

Journal of Threatened Taxa

Building evidence for conservation globally

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

COMMUNICATION

THE IDENTIFICATION OF PIKA AND HARE THROUGH TRICHO-TAXONOMY (MAMMALIA: LAGOMORPHA)

Manokaran Kamalakannan, Kailash Chandra, Joy Krishna De &
Chinnadurai Venkatraman

26 August 2019 | Vol. 11 | No. 10 | Pages: 14301–14308

DOI: [10.11609/jott.4014.11.10.14301-14308](https://doi.org/10.11609/jott.4014.11.10.14301-14308)



For Focus, Scope, Aims, Policies, and Guidelines visit <https://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-0>

For Article Submission Guidelines, visit <https://threatenedtaxa.org/index.php/JoTT/about/submissions#onlineSubmissions>

For Policies against Scientific Misconduct, visit <https://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-2>

For reprints, contact <ravi@threatenedtaxa.org>

The opinions expressed by the authors do not reflect the views of the Journal of Threatened Taxa, Wildlife Information Liaison Development Society, Zoo Outreach Organization, or any of the partners. The journal, the publisher, the host, and the partners are not responsible for the accuracy of the political boundaries shown in the maps by the authors.

Partner



الصندوق محمد بن زايد
للمحافظة على
الحافلات الحية

The Mohamed bin Zayed
SPECIES CONSERVATION FUND

Member



Publisher & Host



THE IDENTIFICATION OF PIKA AND HARE THROUGH TRICHO-TAXONOMY (MAMMALIA: LAGOMORPHA)



Manokaran Kamalakannan¹ , Kailash Chandra² , Joy Krishna De³  &
Chinnadurai Venkatraman⁴ 

ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

^{1,2,3,4} Zoological Survey of India, Prani Vigyan Bhawan, Block M, New Alipore, Kolkata, West Bengal 700053, India.
¹ kamalakannanm1@gmail.com (corresponding author), ² kailash611@rediffmail.com, ³ jkdezsi@gmail.com,
⁴ cvrmanmbs@yahoo.com

PLATINUM
OPEN ACCESS



Abstract: The macroscopic and microscopic characters of dorsal guard hairs of Indian lagomorphs (four species of pikas and three species of hare) are described; the cuticular and medullary characters are similar between the species studied. The cuticular and medullary characters, however, are dissimilar between the family Ochotonidae and Leporidae. The cross-section of hair of the species had shown two identical shapes between the family Ochotonidae and Leporidae. The cross-section was observed as an oval shape in all the four ochotonid species, whereas there was a dumb-bell shape in all three leporid species. The hair of the Indian lagomorphs can easily be differentiated up to the family level on the basis of their unique cuticula, medulla and cross-section of the dorsal guard hair. The high-resolution microphotographs and key characteristics of hair that are presented here can be used as an appropriate reference for family-level identification of Indian lagomorphs.

Keywords: Cuticular, dorsal guard hairs, lagomorphs, medullary character, microphotographs.

DOI: <https://doi.org/10.11609/jott.4014.11.10.14301-14308>

Editor: Nishith Dhariaiya, HNG University, Patan, India.

Date of publication: 26 August 2019 (online & print)

Manuscript details: #4014 | Received 15 January 2018 | Final received 13 July 2019 | Finally accepted 31 July 2019

Citation: Kamalakannan, M., K. Chandra, J.K. De & C. Venkatraman (2019). The identification of pika and hare through tricho-taxonomy (Mammalia: Lagomorpha). *Journal of Threatened Taxa* 11(10): 14301–14308. <https://doi.org/10.11609/jott.4014.11.10.14301-14308>

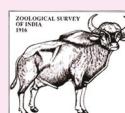
Copyright: © Kamalakannan et al. 2019. Creative Commons Attribution 4.0 International License. JoTT allows unrestricted use, reproduction, and distribution of this article in any medium by adequate credit to the author(s) and the source of publication.

Funding: Ministry of Environment, Forest and Climate Change, Govt. of India.

Competing interests: The authors declare no competing interests.

Author details: DR. M. KAMALAKANNAN is specialized in mammal taxonomy; he is currently working as Senior Zoological Assistant at the Mammal & Osteology Section of Zoological Survey of India, Kolkata, India. His research interests lie on the taxonomic studies of mammal components housed in the National Zoological Collections, ZSI. He also specialized in identification of confiscated materials of mammals. He holds a PhD in Zoology for working on the tricho-taxonomy of Indian mammals. DR. KAILASH CHANDRA is currently the Director of Zoological Survey of India under the Ministry of Environment, Forest and Climate Change, Govt. of India. He has 37 years of research experience in the field of zoological research with special reference to taxonomy. He has also described several species and three genera of insects, new to science. DR. J.K. DE, was a former Senior Scientist of Zoological Survey of India and he was also served as a Scientific Officer at the West Bengal Zoo Authority, Kolkata. He is expertise on tricho-taxonomy of Indian mammals especially carnivores and primates. DR. C. VENKATRAMAN, is a Senior Scientist in Zoological Survey of India. Currently he is In-Charge of Mammal & Osteology section and Ecology and Conservation division. He is expertise on birds and mammals and surveyed many areas in Western Ghats as well as Eastern Ghats.

Author contribution: MK conducted the laboratory examinations, designed the study and prepared the manuscript. KC directed and encouraged the study and provided the necessary facilities to accomplish the work. JKD and CV supervised the study.



INTRODUCTION

Mammalian hair characters are one of the important features that can be used to identify the species when the external morphology is unable to help with identification in case only of a small part of the skin of the mammal is available (Teerink 1991; Chakraborty & De 2010). Tricho-taxonomy (the study of hair) is relatively significant in the study of the food habit of carnivores and is supportive of controlling the illegal trade of wildlife and its derivatives (Chakraborty & De 2010; Sahajibal et al. 2010). There are many researchers, viz., Mayer (1952), Stains (1958), Brunner & Comman (1974), Moore et al. (1974), Koppiker & Sabins (1976), Teerink (1991), Wallis (1993), Chakraborty & De (2010), and Dharaiya & Soni (2012), who have documented the different hair characters of mammals well. Least importance has been given to the species belonging to the order Lagomorpha, except for a few studies by Moore et al. (1974) and Teerink (1991).

The order Lagomorpha comprises of two living families: Ochotonidae and Leporidae. The family Ochotonidae comprises the pikas, under the single genus *Ochotona*; out of a total of 30 species worldwide, India has seven species. The family Leporidae includes hares and rabbits consisting of 61 species under 11 genera, of which India has four species under two genera (Wilson & Reeder 2005).

Ochotonids are distinguished by a small-sized body (head-body length: average 15cm) and weighing 70–300 g, having greyish-brown silky fur. Unlike leporids, the pikas lack a visible tail and have short rounded ears, short limbs, with the hind limbs being barely longer than the forelimbs (Vaughn et al. 2000; Smith 2008; Sokolov et al. 2009).

The leporids are distinguished by a medium-sized body (head and body length: 40–70 cm), long hindlimbs and feet, a small visible tail, and relatively long ears (up to 20cm in length). Most leporids are counter-coloured, with dark-coloured dorsal pelage and light-coloured ventral pelage. Pelage texture can be thick and soft or coarse and woolly (e.g., Hairy Hare) and may become increasingly sparse along the length of the ears. Rabbits and hares have short bushy tales, which are sometimes conspicuously marked, and the soles of their hind limbs are covered with hair (Nowak 1999; Vaughn et al. 2000; MacDonald 2001; Sokolov et al. 2009).

The above-mentioned morpho-taxonomic characters have differentiated the families Ochotonidae and Leporidae. The present tricho-taxonomy study, however, helps to differentiate the two families only with the help of hairs when morpho-taxonomy is unable to offer the

fruitful result (Teerink 1991; Chakraborty & De 2010).

METHODS

A bunch of dorsal guard hairs was collected from five, dry, preserved skins of four pika species, namely Ladakh Pika *Ochotona ladacensis* (Günther, 1875), Large-eared Pika *Ochotona macrotis* (Günther, 1875), Royle's Pika *Ochotona roylei* (Ogilby, 1839), and Moupin's Pika *Ochotona thibetana* (Milne-Edwards, 1871) of the family Ochotonidae, and three species of hare, namely, Hairy Hare *Caprolagus hispidus* (Pearson, 1839), Indian Hare *Lepus nigricollis* F. Cuvier (1823), and Woolly Hare *Lepus oïstolus* Hodgson (1840) of the family Leporidae, housed at the National Zoological Collections of Zoological Survey of India, Kolkata, India.

The morphological characters of hairs (n=20) such as colour, number of bands and profile of hairs were recorded, and the length and diameter of hairs were measured using a dial calliper (Mitutoyo). To study the cuticular characters, the acetone washed hair samples were placed over the varnish coated-microscopic glass slide and the dried hairs were dragged gently over it to leave the imprint of scales over the microscopic glass slide. To study the medulla characters, the hair samples were mounted over the microscopic glass slide using D.P.X. To study the shape of the cross section, the hair samples were hand sliced and mounted over the microscopic glass slide using D.P.X. The cuticular characters of hair such as scale position, scale patterns, structure of scale margins and distance between scale margins, the medullary characters such as width composition, the structure and form of margins of the medulla and the shape of cross-section of hairs were examined and photographed (400x magnifications) using a digital camera set onto an optical microscope (Olympus BX41).

To obtain the three-dimensional structure and a more detailed examination of cuticular scales of the hair, the scanning electron microscope (ZEISS EVO18 - special edition) was used. The cuticular structures of hairs were observed under the high magnifications 1630x and 2600x, and the observed cuticular structures of hairs were photographed.

The measurement data such as the maximum, minimum, mean and standard deviation of cuticular scales and medulla were obtained through the digital scale fitted on an optical microscope. The methodology was followed according to the descriptions provided by Brunner & Comman (1974) and Teerink (1991). The description of different terms of patterns used in the

results and discussion that have been given herewith were followed from Teerink (1991) and the nomenclature of colour was followed as per Ridgway (1886).

RESULTS

Family Ochotonidae

The pelage colour of four species of the family Ochotonidae show different shades of brownish-grey; however, the colour of single guard hairs that was observed was grey-buff. The hair of all four species were observed as bicoloured with two bands. The profile of the hair of all species had shown no variations and was observed as a wavy form (Table 1).

The mean length of hair significantly varied among the four species (range: 8.5–22.6 mm): the maximum length was recorded in *Ochotona roylei* (16.6±3.4 mm) and the minimum in *O. ladacensis* (11.7±1 mm), the mean length of hair of *O. macrotis* and *O. thibetana* were recorded as 15.6±4.7 and 16.3±3.1 mm, respectively (Table 1). The mean diameter of hair also significantly varied among the four species (range: 11.4–56.3 µm): The maximum diameter was recorded in *O. macrotis* (44.7±14.4 µm) and the minimum in *O. thibetana* (32.2±10 µm), the mean diameter of hair of *O. ladacensis* and *O. roylei* was recorded as 38.6±11.4 and 33.4±8.2 µm, respectively (Table 1).

The hair of four species had shown almost similar cuticular characters (Images 1 & 7) between the species: the scale position, scale patterns, the structure of scale margins and distance between scale margins were observed in all the four species as 'transversal', 'streaked' ('regular wave' in *O. thibetana*), 'smooth' and 'near',

respectively (Table 2).

The measurement values had shown significant variations among the four species, the mean scale count per millimetre length of hair (range: 69–201 µm) was highest in *O. ladacensis* (158±34.8 µm) and lowest in *O. roylei* (82.8±11.7 µm). The mean length of cuticular scales (range: 20–37.9 µm) was observed; as a maximum (35.9±1.2 µm) in *O. thibetana* and as a minimum (21.8±1.7 µm) in *O. ladacensis*. The mean width of cuticular scales (range: 4.3–13.6 µm) was highest in *O. ladacensis* (10.3±2.1 µm) and lowest in *O. thibetana* (6.3±1.7 µm) (Table 1).

The medullary characteristics of hair (Image 2) showed no variations between four species: the composition of medulla, the structure of medulla and medulla margins were observed as 'multicellular', 'isolated' and 'scalloped', respectively (Table 3).

The mean width of medulla (range: 27.1–47.8 µm) showed slight variations among the species. *Ochotona ladacensis* had the highest (45.1±1.1 µm) mean medullary width while the lowest (34.3±2.8 µm) was in *O. thibetana*. The mean medullary width of *O. macrotis* and *O. roylei* were recorded as 39.3±3 and 34.6±1.1 µm, respectively (Table 3).

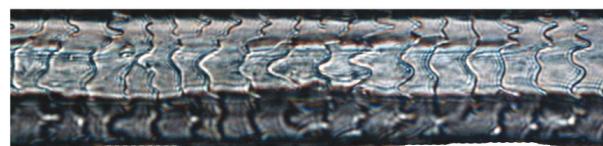
The cross-section of hair (Image 3) of the species showed similar shapes in the family Ochotonidae and was observed as an oval shape in all the four ochotonid species (Table 3).

Family Leporidae

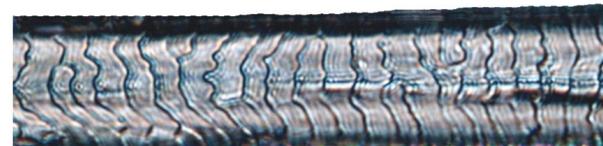
The pelage colour of the three species of the family Leporidae had shown different shades of blackish-grey and the colour of a single guard hair had also shown various shades of black yellow. The hair of all three

Table 1. Macroscopic characteristics of dorsal guard hairs of the species of the order Lagomorpha.

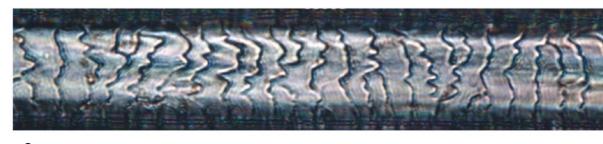
Species	Coat colour	Colour of hair	Base	Tip	No. of Bands	Profile	Length (mm)	Width (µm)
Family Ochotonidae								
<i>O. ladacensis</i>	Orangeish, sandy brown or grey	Bicoloured	Slate gray	Buff	2	Wavy	10.3–13.5 (11.7±1)	17.4–49.1 (38.6±11.4)
<i>O. macrotis</i>	Pale brownish-grey with an ochre tinge	Bicoloured	Gray	Buff	2	Wavy	8.5–21.6 (15.6±4.7)	18.1–56.3 (44.7±14.4)
<i>O. roylei</i>	Rufous grey	Bicoloured	Gray	Earth yellow	2	Wavy	11.6–22.6 (16.6±3.4)	18.1–41.2 (33.4±8.2)
<i>O. thibetana</i>	Rich russet brown	Bicoloured	Slate gray	Earth yellow	2	Wavy	13.1–22.6 (16.3±3.1)	11.4–40.1 (32.2±10)
Family Leporidae								
<i>C. hispidus</i>	Brown with black grizzled hair	Bicoloured	Black	Yellow	4	Slightly wavy	14.9–34 (27.5±6.6)	71.5–166.5 (113.2±39.6)
<i>L. nigriceps</i>	Reddish-brown with black hair	Bicoloured	Cream	Black	3	Wavy	12–23.2 (18.5±3.4)	64.1–109.2 (78.6±13.4)
<i>L. oiotolus</i>	Black grizzled with brownish-grey	Bicoloured	Pale yellow	Black	4	Wavy	10.3–33.2 (21.8±7.5)	36.1–76.1 (65.8±14.8)



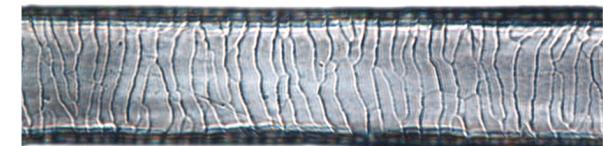
a



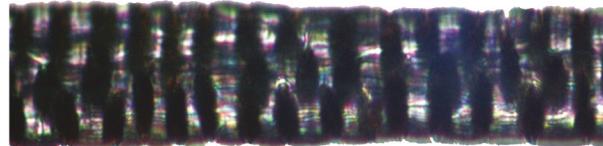
b



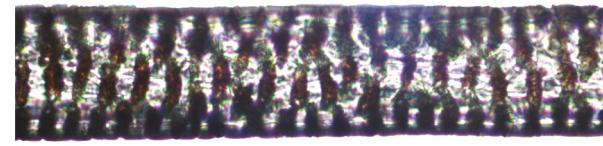
c



d



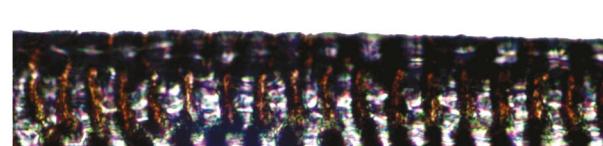
a



b



c



d

Image 1. Micro-photographs of cuticula (400 X) of dorsal guard hair:
a—*O. ladacensis* | b—*O. macrotis* | c—*O. roylei* | d—*O. thibetana*

Image 2. Micro-photographs of medulla (400 X) of dorsal guard hair:
a—*O. ladacensis* | b—*O. macrotis* | c—*O. roylei* | d—*O. thibetana*.

Table 2. Cuticular characteristics of dorsal guard hairs of the species of the order Lagomorpha.

Species	Scale position	Scale patterns	Structure of scale margins	Distance between scale margins	Scale count/mm length of hair	Length of scale (μm)	Width of scale (μm)
Family Ochotonidae							
<i>O. ladacensis</i>	Transversal	Streaked	Smooth	Near	104–201 (158±34.8)	20–26.3 (21.8±1.7)	6.7–13.6 (10.3±2.1)
<i>O. macrotis</i>	Transversal	Streaked	Smooth	Near	104–160 (139.6±18.5)	23.8–29.6 (27.4±1.6)	6.7–13.6 (9.4±2)
<i>O. roylei</i>	Transversal	Streaked	Smooth	Near	69–102 (82.8±11.7)	28.1–32.1 (30.6±1.4)	6.9–10.2 (8.1±1.4)
<i>O. thibetana</i>	Transversal	Regular wave	Smooth	Near	103–163 (125.8±18.3)	34.1–37.9 (35.9±1.2)	4.3–9.2 (6.3±1.7)
Family Leporidae							
<i>C. hispidus</i>	Transversal	Regular wave	Smooth	Near	176–226 (200.6±15.7)	88.7–116.2 (99.9±7.8)	7.4–11.4 (9.3±2.2)
<i>L. nigriventer</i>	Transversal	Regular wave	Smooth	Near	118–168 (137.9±14.2)	47.1–51.3 (49.3±1.3)	9.6–13.2 (12.2±1.3)
<i>L. oiotolus</i>	Transversal	Regular wave	Smooth	Near	135–160 (148.6±8.5)	34.6–40.8 (37.1±2.1)	14.2–15.1 (14.3±0.8)

species were observed as bicoloured with 3–4 bands. The profile of the hair had shown slight variations and was observed as slightly wavy in *C. hispidus*, and wavy in both *L. nigriventer* and *L. oiotolus* (Table 1).

The mean length of hair significantly varied among the three species (range: 10.3–34 mm): the maximum length was observed in *C. hispidus* (27.5±6.6 mm) and minimum

in *L. nigriventer* (18.5±3.4 mm), whereas the mean length of hair of *L. oiotolus* was recorded as 21.8±7.5 mm (Table 1). The mean diameter of hair also significantly varied among the three species (range: 36.1–166.5 μm): the maximum diameter was observed in *C. hispidus* (113.2±39.6 μm) and minimum in *L. oiotolus* (65.8±14.8 μm), whereas the mean diameter of hair of *L. nigriventer* was recorded as

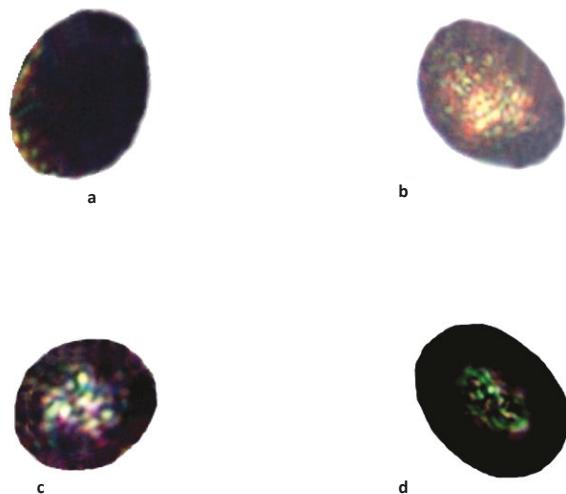


Image 3. Micro-photographs of cross-section (400 X) of dorsal guard hair: a—*O. ladacensis* | b—*O. macrotis* | c—*O. roylei* | d—*O. thibetana*.

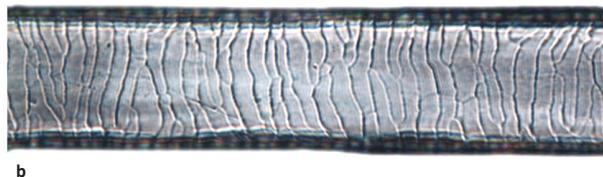


Image 4. Micro-photographs of cuticula (400 X) of dorsal guard hair: a—*C. hispidus* | b—*L. nigricollis* | c—*L. oiostolus*.

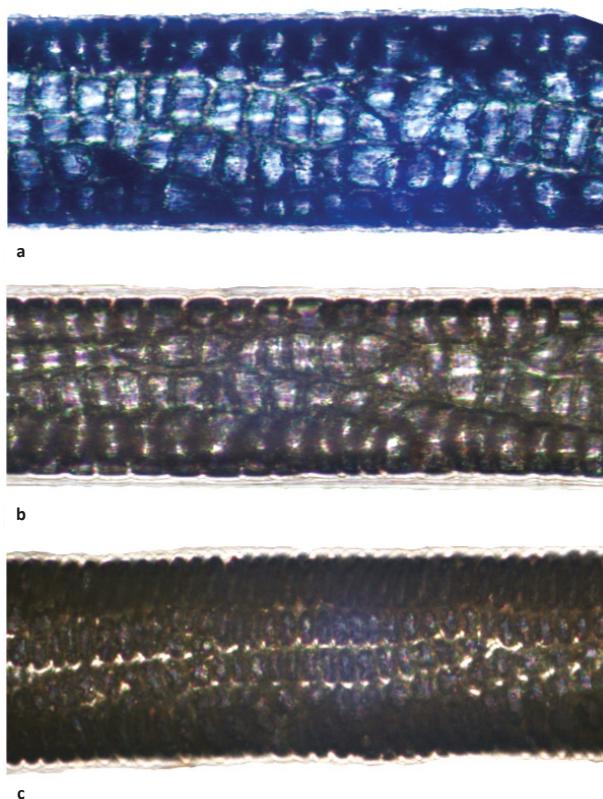


Image 5. Micro-photographs of medulla (400 X) of dorsal guard hair: a—*C. hispidus* | b—*L. nigricollis* | c—*L. oiostolus*.

$78.6 \pm 13.4 \mu\text{m}$ (Table 1).

The cuticular characteristics of hairs of all the three leporid species (Images 4 & 8) had shown no variations between the species and were observed with

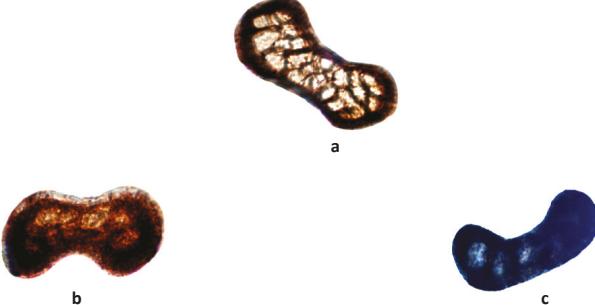
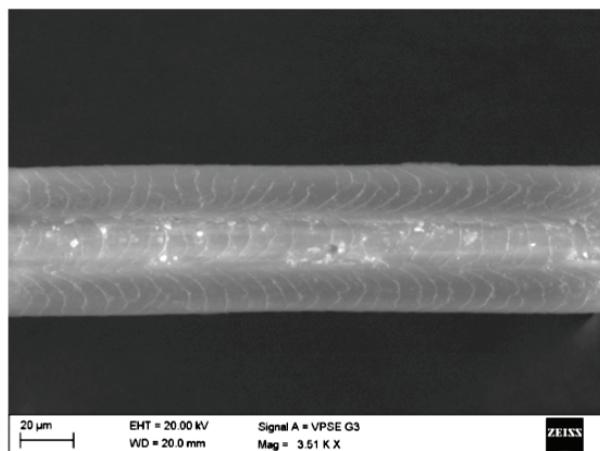


Image 6. Micro-photographs of cross-section (400 X) of dorsal guard hair: a—*C. hispidus* | b—*L. nigricollis* | c—*L. oiostolus*.

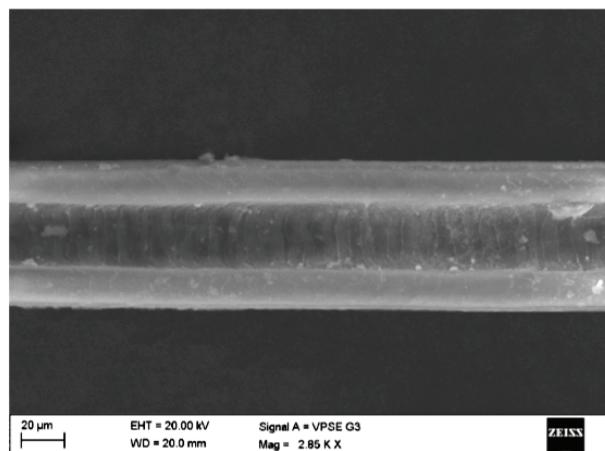
scale position- 'transversal', scale patterns- 'regular wave', the structure of scale margins- 'smooth' and distance between scale margins- 'near'. The measurement values had shown slight variations among the species, the mean scale count per millimetre length of hairs (range: 118-226 μm) were observed as maximum in *C. hispidus* ($200.6 \pm 15.7 \mu\text{m}$) and minimum in *L. nigricollis* ($137.9 \pm 14.2 \mu\text{m}$), whereas *L. oiostolus* was $148.6 \pm 8.5 \mu\text{m}$. The mean length of scale (range: 34.6-116.2 μm) was observed to be the highest in *C. hispidus* ($99.9 \pm 7.8 \mu\text{m}$) and the lowest in *L. oiostolus* ($37.1 \pm 2.1 \mu\text{m}$), whereas *L. nigricollis* was $49.3 \pm 1.3 \mu\text{m}$. The maximum and minimum of mean

Table 3. Medullary characteristics and shape of cross-section of dorsal guard hairs of the species of the order Lagomorpha.

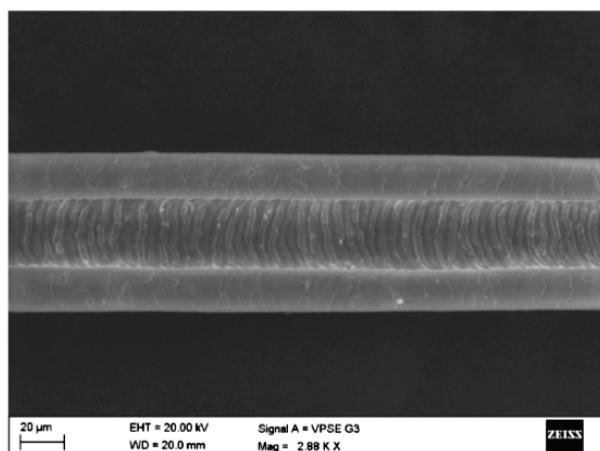
Species	Composition of medulla	Structure of medulla	Margins of medulla	Width of medulla (μm)	Shape of cross-section
Family Ochotonidae					
<i>O. ladacensis</i>	Multicellular	Isolated	Scalloped	44.1–47.8 (45.1±1.1)	Oval
<i>O. macrotis</i>	Multicellular	Isolated	Scalloped	34.6–45.6 (39.3±3)	Oval
<i>O. roylei</i>	Multicellular	Isolated	Scalloped	33.1–36.1 (34.6±1.1)	Oval
<i>O. thibetana</i>	Multicellular	Isolated	Scalloped	27.1–38.1 (34.3±2.8)	Oval
Family Leporidae					
<i>C. hispidus</i>	Multicellular in rows	Multiserial ladder	Scalloped	7.4–11.4 (9.3±2.2)	Dumb-bell
<i>L. nigricollis</i>	Multicellular in rows	Multiserial ladder	Scalloped	64.1–68.1 (65.9±1.2)	Dumb-bell
<i>L. oïostolus</i>	Multicellular in rows	Multiserial ladder	Scalloped	64.1–69.8 (66.9±2)	Dumb-bell



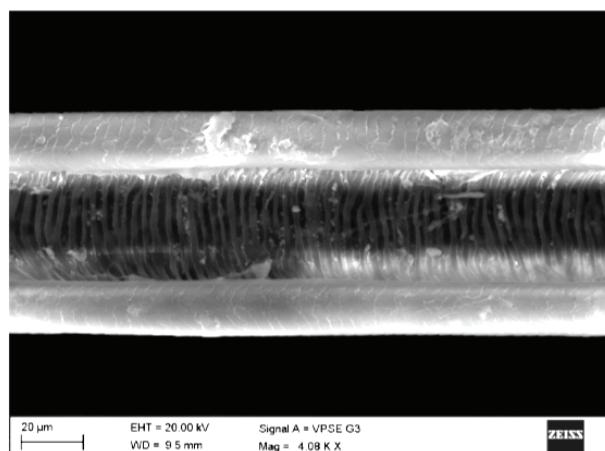
a



b



c



d

Image 7. Scanning electron micrographs of cuticula (400 X) of dorsal guard hair: a—*O. ladacensis* | b—*O. macrotis* | c—*O. roylei* | d—*O. thibetana*.

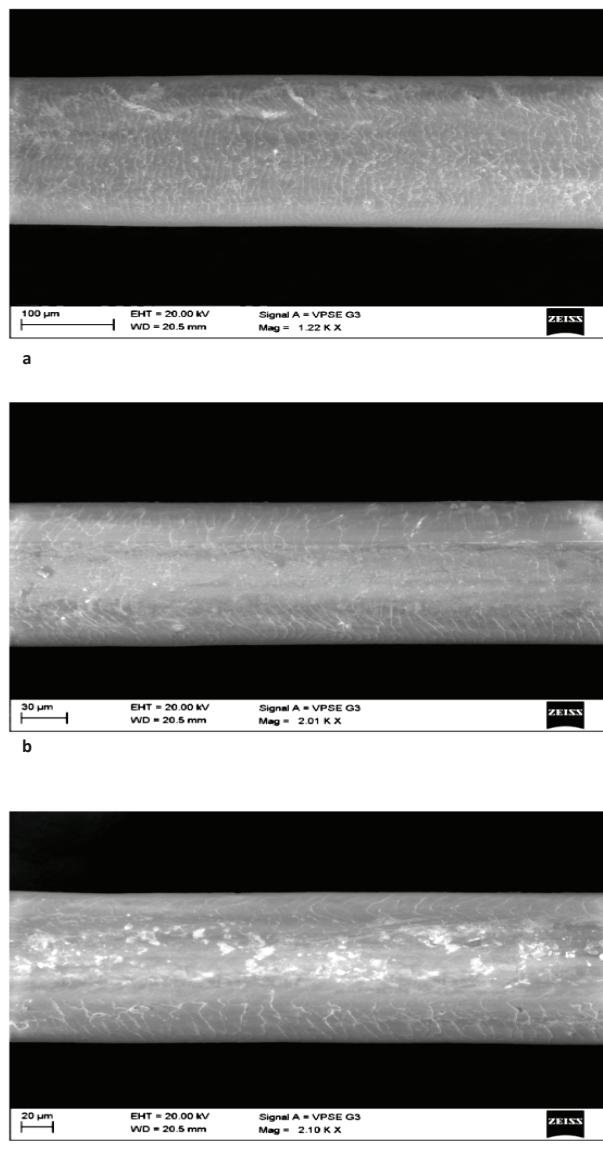


Image 8. Scanning electron micrographs of cuticula (400 X) of dorsal guard hair: a—*C. hispidus* | b—*L. nigricollis* | c—*L. oiotolus*.

scale width of hair (range: 7.4–15.1 µm) was recorded in *L. oiotolus* (14.3±0.8 µm) and *C. hispidus* (9.3±2.2 µm), respectively, where *L. nigricollis* was 12.2±1.3 µm (Table 2).

The medullary characteristics of the hair of three species (Image 5) had shown similar characters between the species and were observed as the composition of medulla- 'multicellular in rows', the structure of medulla- 'multiserial ladder' and 'medulla margins scalloped'. The mean width of medulla was observed to be the highest as 77.1±1.6 µm in *C. hispidus* and lowest as 65.9±1.2 µm in *L. nigricollis*, whereas *L. oiotolus* was 65.9±1.2, µm (Table 3).

The cross-section of hair of the species (Image 6) showed similar shapes in the family Leporidae and was observed as a dumb-bell shape in all the three leporid species (Table 3).

DISCUSSION

Family Ochotonidae

The pikas can be distinguished as the family of the order Lagomorpha by their specific cuticular scale pattern and unique medullary structure such as the different cuticular patterns. The multicellular composition of medulla and isolated structure of medulla of hair differentiates it from the other groups which is confirmed by comparing the previous study of Koppiker & Sabins (1976), Teerink (1991), Chakraborty & De (2010), Dharaiya & Soni (2012), Kamalakannan (2018, 2019). The hair characters, however, are similar between the four species studied. The hair characteristics of pikas of Wyoming, United States by Moore et al. (1974) reviewed that the identification hairs of pika up to the species level is difficult, as the microscopic characters of hairs are similar and the present study also supports the same.

Family Leporidae

The hare of the family Leporidae is one of the easiest to distinguish because of its specific cuticular scale position and pattern, and unique medulla structure and the dumb-bell shape of the cross-section. The transverse cuticular and multiserial ladder medulla patterns of hair differentiates it from the other groups of mammals (Chakraborty & De 2010; Sarkar 2011; Kamalakannan 2018, 2019). The above-mentioned characters are similar in all the three species. The present study shows that the result is consistent with the findings of hares that occur in Wyoming, United States by Moore et al. (1974) and western Europe by Teerink (1991).

According to Hoffmann & Smith (2005), the difference between the order Lagomorpha and Rodentia had been discussed first by Simpson (1945). Later, many morphological and molecular phylogeny studies supported the differences between the order Lagomorpha and Rodentia (Huchton et al. 1999). As mentioned earlier, the hares are often differentiated by external morphology from the pikas by the medium-sized body, and length of their tails and ears. The hares have a highly arched skull, pikas have a less arched skull; the hares have an upright posture of the head, strong hindlimbs and pelvic girdle, which the pikas lack (Vaughn et al. 2000; Sokolov et al. 2009). The dental formula (incisors, canines,

premolars and molars of the upper and lower jaw) also varies between these two groups as $2.0.3.3/1.0.2.3 \times 2 = 28$ and $2.0.3.2/1.0.2.3 \times 2 = 26$ in the hares and pikas, respectively (Sokolov et al. 2009). The present tricho-taxonomic study also shows the difference between the families Ochotonidae (pikas) and Leporidae (hares) under the order Lagomorpha by highlighting the unique characters of cuticula, medulla and cross-section.

Identification up to species level of the order Lagomorpha was difficult through tricho-taxonomic study, as all the four ochotonid species and three leporid species have similar microscopic characters between the species (Moore et al. 1974; Teerink 1991). The macroscopic characters of hair of mammals may also differ due to age, sex, season, climate, geographical variations, etc., especially since the pikas change pelage colour seasonally (Grange 1932; Nowak 1999; Vaughn et al. 2000; Grzimek 2003; Smith 2008). The macroscopic and microscopic characters (Table 1–3) and the microscopic photographs (Images 1–8) of dorsal guard hairs of lagomorphs would be helpful in the identification of species under the families Ochotonidae and Leporidae of the order Lagomorpha by considering the combination of all the characters of hairs.

CONCLUSION

It should be noted that very meagre information is available in the literature on tricho-taxonomic studies of species under the order Lagomorpha particularly as there is no tricho-taxonomic study in India. Thus, this study may be regarded as the first attempt from India.

Hare species are highly trafficked due to the local bush-meat consumption (Menon & Kumar 1999). They are the chief prey of small and large carnivores, similarly, pikas are also chief prey of small carnivores. Hence, the identification keys (provided here) would be useful in animal forensic science as well as in food habit analysis of carnivores.

REFERENCES

Brunner, H. & B. Coman (1974). *The identification of mammalian hair*. Inkata Press, Melbourne, Australia, 176pp.

Chakraborty, R. & J.K. De (2010). *Atlas on hairs Indian mammals. Part- I: Carnivora*. Zoological Survey of India, Kolkata, 141pp.

Dharaiya, N. & V.C. Soni (2012). Identification of hairs of some mammalian prey of large cats in Gir protected area, India. *Journal of Threatened Taxa* 4(9): 2928–2932. <https://doi.org/10.11609/JoTT.o3032.2928-32>

Grange, W.B. (1932). The pelages and color changes of the snowshoe hare, *Lepus americanus phaeotus*, Allen. *Journal of Mammalogy* 13: 99–116.

Grzimek, B. (2003). Artiodactyla (Even-toed ungulates). pp. 263–417. In: Hutchins, M., D. Kleiman, V. Geist, M. McDade (eds.) *Grzimek's Animal Life Encyclopaedia, Vol. 15, Mammals IV, 2nd Edition*. Farmington Hills, Michigan, USA: Gale Group, 480pp.

Kamalakannan, M. (2018). The identification of Takin *Budorcas taxicolor* (Mammalia: Bovidae) through dorsal guard hair. *Journal of Threatened Taxa* 10(15): 13014–13016. <https://doi.org/10.11609/jott.3357.10.15.13014-13016>

Kamalakannan, M. (2019). Characterization of dorsal guard hair of the wild goats and sheep (Bovidae: Caprinae) occurring in the Himalaya and Western Ghats of India. *Journal of Threatened Taxa* 11(3): 13304–13309. <https://doi.org/10.11609/jott.3344.11.3.13304-13309>

Koppiker, B.R. & J.H. Sabins (1976). Identification of hairs of some Indian mammals. *Journal of the Bombay Natural History Society* 73: 5–20.

Hoffmann, R.S. & A.T. Smith (2005). Lagomorpha, pp. 185–211. In: Wilson, D.E. & D.M. Reeder, D. M. (eds.). *Mammal Species of the World: A Taxonomic and Geographic Reference- 3rd Edition*. Johns Hopkins University Press, 2142pp.

Huchon, D., F.M. Catzeffis & E.J.P. Douzery (1999). Molecular evolution of the nuclear Willebrand factor gene in mammals and the phylogeny of rodents. *Molecular Biology and Evolution* 16: 577–589.

MacDonald, D. (2001). *The Encyclopaedia of Mammals*. Andromeda Oxford Limited, Oxford, 944pp.

Mayer, W.V. (1952). The hair of California mammals with keys to the dorsal guard hairs of California mammals. *American Midland Naturalist* 38: 480–512.

Menon, V. & A. Kumar (1999). *Wildlife Crime: An Enforcement Guide*. Wildlife Protection Society of India, New Delhi, 111pp.

Moore, T.D., L.E. Spence & C.E. Dugnolle (1974). *Identification of the dorsal guard hairs of some mammals of Wyoming*. Game and Fish Department, Wyoming, 177pp.

Nowak, R. (1999). Order Lagomorpha, pp. 1715–1738. In: Nowak, R. (ed.) *Walker's Mammals of the World, Vol. 2, 6th Edition*. Johns Hopkins University Press, Baltimore and London, 2015pp.

Ridgway, R. (1886). *Nomenclature of colours*. University Press, John Wilson and Son, Cambridge, 129pp.

Sahajibal, V., S.P. Goyal, K. Singh & V. Tahkur (2010). Dealing wildlife offences in India: Role of the hair as physical evidence. *International Journal of Trichology* 1: 18–26.

Sarkar, P.S., J.K. De & C.K. Manna (2011). Identification of dorsal guard hair of five species of the family Cercopithecidae (Primates: Mammalia). *Current Science* 100: 1725–1728.

Simpson, G.G. (1945). The principles of classification and a classification of mammals. *Bulletin of the American Museum of Natural History* 85: 1–350.

Smith, A. (2008). The world of pikas, pp. 89–102. In: Alves, P., N. Ferrand, K. Hackland (eds.) *Lagomorph Biology: Evolution, Ecology, and Conservation*. Springer-Verlag, Berlin, XVIII+414pp.

Stains, H.J. (1958). Field key to guard hair of middle western furbearers. *Journal of Wildlife Management* 22: 95–97.

Sokolov, V.E., E. Yu. Ivanitskaya, V.V. Gruzdev & V.G. Heptner (2009). *Lagomorphs- Mammals of Russia and Adjacent Regions*. Smithsonian Institution Libraries, Amerind Publishing Co. Pvt. Ltd, New Delhi, 400pp.

Teerink, B.J. (1991). *Hair of West-European Mammals Atlas and Identification Key*. Cambridge University Press, Cambridge, 223pp.

Vaughn, T., J. Ryan. & N. Czaplewski (2000). *Mammalogy, 4th Edition*. Brooks-Cole, Fort Worth, 672pp.

Wallis, R.L. (1993). A key for the identification of guard hairs of some Ontario mammals. *Canadian Journal of Zoology* 71: 587–591.

Wilson, D.E. & D-A.M. Reeder (Eds.) (2005). *Mammal Species of the World: A Taxonomic and Geographic Reference (3rd Edition)*. Johns Hopkins University Press, Baltimore, 1 & 2: 2141pp.





www.threatenedtaxa.org

PLATINUM

OPEN ACCESS



The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at www.threatenedtaxa.org. All articles published in JoTT are registered under Creative Commons Attribution 4.0 International License unless otherwise mentioned. JoTT allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

August 2019 | Vol. 11 | No. 10 | Pages: 14247–14390

Date of Publication: 26 August 2019 (Online & Print)

DOI: 10.11609/jott.2019.11.10.14247-14390

Editorial

Wildlife's Wonder Woman—Sally Raulston Walker (12 October 1944–22 August 2019)

— Sanjay Molur, Pp. 14247–14248

Communications

Species diversity and spatial distribution of amphibian fauna along the altitudinal gradients in Jigme Dorji National Park, western Bhutan

— Bal Krishna Koirala, Karma Cheda & Tshering Penjor, Pp. 14249–14258

The soft-release of captive-born Kaiser's Mountain Newt *Neurergus kaiseri* (Amphibia: Caudata) into a highland stream, western Iran

— Tayebe Salehi, Vahid Akmali & Mozafar Sharifi, Pp. 14259–14267

The status of waterbird populations of Chhaya Rann Wetland Complex in Porbandar, Gujarat, India

— Dhavalkumar Vargiya & Anita Chakraborty, Pp. 14268–14278

Diversity and temporal variation of the bird community in paddy fields of Kadhiramangalam, Tamil Nadu, India

— Chaithra Shree Jayasimhan & Padmanabhan Pramod, Pp. 14279–14291

First videos of endemic Zanzibar Servaline Genet *Genetta servalina archeri*, African Palm Civet *Nandinia binotata* (Mammalia: Carnivora: Viverridae) and other small carnivores on Unguja Island, Tanzania

— Helle V. Goldman & Martin T. Walsh, Pp. 14292–14300

The identification of pika and hare through tricho-taxonomy (Mammalia: Lagomorpha)

— Manokaran Kamalakannan, Kailash Chandra, Joy Krishna De & Chinnadurai Venkatraman, Pp. 14301–14308

Palynological analysis of faecal matter in African Forest Elephants *Loxodonta cyclotis* (Mammalia: Proboscidea: Elephantidae) at Omo Forest Reserve, Nigeria

— Okwong John Walter, Olusola Helen Adekanmbi & Omonu Clifford, Pp. 14309–14317

Avitourism opportunities as a contribution to conservation and rural livelihoods in the Hindu Kush Himalaya - a field perspective

— Nishikant Gupta, Mark Everard, Ishaan Kochhar & Vinod Kumar Belwal, Pp. 14318–14327

Pollination in an endemic and threatened monoecious herb *Begonia satrapis* C.B. Clarke (Begoniaceae) in the eastern Himalaya, India

— Subhankar Gurung, Aditya Pradhan & Arun Chettri, Pp. 14328–14333

Multivariate analysis of elements from the microhabitats of selected plateaus in the Western Ghats, Maharashtra, India

— Priti Vinayak Aphale, Dhananjay C. Meshram, Dyanesh M. Mahajan, Prasad Anil Kulkarni & Shraddha Prasad Kulkarni, Pp. 14334–14348

Partner



The Mohamed bin Zayed
SPECIES CONSERVATION FUND

The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at www.threatenedtaxa.org. All articles published in JoTT are registered under Creative Commons Attribution 4.0 International License unless otherwise mentioned. JoTT allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

August 2019 | Vol. 11 | No. 10 | Pages: 14247–14390

Date of Publication: 26 August 2019 (Online & Print)

DOI: 10.11609/jott.2019.11.10.14247-14390

Short Communications

Diversity of butterflies of the Shettihalli Wildlife Sanctuary, Shivamogga District, Karnataka, India

— M.N. Harisha, Harish Prakash, B.B. Hosetti & Vijaya Kumara, Pp. 14349–14357

First record of two rare brachyuran crabs: *Drachiella morum* Alcock, 1896 and *Quadrella maculosa* Alcock, 1898 along the Tamil Nadu coast, India

— Chinnathambi Viswanathan, Sampath Goutham, Vijay Kumar Deepak Samuel, Pandian Krishnan, Ramachandran Purvaja & Ramachandran Ramesh, Pp. 14358–14362

Records of the Marbled Cat *Pardofelis marmorata* and the Asiatic Golden Cat *Catopuma temminckii* (Mammalia: Carnivora: Felidae) from the community forests surrounding the Dzükou Valley in Nagaland, India

— Bhavendu Joshi, Biang La Nam Syiem, Rokohebi Kuotsu, Arjun Menon, Jayanta Gogoi, Varun Rshav Goswami & Divya Vasudev, Pp. 14363–14367

Rediscovery of *Calanthe davidii* (Orchidaceae) after 11 decades in the western Himalaya, India

— Ashutosh Sharma, Nidhan Singh & Pankaj Kumar, Pp. 14368–14372

Notes

Range extension of the Gooty Tarantula *Poecilotheria metallica* (Araneae: Theraphosidae) in the Eastern Ghats of Tamil Nadu, India

— Kothandapani Raman, Sivangnanaboopathidoss Vimalraj, Bawa Mothil Krishnakumar, Natesan Balachandran & Abhishek Tomar, Pp. 14373–14376

Some recent evidence of the presence of the Critically Endangered *Gyps* vulture populations in northern Shan State, Myanmar

— Sai Sein Lin Oo, Nang Lao Kham, Kyaw Myo Naing & Swen C. Renner, Pp. 14377–14380

Two new locations for the Vulnerable Black-necked Crane *Grus nigricollis* (Przhevalsky, 1876) (Aves: Gruiformes: Gruidae) in Arunachal Pradesh, India

— Rohan Krish Menzies, Megha Rao & Abhinav Kumar, Pp. 14381–14384

***Aquilaria malaccensis* (Malvales: Thymelaeaceae): a new host plant record for *Deudorix epijarbas cinnabarus* (Lepidoptera: Lycaenidae) in Malaysia**

— Kah Hoo Lau & Su Ping Ong, Pp. 14385–14387

Rediscovery of Nilgiri Mallow *Abutilon neelgerrense* var. *fischeri* T.K. Paul & M.P. Nayar (Malvaceae) after a century from southern India

— Varsha Vilasrao Nimbalkar, Arun Prasanth Ravichandran & Milind Madhav Sardesai, Pp. 14388–14390

Publisher & Host

Member

