

Characterization of Pugmark for Animal Species Identification for Forensic Importance

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Abstract

In the current investigation, 16 sample of pugmark of various creatures' species were gathered from various territories. The assortment was done through photography technique. After the assortment of every single pugmark tests of various creature species then it was exclusively inspected for the distinguishing proof motivation behind explicit creature species. The current examination was finished by physical investigation of pugmarks to distinguish the diverse trademark present in the pugmarks. Certain estimation was likewise taken like length and broadness of each pugmark to separate from the other diverse sample of pugmark. From the perception, it is deciphered that the pugmarks are indistinguishable which implies that pugmark are diverse of various species, no two pugmarks were same. It was likewise discovered that fore foot and hind foot of same creature species demonstrated distinctive trademark which were not same. Through pugmark we can recognize the particular species as well as distinguish climate it is fore foot or hind foot of the particular creature. Pugmark connotes character.

Keywords: Pugmarks; Animals; Photography; Fore Foot; Hind Food

Introduction

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 "paw print" of most feline animals for e.g. like dog, cat, etc. 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 (Gu *et al.*, 2014) [1]. 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 (Patil *et al.*, 2012) [2]. 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 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 (Smallwood and Fitzhugh., 1993) [3]. 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) (Sharma *et al.*, 2005) [4]. 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 (Francois *et al.*, 2016) [5].

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. Through pugmark we can also track rogue animals which may be danger to humans or to others animals' species. Pugmark play very important role in identifying a given specific animals

species. 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 characteristic and class characteristic 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. For this purpose, the topic entitled "Characterization of pugmark for animal species identification for forensic importance" was carried out for different outcomes.

Methodology

Collection of Sample

In the present work, total 16 samples of pugmark of different animals' species were collected from different places like animals' farms, rural area etc. The collection of samples of pugmark of different animal species was done with the help of digital camera. For collection of samples of pugmarks muddy surface was prepared near by the areas in which animals were present because in the muddy surface the pugmarks were more clearly visible than any other surface and it was an easy way to collect the pugmark sample. The pugmark left behind over the surface was then measured with the help of scale. Scale was place around the pugmark sample so that length and breadth of the pugmark can be measured. At last five photography of pugmark from different angle using digital camera was clicked, so that it becomes easy for us during observation of pugmarks. While the collection of the sample care was taken that each and every photograph was clear to see from naked eyes. No photograph was blurring. The pugmarks of both hind foot and fore foot of the animal were collected for the study.

Procedure for Examination

After the collection of pugmarks, each and every pugmark was observed individually. Both hind foot and fore foot of the different animal species were observed. Different characteristic 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. After the complete examination of the known sample then unknown sample were compared within the characteristic features of the known sample for the species identification.

Results

After observing all samples of pugmark of different animal's species, following results were obtained (Figures 1 to 30).



Figure 1: Pugmark of duck



Figure 2: Pugmark of hen



Figure 3: Pugmark of cow (fore foot)



Figure 4: Pugmark of cow (hind foot)



Figure 5: Pugmark of bull (fore foot)



Figure 6: Pugmark of bull (hind foot)



Figure 7: Pugmark of deer (fore foot)



Figure 8: Pugmark of deer (hind foot)



Figure 9: Pugmark of sheep (fore foot)



Figure 10: Pugmark of sheep (hind foot)



Figure 11: Pugmark of goat (fore foot)



Figure 12: Pugmark of goat (hind foot)



Figure 13: Pugmark of buffalo (fore foot)



Figure 14: Pugmark of bull (hind foot)



Figure 15: Pugmark of dog (fore foot)



Figure 16: Pugmark of dog (hind foot)



Figure 17: Pugmark of cat (fore foot)



Figure 18: Pugmark of cat (hind foot)



Figure 19: Pugmark of horse (fore foot)



Figure 20: Pugmark of horse (hind foot)



Figure 21: Pugmark of elephant (fore foot)



Figure 22: Pugmark of elephant (hind foot)



Figure 23: Pugmark of pig (fore foot)



Figure 24: Pugmark of pig (hind foot)



Figure 25: Pugmark of rabbit (fore foot)

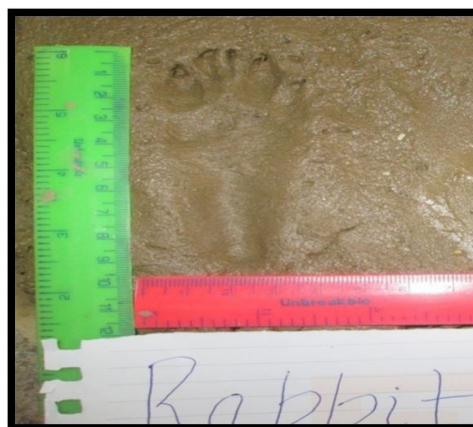


Figure 26: Pugmark of rabbit (hind foot)



Figure 27: Pugmark of donkey (fore foot)



Figure 28: Pugmark of donkey (hind foot)



Figure 29: Pugmark of camel (fore foot)

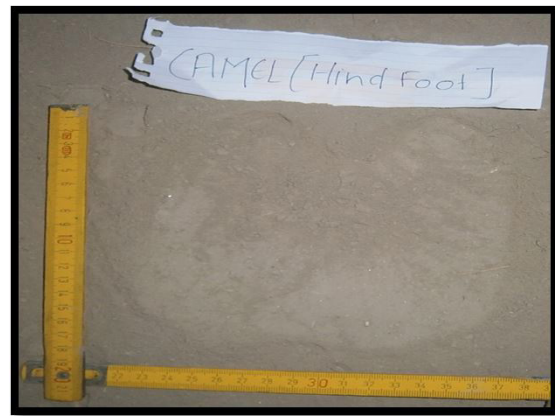


Figure 30: Pugmark of camel (hind foot)

A	SPECIES NAME: ARTIODACTYLA					
S.No.	Animal name	Characteristic of fore foot pugmark				
		Shape	Size	Dew mark	Claw mark	Specific feature
1	Goat	Kidney shape mark	Medium	Absent	Absent	Gap is present in between the hooves forming a V shape.
2	Pig	2 bilaterally symmetrical mark shape	Medium	Present	Absent	Marks of dew claws present behind.
3	Deer	Up-side down heart shape	Small	Absent	Absent	Tip of the hooves mark are slightly pointed and bottom is arch shaped.
4	Cow	2 bilaterally symmetrical mark somewhat circular shape.	Large	Absent	Absent	Half of the hoof mark is semi-circle in shape.
5	Buffalo	2 bilaterally symmetrical mark shape	Large	Absent	Absent	Uneven sizes of hooves mark are formed i.e one hooves mark is larger than other mark.
6	Bull	2 bilaterally symmetrical mark shape	Large	Absent	Absent	Complete shape of mark is up-side down heart shape.
7	Sheep	2 bilaterally symmetrical mark somewhat up-side down heart shape.	Medium	Absent	Absent	Hoof mark is narrow at front and border at bottom.
8	Camel	Somewhat heart shape.	Large	Absent	Absent	Front side is arch in shape and rear side is circular.
B	SPECIES NAME: PERISSODACTYLA					
S.No	Animal name	Characteristic of fore foot pugmark				
		Shape	Size	Dew mark	Claw mark	Specific feature
9	Horse	Up-side down heart shape.	Large	Absent	Absent	The hoof is not cloven or it is not divided into two equals' parts.
10	Donkey	Circular	Medium	Absent	Absent	The hoof mark is pyramid in shape.
11	Elephant	Round	Large	Absent	Absent	Scales marks are present.
C	SPECIES NAME: ANISODACTYLIE					
S.No	Birds Name	Characteristic of fore foot pugmark				
		Shape	Size	Dew mark	Claw mark	Specific feature
12	Hen	Anisodactylie	Small	Absent	Absent	All the four toes marks are slightly pointed.
13	Duck	Anisodactylie	Large	Absent	Absent	Webbed feet.
D	SPECIES NAME: LEPORIDAE					
S.NO	Animals Name	Characteristic of fore foot pugmark				
		Shape	Size	Dew mark	Claw mark	Specific feature
14	Rabbit	Somewhat oval shape	Small	Absent	Absent	Five toes show on front feet.
E	SPECIES NAME : FELIDAE					

S.NO	Animals Name	Characteristic of fore foot pugmark				
		Shape	Size	Dew claw	Claw mark	Specific feature
15	Cat	Central pad is circular shape	Medium	Absent	Absent	Front of heel pad has 2 lobe & rear has 3 lobe.
F	SPECIES NAME : CANIDAE					
S.NO	Animals Name	Characteristic of fore foot pugmark				
		Shape	Size	Dew claw	Claw mark	Specific feature
16	Dog	Up-side down heart shape heel pad	Medium	Absent	4 mark are present	Front of heel pad has 1 lobe & rear has 2 lobe.

Table 1: Characteristic of pugmark of (fore foot) of different animals' species

A	SPECIES NAME: ARTIODACTYLA					
S.No	Animal name	Characteristic of hind foot pugmark				
		Shape	Size	Dew claw	Claw mark	Specific feature
1	Goat	Oval shape	Small	Absent	Absent	Tip of the hooves mark are circular and bottom is arch in shape.
2	Pig	2 bilaterally symmetrical mark shape	Medium	Present	Absent	Marks of dew claws present behind.
3	Deer	Oval	Small	Absent	Absent	Tip of the hooves mark are slightly pointed and bottom is circular in shape
4	Cow	2 bilaterally symmetrical mark	Large	Absent	Absent	Tip is circular and bottom of the hooves mark is arch in shape.
5	Buffalo	2 bilaterally symmetrical mark shape somewhat oval shape.	Large	Absent	Absent	Both Tip and bottom of the hooves mark is arch in shape.
6	Bull	2 bilaterally symmetrical mark shape	Large	Absent	Absent	Complete shape of mark is apple shape
7	Sheep	2 bilaterally symmetrical mark somewhat up-side down heart shape.	Medium	Absent	Absent	Tip of the hooves mark are circular and bottom is arch in shape.
8	Camel	Somewhat heart shape.	Large	Absent	Absent	Front side is arch in shape and rear side is circular
B	SPECIES NAME: PERISSODACTYLA					
S.No	Animal name	Characteristic of hind foot pugmark				
		Shape	Size	Dew claw	Claw mark	Specific feature
9	Donkey	Circular	Large	Absent	Absent	Rear side of the hoof mark is W in shape.
10	Elephant	Oval	Large	Absent	Absent	The hoof is not cloven.
11	Horse	Up-side down heart shape.	Large	Absent	Absent	The hoof is not cloven or it is not divided into two equals' parts.
C	SPECIES NAME: ANISODACTYLIE					
S.NO	Birds Name	Characteristic of hind foot pugmark				
		Shape	Size	Dew claw	Claw mark	Specific feature
12	Hen	No hind foot present				
13	Duck	No hind foot present				
D	SPECIES NAME: LEPORIDAE					
S.No	Animals Name	Characteristic of hind foot pugmark				
		Shape	Size	Dew claw	Claw mark	Specific feature
14	Rabbit	Somewhat baby human footprint shape.	Large	Absent	Absent	Five toes show on rear feet.
E	SPECIES NAME: FELIDAE					

S.No	Animals Name	Characteristic of hind foot pugmark				
		Shape	Size	Dew claw	Claw mark	Specific feature
15	Cat	Central pad is somewhat up-side down heart shape	Medium	Absent	Absent	Front of heel pad has 1 lobe & rear has 2 lobe.
F	SPECIES NAME: CANIDAE					
S.No	Animals Name	Characteristic of hind foot pugmark				
		Shape	Size	Dew claw	Claw mark	Specific feature
16	Dog	Up-side down heart shape heel pad	Medium	Absent	Present	Heel pad is smaller as compared with the heel pad of fore foot.

Table 2: Characteristic of pugmark of (hind foot) of different animals' species

From the Tables 1 and 2, it is clearly shown that pugmark of different species has different type of shape, size, dimension, etc. It also shows that fore foot and hind foot of same animal is also having some differences. And there is also specific feature in each and every pugmark. As per given in Table 1 comparison of pugmark of fore foot of different animal species the goat pugmark was kidney shaped, its size was medium, both dew and claw mark were absent and the specific feature was that gap is present in between the hooves marks forming V shape.

Pig pugmark shape was 2 bilaterally symmetrical toes with cloven hooves, size was medium. No claw marks were present and the specific feature was that dew claw marks were present behind. Dog pugmark heel pad shape was up-side down heart shape, size was medium. Dew mark was absent and four claw marks were present. Specific features were that front of the heel pad has 1 lob and rear has 2 lobe. Deer hooves mark was like up-side down heart shape, size was small. Both claw and dew marks were not present. Specific feature was that front tips of the hooves were pointed and bottom was arched shaped.

Duck marks were Anisodactylie shaped, size was large in shape, claw and dew mark were absent. Specific feature was that it has webbed feet. Cow hooves marks were 2 bilaterally symmetrical marks somewhat circular in shape, size was large. Specific feature was that half of the hooves marks were semi-circle in shape. Buffalo hooves marks were 2 bilaterally symmetrical in shape, size was large, Specific feature was that the uneven size of mark was formed i.e. one of the half side of hooves mark was larger than the other half side. Bull hooves marks were 2 bilaterally symmetrical in shape, size was large. Specific feature was that the complete shape of the mark was somewhat up-side down heart shape. Horse pugmarks were up-side down heart shape, large in size. Both claw and dew marks are absent. Specific feature was that the hooves mark was not cloven or it is not divided into two parts. Donkey pugmarks were also circular in shape but size was medium. Both dew and claw marks are absent. Specific feature was that rear side of the hoof mark is pyramid in shape.

Elephant pugmark is round in shape, its size is large. Both dew and claw mark are absent. Specific feature is that scales marks were present. Hen pugmark shape was Anisodactylie in shape. Size of mark was small. Both claw and dew mark are absent. Specific feature is that all 4 toes marks are slightly pointed in shape.

Sheep hooves mark shape is 2 bilaterally symmetrical mark somewhat up-side down heart in shape, size is medium and dimension is approx. 7 cm is long and 6 cm is wide. Both dew and claw mark are absent. Specific feature was that hoof mark was narrow at front and border at bottom. Rabbit fore foot was oval in shape, size was small, dimension was approx. 5 cm long and 3 cm wide of the fore foot, and Specific feature was that five toes show on fore foot. Both dew and claw mark is absent.

In cat pugmark central pad was somewhat circular in shape, size was medium, both claw mark and dew claw mark were absent and Specific feature was that front of heel pad has 2 lobe and rear has 3 lobes. Camel hoof mark was somewhat heart shape, large size of hoof mark was formed. Both dew claw and claw mark were absent. Specific feature was that front side was arch shape and rear side was circular in shape.

Now according to Table 2 showing the Comparison of pugmark of (hind foot) of different animals' species the goat pugmark was oval shaped, its size was small. Both dew and claw mark were absent and the specific feature was that tip of the hooves mark are circular in shape and bottom was arched. Pig pugmark shape was 2 bilaterally symmetrical toes with cloven hooves, size was medium. No claw marks were present and the specific feature was that dew claw marks were present behind.

Dog pugmark heel pad shape was up-side down heart shape, size was medium. Dew mark was absent and four claw marks were present. Specific features were that front of the heel pad has 1 lob and rear has 2 lobes. Deer hooves mark was oval in shape, size was small. Both claw and dew marks were not present. Specific feature was that front tips of the hooves were pointed and bottom was arched shaped.

Cow hooves marks were 2 bilaterally symmetrical marks in shape, size was large. Specific feature was that tip was circular in shape and bottom of the hooves mark was arched shaped. Buffalo hooves marks were 2 bilaterally symmetrical marks somewhat oval in shape, size was large. Specific feature was that both top and bottom of the hooves mark was arched shaped. Bull hooves marks were 2 bilaterally symmetrical in shape, size was large. Specific feature was that the complete shape of the mark was somewhat apple shape.

Horse pugmarks were up-side down heart shape, large in size. Both claw and dew marks are absent. Specific feature was that the hooves mark was not cloven or it is not divided into two parts.

Donkey pugmarks were also circular in shape but size is medium. Both dew and claw marks are absent. Specific feature was that rear side of the hoof mark is pyramid in shape. Camel pugmarks are circular in shape and its size was large. Both dew and claw mark is absent. Specific feature is that gap is present on the front side of hoof mark.

Elephant pugmark was oval in shape, its size is large. Both dew and claw mark are absent. Specific feature is that scales marks were present. Sheep hooves mark shape is 2 bilaterally symmetrical mark somewhat up-side down heart in shape, size is medium. Both dew and claw mark is absent. Specific feature was that tip of the hoof mark was circular in shape and bottom was arched shaped. Rabbit hind foot was somewhat baby human footprint shape, size was large and Specific feature was that five toes show on hind foot. Both dew and claw mark are absent. In cat pugmark central pad was somewhat up-side down heart shape, size was medium, both claw mark and dew claw mark were absent and Specific feature was that front of heel pad has 1 lobe and rear has 2 lobes. Camel hoof mark was somewhat heart shape, large size of hoof mark was formed. Both dew claw and claw mark were absent. Specific feature was that front side was arch shape and rear side was circular in shape. Pugmark of different animal species which were included in the present study shows so many different characteristics. Thus, by the analysis of the pugmark of different animals' species we can identify the specific animal species. Though some of the characteristic were same in the pugmark of many species but there was some difference in each species pugmark in spite of having some common characteristic on bases of which we can easily identify the specific animal species.

Discussion

The present study was aimed for the identification of different animal species by the characterizations of their pugmark. 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 16 animal species pugmark were included in the present study. The animal which were included in the study are deer, goat, cow, buffalo, bull, camel, dog, cat, sheep, hen, duck, pig, horse, donkey, rabbit and elephant. 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 characteristic were found and noted down. The characteristic 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 characteristic which were same in the pugmark of the most of different animal species. Similar type of study was also carried by Raj *et al.* (2015) [6] for identifying tigers through their pugmark using image processing techniques. 14 features were extracted from each pugmark image and stored in master data base [7-12].

Conclusion

After the complete examination of pugmarks of different species, it was concluded that in each and every different 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 characteristic 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. There was also some characteristic which were same in different type of species pugmark. Pugmarks of different species are distinct it is not same. There were some specific characteristics features found in each pugmark through which we can differentiate between the same family species. Cow, bull, and buffalo almost have same type of pugmark as they belong to same family but there was some specific feature in each animal pugmark through which we can differentiate between them.

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