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# Refined techniques for the analysis of Asiatic lion *Panthera leo persica* scats

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We improved the techniques for determining prey items based on hair characteristics from scats of the free-ranging Asiatic lion *Panthera leo persica* (Meyer, 1826) in terms of accuracy and time efficiency. Cuticular characteristics of hair are similar in many Indian prey species and are not species specific. A combination of hair characteristics, e.g. hair width, medullary structure, and medulla width expressed as per cent of hair width, are most useful to identify the common mammalian prey species. We found that examination of a minimum of 20 hairs/scat and 30 scats would provide a reliable estimate of the lion's diet based on the per cent occurrence of prey species hair in the scats.

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*Key words*: *Panthera leo persica*, scat, hair structure, prey items, India

## Introduction

Among food habit studies of carnivores, scat analysis has been widely used for describing diet because it is non-destructive and scats are easy to collect (Joslin 1973, Johnsingh 1983, Norton *et al.* 1986, Palmer and Fairall 1989, Windberg and Mitchell 1990). Cuticular and medullary characteristics of hair have been widely used for identifying prey species from the scats (Joslin 1973, Perrin and Campbell 1979, Keogh 1983, Palenik 1983). Some of the limitations of the use of scats in general and of cuticular characteristics for identifying species have been discussed by Norton *et al.* (1986) and Palmer and Fairall (1989).

Only a few studies have identified Indian mammals based on hair characteristics. Joslin (1973) reported that the crenate or flattened scale impressions, typical of most large Indian mammals were not specific even to the genus. Therefore, Joslin (1973) used cross section of hairs to examine the medullary pattern for identifying Indian mammals to estimate the lion diet. Other studies involved examination of the cuticular and medullary characteristics (Koppikar and Sabnis 1976) and distribution of hair keratin (Rajaram and Menon 1986) in some Indian mammals.

The purpose of this study was to determine variations in cuticular and medullary structures of hairs among body locations in various age classes of the

prey species and to compare scat analysis techniques based on hair structure, in terms of accuracy and time efficiency for the Asiatic lion *Panthera leo persica* (Meyer, 1826).

## Methods

Gir Wildlife Sanctuary and National Park (20°57'–21°20'N; 70°27'–71°13'E) extending for ca 1,400 $km^2$ in Gujarat state, western India, has the sole wild and free-ranging population of Asiatic lions. Major prey species for lions are chital *Axis axis*, sambar *Cervus unicolor*, nilgai *Boselaphus tragocamelus*, chinkara *Gazella gazella*, four-horned antelope *Tetracerus quadricornis*, wild pig *Sus scrofa*, domestic buffalo *Bubalus bubalis* and cattle *Bos taurus*. Scats of lions ($n$ = 2000) collected during a long-term study on the ecology of the Asiatic lions were used for this analysis (Chellam 1993).

Hair was collected from preserved and dried skins of each prey species kept at the Bombay Natural History Society Museum, Bombay, or from kills made by lions. We examined cuticular characteristics by preparing hair imprints in gelatin as described by Keogh (1983). Cuticular and medullary characteristics defined by Moore *et al.* (1974) were used for describing patterns for Indian mammals. We measured hair and medulla thickness for eight common lion prey species at the thickest portion, usually in the middle of the hair, by using an overhead projection microscope.

We determined variations in cuticular and medullary patterns and medulla thickness expressed as per cent of hair width for each body location and age class for chital from skins. We classified chital skins in three age categories: fawn – < 6 months, sub-adult – 6–24 months, and adult – > 24 months. Twenty hairs were collected from six different body locations in various age classes. Their cuticular and medullary patterns, were examined and measurements of hair and medulla thickness were taken.

Observation area-curve (Odum and Kuenzler 1955) was used to estimate the minimum number of hairs/scat and the minimum number of scats that need to be examined for determining the lion's diet.

## Results and discussion

In chital, the mean (± SE) maximum hair thickness, based on the six different body locations, was 0.067 ± 0.0004 mm in 4 fawns, 0.086 ± 0.0005 mm in 5 sub-adults, and 0.084 ± 0.0007 mm in 3 adults. A two-way analysis of variance of the maximum hair thickness revealed statistically significant differences among body locations ($p < 0.001$), age classes ($p < 0.001$) and body locations × age class interaction ($p < 0.001$). Despite significant differences in hair thickness among age classes, the mean medulla thickness expressed as per cent of hair width in skins of chital of various age classes was 65.3 ± 0.5 in fawns, 67.5 ± 0.4 in sub-adults and 66.7 ± 0.5 in adults. Differences in medulla thickness expressed as percent of hair width were statistically significant ($p < 0.001$) only between fawns and adults.

Examination of cuticular pattern revealed a high degree of variation (12–87% of all samples) in scale patterns at the tip compared with the basal and middle (0–4% of all samples) portions of the hair in chital of various age classes. Variations in cuticular pattern over the length of the hair were also reported in the prey species of leopard *Panthera pardus* in south-western Cape Province (Norton *et al.* 1986). Medullary pattern of hair of chital of various age classes were however consistent over most part of the hair.

Hair cuticular characteristics of the common prey species of lion revealed that scale patterns are either irregularly waved or an irregularly waved mosaic with rippled or smooth margins (Table 1). Medullary patterns in prey species were either amorphous, unbroken with cortical intrusion or unbroken latticed (Table 1).

Mean hair width of eight prey species ranged from 0.03 to 0.21 mm whereas medulla thickness expressed as per cent of hair width was between 38% and 87% (Fig. 1). A one-way analysis of variance among prey species revealed statistically

Table 1. Hair cuticular and medullary patterns of some common prey species of the Asiatic lion (*Panthera leo persica*).

| Prey species | Cuticular characteristics | | Medullary pattern |
|---|---|---|---|
| | Margin | Scale pattern | |
| Cow | rippled | irregular waved | amorphous |
| Buffalo | rippled | irregular waved | amorphous |
| Sambar | rippled | irregular waved | unbroken lattice |
| Chital | smooth | irregular waved mosaic | unbroken lattice |
| Nilgai | smooth | irregular waved | amorphous |
| Chinkara | smooth | irregular waved mosaic | unbroken with cortical intrusions |
| Chowsingha | rippled | irregular waved | unbroken with cortical intrusions |
| Wild pig | Good imprints could not be obtained | | amorphous |

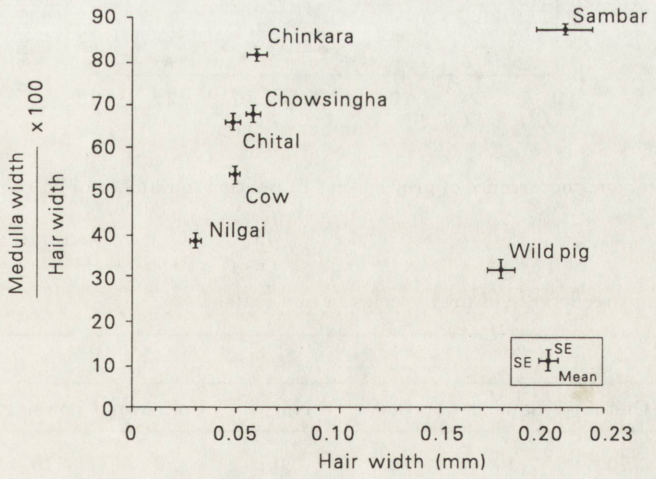


Fig. 1. Relationship between hair width and medullary thickness as per cent of hair width in common prey species of Asiatic lion.

significant differences in hair thickness ($p < 0.001$) and per cent medulla thickness ($p < 0.001$). The relationship between hair thickness and medulla thickness for the prey species showed complete separation of species from each other except between chowsingha and chital (Fig. 1). However, the two species can be differentiated by using their medullary pattern. A combination of hair thickness, medullary pattern and per cent medulla thickness appears to be a better method for identifying the hair of medium to large-sized Indian mammals than using cuticular characteristics alone.

For the determination of the minimum number of hairs that need to be examined per scat, our analysis of 10 scats revealed that per cent frequency occurrence of prey species were similar beyond 5 (single prey species) and 15 hairs (multiple prey species) in lion scats (Fig. 2). However, to be conservative, a minimum of 20 hairs per scat should be examined to obtain more reliable estimates of the per cent occurrence of prey species in lion scats.

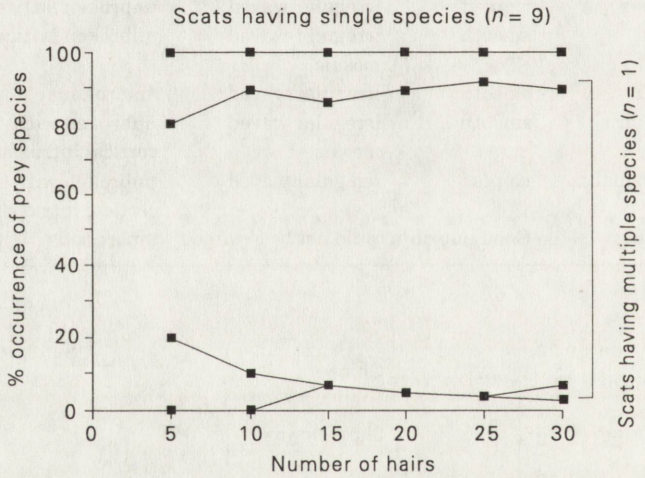


Fig. 2. Per cent frequency occurrence of prey species in relation to number of hairs examined per scat.

Table 2. Per cent occurrence of prey species in lion scats.

| Number of scats | Species | | | | | | |
|---|---|---|---|---|---|---|---|
| | Chital | Sambar | Cow | Nilgai | Unknown | Chowsingha | Wild pig |
| 10 | 70 | 10 | 0 | 0 | 0 | 10 | 10 |
| 20 | 70 | 25 | 5 | 15 | 5 | 9 | 10 |
| 30 | 67 | 20 | 13 | 13 | 7 | 8 | 5 |
| 40 | 65 | 25 | 15 | 12 | 12 | 8 | 4 |

Occurrence of prey species suggests that 72% of scats contained single prey species while the remaining have 2 to 5 prey species. Our analysis, in increments of 10 from 10 to 40 randomly chosen samples revealed a similar per cent frequency occurrence of prey species above 20 scats (Table 2). Although a minimum of 20 scats seems to be sufficient to determine the lion diet in Gir, we feel that 30 scats will yield a more reliable estimate of its diet based on the per cent occurrence of prey species in the scats. In a study on coyote diet estimation in Texas, Windberg and Mitchell (1990) reported that percentages of prey were generally similar with sub-samples of 30 scats and they used 50 scat samples for obtaining a more reliable estimate of coyote diet. Seasonal and temporal factors are likely to influence the diet of predator, the number of scat of the recommended sample size should ideally be collected within a season and in a particular area to enable the accurate determination of the carnivore's diet. A combination of hair thickness and medullary characteristics was more accurate, and required 74% less time in identification of hair of Indian mammals from scats, than using hair cuticular characteristics alone.

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