

Identification of dorsal guard hairs of five species of the family Cercopithecidae (Primates: Mammalia)

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Mammalian hairs have certain advantages from the viewpoint of taxonomy and systematics. Consequently, tricho-taxonomic studies of different mammalian species have been carried out by many workers. But scanty information is available in India regarding the tricho-taxonomic study of species belonging to Order Primates. The main objective of the present study is to develop an identification key to identify the species on the basis of the study of their hairs. This study may help agencies engaged in controlling illegal trade of wildlife and its derivatives towards better management of wildlife. Dorsal guard hairs of five species belonging to the sub-family Colobinae, family Cercopithecidae have been studied. The key has been prepared on the basis of a combination of characters, viz. transverse section, medullary configuration, cuticular structures and measurements.

Keywords: Dorsal guard hair, identification key, primates, tricho-taxonomy, wildlife management.

TAXONOMIC studies of the hairs of primates have been made, with a focus on the relationship between mammalian (guard) hair diameter and body mass at several taxonomic levels (inter-ordinal, intra-familial, intra-genic and intra-specific)¹. Studies on Hungarian Mustelidae have shown that qualitative and quantitative characters along with statistical analysis are required for preparation of the key necessary for ecological and faunistic research like food analysis from scats, track analysis, collecting hairs from baiting sites, burrows, traps, etc.².

Both macro- and micro-structures of the external surface along with the internal structure are necessary for analysis of dorsal guard hairs³. Meyer *et al.*⁴ also studied cuticle pattern of primary hairs of 94 mammalian species from seven orders and found relevant relationships for scale area, scale perimeter, ratio of scale width to height, and subsequent relationships between scale-dependent parameters and hair coat density. Architectonic and diagnostic significance of hair medulla and cortex of 354 mammalian species was studied using SEM, and Chernova⁵ proposed a consistent terminology along with sig-

nificance of structural patterns of cortex and medulla for taxon identification. Many works on other mammalian hairs have also been reported from India⁶⁻⁹, but least emphasis was given to the species belonging to the order Primates, except for a few studies^{10,11}.

All the five species in the present study, i.e. *Semnopithecus entellus*, *Trachypithecus geei*, *Trachypithecus pileatus*, *Trachypithecus johnii* and *Trachypithecus phayrei*, under the sub-family Colobinae are present in the National Zoological Collection of the Zoological Survey of India (ZSI), Kolkata. They have been included in the Schedules of Indian Wildlife (Protection) Act, 1972 as well as in CITES (Table 1).

A tricho-taxonomic study has been carried out on the species belonging to the genus *Semnopithecus* and *Trachypithecus*. The genus *Semnopithecus* has only one species, viz. *S. entellus* in India, whereas *Trachypithecus* has four species, viz. *T. geei*, *T. pileatus*, *T. johnii* and *T. phayrei*. According to Brandon Jones¹², *Trachypithecus* is considered as a sub-genus of *Semnopithecus*.

About 10–15 tufts of dorsal guard hairs from the mid-dorsal region were collected randomly from 5–6 specimens of each species. The samples are washed in acetone and kept in carbon tetrachloride overnight following the method of Chakraborty *et al.*⁷. Macroscopic study, i.e. diameter and total length were measured by dial calipers millimeter scale respectively and nomenclature of colour was after Ridgway¹³. Surface structure¹⁴, viz. scale pattern, scale margin, scale margin distance, scale count, side-to-side cuticular scale length (SS) and proximo-distal cuticular scale length (PD) of the hair was studied by casting the hair in clear varnish overnight. For medullary configuration and medullary index, the cleaned hair was mounted in a solution of xylene and DPX in 50 : 50 ratio, after Chakraborty *et al.*⁷. Hair cross-sections were made after Chakraborty *et al.*⁷. Different terminologies were followed according to Teerink¹⁵, and Brunner and Coman¹⁶.

According to the macroscopic and microscopic analysis, the dorsal guard hairs of *S. entellus* (Dufresne, 1797) commonly called langur, can easily be identified on the basis of the following characters.

Physical characters – Profile: Slightly wavy; colour: hair brown (females – olive brown); bands: none; length (mm): 35–45 (39.9 ± 4.4) and diameter (μ): 27–47 (39.6 ± 6.4).

Surface structure (Figure 1 a) – Scale pattern: irregular wave; scale margin distance: distant; scale margin:



Figure 1. *Semnopithecus entellus* dorsal guard hairs. *a*, Cuticular scales; *b*, Medulla, and *c*, Transverse section.

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Table 1. Comparative account of the characteristics of the guard hairs of five Indian species of sub-family Colobinae

| Species | Profile | Colour | Length (mm) | Diameter (μ) | Scale pattern | Scale margin distance | Scale margin | Scale count/mm hair length |
|--|----------------------------------|---------------------------------|---------------------------|----------------------------------|----------------|--|--------------|---------------------------------------|
| <i>Semnopithecus entellus</i> (Dufresne, 1797) | Slightly wavy | Hair brown | 35–45 39.9 \pm 4.4 | 27–47 39.6 \pm 6.4 | Irregular wave | Distant | Crenate | 125.22–132.3 (129.02 \pm 2.79) |
| <i>Trachypithecus pileatus</i> (Blyth, 1843) | Slightly wavy | Prout's brown | 36–56 (45.2 \pm 8.6) | 22–40 (30 \pm 7.4) | Regular wave | Distant | Smooth | 165.62–217.39 (187.55 \pm 19.46) |
| <i>Trachypithecus geei</i> (Khajuria, 1956) | Slightly wavy | Raw umber | 40–55 (48.5 \pm 5.8) | 15–26 (21 \pm 3.7) | Regular wave | Distant | Smooth | 122–131 (126.68 \pm 3.74) |
| <i>Trachypithecus johnii</i> (Fischer, 1829) | Slightly Wavy | Black | 42–48 (45.2 \pm 2.5) | 22–36 (29.3 \pm 5.6) | Regular wave | Distant | Crenate | 123–135.38 (128.13 \pm 4.84) |
| <i>Trachypithecus phayrei</i> (Blyth, 1847) | Slightly wavy | Tawny olive | 42–54 (48.8 \pm 4.6) | 10–30 (22 \pm 8) | Regular wave | Distant | Smooth | 122.5–133.3 (127.31 \pm 4.31) |
| Species | SS (μ) | PD (μ) | Medullary configuration | Medullary index | TS | Common name and status | | |
| <i>Semnopithecus entellus</i> | 11.6–14.4 (13.3 \pm 1.04) | 7.65–7.79 (7.73 \pm 0.058) | Simple | 0.72–0.75 (0.734 \pm 0.015) | Round | Langur IWPA–Sch II CITES–App I | | |
| <i>Trachypithecus pileatus</i> | 11.7–13.5 (12.74 \pm 0.76) | 5.6–6.1 (5.82 \pm 0.19) | Uniserial ladder | 0.17–0.20 (0.19 \pm 0.01) | Oval | Capped langur IWPA–Sch I CITES–App I | | |
| <i>Trachypithecus geei</i> | 7.8–9.4 (8.7 \pm 0.59) | 5.6–6.8 (6.16 \pm 0.44) | Interrupted | 0.62–0.67 (0.65 \pm 0.02) | Round | Golden langur IWPA–Sch I CITES–App I | | |
| <i>Trachypithecus johnii</i> | 7.75–9.95 (8.97 \pm 0.97) | 4.94–5.20 (5.06 \pm 0.09) | Interrupted | 0.25–0.28 (0.26 \pm 0.01) | Oval | Nilgiri langur IWPA–Sch I CITES–App II | | |
| <i>Trachypithecus phayrei</i> | 12.2–16.14 (13.98 \pm 1.55) | 5.56–6.67 (6.02 \pm 0.46) | Interrupted | 0.23–0.33 (0.27 \pm 0.04) | Oval | Phayre's leaf monkey IWPA–Sch I CITES–App II | | |

Mean and SD values are given in parenthesis. SS, Side-to-side cuticular scale length; PD, Proximo-distal cuticular scale length; TS, Transverse section.

crenate; scale count (per mm length of hair): 125.22–132.3 (129.02 \pm 2.79); SS: 11.6–14.4 (13.3 \pm 1.04 μ m), and PD: 7.65–7.79 (7.73 \pm 0.058 μ m).

Medulla (Figure 1b) – Medullary configuration: simple; medullary index: 0.72–0.75 (0.734 \pm 0.015).

Transverse section (Figure 1c) – Round.

In case of the genus *Trachypithecus*, the hair coat colour of most of the species is in different shades of brown and black. Colour of dorsal guard hairs of *T. pileatus* is Prout's brown (females – brown), and for *T. phayrei* it is Tawny olive (females – Prout's brown). However, both males and females of *T. geei* and *T. johnii* have raw umber and black coloured hair respectively. The hairs of all species are devoid of any bands. All four species have slightly wavy hair.

Average length of hair varied slightly in the four species: 45.2 \pm 8.6 and 45.2 \pm 2.5 mm in *T. pileatus* and *T. johnii* respectively, and 48.5 \pm 5.8 and 48.8 \pm 4.6 mm in *T. geei* and *T. phayrei* respectively. Average diameter of the hair also varied slightly from 30 \pm 7.4 μ m as maximum in *T. pileatus* and 21 \pm 3.7 μ m as minimum in *T. geei*. Table 1 shows that average diameter of *T. johnii* is 29.3 \pm 5.6 μ m and of *T. phayrei* is 22 \pm 8 μ m respectively.

The scale count per millimetre of hair length differs slightly in different species, except *T. pileatus* (187.55 \pm 19.46). Dorsal guard hairs of all species of *Trachypithecus* have 'regular wave' of scale pattern. *T. johnii* has 'crenate' scale margin (Figure 2g), whereas *T. pileatus*, *T. geei*, and *T. phayrei* have smooth scale margin (Figure 2a, d and j). However, all the species have 'distant' scale margin distance. SS does not vary considerably to a great extent among different species. It is almost the same in *T. geei* (8.74 \pm 0.94 μ m) and *T. johnii* (8.97 \pm 0.973 μ m), as well as in *T. pileatus* (12.74 \pm 0.76 μ m) and *T. phayrei* (13.98 \pm 1.55 μ m). PD is also more or less similar in all species, i.e. 6.12 \pm 0.54 μ m and 6.02 \pm 0.46 μ m in *T. geei* and *T. phayrei* respectively, and 5.82 \pm 0.19 μ m and 5.06 \pm 0.099 μ m in *T. pileatus* and *T. johnii* respectively.

The present study shows 'interrupted medulla' (Figure 2e, h and k) in *T. johnii*, *T. geei* and *T. phayrei*, but *T. pileatus* has 'uniserial ladder' (Figure 2b) medullary configuration. Smallest medullary index (0.192 \pm 0.0013) is found in *T. pileatus* and highest medullary index is found in *T. geei* (0.65 \pm 0.02). Transverse section of *T. geei* is 'round' (Figure 2f), whereas that of *T. pileatus*, *T. johnii* and *T. phayrei* is 'oval' (Figure 2c, i and l) in shape. Detailed observations are shown in Table 1.

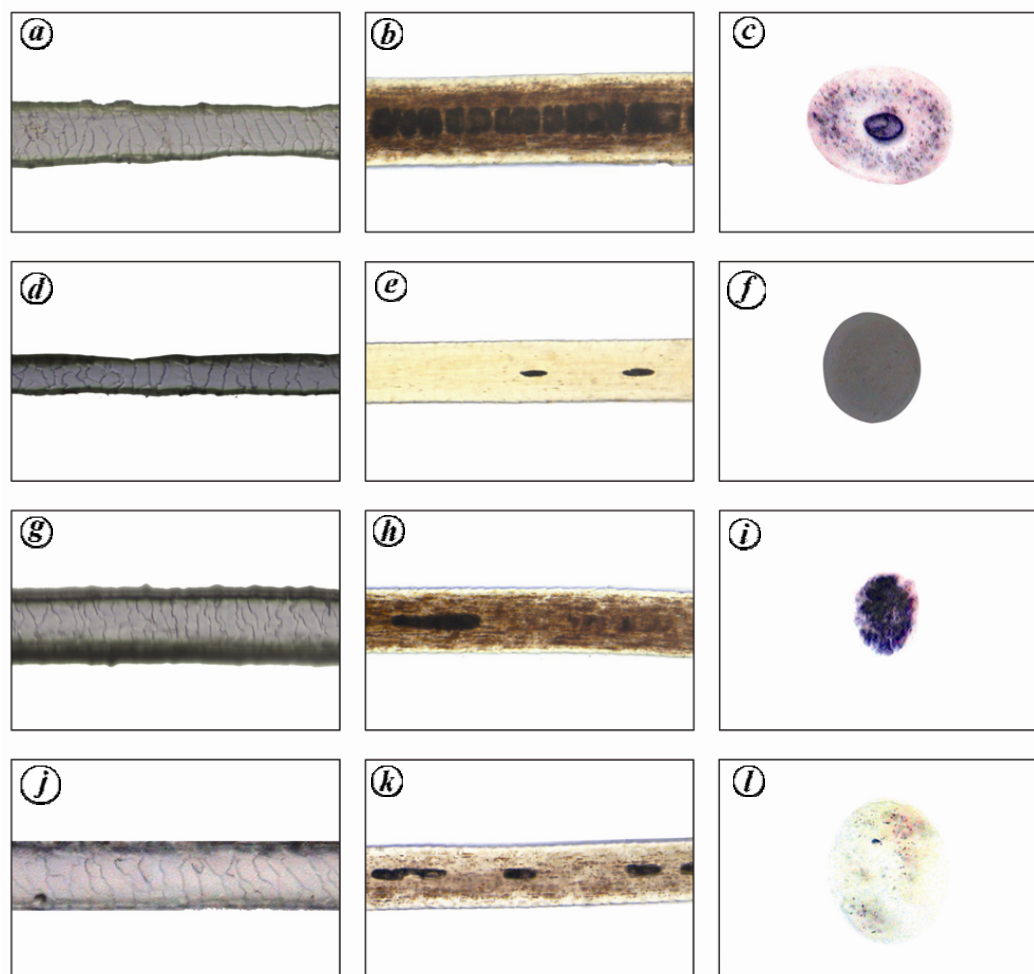


Figure 2. *Trachypithecus pileatus* dorsal guard hairs of (a) cuticular scales, (b) medulla and (c) transverse section. *Trachypithecus geei* dorsal guard hairs of (d) cuticular scales, (e) medulla and (f) transverse section. *Trachypithecus johnii* dorsal guard hairs of (g) cuticular scales, (h) medulla and (i) transverse section. *Trachypithecus phayrei* dorsal guard hairs of (j) cuticular scales, (k) medulla and (l) transverse section.

Table 2. Key to the genus *Trachypithecus*

| | |
|---|--------------------|
| Medullary index | |
| <0.50 | 2 |
| >0.50 | 5 |
| Scale margin | |
| Smooth | 3 |
| Crenate | 4 |
| Medullary configuration interrupted, scale pattern regular wave, TS oval and scale count/mm (127.31 ± 4.31) | <i>T. phayrei</i> |
| Medullary configuration uniserial ladder, scale count/mm (187.55 ± 19.46). TS oval, and regular wave of scale pattern | <i>T. pileatus</i> |
| Medullary configuration interrupted, scale pattern regular wave, TS oval and scale count/mm (128.13 ± 4.84) | <i>T. johnii</i> |
| Scale margin smooth, scale pattern regular wave, and scale count (126.68 ± 3.74) | <i>T. geei</i> |

From the tricho-taxonomic study it may be concluded that *Semnopithecus* and *Trachypithecus* are separate genera, as already mentioned by Wilson and Reeder¹⁷. Thus

detailed analysis of dorsal guard hairs of *S. entellus* is described separately from the rest of the langurs. Study of physical characters showed that variation of coat colour is not so important for critical identification of dorsal guard hairs of different species and may be taken into consideration with a combination of other characters because coat colour of mammals varies in different sexes, habitats and seasons. Diameter of the hair also varies widely and according to Short¹⁸, hair diameter is not specific and varies from root to tip. Similar observation has been made by Chakraborty and De⁸ in a study of hairs of species belonging to the family Viverridae. Analysis of scale shows that *S. entellus* has crenate scales, which is similar to the observation by Koppiker and Sabnis¹¹. Though these scalar characters have some variations, they cannot be used as identifying characters and may be considered along with other characters⁹. Medullary study shows the presence of medulla in all species of *Trachypithecus*, but simple or no medulla is found in dorsal guard hair of *S. entellus*. This also supports the findings of Koppiker and

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Sabnis¹¹, who concluded that medulla was not visible in any region of the dorsal guard hair of *S. entellus*.

On the basis of above-mentioned characters of the dorsal guard hairs, a key to identifying different species under genus *Trachypithecus* is presented in Table 2.

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