

Comparison of Fore and Hind Foot of *Artiodactyla* Species of Animals for Forensic Importance

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Abstract

In the present study, samples of pugmark of *Artiodactyla* animals' species were collected from different areas. The collection was done through photography method. After the collection of each and every pugmark samples of animal species then it was individually examined for the comparison of fore and hind foot of the specific animal species pugmark. Comparison of fore foot and hind foot was done on the bases of physical analysis such as shape, size, dimension, dew mark, claw mark and specific feature. From the observation, it is interpreted that fore foot and hind foot of same animal species showed different characteristics which were not same. Through pugmark we can not only identify the specific species but also identify whether it is fore foot or hind foot of the specific animal. Pugmark signifies identity.

Keywords: Pugmarks • Animals • Photography • Hind foot • Fore foot

Introduction

Artiodactyla, or cloven-hooved mammals, include such familiar animals as sheep, goats, camels, pigs, cows, deer, giraffes, and antelopes — most of the world's species of large land mammals are artiodactyls. Many living artiodactyls have evolved features that are adaptive for life on open grasslands. As beasts of burden and as sources of meat, hair, and leather, artiodactyls have assumed important roles in many cultures around the world. Pugmarks are the marks which are left by different animal's species while they are walking, running, or moving from one place to another place. Pugmarks refer to the footprints of most animals species. "PUG" also means foot in Hindi. Pugmarks of some animals are denoted by some different terms. Pugmarks denote "pawprint" of most feline animals. Herbivore footprints are called as hoofmark. Some of the herbivore animals are like cow, goat, buffalo etc. Mostly the footprints of tigers are termed as pugmarks. Every animal species has different type of pugmark and this factor can be used for their identification purpose.

Through pugmark it is not only possible to identify the animals, but also identify its sex whether it is male or female, age, and its size is also possible to identify accurately. Report on the development of non-invasive, robust, and cost-effective technique through which it is possible to identify the sex of Amur tigers from snow print [1-3]. This all can be identified by a well-trained investigator. Identify the wild animal species on the basis of their pugmark and hair morphology is also possible. This study may be helpful to many different agencies which are engaged in controlling illegal trade of wildlife such as poaching and its derivatives towards better management of wildlife. In this study pugmark was evaluated by shape and measurement [4-6]. Developing 3D method to obtain pugmark through close range photogrammetry of lion *Panthera Leo* paws and tracks so that it enables better understanding of the paws mark by Pirie, Tara et al. [7]. Different investigator uses different type of method and procedure for the study of pugmark of different species to finding out different information through their pugmark such as sex age etc. The Development of the technique to make individual animal identification by their

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tracks basically mountain lion and large animals from the collected pugmarks with measurements from acetate tracings of two to six tracks from each rear foot of nine mountain lions *Felis concolor* for the study. This technique can be used to improve population studies of mountain lions and other large animals [8-10]. The Description of multivariate technique for the identification of individual tigers *Panthera tigris* from their pugmarks was done by tracings and photographs of hind pugmarks of the known tigers (17 wild and two captive tigers) [11,12]. A cost-effective and invasive footprint identification technique for the identification of individual white rhino *Ceratotherium simum* and the differentiation of the species from black rhino *Diceros bicornis* was introduced. For this purpose, FIT is a traditional tracking identification technique and is a useful monitoring and censusing tool for wildlife conservation [1]. Due to increase in criminal cases against animal, especially in rural areas and remote areas, it has become very important to study the pugmark of the animal in forensic aspect to reduce the crime against the animal. Like footprint of human frequently found at crime scene in same manner pugmark are also been found at the crime scene. Pugmark can give valuable information regarding the animal involved in the crime. The pugmarks of different animal are different they are not same. Each of the pugmark has its own unique individual characteristics and class characteristics which help in differentiating from other groups of animals. Pugmark can also be examined in forensic science as it can provide reliable data of presence of different species in the area of study, population of the species, sex ratio, etc.

Methodology Adopted

After the collection of pugmarks of both hind foot and fore foot of animals, each and every pugmark was observed individually. Both hind foot and fore foot of the different animal species were observed. Different characteristics features were identified through which we can know easily which pugmark belongs to which animals. For the identification of the Characteristics of different pugmarks, help of different sources through internet were taken. Reading Pugmark (a pocket guide for forest guards) is one of the sources through which help we identified some of the features. After identifying the different Characteristics, the length and breadth of each pugmark were measured through scale and noted down.

Results

After observing all samples of fore foot and hind foot pugmark of *Artiodactyla* animals' species, following results were obtained (Figures 1-16).

Sample No. 1: Deer

Characteristics of deer fore foot:

- The pugmark is up-side down heart shape.
- Two bilaterally symmetrical toes with cloven hooves.
- Large gap is present between the two hooves marks
- The pugmark of deer is even-toed ungulates i.e., *Artiodactyla*.
- Dimension is approx. 4.5 cm long and 4 cm wide.
- No claw marks are present.
- Dew claw marks are also absent.
- Small sizes of hooves mark are formed.
- Tip of the hooves mark are slightly pointed and bottom is arch shaped.



Figure 1: Pugmark of deer (fore foot).

Characteristics of deer hind foot:

- The hooves mark is somewhat oval in shape.
- Two bilaterally symmetrical toes with cloven hooves.
- Large gap is present between the two hooves marks
- The pugmark of deer is even-toed ungulates i.e., *Artiodactyla*.
- Dimension is approx. 4 cm long and 3.5 cm wide.
- No claw marks are present.
- Dew claw marks are also absent.
- Small sizes of hooves mark are formed.
- Tip of the hooves mark are slightly pointed and bottom is circular in shape.



Figure 2: Pugmark of deer (hind foot).

Sample No. 2: Sheep

Characteristics of sheep fore foot

- The complete shape of hoof mark is up-side down heart shape.
- Two bilaterally symmetrical toes with cloven hooves.
- Gap is present between the two hooves marks
- The pugmark of sheep is even-toed ungulates i.e., *Artiodactyla*.
- Dimension is approx. 7 cm long and 6 cm wide.
- No claw marks are present.
- Dew claw marks are also absent.
- Medium sizes of hooves mark are formed.
- Tip of the hooves mark are slightly pointed and bottom is arch in shape.
- Hoof mark is narrow at front and border at bottom.

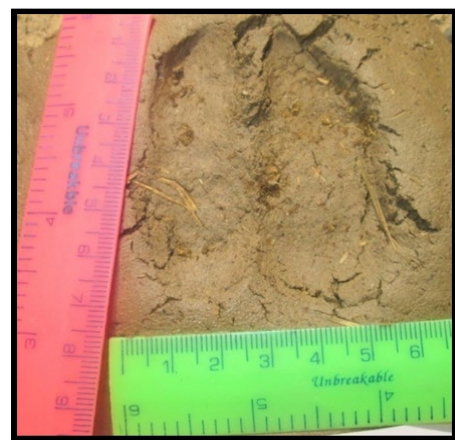


Figure 3: Pugmark of sheep (fore foot).

Characteristics of sheep hind foot

- The complete shape of hoof mark is up-side down heart shape.
- Two bilaterally symmetrical toes with cloven hooves.
- Gap is present between the two hooves marks
- The pugmark of sheep is even-toed ungulates i.e., *Artiodactyla*.
- Dimension is approx. 6.5 cm long and 5.5 cm wide.
- No claw marks are present.
- Dew claw marks are also absent.
- Medium sizes of hooves mark are formed.
- Tip of the hooves mark are circular and bottom is arch in shape.



Figure 4: Pugmark of sheep (hind foot).

Sample No. 3: Goat

Characteristics of goat fore foot

- Pointed cleaved hooves are formed.
- Pugmarks of goat are more kidneys shaped.
- Gap is present between the two hooves marks forming V shape in between.
- The pugmark of goat is even-toed ungulates i.e., *Artiodactyla*.
- Dimension is approx. 6 cm long and 5 cm wide.
- No claw marks are present.
- Dew claw marks are also absent.
- Medium sizes of hooves mark are formed.
- Tip of the hooves mark are slightly pointed and bottom is arch in shape.



Figure 5: Pugmark of goat (fore foot).

Characteristics of goat hind foot

- The shape of hoof mark is somewhat oval shape.
- Two bilaterally symmetrical toes with cloven hooves.
- Gap is present between the two hooves marks
- The pugmark of goat is even-toed ungulates i.e., *Artiodactyla*.
- Dimension is approx. 4.5 cm long and 3.5 cm wide.
- No claw marks are present.
- Dew claw marks are also absent.
- Medium sizes of hooves mark are formed.
- Tip of the hooves mark are circular and bottom is arch in shape.



Figure 6: pugmark of goat (hind foot).

Sample No. 4: Buffalo

Characteristics of buffalo fore foot

- The hoofs are cloven or it is divided into two parts.
- Pugmarks of buffalo are more circular shaped.
- Gap is present between the two hooves marks.
- The pugmark of buffalo is even-toed ungulates i.e., *Artiodactyla*.
- Dimension is approx. 12.5 cm long and 13 cm wide.
- No claw marks are present.
- Dew claw marks are also absent.
- Large sizes of hooves mark are formed.
- Uneven size of hooves mark is formed i.e., one mark is larger than other.



Figure 7: Pugmark of buffalo (fore foot).

Characteristics of buffalo hind foot

- The shape of hoof mark is somewhat oval shape.
- Two bilaterally symmetrical toes with cloven hooves.
- Gap is present between the two hooves marks
- The pugmark of buffalo is even-toed ungulates i.e., *Artiodactyla*.
- Dimension is approx. 15 cm long and 11.5 cm wide.
- No claw marks are present.
- Dew claw marks are also absent.
- Large sizes of hooves mark are formed.
- Both Tip and bottom of the hooves mark is arch in shape.



Figure 8: Pugmark of buffalo (hind foot).

Sample No. 5: Cow

Characteristics of Cow fore foot

- Two bilaterally symmetrical toes with cloven hooves.
- Pugmarks of cow are also more circular shaped.
- Gap is present between the two hooves marks.
- The pugmark of cow is even-toed ungulates i.e., *Artiodactyla*.
- Dimension is approx. 12.5 cm long and 11 cm wide.
- No claw marks are present.
- Dew claw marks are also absent.
- Large sizes of hooves mark are formed.
- Half of the hoof mark is semi-circle in shape.
- Both top and bottom of the mark is circular in shape.



Figure 9: Pugmark of cow (fore foot).

Characteristics of Cow hind foot

- The shape of hoof mark is somewhat circular in shape.
- Two bilaterally symmetrical toes with cloven hooves.
- Gap is present between the two hooves marks
- The pugmark of cow is even-toed ungulates i.e., *Artiodactyla*.
- Dimension is approx. 12.5 cm long and 10.5 cm wide.
- No claw marks are present.
- Dew claw marks are also absent.
- Large sizes of hooves mark are formed.
- Tip is circular and bottom of the hooves mark is arch in shape.



Figure 10: Pugmark of cow (hind foot).

Sample No. 6: Bull

Characteristics of bull fore foot

- Two bilaterally symmetrical toes with cloven hooves.

- Pugmark of bull is like up-side down heart shape.
- Large Gap is present between the two hooves marks.
- The pugmark of bull is even-toed ungulates i.e., *Artiodactyla*.
- Dimension is approx. 15 cm long and 12.5 cm wide.
- No claw marks are present.
- Dew claw marks are also absent.
- Large sizes of hooves mark are formed.
- Half of the hoof mark is semi-circle in shape.
- Top of mark is circular and bottom of the mark is arch shape.



Figure 11: Pugmark of bull (fore foot).

Characteristics of bull hind foot

- The shape of hoof mark is somewhat apple in shape.
- Two bilaterally symmetrical toes with cloven hooves.
- Large Gap is present between the two hooves marks.
- The pugmark of bull is even-toed ungulates i.e., *Artiodactyla*.
- Dimension is approx. 11.5 cm long and 10 cm wide.
- No claw marks are present.
- Dew claw marks are also absent.
- Large sizes of hooves mark are formed.
- Both top and bottom of the marks is arch in shape.



Figure 12: Pugmark of bull (hind foot).

Sample No. 7: Pig

Characteristics of pig fore foot

- Two bilaterally symmetrical toes (cleaves) with cloven hooves.
- Marks of dew claws present behind
- Dimension is approx. 9 cm long and 6 cm wide

- No claw mark are present
- Pugmark is up-side down heart shape.
- Gap is present in between the two bilaterally symmetrical toes.
- Tip is slightly pointed and the bottom of the mark is arched shaped.
- Medium size of hoof mark is formed.
- The even-toed ungulates i.e., *Artiodactyla*.



Figure 13: Pugmark of pig (fore foot).

Characteristics of pig hind foot

- Two bilaterally symmetrical toes (cleaves) with cloven hooves.
- Marks of dew claws present behind
- Dimension is approx. 9.5 cm long and 7 cm wide
- No claw mark are present
- Pugmark is up-side down heart shape.
- Gap is present in between the two bilaterally symmetrical toes.
- Tip is slightly pointed and the bottom of the mark is arched shaped.
- Medium size of hoof mark is formed.
- The even-toed ungulates i.e., *Artiodactyla*.



Figure 14: Pugmark of pig (hind foot).

Sample No. 8: Camel

Characteristics of camel fore foot

- The hoof is cloven or it is divided into two equals' parts.
- Large size of hoof is formed.
- Rear side of the hoof mark is circular in shape.
- On the Front side slightly, gap is present between the hoof marks and is arch in shape.

- Dimension is approx. 21 cm long and 17.5 cm wide.
- Dew claw marks are absent.
- Claws marks are also not present.
- Half of hoof mark is somewhat oval in shape.
- The even-toed ungulates i.e., *Artiodactyla*.



Figure 15: Pugmark of camel (fore foot).

Characteristics of camel hind foot

- The hoof is cloven or it is divided into two equals' parts.
- Large size of hoof is formed.
- Rear side of the hoof mark is circular in shape.
- On the Front side slightly, gap is present between the hoof marks and is in arch in shape.
- Dimension is approx. 18 cm long and 15.5 cm wide.
- Dew claw marks are absent.
- Claws marks are also not present.
- Half of hoof mark is somewhat oval shape
- The even-toed ungulates i.e., *Artiodactyla*.



Figure 16: Pugmark of camel (hind foot).

Discussion

The present study was aimed for the comparison of fore and hind foot of *Artiodactyla* species animal for forensic importance. For this purpose, pugmark of different animal species on soil surface were collected through digital photography method. At least 5 photographs of each pugmark were collected.

A total number of 8 animal species pugmark were included in the present study. The animal which were included in the study are deer, goat, cow, buffalo, bull, camel, sheep and pig. The pugmark of different animal species both fore foot and hind foot were collected. The pugmark of fore foot and hind foot that were collected were than individually examined and observed. After the complete examination and observation of the pugmark of different animal species of both fore foot and hind foot then different type of the characteristics were found and noted down. The characteristics which were found are such as shape of the pugmark, size of the pugmark, dimension of the pugmark, dew claw mark and claw mark and most importantly specific features of the pugmark. Beside these Characteristics many different Characteristics was also been observed that can help in the purpose of the identification of the different animal species. There were also many different types of characteristics which were same in the pugmark of the most of different animal species. Similar type of study was also carried by Raj et al. in 2015 for identifying tigers through their pugmark using image processing techniques. 14 features were extracted from each pugmark image and stored in master data base [8].

Conclusion

After the complete examination of pugmarks of *Artiodactyla* species, it was concluded that in each and every *Artiodactyla* species pugmark number of different Characteristics was present and according to which we can successfully identified the specific species through their pugmarks. Both in fore foot and hind foot of different animal species different characteristics were found. We can not only identify the species by their pugmark but also, we can identify whether it is fore foot or hind foot of the specific animal species. Through pugmark we can differentiate different species and also differentiate between if it is hind foot or fore foot of the different animal species Pugmarks of *Artiodactyla* species are distinct it is not same.

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