Camera-trap avoidance by Kinkajous *Potos flavus*: rethinking the "non-invasive" paradigm

Jan SCHIPPER

Abstract

Nocturnal arboreal mammals are challenging to study in the wild, especially in dense tropical forests. Camera-trapping is a non-invasive method to study elusive species and is increasingly used to document species presence, habitat use, and density. However traditional camera-flash systems may in fact be "invasive" when used to study animals that completely rely on vision to navigate the rainforest canopy at night. This study demonstrates that using standard flash photography in camera-traps can lead to avoidance behaviour in Kinkajou *Potos flavus*. Researchers wishing to study nocturnal arboreal mammals should explore infrared techniques when using camera-traps in the canopy.

Keywords: arboreal, canopy highway, Costa Rica, frugivore, neotropical, nocturnal

Resumen

Los mamíferos nocturnos arbóreos son muy difíciles de estudiar en el campo, principalmente en bosques tropicales densos. El uso de cámaras trampa es considerado un método "no invasivo" para estudiar los mamíferos huidizos (esquivos) y es muy útil para confirmar su presencia, evaluar el uso de hábitat y estimar densidades. Sin embargo, el flash de las cámaras fotográficas podría ser invasivo para estudiar especies que tienen ojos adaptados para la visión nocturna para poder navegar las copas de los árboles en la oscuridad. Este estudio demuestra que el uso de flash en sistemas tradicionales de cámaras trampa puede afectar el comportamiento de algunas especies que podrían cambiar sus rutas de movimiento dentro el dosel. Por lo tanto, sugerimos buscar alternativas para cámaras trampa (ej. técnicas infrarojo), que no tengan ningún efecto sobre las variables que queremos medir, tales como presencia y frecuencia de pasaje por un punto de muestreo.

Introduction

The Kinkajou *Potos flavus* is a relatively poorly understood nocturnal, arboreal, and frugivorous carnivore, which inhabits tropical forests throughout Middle and South America. These seemingly contradictory ecological parameters have arisen from evolutionarily selective pressures to exploit the bounty of resources in the rainforest canopy, namely, fruit, leaves, and insects (Kays 1999). These traits also differentiate the Kinkajou from most other neotropical small carnivores (with the notable exception of the sympatric olingoes *Bassaricyon* spp.). Kinkajous are difficult to study *in situ*, and most of what we do know about them in the wild comes from a handful of studies, notably in Guatemala (Walker & Cant 1977), Panama (Kays & Gittleman 1995, 2001, Kays 1999) and French Guiana (Julien-Laferrière 1993, 1999). In this study, we examine Kinkajou behavioural responses associated with the use of camera-traps, specifically, the effect that standard flash photography has on trap avoidance behaviour. This behavioural response has subsequent impacts on data analysis and interpretation of inferences of abundance derived from this method. Based on our observations and findings, I do not recommend the use of standard flash camera-traps for the study of Kinkajou or nocturnal arboreal species whose hyper-sensitive eyes, though ideal for climbing trees at night, are not suited well for standard flash photography.

Arboreal tropical forest mammals can be extremely challenging to study in the wild (Kays & Allison 2001), which with the notable exception of primates, explains why so little is known about them. Most of the scientific information available for Kinkajou comes from *ex situ* work with captive animals (Ford & Hoffman 1988), therefore developing non-invasive techniques to study this species *in situ* is a priority for ecological research. Camera-traps are becoming an increasingly useful "non-invasive" tool for studying ecological parameters and activity patterns of elusive and otherwise difficult to study species (Sanderson & Trolle 2005). Camera-trap design and functionality have improved greatly over the past few years and they have begun to incorporate digital and infra-red technology, though not without limitations. As camera-traps continue to aid scientists in answering previously difficult research questions, there is some need to evaluate the potential effects this research and monitoring tool can have on the species being studied. Below, I present ecological notes on the observed effect of camera-trapping on Kinkajous in Costa Rica. Inference would suggest that information described for Kinkajou would also pertain to the olingoes and other nocturnal arboreal species.

Many different types of information can be collected from a camera-trap array—including patterns of density and distribution, habitat use, and activity. The interpretation of such data often assumes that species do not have a behavioural response; however that assumption is not always valid. If a behavioural response occurs, analytical tools should be used which account for heterogeneous capture probabilities (e.g., a nested model such as M_h or M_{bh} in program CAPTURE) otherwise results will be biased (Otis *et al*. 1978, White *et al*. 1982). We have noticed in our work in the neotropics that a number of species will change their behaviour, often several times, during a camera-trap study (J. Schipper unpublished data). We attribute some of these changes to the cameras themselves and others to the presence of researchers. One behaviour effect which can have a compounding effect on data and estimates of "recapture" necessary to calculate density in a capture-recapture framework is trap shyness. This behaviour effect has been observed in a number of carnivores, including Tiger *Panthera tigris* (Wegge *et al.* 2004). Another effect, which I will describe herein, is trap avoidance—a behaviour I observed with Kinkajou during a 20-day canopy camera-trap campaign.

Study Site

This study was undertaken in the Gandoca–Manzanillo National Wildlife Refuge (9°37'N, 82°39'W), located in the southern coastal Caribbean plain of Costa Rica between the towns of Puerto Viejo and Manzanillo, Canton de Talamanca, Provincia de Limon. The region is dominated by lowland coastal moist forests interspersed with swamp forests and wetlands. The wildlife refuge laws do not exclude people, thus the study site was located in a mosaic of forest patches amidst hotels and residences. Outside the existing protected areas, there are extensive banana plantations mixed with plantain, cacao, and other crops. The study site was selected for this particular investigation because of numerous reports of "night monkeys (mono nocturno)" and a canopy camera-trapping system was devised in attempt to record Western Night Monkeys *Aotus lemurinus* that have not been recorded in Costa Rica in over 40 years (Timm 1994). Researchers later learned that the local Creole language had adopted the term "night monkey" to refer to *Potos flavus* and not to the nocturnal primate, although this was not historically the case. Thus the study described herein began as a search for night monkeys and became an experiment on the effect of placing camera traps in treetops on Kinkajous.

Methods

The information provided herein is based on observations and photographs taken over a 20-day period (6–26 November 2004) at one trap site, nested within a 100+ site camera-trapping campaign that lasted two years. Observational data collection began one week prior to setting the camera-trap and extended until the end of the study. The camera-trap used in this study was placed in the canopy of a large *Persea* (Lauraceae) tree. Direct observations were made periodically during the study by flashlight and binoculars in order to document species behavioural response. These observations consisted of following an active individual or group of Kinkajous as they moved through the treetops of the study site from one forest fragment to another, which they did every 3–5 nights (weather permitting) as part of their foraging routine.

We used a standard film camera-trap (PTC Technologies), modified to improve moisture resistance and security, set with a 1-minute time delay between photographs and 24-hour activity (day/night). The camera-trap was attached to the main trunk of the tree 15 m above the ground, facing horizontally down a branch that extended into a neighbouring canopy. This interlinking of canopies, sometimes referred to as "canopy highways" allows animals to cross relatively effortlessly between trees and, in this case, between forest patches. Thus using such a "highway" as a camera-trapping site greatly increases the probability of capture and catch per unit effort. However, care must be taken to ensure that the sensor beam is crossed diagonally. Species approaching directly do not actually "cross" the passive infrared sensor to trigger the cameras until it is too late and photos tend to be out of focus, at best. Prior to selecting a site for setting the camera-trap, it is useful to watch diurnal species approach the problem of crossing from tree to tree. In this study, we watched how various species (including squirrels) would navigate the branches at the site to lend some insight on how and where to place the camera.

The tree chosen for placing the camera-trap was located in a strip of forest connecting two fragments along the coastal zone, providing a critical link between fragments and between neighbouring trees for movement. Interviews with local people had suggested that there was occasionally nocturnal activity in the treetops in this area. A bow and arrow (weighted with nails) were use to place a monofilament line over the desired branch in the tree crown, which was then used to hoist a nylon cord. A braided static climbing rope was then hoisted up using the nylon cord, which was then used to ascend the tree. Jumar ascenders, connected to a climbing harness (see Perry 1978 for access technique), were used to climb the rope and access the trap site. Once in the canopy, the camera-trap was fixed to the tree using two nylon straps. The camera was set facing outwards from the tree trunk to a branch which was known to serve as a movement corridor for arboreal species. The sensor was directed to detect movement approximately 10 feet away, such that the field of view was sufficiently ample for

From top to bottom: Kinkajou looking at camera-trap; Kinkajou stunned from flash; Kinkajou returning to where it came from after third flash from camera trap.

any error in levelling of the apparatus. The camera-trap was tested with great caution as it is quite difficult to move horizontally on a vertical rope.

Direct observations of the site were made from a hide nearby at ground level and by scanning the nearby trees for movement. Investigators waited for a group of Kinkajous to approach the site, then watched the group as it made its way across the trap-site. As the purpose of this study was to simply record the presence of nocturnal arboreal mammalian species, traps were neither paired nor rigorously maintained (as access to the canopy is somewhat strenuous) during the relatively short period of study.

Results

A total of ten photographs of Kinkajous were taken during the 20-day period of the study. Six of the photos were taken almost consecutively on the second night of the study, after which there were no photos for 10 days when another four pictures were taken. Observation of the site prior to installation of the camera demonstrated that a group of Kinkajous (three individuals, including two juveniles) were using the site every 2–5 days. On the second night of operation of the camera, the group attempted to cross the branch where the camera-trap was aimed, however the lead animal would not pass the point at which the camera was triggered. Instead the individual would ascend the branch until its photograph was taken (see sequential photographs, 1–3) and not further. On no occasion did the other individuals in the group attempt to pass the spot, and in fact, during the study the group never traversed the site.

Our findings suggest that Kinkajous exhibit a progressive avoidance behaviour over time following the triggering of a canopy camera-trap with a traditional flash. Although the physiological reason for this behaviour is not clear, I believe that the brightness of the flash temporarily affects their vision and is likely to cause great distress to the individual. There is a small recovery period following the flash when the individual does not move at all—which I believe to be due to the fact that it is temporarily blinded by the flash. This seems plausible as their eyes are much more sensitive to light than humans, who would react similarly to such a flash. The Kinkajou would only approach to the point a photo was taken, get very anxious and look stunned following the flash, turn around, sometimes call out, and repeat the process. However, the individual always stopped and turned around to rejoin the other members of the group after being flashed upon, and would not advance past the camera-trap. We refer here to this behaviour as trap avoidance, and distinguish this from trap shyness because where 'shyness' suggests reduced visitations, avoidance suggests a complete abandonment of the area—in this case, a branch along a frequently-used canopy highway.

Placement of a camera-trap in the canopy is not without its complications. Finding an appropriate branch configuration that is functional both for research and for a species' movement is a challenge, though we have found attaching directly to the trunk is helpful for several reasons: 1) it prevents excessive sway from wind and thus false triggers, 2) the wider contact surfaces prevent slippage of the camera-trap and thus misalignment, and 3) the camera-trap is much easier to access along a trunk than on outer branches. One additional recommendation is that, when on an emergent tree or along clearings (where a horizon is visible), the camera should not be facing towards sunrise or sunset as it will reduce the chances of photographing crepuscular animals and also cause false triggers.

Conclusions

Trap avoidance or the behaviour change in which a species avoids the precise spot in which a trap is located, is the observed result of flash photography in the canopy at night. A possible solution for future efforts would be to use infrared flash or infrared film, or low-light night vision technology that does not employ a bright light aimed directly at the study subject.

The implications of this behaviour are three-fold. First, camera-trapping in this case should not be considered a non-invasive study technique and it appears to have caused certain stress both to the individual being photographed and to what is presumed to be a family group. Second, the camera flash acted as an effective deterrent and prevented the kinkajou from passing the spot and thus blocked the group from continuing on an otherwise normal foraging routine. Third, this behaviour effect would preclude effective density estimation (absolute or relative) of animals or effective monitoring, as the use of flash influences the probability and likelihood of recapture (thus skewing any possibility of analysis using capture-recapture techniques). In addition, if there had been an alternative method to crossing the fragment without passing the camera this would doubtless have been used (and could result in a recapture rate of zero once the group learned how to avoid the camera flash). Kinkajous do not have patterned coat variation, however they can be readily identified by scars, fur markings and other physical characteristics (similarly, we can easily distinguish individual Pumas *Puma concolor* and Baird's Tapirs *Tapirus bairdii* with some practice). The ability to identify individuals is an important attribute in estimation of absolute density using capture-recapture techniques. The next logical step in researching the effects of flashes on nocturnal arboreal species is to try infra-red camera-traps to see if there is any notable trap avoidance over time.

It should be noted that standard flash camera-trapping is not a useful tool for studying this and similar species. In three years (over 7,000 trap nights) of using camera-traps in this and other nearby forests, only one photo of a Kinkajou was taken on the ground, walking across a dirt road where the canopy connectivity had been broken. During observational studies, it was also noted that even low powered flashlights are enough to stop a Kinkajou in its tracks for some time and brighter lights seem to cause greater disturbance.

In conclusion, I propose that researchers wishing to study nocturnal arboreal species consider the possible effects traditional camera flashes might have on the species of interest. Although in most cases camera-trapping is an excellent non-invasive tool, this is not always the case. Regrettably, this study was not designed to systematically collect information on behavioural effects and was done opportunistically. However, we have documented by direct observations and photographs that the installation of a camera-trap in the canopy acted as a barrier for movement between two forest fragments linked only by a narrow stretch of trees. By using an alternative flash system (infra-red) this problem could presumably be avoided. Thus, researchers should seriously consider the use of infra-red camera-trapping systems when studying species which might be adversely affected by flash photography—such as Kinkajous and olingoes. It is proposed that arboreal species that risk falling out of a tree should they be startled due to their specialised nocturnal vision are the most likely to show trap avoidance behaviour, while nocturnal terrestrial species that do not risk falling are more likely to develop trap shyness or display no unusual behaviour. Further research is needed to expand upon this hypothesis. However, the lesson learned is to take these factors into consideration when working with "light-sensitive" species, as camera-trapping is not always a non-invasive technique.

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IUCN Global Mammal Assessment,
Dept. of Environmental Science, University of Virginia,
Clark Hall, 291 McCormick Road, PO Box 400123,
Charlottesville, VA 22904, USA.
Email: jschipper@virginia.edu

Addendum

Addendum to: Anisimova, E. I., Katchanovskaya, P. D. & Katchanovsky, V. A. 2006. European Mink *Mustela lutreola* as a host of the *Spirometra erinaceieuropaei*. *Small Carnivore Conservation* 34&35: 25.

In the last issue we excluded the photographs accompanying this article showing the helminth *Spirometra erinaceieuropaei* (marked by arrows) in dissected European Minks. We reproduce them here, with apologies to the authors.