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Tricho-taxonomic Studies for Identification of the Rhesus Macaque, *Macaca mulatta* (Zimmermann, 1780) and Bonnet Macaque, *Macaca radiata* (E. Geoffroy, 1812) (Primates: Cercopithecidae)

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ABSTRACT: The dorsal guard hairs of two common macaque species of India, namely Rhesus macaque, *Macaca mulatta* (Zimmermann, 1780) and Bonnet macaque, *Macaca radiata* (E. Geoffroy, 1812) were examined using the optical light microscope for species identification. Significant differences were observed in cuticular and medullary characters of hair between the two species. The photo-micrographs and characters of hairs can be used as a ready-references for species identification of these two species.

Key words: Dorsal guard hair, macaques, morphological and microscopic characters.

INTRODUCTION

Possession of hair is one of the important characters to distinguish the mammals (Prater 1971). Most of the mammals' species are identified through their external morphology *i.e.* different coat colour, shape and profile of the animal. The mammalian (individual) hair also helps in identification, if external characters are lacking (Brunner & Comman 1974; Koppiker & Sabins 1976; Teerink, 1991). Details of hair structure based on a combination of physical and microscopic characters are helpful in the identification of species (Mayer 1952; Teerink 1991; Sahajibal 2010).

Tricho-taxonomic studies of mammalian fauna have been well documented *viz.*, Stains (1958); Brunner & Comman (1974); Moore *et al.* (1974); Koppiker & Sabins (1976); Teerink (1991); Wallis (1993); Bahuguna *et al.* (2010) Chakraborty & De (2010), *etc.* Study on the dorsal guard hair characters of macaque species is limited except a study by Sarkar *et al.* (2010).

There are nine species of macaque found in India, of which *Macaca mulatta* and *Macaca radiata* are considered as common in India. In general, both the species are medium-sized monkey, having a light pink or flesh-coloured face. The dorsal side is olive, and loins region, rump and base of tail are orange red in colour. The under parts are whitish. The crown hairs radiates outward and backward and forms small cap in Bonnet macaque and the characters difference from Rhesus macaque (Alfred *et al.* 2006; Menon 2014).

Macaques are traded mainly for local pet trade, sport, zoo exhibits, road shows, traditional medicine, and poached for body parts, and biological uses (Menon & Kumar 1999; Alfred *et al.*, 2006). The Bonnet macaque is endemic to India found in Southern India, Goa, Gujarat and Maharashtra, whereas the Rhesus macaque is distributed in North and North-eastern India. In the present study, the physical and microscopic characters of dorsal guard hair of the two common macaque species of India such as Rhesus Macaque, *Macaca mulatta* (Zimmermann, 1780) and Bonnet Macaque, *Macaca radiata* (E. Geoffroy, 1812) were examined to provide a complete combination of characters such as physical, cuticular, medullary and cross-sectional characteristics of hair with high resolution images for species identification.

MATERIAL AND METHODS

The dorsal guard hairs were collected from the mid-dorsal regions of three identified specimens of each species (*Macaca mulatta* and *M. radiata*), housed at the National Zoological Collections in Mammal and Osteology Section of Zoological Survey of India, Kolkata, India. The samples were treated with Acetone and Carbon tetrachloride to remove the dirt of exogenous materials. The physical characters of hairs (n=15) such as colour, number of bands, profile and colour of dorsal pelage were recorded. The cuticular characters of hair such as scale position, scale patterns, structure of scale margins and distance between scale margins, and medullary characters such as width composition, structure and form of margins of the medulla, and shape of cross-section of hair were examined under 300-400 X magnifications with help of the digital camera fitted on optical microscope (Olympus BX41). The methodology and nomenclature of hair characteristics is as per Brunner & Comman (1974); Teerink (1991).

Cuticle characteristics**:** *Transversal*- the scales lie at right directions and the width is bigger than their length; *Regular wave*- scales are mostly equal; *Irregular wave*- scales are dissimilar; *Smooth* – the margins of the scales without any interruptions; *Rippled*- the margins of the scales have a saw-toothed appearing edge with deeper indentations; *Distant* - the margins of the two sequential scales lie away from each other; *Near*– the distance between the margins of the two consecutive scales are neither too close nor too away from each other.

Medulla characteristics**:** *Unicellular*- the medulla is composed of a continuous single column of discrete cells formed by transversal position; *Ladder* - a continuous single column of cells interrupted with cortical matter and looks like a septa; *Intermediate*- a ladder pattern is sometimes so indistinct that a sort of 'wreathy' pattern; *Scalloped* - a series of convex, rounded projections form the margin of the medulla.

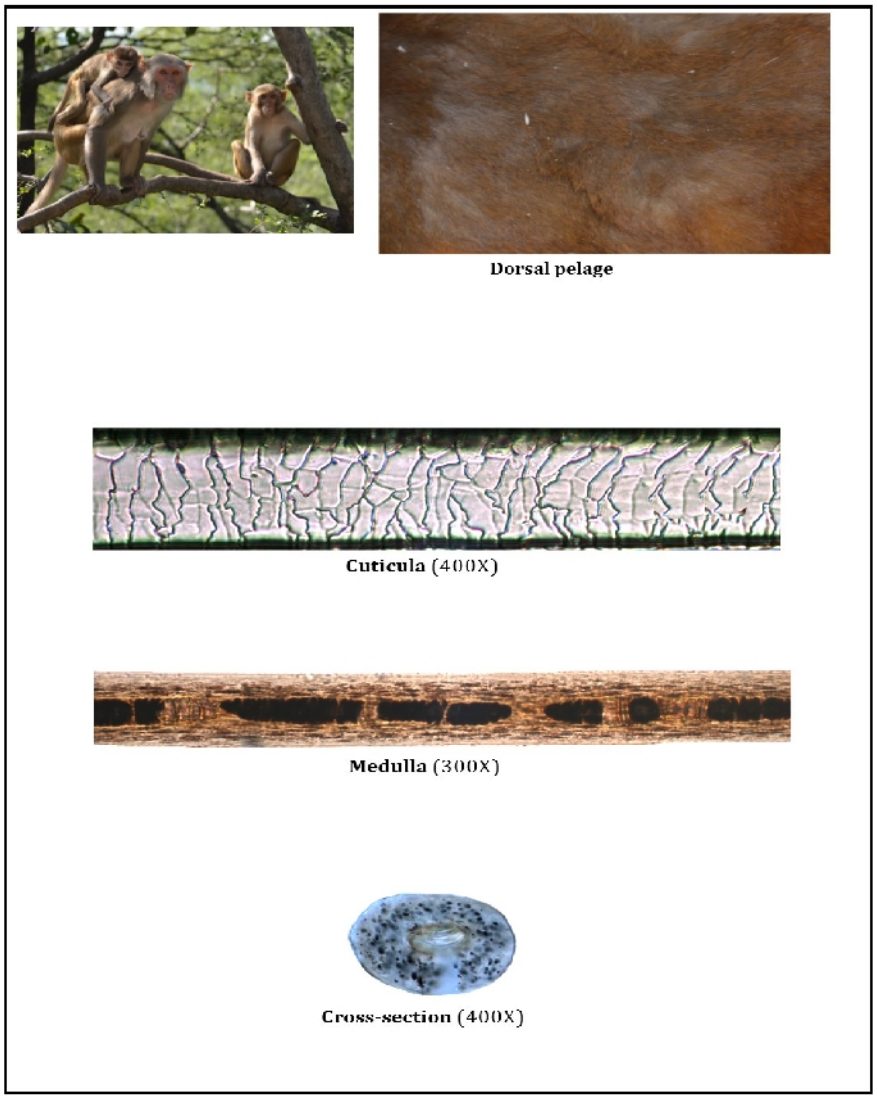

Fig. 1. Photo-micrograph of dorsal guard hair of Rhesus Macaque, *Macaca mulatta* (Zimmermann, 1780).

RESULTS AND DISCUSSION

Physical characters of both the species- *colour of dorsal pelage*: olive grey to grey brown; *colour of hair*: grey brown (unicoloured); bands: none; *profile*: undulated.

The Physical characters of hair may vary due to the physiological process, seasons, age, gender, *etc*. (Teerink 1991). However, the combination of characters and microscopic characters of hair can be used for identification of species.

Table 1. Comparative account of the characteristics of the dorsal guard hair of *Macaca mulatta* and *Macaca radiata.*

Species	***Colour of pelage***	***Colour of dorsal guard hair***	***No. of bands***	***Profile***	***Scale position***	***Scale patterns***	***Scale margin structure***	***Scale margin distance***
Macaca mulatta	Olive –grey brown	Grey brown (unicoloured)	None	Undulated	Transversal	Regular wave	Smooth	Distant
Macaca radiata	Olive –grey brown	Grey brown (unicoloured)	None	Undulated	Transversal	Irregular wave	Rippled	Near
Species	***Medulla composition***	***Medulla structure***	***Medulla margin***	***Cross- section***				
Macaca mulatta	Unicellular	Intermediate	Scalloped	Oval				
Macaca radiata	Unicellular regular	Ladder	Scalloped	Oval				

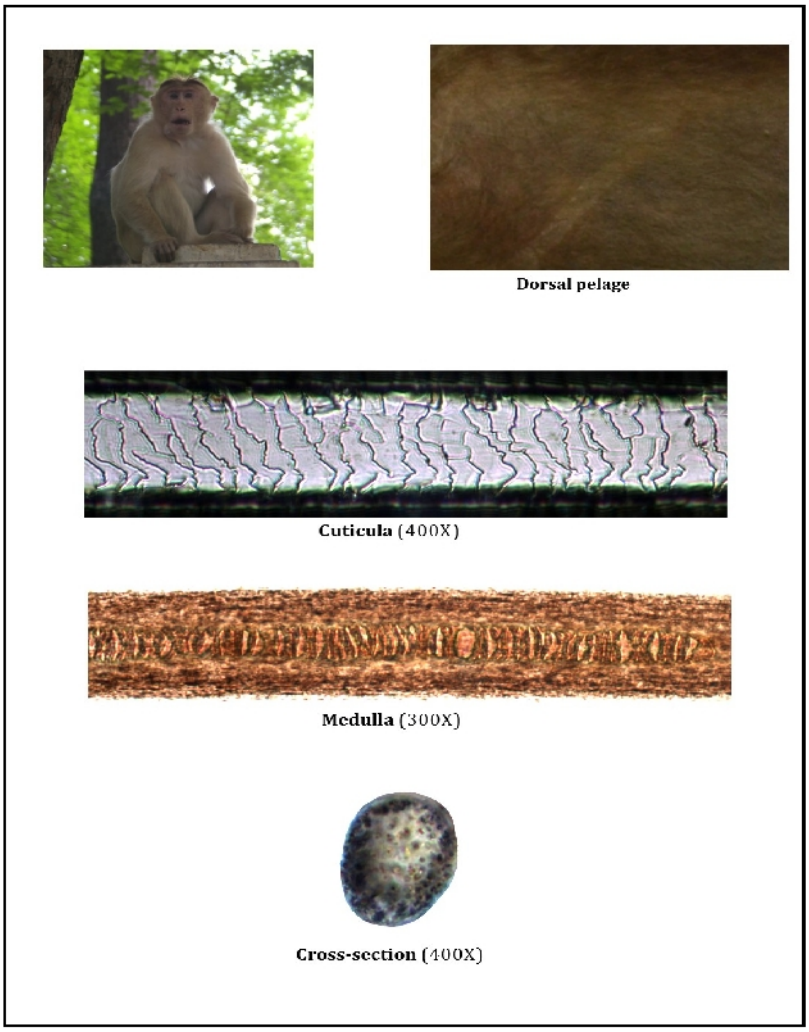

Fig. 2. Photo-micrograph of dorsal guard hair of Bonnet Macaque, *Macaca radiata* (E. Geoffroy, 1812).

The cuticular characteristics of the two species studied had shown significant variations. The scale positions- 'transversal' between the two species; scale patterns- 'regular wave' (*Macaca mulatta*) and 'irregular wave' (*M. radiata*); structure of scale margins- 'smooth' (*M. mulatta*) and 'rippled' (*M. radiata*); distance between scale margins- 'distant' (*M. mulatta*) and 'near' (*M. radiata*).

The composition of medulla- 'unicellular' (*M. mulatta*) and 'unicellular regular' (*M. radiata*); structure of medulla- 'intermediate' (*M. mulatta*) and 'ladder' (*M. radiata*); form of the medulla margins- 'scalloped' between the two species. The shape of cross-section had shown no variations between the species and it was observed as 'oval'.

The different cuticular and medullary characters determines the species identity between the two species. The similar observation were made by Sarkar *et al.* (2010). The shape of body and crown hairs are the major external characters differentiate the two species. In addition to that the characteristics of dorsal guard hair also be considered for differentiating the (*Macaca mulatta* and *M. radiata*) these species.

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