DISCUSSION

Introduction

Tiger is a pride and having great socio-cultural relevance in tribal and nontribal communities in India. Being respected and worshiped, a number of folktales are associated with tiger in North Eastern India. Often tiger is associated with the surname of few tribes. On hearing of the death of a tiger, some tribes perform rituals, change dress codes for a few days. This is an indication of the place of a tiger in the social system of a number of tribes in India.

In North Eastern region and in other parts of India, the rural lifestyle and livelihood are supported and intermingled with the forests and other natural ecosystems. Hence the produces and services of the ecosystems are critical for the life of the communities in the rural and semi urban population. Tiger is a prized wild animal of India, and has been recognized as the top carnivore. Presence of tiger in a forest is a distinct indicative of the dynamic ecosystem and hence offers invaluable ecosystem services for the communities. Tiger helps in maintaining the forest dynamics and capable of maintaining balance between predator and prey.

The threat of the tiger population has been recognized since long but the gravity of the situation came only recently. Individual killing by poachers has been identified as more serious cause, which might be a deadly combination of degrading habitat in critical areas which is coupled with international dimensions of the demand for tiger body parts.

The tiger population in India was 1827 individual in the year 1972 and the present population is estimated to be 1706 individual in 2013. In 1972 Tiger Task Force was constituted under the chairmanship of Shri Karan Singh and submitted the report under the heading “Project Tiger: a planning proposal for preservation of tiger (Panthera tigris tigris) in India”. And on the recommendation of Tiger Task Force, Project Tiger was launched in 1973. India, apart from Bangladesh and Nepal is one of the last strongholds for the conservation of the Royal Bengal Tiger. As per government initiative, National Tiger conservation Authority (NTCA) has been
created in the year 2007 after the 6th amendment to the Wildlife (Protection) Act 1972 in the year 2006 wherein Chapter IV to deal with Tiger protection and conservation. At the same time Chapter IVC was also inserted and Tiger and Other Endangered Species Crime Control Bureau or Wildlife Crime Control Bureau (WCCB) was created. WCCB is entrusted to create a nationalized wildlife crime databank, collect and collate intelligence related to organized wildlife crime activities and disseminate the same to various enforcement agencies of States implementation of various international conventions, develop scientific and professional investigation and to advice Government of India in wildlife crimes.

The seriousness of the matter accelerates due to the killing of individual tiger, through poisoning of carcasses of the kill and by putting traps. Individual killing also adversely impact in the tiger family bonding. An important case was reported in January 2014 when a tigress becomes man-eater and mauls six humans to death after two of her cubs was trapped by poachers in Amangarh Tiger Reserve, Uttar Pradesh and beaten to death. Retaliatory killing of tiger by poisoning against cattle lifting has also been reported from various places of India including North East India.

Several nomadic tribes mainly Bawaria, Behaliya, Pardhi, Mongia, Sapera, Nath, Kalander and Kanjars are operating the Central and Northern India landscape and are poaching tiger for its body parts. These tribes used to travel to all the tiger reserves of the country for killing of the tiger, are good tracker of the tiger paths, and have expertise in locating the tiger.

As many as 534 tigers were killed/died or poached between 2000 to 2013 with an average death of 38 tiger per year. (TRAFFIC, INDIA)

The tiger were mostly poached for their skin, bone, canine, claws, fat, penis etc. mainly used in traditional Asian medicine, tonics and folk remedies (Nowell, 2000, Broad and Damania, 2009). The result of these poaching of individuals- creates other ecological and demographic problem to the species. The illicit demand of tiger body parts for use in Traditional Chinese Medicine (TCM), is aiding the unrelenting poaching of tiger in India. Death of female- having dependent cubs, jeopardize the life of young as they unable to feed themselves.
Moreover, the longevity of the tiger in the wild is much less than in captivity. In captive, it is around 25 years, whereas in the field it might be as low as 13/14 years, primarily because of the harsh life in the wild. Change in the composition of the prey base, and prey population is also influence the survivality of the individual in the field.

The gravity of the threat could very well be ascertained by the type and quantity of the seizure of the tiger body parts in the region.

Seizures of Tiger body parts from N.E. India (Source-TRAFFIC –INDIA)

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Year</th>
<th>Place</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2001</td>
<td>Lawngtali, Mizoram</td>
<td>Bones (6.28 kgs)</td>
</tr>
<tr>
<td>2</td>
<td>2005</td>
<td>Tezpur, Assam</td>
<td>Skin (1 no.)</td>
</tr>
<tr>
<td>3</td>
<td>2005</td>
<td>Jonai, Assam</td>
<td>Skin (1 no.) Bones (4.5 kgs)</td>
</tr>
<tr>
<td>4</td>
<td>2006</td>
<td>Hojai, Assam</td>
<td>Bones</td>
</tr>
<tr>
<td>5</td>
<td>2007</td>
<td>Jonai, Assam</td>
<td>Skin (1 pc)</td>
</tr>
<tr>
<td>6</td>
<td>2007</td>
<td>Barpeta Road, Assam</td>
<td>Canine</td>
</tr>
<tr>
<td>7</td>
<td>2009</td>
<td>Guwahati, Assam</td>
<td>Bone (1)</td>
</tr>
<tr>
<td>8</td>
<td>2009</td>
<td>Bongyang, Manipur</td>
<td>Skull (4 pcs) Paw (2 pcs) Bones (16 kgs)</td>
</tr>
<tr>
<td>9</td>
<td>2009</td>
<td>Orang, Assam</td>
<td>Skin (2 pcs)</td>
</tr>
<tr>
<td>10</td>
<td>2010</td>
<td>Numuk district, Arunachal Pradesh</td>
<td>Carcass (1)</td>
</tr>
<tr>
<td>11</td>
<td>2010</td>
<td>Kaziranga National Park, Assam</td>
<td>Skull &amp; Bone (20 kgs)</td>
</tr>
</tbody>
</table>

Preventing poaching by apprehending the suspected poacher and initiating appropriate legal arbitration is a time taking and evidence dependent exercise. Any loophole in putting the evidence in the court of law will jeopardize the whole exercise and resulting in acquittal of often habitual poachers. This becomes, on one side a futile exercise in punishing the guilty, but acquittal of a poacher after a long legal exercise also frustrates the otherwise efficient officer.
A number of stages and steps are to be followed in investigation of poaching case. The following steps are normally being followed.

| Stage –I : | Seizure of contraband items |
| Stage-II : | Looking for corroborative evidences from Scene of crime |
| Stage III: | Investigation of the case |
| (i) Forward linkage | (a) Contraband seized without the criminal  
| | (b) Contraband seized along with suspected criminal  
| | (c) Collection of evidences (name of other associates, mobile number, any digital stamping etc.) |
| (ii) Backward linkage | (a) Tracing the location of the poaching  
| | (b) Collection of corroborative evidences. (collection of hair, other remnants of animals, meat, viscera, scat tool for poaching etc.) |

Stage IV: Examination of seized items by forensic or other scientific authority  
Stage V: Trial in the jurisdictional court.

The successful identification of the origin of the body parts is a critical component in formulating a full proof strategy of presenting the scientific evidence in the court of law. This remains a challenge in the scientific and legal field in India.

Hair was found to an important tool for identification of species in the forensic science. Several studies were initiated by De and Chakraborty, (1995), Chakraborty et al. (1996, 1999) De et al. (1998) and Sahajpal et al., (2009) but still a habitat specific study of the tiger population based on the variation in terms of Guard hair architectonic has not yet been explored, which still remains a lacuna in overall understanding the hair architectonic to fulfill the legal requirements.

The present study has identified some of the critical parameter from of the guard hairs as a tool for clearing the ambiguity in offering evidence in legal requirement in the arbitration process in punishing the poachers.
LENGTH OF GUARD HAIR

The average length of guard hair is found to be 23.2 mm (6.8 mm – 47.7 mm). The range is broader than 17.9 mm – 20.3 mm reported by Soni et al. (2004) and (12 mm – 37 mm) as reported by Chakraborty et al. (1996) while it is almost similar to the range (5.2 – 45.0 mm) as reported by Kitpipit et al. (2013). This is shorter than those of domestic cat (25.4 mm) and domestic dog (31.9 mm) as reported by Sato et al. (2006).

The shortest Guard hair of 7.1 mm is found on the head region (6.8 mm – 36.4 mm) whereas the longest guard hair of 47.7 mm which is found on the ventral region (153 mm – 47.7 mm). The length of Guard hair is shortest on head followed by dorsal and tail while longest on ventral region. Mammals often have longer hairs on the back (Meyer et al. 1982, Korhonen et al. 1984). The present finding contravenes the findings of Meyer et al. 1982, Korhonen et al.(1984). The ventral region carries all the vital body organs and for their protection and hence the Guard hairs are longer in this region than the other body region of the tiger. Whereas the shortest guard hair is found on the dorsal region of the body, which is subjected to constant stress, pressure from the vegetation and other abiotic obstacles inside the territory of the tiger.

The length of Guard hair in tiger is 26.5 mm, range (12.9 mm - 43.0 mm) and the length of Guard hair in tigress is 21.5 mm, range (12.0 mm - 49.0 mm). The Guard hair of tiger is longer than the Guard hair of tigress. This will help in the identification of the source of the confiscated trophy and will show the line of the investigation.

LENGTH OF GUARD HAIR IN DIFFERENT SEASONS

Not much work have been carried on the seasonal variation of length of guard hair on felidae. The pelage of Mule Deer in Summer & Winter and observed the increase of hair width in winter (Sessions et al., 2009). In the present study it is found that the diameter of guard hair from all the body region increases in the winter as compared to the summer. Some studies have being conducted that deal with the variability of hair structure between seasons, are principally related to Cervidae and
Bovidae. Williamson (1950) observed that the cuticular scales from (Primary hairs) PHs taken from different seasons in several species of cervids remained similar in general characters, whereas De Marinis & Asprea (2006) found a variability in the cuticular features of the winter and summer coats of deer (*Dama dama, Cervus elaphus, Capreolus capreolus*), and considered that these 3 species can be separated from each other only when comparing winter hairs. Ushakova & Tselikova (1998) and Sokolov *et al.*, (1999) observed that the summer and winter cuticle of the Saiga antelope (*Saiga tatarica*) differ morphologically.

The length of guard hair varies according to the climatic changes. The length of Guard hair during the summer season is 21.7 mm, range (12.9 mm - 38.2 mm) and the length of Guard hair during the winter season is 30.2 mm range (19.0 mm - 43.0 mm). The length of Guard hair increases in winter season for insulation and preserving heat inside the body. In winter the length increases (40 %) as compared to the summer season.

**DIAMETER OF GUARD HAIR**

The guard hair is of fusiform type with pointed tip. The diameter is 33.1 µm at apical, 70.6 µm at middle and 46.9 µm at basal portion of the guard hair. The middle portion is widest followed by basal and apical. Dreyer (1966) found that sex had no influence on the cuticle structure of bovids, and (Keogh, 1975, 1983) came to the same conclusion for rodents. However, Ushakova & Tselikova (1998) observed an influence of sex on some metrical morphometric parameters of the hair in the Saiga antelope (*Saiga tatarica*).

The diameter of the Guard hair is thicker in the middle portion (70.6 µm) followed by basal portion (46.9 µm) and thinner on the apical portion (33.1 µm). The Guard hairs from the tail region (32.4 µm, 55 µm, 38 µm) are thinnest while the Guard hairs from the head region (35.8 µm, 85.4 µm, 41 µm) are thickest followed by Guard hair from the dorsal (33 µm, 64.1 µm, 38 µm) and ventral region (31.2 µm, 65.1 µm, 45.5 µm). The tigresses have longer & widest guard hair as compared to tiger.
From the ANOVA calculation & Post Hoc test it has come to the conclusion that significant difference is found among the diameter of guard hair different body portions. The apical and basal portion of the guard hair has no significant difference in guard hair from head, dorsal, ventral and tail portion. Whereas the middle portion of the guard hair has significant differences. (p = .039) The difference is at 5% level. The middle portion of the guard hair from the Head and Dorsal are statistically significant. This result corroborates with the finding of Kitpipit et al. (2013). This is the first report and not reported by any researcher earlier whereas Kitpipit describes it as the minimum and maximum diameter.

**DIAMETER OF GUARD HAIR IN DIFFERENT GEOGRAPHICAL LOCATIONS**

From the ANOVA calculation & Post Hoc test it has come to the conclusion that significant difference is found among the diameter of guard hair in different body portions in different habitats. The apical and basal portion of the diameter of the guard hair has significant difference in tigers from different geographical locations. (p = .000) The difference is at 5% level. The middle portion of the guard hair has no significant differences. This result corroborates with the finding of Kitpipit et al. (2013). This is the first report and not reported by any researcher earlier whereas Kitpipit describes it as the Minimum and Maximum diameter.

**DIAMETER OF GUARD HAIR IN DIFFERENT SEASONS**

From the ANOVA calculation & Post Hoc test it has come to the conclusion that significant difference is found among the diameter of guard hair in different body portions in different seasons. The apical portion of the diameter of the guard hair has significant difference in tigers in different seasons. (p = .023) The difference is at 5% level. The diameter of the middle portion and the basal portion of the guard hair has no significant differences. This result corroborates with the finding of Kitpipit et al. (2013). This is the first report and not reported by any researcher earlier whereas Kitpipit describes it as the Minimum and Maximum diameter.
DIAMETER OF GUARD HAIR IN DIFFERENT SEXES

From this study, it is found that sex has also some kind of role to play. The diameter of the Guard hair increases in the winter as compared to the summer season. This is due to retention of air in the grooves for insulation of the body.

From the ANOVA calculation & Post Hoc test it has come to the conclusion that no significant difference is found among the diameter of guard hair in different body portions in different sexes. The diameter of the guard hair in apical, middle & basal portion did not reach the conventional $p < .05$ level. Thus, there are no statistically significant differences in diameter of the guard hair in different sexes. This is the first report and not reported by any researcher earlier involving the sexual criterion.

CUTICULAR SCALE PATTERN

Four different types of cuticular scale pattern has been observed in the present study viz. regular wave pattern, single chevron pattern, irregular wave pattern and streaked pattern (Table 20, Figure 7). But the unique observation of the present study is that, only three, out of four patterns are found together in a single hair. Interestingly the regular waved pattern and streaked pattern are found in all hairs cuticles. The third option is between single chevron pattern and streaked pattern.

The regular wave cuticular scale pattern dominates the apical portion with 83.1%, 68.5% in the proximal portion and 21% on the basal portion. The single chevron pattern of cuticular scale is found on the apical portion of the guard hair. The irregular wave cuticular scale pattern is found mainly on the distal portion with 69.6% and 16% on the basal portion of the guard hair. The streaked pattern of cuticular scale is found mostly in the basal portion of the guard hair with 15.5% followed by regular on the apical portion and streaked pattern on the distal portion of the guard hair. The single chevron cuticular scale pattern is found in the apical portion of head guard hair.
In a similar type of study conducted by Kitpipit et al. (2013) who reported 5 types cuticular scale pattern in the guard hair i.e. regular, irregular, single chevron, streaked & mixture. It is also interesting to note that Kitpipit et al. (2013) in their study, restricted the hair sample only to four captive tigers, from Songkhla Zoo and Chingmia Zoo, Thailand, whose original distribution was not mentioned. Hence, the variations in the cuticular scale pattern might be in relation to the original distributional angle and has ecological or genetical influences in the establishment of the cuticular scale pattern. Moreover the “mixed pattern” in the cuticular structure is also confusing. But Chakraborty et al. (1996) observed only Irregular wave pattern. This diversity of the observations has opened up a new vista for establishment of the cause of the diverse cuticular scale pattern on the guard hair.

Some variation is also found among different sexes. In the apical portion of guard hair from head & ventral region of male tiger streaked type of cuticular scale pattern is found. The apical portion of guard hair has cuticular scale pattern of regular wave, single chevron and streaked type.

The middle portion of the guard hair is of regular wave pattern, irregular wave and streaked cuticular wave pattern. Three types of cuticular scale pattern is observed on the basal portion of the guard hair i.e. irregular, regular and streaked. The regular wave cuticular scale pattern is found in almost all the guard hair from head, dorsal, ventral and tail parts of the animal. The irregular wave cuticular scale pattern is observed from the basal portion of the guard hair from ventral and tail parts of the tiger.

This finding has a great importance in and identifying the species of the poached animal and possible help in identifying the location of the poached tiger if only hair of a portion of pelage is recovered from the poaching site.
CUTICULAR SCALE SEPARATION (SPACING)

The cuticular scales are arranged in various distances on a guard hair. Three different types of cuticular scale separation are observed mainly close, distant and near. The result is almost similar to Kitpipit et al. (2013) i.e. close, distant, near & mixed, while Chakraborty et al. (1996) describes only Intermediate scale separation.

CUTICULAR SCALE: MARGIN

Three types of cuticular scale margin are observed i.e. crenate, rippled and smooth. The scale margins are also varies along the shaft of the hair. The scale margins are different on the apical, middle and basal portion of the guard hair. Three types of cuticular scale margin are observed i.e. crenate, rippled and smooth. (Ref Table 21, Figure-8). It was found that the scale margins are varies along the shaft of the hair. The scale margins are different on the apical, middle and basal portion of the guard hair. Only Crenate type of cuticular scale margin was reported by Chakraborty et.al (1996) while Kitpipit et al. (2013), reported Crenate, rippled, smooth and a mixture of smooth and rippled.

This finding has a great importance in identifying the location of the poached animal and identifying the species of the poached animal if only guard hair of a portion of pelage is recovered from the poaching site.

CUTICULAR SCALE WIDTH & HEIGHT

The width & height of the cuticular scale areas not constant and varies along the length of guard hair. So, these criteria cannot be taken as identification of the animal.

MEDULLA STRUCTURE

The medulla of Guard hair is found to be of two different types, viz. uniserial ladder and simple medulla. In the female tiger the uniserial ladder type of medulla is observed and simple type is found in male tiger. This finding was not observed by any
earlier worker. Kitpipit et.al (2013) reported three different types of medulla i.e. Simple, Uniserial ladder and mixture of uniserial ladder and simple, while only simple type of medulla was reported by (Chakraborty et.al (1996). The present finding is almost agreeable with the finding of Kitpipit et.al.(2013)

This finding has got a great bearing in identifying the sex of the poached tiger. This may help in the study of the demographic change as a result of poaching in a particular protected area.

GROOVE STRUCTURE

Two types of grooves have been observed on the guard hair of tigers i.e. front and lateral. The grooves help in retention of air from the environment and control the heat loss from the body to the environment. This is the first report and not reported in earlier study.

The grooves help in retention of air from the environment and control the heat loss from the body to the environment. Fur plays an important role in the thermoregulation of animals with high metabolic rate. The groove acts as air container as the diameter of the Guard hair changes and also the length of the Guard hair vary in different body portion of the tiger. When the hair twist together, a space is created in between the epidermis and the pelage where the air is retain. The groove structure of biological surface which function as air container (or barrier) can also be found in a famous insect Water Strider’s legs (Gao and Jiang, 2004; Goodwyn et al., 2008).

HAIR COLOURATION

Hair color is mostly the results of pigments – chemical compounds that reflect certain wavelength of visible light. The coat of the tiger is orange-yellow with numerous prominent black stripes; black and albino specimens are sometimes found. The Siberian tiger tends to be the lightest in coloring. The tiger's stripes give it a highly effective camouflage in its native habitat. The colouration of individual Guard Hair (GH) is recorded following (Ridgway, 1886).
In the present study, mainly three different colours i.e. brown, black and white are found in different combinations and banding of two and three different colours are found in a single guard hair. Combinations like yellow with white base, black with white base, black base with white base and banding of three colour viz. black-white-brown base are observed from different body regions. Thus, the study corroborates with the findings of Mayer (1952) and Stains (1958). Interestingly yellow colour is not found in the sample collected during the winter season. This may be of important criteria in the seasonal change in the pelage colouration of this majestic animal, which was not reported earlier in any of the scientific study.

The findings of this research can be implemented in the identification of hair sample that may be collected from the scene of crime or from the victim or the suspected poacher or from any other tools used in the incident. The following questions may be answered –
1. Hair – animal or human?
2. Species to which the hair belongs?
3. The sex of the animal?
4. The body regions from which the hair belongs?
5. The colouration of hair may speak the season?
6. The cuticular scale can be calculated/measured for determining the hair portion of the Guard hair?
7. The geographical region from which the animal was poached?

This multiple questions and the answers will be applicable in the court of law and can be an exemplary kit for cracking the case and corroborates with the other materials evidence. If, one criterion is not applicable in the court of law or opposed by the defence side the subsequent answers can be taken into consideration.

The tigers inhabits in the Brahmaputra valley can be identified based on the following key that have been generated from this research.
KEY TO IDENTIFICATION OF TIGER FROM GUARD HAIR
ARCHITECTONIC ON REGIONAL BASIS (ASSAM)

A. **Length of Guard hair:** Male and female covering all seasons:

B.

1. Average length Guard Hair: 23.2 mm, range (7.1 – 47.7 mm)
2. Tiger: 26.5 mm, range (12.9 mm - 43.0 mm)
3. Tigress: 21.5 mm, range (12.0 mm - 49.0 mm)
4. Head region: 21.9 mm ± 9.3 mm (7.1 mm to 36.4 mm)
5. Dorsal region: 18.5 mm ± 6.1 mm (6.8 mm to 26.8 mm)
6. Ventral region: 32.6 mm ± 8.1 mm (18.3 mm to 47.7 mm)
7. Tail region: 19.9 mm ± 4.3 mm (12.9 mm to 25.7 mm)

The parameter for the identification of the male and female individual based on guard hair length showed an interesting dimension. The male has an average of 25 percentage longer hair than female.

Amongst the length of the guard between different regions of the body are also an indicative of the possible parameter for detection of the contraband. The length of the guard hair in the ventral region is the longest (32.6 mm), whereas it is shortest in the dorsal region. The length of the hair in the head region (21.9 ± 9.3 mm) and tail region (19.9 ± 4.3 mm) comes in between.

There seems to be a variation while considering the season into account as one of the parameter for identification. In summer season the average length of the guard hair decreased by 6.5 % over the normal range, whereas it increases by 28 % during winter from the average length. But an increase of 35 % from winter to summer has been observed.

This variation in the hair length summer and winter is primarily due to the change in the temperature in the habitat, which has been an ecological and physiological adjustment for the animal.
A. Seasonal variation in the length of the Guard hair:

1. Summer season: 21.7 mm, range (12.9 mm - 38.2 mm)
2. Winter season: 30.2 mm range (19.0 mm - 43.0 mm)

Another aspect of the guard hair which could very well be considered as a parameter for identification of the location of the sized contraband might be the diameter of the various area of the guard hair.

Ration of the diameter between Apical : Middle : Basal can be an interesting parameter, instead of considering the diameter of the regions of a guard hair separately. This parameter can be an added factor for identification of the seized tiger parts.

In a normal assessment of the diameter of the various parts of the hair indicates that the diameter of the middle and basal portion is the highest (broadest) in ventral portion. This varies slightly in the apical portion.

C. Diameter of the Guard hair:

1. Head region- Apical - 35.8 µm, Middle- 85.4 µm, Basal - 41 µm
2. Diameter of the Guard hair from dorsal region - 33 µm, 64.1 µm, 38 µm respectively in apical, middle and basal portion.
3. Diameter of the Guard hair from ventral region - 31.2 µm, 65.1 µm, 45.5 µm respectively in apical, middle and basal portion.
4. Diameter of the Guard hair from tail region - 32.4 µm, 55 µm, 38 µm respectively in apical, middle and basal portion.
D. Cuticular scale, medulla, groove and colouration:

1. Four different types of cuticular scale pattern viz. regular wave pattern, single chevron pattern, irregular wave pattern and streaked pattern are found. Only three, out of four patterns are found together on a single Guard hair.

2. Cuticular scales separation - close, distant and near.

3. Cuticular scale margin - crenate, rippled and smooth. The scale margins are different on the apical, middle and basal portion of the guard hair.

4. Cuticular scale width & height of the areas not constant and varies along the length of guard hair.

5. Medulla of Guard hair is of two different types, viz. uniserial ladder and simple medulla. In the female tiger the uniserial ladder type of medulla is observed and simple type in male tiger.

6. Two types of grooves are observed on the guard hair of tigers i.e. front and lateral.

7. Four different colours i.e. yellow, brown, black and white are found in various combinations and banding of two and three different colour are found in a single guard hair. Yellow colour is not found in the sample collected during the winter season. The colouration of tail remains unchanged irrespective of seasonal change.

**Kitpipit, et al., 2013** reported the following outcome while working on tigers of Thailand.

- **Average length**: 14.4 mm (5.2 -45.0 mm)
- **Proximal width**: 15.0-97.5 µm
- **Maximum width**: 22.5-120.0 µm
- **Cross section of diameter**: 7.0-197.5 µm
- **Medulla**: Simple, uniserial ladder and a mixture of both
- **Cuticular scale pattern**: Regular wave, single chevron, irregular wave, streaked and a mixture of these.
FUTURE PRESPECTIVE OF RESEARCH

The regional identification of the Guard hair architectonic may be worked out for all the tiger reserves in India. This will help to create a repository to be used as reference sample for identification of the poached tiger and would help in subsequent trial in the court of law. This will enhance the rate of conviction and help to develop better protection strategy.
SUMMARY

Five types of hair are frequently observed in mammalian species. These include vibrissae, bristles, over hairs, under hairs and guard hairs. Among these only guard hairs appear to be important in hair identification, although over hair and under hair may provide additional data. The hair is composed of the cuticle externally, the cortex or inner sheath, the medulla or central core and pigment granules dispersed over core and cortex. Microscopic structures within the cortex are used to compare one hair with the other. The shape of the medulla as well as the pattern it exhibits can be used to determine species. Descriptive guides on microscopic hair characteristics of some mammalian species of particular regions have been presented by Brunner and Coman (1974). Hair structure may differ significantly in phylogenetically close species, sub species and breeds as well as at different developmental stages of the same individual. Hair structures of quite a number of mammalian species have been worked out by different authors. In this context it is to be noted that reports on microscopical studies on human hair in relation to physiological and pathological states of the subjects exit in literature, but the same is not available for wild animals. The important observations made on the effect of nutrition and different pathological states including genetic defects, psychomotor development, immunological status, intestinal resorption, disturbed amino acid metabolism etc. on morphology of hair and scale pattern in human and experimental animals suggest that microscopy of hair may have wide applications in studies concerning Wildlife. Further, surface features of guard hair of some animals appear to be different from others and may be used as additional means for animal identification. It is known that guard hair is affected by genetic, hormonal and environmental factors, but this information has not been utilized in Wildlife Biology, conservation and management. Dey et al. (1999) detected toxicity and deficiency of certain elements in some wild animal species of North-East India with the help of SEM and Atomic Absorption Spectrometry (AAS) of hair along with relevant behavioral studies. As far as the role of SEM in guard hair identification is concerned, classification based on micro-morphology of medulla in the major mammalian orders has been documented by some authors. However, classification at family, genus and species level are yet to be done in a systematic manner. Further, studies on fine
structural features of hair from different body parts of wild animals and their possible relation with behavioural physiology have not been carried out in detail. Besides this, it appears that the arrangement of cuticle, cortex and medulla of guard hair from different body parts may be important in hair identification with the help of different forms of microscopy.

Hair identification assumes great significance in wildlife forensic science, since an animal that has been poached can be identified through microscopical examination of hair. Further, other details such as sex, geographical distribution of the animal, subspecies status, time of the year when it was poached etc., can be obtained from microscopical analysis of hair. Keeping these in view, this study was undertaken for developing a key for identification of tiger of Brahmaputra valley on regional basis using morphometry, optical and scanning electron microscopy.

Six qualitative guard hair characteristics have been used in the study, which include hair coloration, scale pattern, scale separation, scale margin, medulla structure and groove structure. The aforementioned six characteristics were recorded from apical, proximal and distal parts of the guard hair. The quantitative characteristics used for analysis of guard hair were (a) length (mm) of each guard hair using dial caliper (b) diameter (µm) of each guard hair in apical, middle & basal portion and (c) cuticular scale width and height measured with a calibrated micrometre in the eyepiece.

Guard hair is a cuticular structure with various appearance, colouration, length, and diameter. The length of guard hair is found to be longer in female as compared to male and longer in winter than summer season in both the sexes. Two different types of medulla are found in male and female i.e. simple and uniserial ladder. Two different types of grooves are found- lateral groove and front groove. This unique lateral groove found on the guard hairs of tiger is another important observation and not been reported earlier.

Four different types of cuticular scale pattern are observed i.e. regular wave, single chevron, irregular wave and streaked scale patterns and combination of any three of these are found on a single guard hair throughout its length. Three
different types of scale margin are also seen i.e. Crenate, Rippled and Smooth. The scale margins and not uniform throughout the length of the Guard hair, but it arranges in different composition on the Guard hair and all the three scale margins present together. The cuticular scales are arranged closely, nearly and distantly on a Guard. This may be change with the growth phase of a hair.

The width of the guard hair also varies among the individual hair and wider in winter as compared to summer. The results were subjected to ANOVA analysis which shows that there are significant variation among the individual, length & diameter of different sections of guard hair, different geographical location.

These findings can be used for the identification of seized contrabands and can be exhibited in the trial courts for legal arbitration. The identification of the contraband along with the source will of immense importance for formulating effective protective strategy in the targeted areas.