboreal langur and (d) for the correlations in (a) to be stronger and (b) to be weaker for the macaque than for the langur.

2. Methods

2.1. Data acquisition

Data were collected from May to July 2006 in Sri Lanka's Southern Province [06°48'N, 80°14'E] through interviews with 273 farmers in nine villages. The economy of the area is based on smallholder farming of rain-fed cultivation with tea (*Thea sinensis*) and rubber (*Hevea brasiliensis*) as the main cash crops. Information

on the ethnoprimateology of the area from 2002 to 2006, with details on the region, its people, and its primates, can be found in Eschmann et al. (2008), Nekaris and de Silva Wijeyeratne (2009) and Nijman and Nekaris (2010).

The following data were collected: the crops grown during the period of the survey (14 crops in total), the size of the farm (in eight classes from <0.2 ha to >1.6 ha), the estimated nearest distance from fields to the edge of the forest (in five 1-km classes, plus 'within 100 m from the forest edge'), and for two species of primates, the purple-faced langur (*Trachypithecus vetulus*) and the toque macaque (*Macaca sinica*), whether or not they entered the farm or were present in close proximity, and if so, whether or not they engaged in crop-raiding. We did not assess the severity of the damage the monkeys caused. In addition, we asked what the farmers did if they observed langurs or macaques in their fields. Note that in this part of Sri Lanka the otherwise widespread tufted gray langur (*Semnopithecus priam*) is absent and the red slender loris (*Loris tardigradus*) is not known as a crop-raider (Nekaris and de Silva Wijeyeratne, 2009; Nekaris and Jayewardene, 2004).

The toque macaque is a terrestrial frugivore consuming a large range of fruits, seeds, leaves and, albeit in smaller amounts, animal prey (Vandercone and Santiapillai, 2003). It tends to select ripe and fleshy fruits rich in mono- and disaccharides. While small amounts of food can be stuffed in the cheek pouches, when walking on the ground, it can also carry larger items in its hands. The purple-faced langur is an arboreal folivore (Hladik, 1977). Dela (2007), however, found populations living in forest fragments to be largely frugivorous.

2.2. Modelling crop-raiding

As argued by Priston and Underdown (2009) crop-raiding is species-dependent, and can, and does, have differential rates of occurrence. Probably the most important factor is time, as this both determines the availability of certain crops on a farm and their phenology (young leaves, flowers, unripe or ripe fruits), as well as the availability of alternative (wild) food sources (e.g. Naughton-Treves et al., 1998). The same field may experience no crop-raiding at all during fallow periods, modest crop-raiding when crops are growing, and severe crop-raiding when plants bear fruits. The incidence rate of crop-raiding is defined as the ratio of new occurrences over a period of time to the crops at risk over that period of time. Our survey covered a short period of time, and hence phenologies of crops and crop composition within farms were stable (fields that were planted with e.g. cinnamon (*Cinnamomum zeylanicum*) at the beginning of our survey still contained cinnamon at the end of the survey). Hence, we here use a single incidence rate, as opposed to the cumulative incidence rate.

The data needed to calculate the incidence rate are the availability of a particular crop to a primate, which is taken here as any crops present at a farm with the farmer indicating presence of that primate species on the fields, and whether or not crop-raiding takes place. Pooling these data

Table 1

Incidence rates as a measure of likelihood for crop-raiding by two species of primate, purple-faced langur (*Trachypithecus vetulus*) and toque macaque (*Macaca sinica*), in 2006 for seven commonly cultivated crops in southwestern Sri Lanka using data from 93 farms.

Crops cultivated (number of farms)	Parts eaten by langurs (l) or macaques (m)	Incidence rate langurs (IR _l)	Incidence rate macaques (IR _m)
Coconut <i>Cocos nucifera</i> (27)	Fruit (l m); young leaves (l)	0.407	0.190
Banana <i>Musa</i> spp. (6)	Fruit (l m); leaves (l m)	0.333	0 ^a
Tea <i>Thea sinensis</i> (62)	Young leaves (l m); mature leaves (l)	0.274	0.189
Cinnamon <i>Cinnamomum zeylanicum</i> (12)	Leaves (l m)	0.500	0.583
Jakfruit <i>Artocarpus heterophyllus</i> (10)	Unripe fruit, leaves (l); ripe fruit (m)	0.400	0.333
Rubber <i>Hevea brasiliensis</i> (19)	Leaves (l m)	0.421	0.222
Rice <i>Oryza sativa</i> (7)	Seeds (l m)	0.143	0.167

^a Crop-raiding of banana did occur on farms not included in the model dataset.

across farms provides the total number of farms on which the crop is damaged (*a*) and the total number of farms where the crop was present and available to crop-raiding primates (*b*). The risk of a crop being raided, the incidence rate, IR, is calculated by dividing *a* by *b* (not $a/(a+b)$ as in Priston and Underdown, 2009, p. 53). The higher risk crops will have an IR closer to 1. Using basic probability theory the IRs are then summed for all the crops present on a farm to reach the total risk value for a farm RV (hence $RV = \sum IR$). These total risk values, RV, can therefore exceed 1. Given that we collected data on two species of primate, each crop receives an incidence rate for langurs (IR_l) and for macaques (IR_m), and each farm then receives risk value for langurs (RV_l) and one for macaques (RV_m).

For calculation of IR we restricted ourselves to the most common crops as this avoids skewing the data towards rare crops present on only a few farms. Following Priston and Underdown (2009) common crops are those that are grown on $\geq 7\%$ of the farms. Seven crops reached this threshold, i.e. banana (*Musa* spp.) and jackfruit (*Artocarpus heterophyllus*) grown on 19 farms, rice (*Oryza sativa*) on 22 farms, cinnamon on 55 farms, rubber on 73 farms, coconut (*Cocos nucifera*) on 78 farms, and tea on 246 farms. Eleven farmers did not grow any of these crops (but e.g. cassava (*Manihot esculenta*) or papaya (*Carica papaya*)) leaving 262 farmers for the analysis. The remaining farmers all grew between one and five crops each.

2.3. Analysis

We split the data into two sets, one for modelling and one for validation, assuring independence of data. The first, with data from 93 farms, was used to model the vulnerability to crop-raiding, and to calculate the primate specific IRs. These data were then used to predict the relative risk of farms to crop-raiding by the two primate species by calculating the farm's risk value for langurs (RV_l) and for macaques (RV_m) using data from the remaining 169 farms. These data allowed us in addition to test whether the farm's risk values are related to the farm's size and its location relative to the forest, and to compare RVs between farms that report crop-raiding with ones that do not. Since the data are not normally distributed, we used non-parametric statistical tests (Mann–Whitney's *U*-tests, χ^2 -tests, Wilcoxon Signed Rank tests, and Spearman Rank Correlations), accepting significance when $P < 0.05$ in a two-tailed test (Siegel, 1956).

3. Results

3.1. The model dataset

The model dataset and the test dataset did not differ in their vital statistics: size of the farm (both medians of 0.7 ha), the distance from the fields to the edge of the forest (median distances of 1.5 km and 1.1 km for model and test dataset, respectively) (Mann–Whitney's *U*-tests, $U = 2310.5$, $P = 0.10$ and $U = 3830.0$, $P = 0.18$, respectively). The proportion of farms recording the presence of langurs (69.9% vs 70.4%) or macaques (60.2% vs 59.7%), or the proportion of farms reporting crop-raiding by langurs (19.3% vs 12.5%) or macaques (10.8% vs 10.6%) (all $\chi^2 < 1.73$, $df = 1$, $P < 0.18$).

Using the model dataset, IR_l and IR_m were calculated for the seven crop species; for five crop species the IR for langurs is higher than for macaques and for two species the reverse is observed. IR does not differ significantly between the two primate species (Wilcoxon Signed Ranks Test, $z = 1.690$, $P = 0.09$) (Table 1). The fact that IR was not related to the number of farms on which the crop is grown (Spearman's $\rho = 0.25$, $N = 7$, $P = 0.59$ and $\rho = 0.32$, $N = 7$, $P = 0.48$, for langurs and macaques, respectively) indicated a preference (or avoidance) by primates for raiding certain crops. This illustrates that IRs are not just a reflection of the abundance of those crops.

3.2. Testing the model

Farms appear to be more susceptible to crop-raiding by langurs than by macaques. The median risk value for langurs (RV_l) is 0.68 (range 0.27–1.66, $N = 119$) whereas the risk value for macaques is 0.38 (range 0.18–1.33, $N = 101$), the difference being significant (Mann–Whitney's *U*-test, $U = 3921$, $P < 0.001$). The reaction of farmers to the primates seems to be similar: for both species $\sim 80\%$ of the farmers that experience crop-raiding actively chase them away, whereas for both species $\sim 15\%$ of the farmers that do not experience crop-raiding still actively chase them away. While the proportion of farmers indicating langurs being crop-raiders was significantly related to the distance to the forest, with a higher incidence of crop-raiding in fields closest to the forest (Spearman's $\rho = 0.84$, $N = 6$, $P = 0.04$), this was not the case for the macaques (Spearman's $\rho = 0.17$, $N = 6$, $P > 0.50$) (Fig. 1).

For the langurs there is a significant positive relationship between RV_l and farm size (Spearman's $\rho = 0.34$,

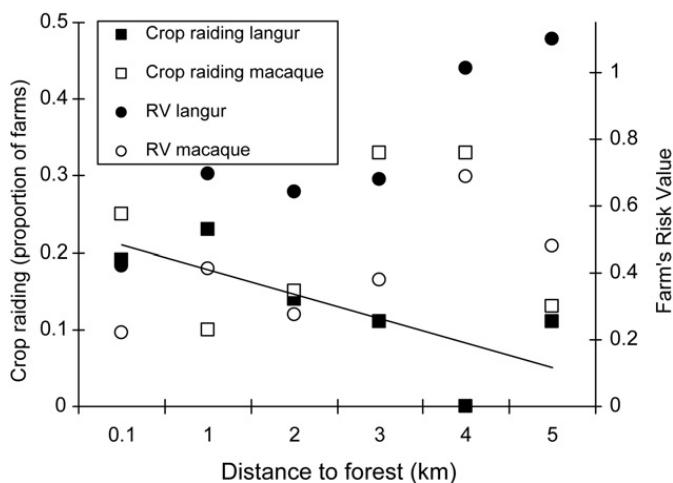


Fig. 1. Relationship between frequency of crop-raiding and the farm's risk value based on the susceptibility of crops and the distance from the fields to the nearest forest for two species of primate, purple-faced langur (*Trachypithecus vetulus*) and toque macaque (*Macaca sinica*). Only the relationship between crop-raiding by langurs and distance to the forest, indicated by the trend line, is statistically significant. Based on data from 169 farms.

$N = 117$, $P < 0.001$) but not between RV_1 and distance to the forest edge (Spearman's $\rho = 0.16$, $N = 116$, $P = 0.09$). There is no relationship between farm size and distance to the forest edge (Spearman's $\rho = 0.09$, $N = 114$, $P = 0.33$). Whether or not langurs are reported as crop-raiding on a farm is not related to the farm's size (Mann–Whitney's U -test, $U = 899$, $P = 0.69$) but farms where crop-raiding by langurs does occur have higher RV_1 values (Mann–Whitney's U -test, $U = 679$, $P = 0.01$).

As with the langurs, for macaques there is a significant positive relationship between RV_m and farm size (Spearman's $\rho = 0.33$, $N = 99$, $P < 0.001$) but not between RV_m and distance to the forest (Spearman's $\rho = 0.06$, $N = 98$, $P = 0.53$) or farm size and distance to the forest (Spearman's $\rho = 0.03$, $N = 96$, $P = 0.81$). As with langurs, crop-raiding by macaques is not related to the farm's size (Mann–Whitney's U -test, $U = 604.5$, $P = 0.57$), and unlike langurs, it is also unrelated to the farm's RV_m (Mann–Whitney's U -test, $U = 676.5$, $P = 0.73$).

4. Discussion

We predicted that crop-raiding on any given farm would be positively correlated to its predicted susceptibility to crop-raiding and negatively correlated to the distance from the farm to the forest edge. This was indeed supported by the data for the langurs but not for the macaques. Contrary to our prediction, the data suggest crop-raiding in this part of Sri Lanka to be more pronounced by the arboreal langur than the terrestrial macaque.

Crop-raiding by primates occurs worldwide, is widespread and can negatively affect large numbers of farmers. In southwestern Sri Lanka about an eighth of the farms reported crop-raiding by langurs, macaques, or both. Farmers with fields close to the forest edge did not plant crops with lower IR values, seemingly not anticipating future crop losses. While Sri Lankans are

generally tolerant to primates, accepting the occasional loss (Rudran et al., 2009; Nijman and Nekaris, 2010), when subjected to crop-raiding, 80% of the farmers actively chase the primates off their land. Killing of primates is rare in rural settings (see however Dela, 2004) but is becoming increasingly common in more urban environments (Parker et al., 2008).

Given the impact primate crop-raiding can have on farmers – instances where >60% of a season's crops is lost have been reported (Warren et al., 2007) resulting in elevated levels of conflict – accurately predicting susceptibility to crop-raiding is desirable. Assessing to what level farms or crops are susceptible to crop-raiding allows a farmer to anticipate and mitigate the impact of crop-raiding. While our model was useful for predicting and assessing crop-raiding in langurs our results were not nearly as straightforward as the data presented by Priston and Underdown (2009). In part this may be due to differences in methodology (interviews vs actual assessment of crop-raiding) but also due to Priston and Underdown (2009) using data from partially the same farms for modelling and testing. While they indicate that these data are independent (as they were collected in different years), it is worthwhile to note that about 40% of the crops included in their study comprise perennials (banana, cocoa (*Theobroma cacao*), coconut, papaya, etc.), suggesting similar crop composition on farms between years. This may explain their very strong correlation between a farm's RV and actual levels of crop damage, with 90% of the variation in crop-raiding being explained by differences in RV s.

Only two crop species, banana and coconut, were included in our and Priston and Underdown's (2009) dataset, and in both studies they were subjected to comparable intermediate risk levels of crop-raiding by primates. Priston and Underdown (2009) found a median IR for 15 crop species of 0.20 while we found IRs of 0.19 (macaque) and 0.40 (langur). Their median RV (1.40) was higher than ours (0.48 and 0.68 for macaque and langur, respectively) but they included twice as many crop species in their assessment (and RV s are cumulative values) suggesting close agreement of data. RV is a good predictor for crop-raiding for langurs on Sri Lanka and macaques on Buton but not for macaques in Sri Lanka.

The results of our study underscore the need for a proper understanding of the behaviour of wild animals in relation to wildlife management, pest management and conservation of rare species. As indicated by Swaisgood (2007) applied behavioural research can illuminate a number of issues important to conservation, including behavioural responses to habitat fragmentation and human disturbance, and human–animal conflict including crop-raiding. He posed the questions on whether crop-raiding is dependent on seasonal fluctuations in resource abundance and what the critical keystone' resources are that provide food during periods when other resources are limited, and, if so, can human activities be changed to limit human impact on these resources? We found clear differences in crop-raiding by two species of primate with lower levels of crop-raiding in macaques than langurs but, conversely, a more predictable pattern of crop-raiding in the langurs.

Our study shows that for farmers it is possible to reduce crop-raiding by langurs by adjusting their planting scheme, and what to plant where. By cultivating areas far away from forest (>3 km) crop-raiding can be reduced by half. Similarly by planting crops with low IR₁ such as rice and tea as a buffer between the forest and other crops, crop-raiding by langurs can be reduced. Reducing crop-raiding by macaques appears to be more complicated than for the langurs. We found substantial differences in IR_m between crops and it seems that one way of reducing crop-raiding by macaques would be to plant different crops. Hence, coconuts and rice are less raided by macaques than e.g. cinnamon and jackfruit, and adjusting the planting scheme would probably substantially reduce conflict between man and macaque. When this is not feasible or realistic, crop-raiding by macaques need to be addressed in other ways. Primates' opportunism, adaptability, intelligence and manipulative abilities make more passive methods, such as using scarecrows, plastic flags, fireworks, unusual scent, or fencing largely ineffective. Even methods such as trapping, shooting and poisoning tend to be only marginally successful for primates (Sillero-Zubiri and Switzer, 2001) and because of their protected status in the Sri Lankan context not an option. As such, we feel that more active guarding of crops, with more people present on the fields during crucial periods, remains one of the few viable options as to reduce crop losses to macaques.

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References

- Baker, S.E., Johnson, P.J., Slater, D., Watkins, R.W., Macdonald, D.W., 2007. Learned food aversion with and without an odour cue for protecting untreated baits from wild mammal foraging. *Appl. Anim. Behav. Sci.* 102, 410–428.
- Baker, S.E., Ellwood, S.A., Watkins, R.W., Macdonald, D.W., 2005. A dose–response trial with ziram-treated maize and free-ranging European badgers *Meles meles*. *Appl. Anim. Behav. Sci.* 93, 309–321.
- Chhangani, A.K., Mohnot, S.M., 2004. Crop raid by Hanuman langur *Semnopithecus entellus* in and around Arawallis (India) and its management. *Primate Rep.* 69, 35–47.
- Cowlishaw, G., Dunbar, R.I.M., 2000. *Primate Conservation Biology*. University of Chicago Press, London and Chicago.
- Dela, J.D.S., 2004. Protecting the endemic purple-faced langur. *Loris* 23, 14–22.
- Dela, J.D.S., 2007. Seasonal food strategies of a colobine frugivore, *Semnopithecus vetulus nestor*, at Panadura and Piliyandala, Sri Lanka. *Int. J. Primatol.* 28, 607–626.
- Eschmann, C., Moore, R., Nekaris, K.A.I., 2008. Calling patterns of Western purple-faced langurs (Mammalia: Primates: Cercopithecoidea: *Trachypithecus vetulus nestor*) in a degraded human landscape in Sri Lanka. *Contrib. Zool.* 77, 57–65.
- Forthman, D.L., Strum, S.C., Muchemi, G.M., 2005. Applied condition taste aversion and the management and conservation of crop-raiding primates. In: Paterson, J.D., Wallis, J. (Eds.), *Commensalism and Conflict: The Human–Primate Interface*. American Society of Primatologists Norman, pp. 420–443.
- Hladik, C.M., 1977. A comparative study of the feeding strategies of two sympatric species of leaf monkeys: *Presbytis senex* and *Presbytis entellus*. In: Clutton-Brock, T.H. (Ed.), *Primate Ecology: Studies of Feeding and Ranging Behaviour in Lemurs, Monkeys and Apes*. Academic Press, London, pp. 323–353.
- Horrocks, J.A., Baulu, J., 1994. Food competition between vervets (*Cercopithecus aethiops sabaues*) and farmers in Barbados: implications for management. *Rev. D'Ecol. (Terre & Vie)* 49, 281–294.
- Linkie, M., Dinata, Y., Nofrianto, A., Leader-Williams, N., 2007. Patterns and perceptions of wildlife crop raiding in and around Kerinci Seblat National Park, Sumatra. *Anim. Conserv.* 10, 127–135.
- Naughton-Treves, L., 1998. Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda. *Conserv. Biol.* 12, 156–168.
- Naughton-Treves, L., Treves, A., Chapman, A., Chapman, C., Wrangham, R., 1998. Temporal patterns of crop-raiding by primates: linking food availability in croplands and adjacent forest. *J. Appl. Ecol.* 35, 596–606.
- Nekaris, K.A.I., de Silva Wijeyeratne, G., 2009. *Primates of Sri Lanka*. Jetwing Eco Holidays, Colombo.
- Nekaris, K.A.I., Jayewardene, J., 2004. Survey of the slender loris (Primates, Lorisidae Gray, 1821: *Loris tardigradus* Linnaeus, 1758 and *Loris lydekkerianus* Cabrera, 1908) in Sri Lanka. *J. Zool.* 262, 327–338.
- Nijman, V., Nekaris, K.A.I., 2010. Changes in levels of tolerance towards commensal primates in relation to deforestation in Sri Lanka. *Int. J. Pest Manage.* 56, 153–158.
- Parker, L., Nijman, V., Nekaris, K.A.I., 2008. When there is no forest left: fragmentation, local extinction, and small population sizes in the Sri Lankan Western purple-faced langur. *Endang. Species Res.* 5, 29–36.
- Pirta, R.S., Gadgil, M., Kharshikar, A.V., 1997. Management of the rhesus monkey *Macaca mulatta* and Hanuman langur *Presbytis entellus* in Himachal Pradesh, India. *Biol. Conserv.* 79, 97–106.
- Priston, N.E.C., Underdown, S.J., 2009. A simple method for calculating the likelihood of crop damage by Primates: an epidemiological approach. *Int. J. Pest Manage.* 55, 51–56.
- Riley, E.P., 2007. The human–macaque interface: conservation implications of current and future overlap and conflict in Lore Lindu National Park, Sulawesi, Indonesia. *Am. Anthropol.* 109, 473–484.
- Rudran, R., Weerakoon, K., Wanasinghe, A., 2009. Western purple-faced langur *Trachypithecus (Semnopithecus) vetulus nestor* Bennett, 1833. In: Mittermeier, R.A., Wallis, J., Rylands, A.B., Ganzhorn, J.U., Oates, J.F., Williamson, E.A., Palacios, E., Heymann, E.W., Kierulff, M.C.M., Long Yongcheng, Supriatna, J., Roos, C., Walker, S., Cortés-Ortiz, L., Schwitzer, C. (Eds.), *Primates in Peril: The World's 25 Most Endangered Primates 2008–2010*. IUCN/SSC Primate Specialist Group, International Primatological Society, and Conservation International, Arlington, VA, pp. 53–55.
- Saj, T.L., Sicotte, P., Paterson, J.D., 2001. The conflict between vervet monkeys and farmers at the forest edge in Entebbe, Uganda. *Afr. J. Ecol.* 39, 195–199.
- Siegel, S., 1956. *Nonparametric Statistics for the Behavioural Sciences*. McGraw-Hill, New York.
- Sillero-Zubiri, C., Switzer, D., 2001. *Crop Raiding Primates: Searching for Alternative, Humane Ways to Resolve Conflict with Farmers in Africa*. Wildlife Conservation Research Unit, Oxford University, Oxford.
- Strum, S.C., 1994. Prospects for management of primate pests. *Rev. D'Ecol. (Terre & Vie)* 49, 295–306.
- Swaigood, R.R., 2007. Current status and future directions of applied behavioral research for animal welfare and conservation. *Appl. Anim. Behav. Sci.* 102, 139–162.
- Vandercone, R., Santiapillai, C., 2003. Feeding ecology and factors influencing the range of the Dusky Toque Monkey (*Macaca sinica aurifrons*) in Udawattakelle Sanctuary, Sri Lanka. *Tigerpaper* 30, 20–27.
- Warren, Y., Buba, B., Ross, C., 2007. Patterns of crop-raiding by wild and domestic animals near Gashaka Gumti National Park, Nigeria. *Int. J. Pest Manage.* 53, 207–216.