

## Assessing the efficacy of hair snares as a method for noninvasive sampling of Neotropical felids

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**ABSTRACT.** Hair snares have been used in North and Central America for a long time in assessment and monitoring studies of several mammalian species. This method can provide a cheap, suitable, and efficient way to monitor mammals because it combines characteristics that are not present in most alternative techniques. However, despite their usefulness, hair snares are rarely used in other parts of the world. The aim of our study was to evaluate the effectiveness of hair snares and three scent lures (cinnamon, catnip, and vanilla) in the detection of felids in one of the largest remnants of the Brazilian Atlantic Forest. We performed tests with six captive felid species – *Panthera onca* (Linnaeus, 1758), *Leopardus pardalis* (Linnaeus, 1758), *L. tigrinus* (Schreber, 1775), *L. wiedii* (Schinz, 1821), *Puma concolor* (Linnaeus, 1771), and *P. yagouaroundi* (É. Geoffroy Saint-Hilaire, 1803) – to examine their responses to the attractants, and to correlate those with lure efficiency in the field. The field tests were conducted at the Parque Estadual Pico do Marumbi, state of Paraná, Brazil. Hair traps were placed on seven transects. There were equal numbers of traps with each scent lure, for a total of 1,551 trap-days. In captivity, vanilla provided the greatest response, yet no felids were detected in the field with any of the tested lures, although other species were recorded. Based on the sampling of non-target species, and the comparison with similar studies elsewhere, this study points to a possible caveat of this method when rare species or small populations are concerned. Meanwhile, we believe that improved hair snares could provide important results with several species in the location tested and others.

**KEY WORDS.** Atlantic Forest; detection technique; hair; scent lure; rubbing behavior.

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Of all 37 recognized wild felid species, eight can be found in Brazil. All of them are placed in the threatened category in regional (BRESSAN *et al.* 2009, BRAGA & VIDOLIN 2010), national (MACHADO *et al.* 2008) or international (IUCN 2011) official lists. Habitat loss and poaching are considered to be the major threats to these animals, (MACHADO *et al.* 2008) and the lack of knowledge about their behavior, basic biology and distribution (OLIVEIRA 2006) is a threat to their conservation in the future.

Due to their secretive behavior, low densities and predominantly crepuscular and/or night habits, the observation and capture of wild felids can be very expensive and require a considerable effort (TOMAS *et al.* 2006, AGUIAR & MORO-RIOS 2009). As a consequence, non-invasive methods and indirect evidence such as scats, tracks, camera-traps, and hair-traps are often used to study felids (LONG *et al.* 2008). Feces can be used in dietary and molecular analyses (MIRANDA *et al.* 2005, LUDWIG *et al.* 2007, MIOTTO *et al.* 2007, HEINEMEYER *et al.* 2008, SILVA-PEREIRA *et al.* 2011). However, finding scats in the field can be harder in humid and

montane forests, where frequent rains over an irregular landscape can remove feces from trails, where they are more easily found (CRAWSHAW *et al.* 1997). Tracks can be used to monitor felids, but the correct discrimination between tracks of small felids is difficult (BECKER & DALPONTE 1999). Automatic camera-traps can provide reliable identifications, but these devices are relatively expensive for developing countries, and several models cannot handle the high humidity of tropical forests. Hair-traps, on the other hand, represent a cheaper alternative, and are less affected by the weather. The identification of the species can be done through microscopic analysis of the cuticle patterns of the guard hairs or through DNA analysis (WEAVER *et al.* 2005, KENDALL & MCKELVEY 2008). Moreover, passive methods such as camera-traps and hair snares can be installed in sites of difficult access, thus minimizing the possible bias in the area covered, a pitfall of other methods (WASSER *et al.* 2004).

There are several kinds of hair-traps, developed according to the target species or group (KENDALL & MCKELVEY 2008).

The most common snares used for felids consist of a rigid plate covered with short-napped carpet or hook-and-loop fasteners (e.g. Velcro™), and wires or nails attached to the carpet (WEAVER *et al.* 2005). These plates are used by the felids in their natural cheek-rubbing behavior, during which some hairs are snagged. However, in order to work properly, this method requires scented lures that attract the species, and also elicit the rubbing behavior (McDANIEL *et al.* 2000, WEAVER *et al.* 2005, KENDALL & McKELVEY 2008). The effectiveness of lures and snares varies among species, individuals and even among study sites (HARRISON 1997, THOMAS *et al.* 2005, CASTRO-ARELLANO *et al.* 2008, SCHLEXER 2008). For this reason, controlled tests of their efficiency are recommended before they are used in field studies (SCHLEXER 2008). Multiple studies have evaluated the efficacy of hair-snares with several lures on the Nearctic region (WEAVER *et al.* 2005, BERTRAND *et al.* 2006, McKELVEY *et al.* 2006, LONG *et al.* 2007, RUELL & CROOKS 2007) and in Central America (HARRISON 1997, DOWNEY *et al.* 2007, CASTRO-ARELLANO *et al.* 2008), but there are no published studies in South America. Therefore, the main objective of our study was to evaluate the effectiveness of three scent lures to attract six Neotropical felid species to hair snares, in one of the largest Atlantic Forest remnants in South America.

## MATERIAL AND METHODS

Catnip (*Nepeta cataria*, Lamiaceae), cinnamon, and vanilla were chosen as potential attractant scents. Catnip is commonly employed in this type of study (HARRISON 1997, McDANIEL *et al.* 2000, CASTRO-ARELLANO *et al.* 2008, SCHLEXER 2008), and cinnamon was successfully used by Niara Martins (per. comm.) to detect pumas, *Puma concolor* (Linnaeus, 1771), in a cerrado region of the Estação Ecológica do Jataí, Brazil. We found no previous studies that employed vanilla as a scent lure, but it proved to be effective in stimulating rubbing behavior in tests that we performed with captive felids.

How efficient these scents are in stimulating the rubbing behavior, and the capacity of the hair-snare to remove hairs were evaluated with captive felids using a methodology similar to that of HARRISON (1997). Using this test, we can assess the intensity of the interactions in captivity, and potentially associate them with the rate of detection of wild animals. The behavioral responses of ten ocelots, *Leopardus pardalis* (Linnaeus, 1758), seven margays, *Leopardus wiedii* (Schinz, 1821), six oncillas, *Leopardus tigrinus* (Schreber, 1775), six pumas, five jaguaroundis, *Puma yagouaroundi* (É Geoffroy Saint-Hilaire, 1803), and five jaguars, *Panthera onca* (Linnaeus, 1758) were evaluated, for all the three scents. To evaluate their responses, we provided, to each individual in an enclosure, wooden blocks sprayed with one of the lures, and then observed the animals for one hour, to record the occurrence and duration of the rubbing behavior. The total amount of time the animal spent rubbing on the block was used as a proxy for the efficiency of the lure. All scent lures were provided for all species and individu-

als, on different days, and the choice of the lure used was defined randomly. As a negative control, we repeated the tests providing only the wooden blocks with no lures. The non-parametric Friedman test was used to evaluate if there was a difference between interactions with each lure for each species. When significant differences occurred, Wilcoxon tests were used to compare the pairs.

Field tests were conducted in the Parque Estadual Pico do Marumbi (PEPM), state of Paraná, southern Brazil. This park has an area of more than 8,000 ha, located within the AEIT (Área de Especial Interesse Turístico) of Marumbi, an area of 66,732.99 ha of continuous Atlantic Ombrophylous Dense Forest, comprising low-slope, montane and high montane forests (MARQUES *et al.* 2011). In accord with Köppen's climate classification, the climate at the PEPM can be classified as Cfb – with cool summers and precipitation in all seasons (SEMA-IAP 1996). Field campaigns were conducted on July and August of 2009, and from April through July of 2010. We used hair-snare mobile stations like those described by DOWNEY *et al.* (2007) in seven transects of varying lengths, with three, six, nine or 12 snares per transect, comprising a total effort of 1,551 trap-days. Along each transect we deployed the same number of snares with each scent lure, evenly spaced, and revisited these sites after five or six nights, thus relocating the snares. The seven transects were never sampled consecutively. Hairs recovered from the snares were mounted on glass slides according to QUADROS & MONTEIRO-FILHO (2006), and identified by comparison of the microscopic structure of the cuticular and medullar patterns with those described by QUADROS & MONTEIRO-FILHO (2010). All the species included in the captivity tests occur in the PEPM (LEITE & GALVÃO 2002, CÁCERES 2004).

## RESULTS

In the tests performed in captivity, pumas did not interacted with any of the scent lures. The Friedman tests show significant differences between the scent lures and the negative control for the ocelot ( $\chi^2 = 16.9$ ,  $p = 0.0007$ ), margay ( $\chi^2 = 9.76$ ,  $p = 0.020$ ) and the oncilla ( $\chi^2 = 8.37$ ,  $p = 0.038$ ). Based on the Wilcoxon tests results (Table I), the ocelot interacted significantly more with cinnamon and vanilla than with catnip and the negative control, and the margay interacted more with vanilla than with catnip and the control, with no significant difference between the other scents. There were no differences between any pair of scents for the oncilla. Evaluating those species that interacted with at least one scent lure, vanilla can be considered the most effective substance in eliciting the rubbing behavior (Table I).

Hair snares yielded little success in the field tests, with no detection of felid species. Hairs of other mammals were recovered from the snares, including *Lontra longicaudis* (Olfers, 1818), *Cerdocyon thous* (Linnaeus, 1766), *Procyon cancrivorus* (G. Cuvier, 1798), *Sapajus nigritus* (Goldfuss, 1809), and one species that

Table I. Results of the Wilcoxon tests comparing pairs of stimulants for those species that had differences indicated by the Friedman test. Cinnamon (Cin), Vanilla (Van), Catnip (Cat), Control (Ctr). n = number of individuals.

	n	Cin/Van		Cin/Cat		Cin/Ctr		Van/Cat		Van/Ctr		Cat/Ctr	
		Z	p	Z	p	Z	p	Z	p	Z	p	Z	p
Ocelot	10	1.35	0.17	2.02	0.04	2.02	0.04	2.36	0.01	2.36	0.01	–	–
Margay	7	1.21	0.22	0.67	0.50	1.48	0.13	2.02	0.04	2.02	0.04	–	–
Oncilla	6	1.60	0.10	1.60	0.10	1.60	0.10	1.60	0.10	1.60	0.10	–	–
All species <sup>1</sup>	33	2.10	0.03	2.53	0.01	3.29	<0.001	3.54	<0.001	3.51	<0.001	1.27	0.20

<sup>1</sup> excluding *Puma concolor*.

could not be identified based on QUADROS & MONTEIRO-FILHO (2010). The respective attractants of these species are presented in Table II. Catnip and cinnamon were the only attractants in the field tests that had any success, while vanilla yielded no records.

Table II. Species recorded on the hair snares on Parque Estadual Pico do Marumbi, and the respective attractants. Cinnamon (Cin), Vanilla (Van), Catnip (Cat), (N) number of occurrences.

Species	Common name	N		
		Cin	Van	Cat
Primates				
Cebidae				
<i>Sapajus nigritus</i>	Capuchin monkey	–	–	1
Carnivora				
Canidae				
<i>Cerdocyon thous</i>	Crab-eating fox	–	–	1
Mustelidae				
<i>Lontra longicaudis</i>	Otter	1	–	–
Procyonidae				
<i>Procyon cancrivorus</i>	Crab-eating raccoon	1	–	–
Unidentified species				
		–	–	1
Total		2	–	3

## DISCUSSION

Due to the fact that no felid species was detected during our field tests, we could not evaluate the correlation between the intensity of responses in captivity with the efficiency of the scent lures to attract wild felids. In a similar study, HARRISON (1997) also could not make this kind of comparison due to the low success in felid detection. But considering all detected carnivorous species, HARRISON (1997) found a positive association between the intensity of the responses of felids in captivity and the attraction of carnivorous species in the field. On the other hand, in our study vanilla was an ineffective attractant in the field, despite eliciting the strongest responses in the tests with captive felids.

The lack of response by the wild species to the scent lures, in contrast to the prominent interaction of the captive individuals, can be a side effect of the different environmental conditions to which these animals are exposed. According to WELLER & BENNETT (2001), captive animals are often sedentary and less engaged in exploratory behaviors than their wild counterparts, probably due to the lower complexity and higher previsibility of captivity. This can undermine the motivation, opportunity, or the necessity of certain behaviors (MCPHEE 2002). Because of this lack of stimuli, when new attractants are introduced into the captive environments, they can elicit stronger behavioral responses than those observed in wild animals (TANÁS & PISULA 2011) or in more complex enclosures. In fact, in our study individuals maintained in less complex enclosures interacted more intensely with the scent lures than those kept in more enriched places (data not shown). By contrast, the captive pumas in our study (some of those maintained in poor enclosures) failed to respond to the stimulants. This is surprising given that this species was detected in the wild by other researchers using catnip (WEAVER *et al.* 2005, CASTRO-ARELLANO *et al.* 2008).

The failure to detect wild felids through hair snares, where they are known to occur, is not uncommon (THOMAS *et al.* 2005, DOWNEY *et al.* 2007, REED 2011). As in our study, several researchers had more success detecting generalist carnivores such as some canid, procyonid and ursid species (HARRISON 1997, THOMAS *et al.* 2005, DOWNEY *et al.* 2007, RUELL & CROOKS 2007). These groups are known to have better olfactory acuity than felids (GITTELMAN 1991), and therefore could be attracted to the snares sooner. According to DOWNEY *et al.* (2007), felids may avoid rubbing in snares already marked by other species, particularly where these other species occur at high densities. In our study, however, non-target species were seldom detected, and therefore it is unlikely that other species inhibited felid rubbing on the snares. However, even the human odor possibly present on the snares can hinder the approximation of felids (SCHLEXER 2008). Contrary to felids, which are known to avoid human contact (MARTINS *et al.* 2008), most of the species detected in our study (with the exception of the otter) are generalist-opportunists, and are acknowledged as being well adapted to anthropic environments (FACURE & MONTEIRO-FILHO 1996, SABBATINI *et al.* 2008, AGUIAR *et al.* 2011). Although we were care-

ful when transporting the snares in the field, avoiding unnecessary human contact, we cannot dismiss the possibility of human scents on the snares, given that we did not use gloves or odor removers. Commercial odor removers can be useful to avoid human odor in this kind of study, but they are not necessarily odorless to carnivores, a point that needs to be evaluated prior to their use.

The profitability of hair snares can also be associated with the study site and density of target species. In a study similar to ours, at Estação Ecológica do Jataí, the use of hair snares, with catnip and cinnamon as attractants, recovered a high number of hairs of *P. concolor* (Niara Martins, pers. comm.). A study conducted by MIOTTO *et al.* (2011) points to a high density of pumas at the Estação Ecológica do Jataí and surrounding areas, and although no similar studies have been conducted on PEPM, Atlantic Ombrophylous Dense Forests are known to support lower densities of medium and large sized mammals than other formations of the Atlantic Forest (GALETTI *et al.* 2009). The fact that no felid hairs were recovered in our study can indicate a low density of these animals at the PEPM, and the inefficiency of hair snares in detecting rare species when used for short periods of time.

The low efficiency of this method in detecting species that occurs at low densities becomes evident when we compare the studies performed by DOWNEY *et al.* (2007) and CASTRO-ARELLANO *et al.* (2008), both conducted in El Cielo Biosphere Reserve, Mexico. DOWNEY *et al.* (2007) had an effort of 1,920 trap-days, and detected only six species, four of those domestic animals, and was unable to detect felids. Using the same transects, but with a total effort of 8,149 trap-days, CASTRO-ARELLANO *et al.* (2008) registered 14 wild species, including four felid species. However, despite their success in detecting felids, only the mountain lion was detected more than 10 times. This comparison points to the necessity of great efforts to reliably assess rare species using hair snares.

The design of the trap can equally affect detection success. We designed a hair trap to be disguised in the environment. Felids are more responsive to visual than to olfactory attractants (SCHELEXER 2008), and several studies already used CDs and aluminum plates near the hair snares to visually entice felids (MCDANIEL *et al.* 2000, WEAVER *et al.* 2005, RUELL & CROOKS 2007). However, despite being frequently used, no study to date has evaluated the efficiency of visual attractants in improving the efficiency of hair snares, nor attempted to assess a possible negative impact of them. HARRISON (1997) and CASTRO-ARELLANO *et al.* (2008) had success using felt cloths hung above the snares, embedded with commercial trapping lures (Carman's Canine Call, Hawbaker's Wildcat lure #.1, Carman's Raccoon lure # 1; Minnesota Trapline Products). However, these commercial lures are sold only in North American countries, what hinders their use elsewhere.

Regardless of the lack of success of hair snares in the present study, and the different factors that can affect the outcomes of

this method, such as interference from non-target species, low abundance, and difficult attraction of some groups to the snares, we believe that this method is still useful. This technique has been used in North and Central America for the last 20 years (KENDALL & MCKELVEY 2008), and through continuous improvement it has contributed in wildlife assessments (CASTRO-ARELLANO *et al.* 2008), recording of species presence (BERTRAND *et al.* 2006) and population monitoring (MOWAT & PAETKAU 2002, DE BARBA *et al.* 2010). Therefore, we believe that, through proper improvements, this technique can prove to be useful for several kinds of studies on many species around the world.

## ACKNOWLEDGEMENTS

We thank T. Margarido and N. Benavicius from Zoológico de Curitiba, P. Mangini and H. Chupil from Criadouro Conservacionista Onça-Pintada, and J. Pereira and C. Adania from Associação Mata Ciliar for their support to our study on their respective institutions. R. Miotto and E. Monteiro-Filho made substantial comments on an early draft of this manuscript, and N. Martins for her contribution. We are also thankful to Diego Astúa and three anonymous reviewers for their suggestions. This study was part of a master's thesis at the Programa de Pós-Graduação em Ecologia e Conservação, and received support from IAP and CNPq by means of the fellowship 135204/2009-7 to TPP. We also thank CAPES for the fellowship to DRB, and CNPq/MCT for provided funding to FCP (grant 300466/2009-9) and MRP (grant 571334/2008-3).

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Submitted: 03.IV.2012; Accepted: 13.IX.2012.

Editorial responsibility: Diego Astúa de Moraes