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STUDY OF THE BEHAVIOUR PATTERN AND INDIVIDUALISATION OF FELIDAE FAMILY IN WILDLIFE FORENSICS

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Author TKG designed the study, managed the literature searches and wrote the first draft of the manuscript. Authors AA and AC improve the manuscript grammatically and contribute in literature search of the study. Author SRP designed the study and contribute through the development of final manuscript by providing critical analysis and also a corresponding author. All authors read and approved the final manuscript.

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Review Article

ABSTRACT

Wildlife forensic is the implementation of the combined sciences, natural and cultural science. The court of law focused on the regulation of wildlife protection and conservation. Criminals that regulate illicit trade across nations and continents face the most significant threat. The tiger is the largest of all cats, the most iconic, and one of the most endangered. Due to its higher trading value, those animals are unlawfully slaughtered or poached for black-marketing, medical use and jewellery products. Tiger or leopard protection indirectly protects habitats and ecological health. By transmitting signals through vision, scent marks and voices, they are socially connected. Because of the dramatic reduction in tiger numbers, studying their behaviour habits is very difficult. Therefore, in this study, the Indian Leopard and Bengal Tigers [Felidae-family] are studied using the non-destructive approach through its claw nail markings. The transactional survey was the approach adopted for collecting data-signs of tiger nail bruises. This review focuses on the study of their behavioural habits and extensively study them for their conservation.

Keywords: Cat family; behaviour pattern; claw marks; wildlife forensics.

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1. INTRODUCTION

Wildlife forensics is the application of science to legal issues concerning biological resources. Forensic science can be used in these forms of investigations to identify and classify suspects with evidence collection. Wildlife trade Monitoring Network detected illegal trafficking of tiger bone, hides, claws, teeth, blood, and others. The Royal Bengal Tiger [*Panthera tigris*] is one of the nine recognised tiger subspecies [*Panthera tigris*], belonging to the Mammalia Class, Carnivore Order, Felidae Family, Pantherinae Subfamily, and the *Panthera* Genus. The Tiger *Panthera tigris* is perhaps the most iconic big cat in the world. Untamed life criminology is a moderately new field of criminal examination. It utilises logical methods to analyse, recognise, and report the cases from crime locations. The crime against wildlife involves four significant categories: illegal taking or poaching possession, trading, shipping or moving, inflicting cruelty or moving. The conservation, management and forensic analysis had a significant influence on life agencies and department activities. Tiger and leopard are carnivore's animals. Occasionally, indian tigers [1] hunt and kill predators such as the Indian Leopard, Indian Wolf, Indian Jackal, Fox, Mugger Crocodile, Asian Black Bear, Sloth Bear, and Dhole. The rarely targeted animals are Adult Indian elephants and Indian rhinoceros. According to the diet composition of tiger and leopard, restoring the large population of prey and reducing human disturbance are the necessary steps for effective conservation of Tiger and Leopard [2]. The most endangered species in India are Asiatic Lion, Bengal Tiger, Snow Leopard, Nilgiri Tahr, Kashmiri Red Stag, Blackbuck, One-horned rhinoceros. The behavioural marking of the tigers and animals, as forensic personals, can correlate the crime locations [3]. Therefore, wildlife is considered one of the fields in forensic science. The conservation of Bengal tigers and Indian panthers is critical to preserve their ecology and monitor wildlife trade. We considered the wild animals' behaviours to understand their habitat to conserve their species for forensic purposes [4].

2. BEHAVIOUR PATTERN

As a behaviour pattern, tigers approach their victims from the side or behind and attack the prey by attacking the throat to kill them. During the chase, Tigers and leopards used claws as their weapons, and their hooks produce a grip to catch the prey. During the attack on a human, leopards prefer bushy areas on the ground [5]. The attack on humans shows several wound with deep marks, many scratches and linear abrasions of various dimensions and directions are observed mainly over the arms and the torso. The internal examination shows a puncture wound of the length of 0.5 cm and a spleen of length 1 cm. On autopsy, the internal organs were very pale, and it shows the grip to catch prey and strength of claw [6-8].

2.1 Territorial Marking Behavior

Territorial marking is associated with sexually intact adult animals. In general, male tigers use territorial markings as significant behaviour to identify their territory. Selecting specific micro-locations by scent marking, they could defend their territory and find mates [9-10]. The reported study shows that the number of possible males, a female evaluates, could outnumber the percentage of tigers it visits [11]. An analysis of territorial marking fluids, the materials found in the study were 98 volatile compounds such as sulfur, urine fraction and lipids [12]. Another study shows marking various ketones, nitrogens, sulfur, alcohol, acid, phenol, amines, and amides. Also, ammonia, methylamine dimethylamine, trimethylamine, triethylamine, propylamine, and butane-1,4-diamine [putrescine] [13-14]. According to the different season's variations found in volatiles and the difference in scent-marking rate between males and females in the field such as males mark twice as frequently as females [15]. Around puberty, male mammals' testosterone levels soar well past adult levels. In the absence of conspecific smell or female scent, the testosterone peak during puberty has little effect on male marking activity. These findings suggest that testosterone organises male territorial-marking activity during puberty [16]. A study described that male tigers have a higher content of 2-butanone in urine than females, and females Tigris have a higher relative acetone content than males [17]. The female tigers use territorial behaviour to take care of their cubs. Generally, two to three years after the birth, the cubs are in the mother tigers' custody. Therefore the mother tigers use it as a significant behaviour for the cubs to identify their home territory.

Male leopards use boundary scent-marking technique, putting more effort into establishing marking sites on their home range outskirts. Leopards scent-marked four times more frequently and searched three times more frequently than when travelling along natural paths. According to the study, human-made environmental changes play an essential role in promoting social harmony within this solitary carnivore [18]. No single scent-marking action was a valid measure of reproductive activity [19]. The ecology and behaviour of tigers vary with different

subspecies and in different environments. Scent marking is specifically correlated in many species with violent behaviour [20,21] by scratching trees, carving out territories. Other animals use the glandular secretions of the tigers' feet to identify the presence of the tigers in that location readily. Spraying urine, scraping with deposits of urine, faeces and secretions of the anal gland, clawing, rubbing of cheeks, and flattening vegetation are some of the behaviour of tigers focused on [22].

2.2 Claw Marking Behavior

Tiger and leopard usually leave deep longitudinal markings on the tree which they have chosen. For practitioners, the height of claw marks on trees indicates the size of the tiger. The definition of claws gives re-tractable evidence, but this is a misnomer. Therefore it is used to estimate the size of the tiger but not for the determination of the size of the tiger. In their usual comfortable position, the claws sheathe is present to prevent the nails from coming into contact with the soil and keeps it sharp. The linking tendons are pulled taut only during a stretch, such as the one used in capturing prey, to push claws outward immediately. Claws protruded in two directions, either ventrally or more dorsal wards, for controlling the claw movements [23]. Tiger claws are up to 5 inches in dimension, forefeet have five claws, plus a dewclaw, while hind paws have four claws without the dewclaw. They do not experience wear from contact with the ground because dewclaws are located high on the leg. It implies that they become particularly long and sharp, beneficial for catching the prey. The Nail Claw's molecular examination reveals that it has pigmentation amide bonds, -C.H. deformations, cysteine oxides in Keratin protein [24].

2.3 Scraping Behavior

The scraping is a hereditary behaviour of the cat family [25]. The tigers' scraping categories are into three types such as Fresh, Recent and old scraping marks. The fresh marks show the sharp edges, and the recent scraping marks show the absence of woody grit, whereas the old scraping marks shows growth on barks [26]. Not all tigers scratch trees but some of them frequently do. High scraping frequencies were not correlated with particular individuals' presence, indicating that scrape-marking behaviour may not indicate dominance in this environment [27]. The rate of the scraping ranges 0.576 scraps/km [28] used to locate the availability of the tiger signs. According to the survey method, number of tigers observed scraping activity shows the scraping marks found near the scrats [29-30]. A Clear set of scratch-posts for Acacia erioloba [31]. When tigers and Leopards grab food, it shows diagonal cuts and scraping marks have penetrated the periosteum and subjacent bones of the prey due to the claw's power to hold food [32].

2.4 Face Rubbing Behavior

Behaviour like: cheek rubbing and olfaction scraping in Leopards are reported [33] 100 volatile organic compounds, identified from cheek and forehead sample [34-35]. The evidence related to the tigers and Leopards is considered as pocket pieces of evidence. The sample includes, skin, hair, territorial marking, pug marks, and other evidence. Tiger distribution pockets and the tiger sighting spot are classified using the software GIS ARC in 9.0 [36]. An epidemic layer of skin and different glands presents in tiger, leopard or golden jackal skin sample, this baseline data of skin sample study is an indispensable tool in wildlife forensics [37].

2.5 Pug Marks

Another Tiger pocket is the pug mark; Pugmark is the term used to refer to most of the animals' footprints. Accurate identification of the species, sex, age, and physical condition of an animal is determined using pugmarks. Research shows that tigers can be identified separately from their pug markings with a high degree of accuracy [38]. Pugmarks depend on the effect of extraneous factors like soil depth, multiple tracers [39]. FCM level was significantly different between tiger subspecies and sex, and it's a destructive technique for analysis. By using of Non-invasive stress endocrinology method, Concentrations of FCM determined using a polyclonal anti-cortisol antiserum. After that, all the faecal data expressed as [ng/g] net dry faeces. $P < 0.05$ was considered as significant. They determined whether the FCM levels were significantly different between tiger sub-species and sex [40].

2.6 DNA Analysis

DNA profiling is the essential criteria for DNA analysis in wildlife forensics, and it is one of the most potent protocols to be followed in dealing with wildlife crime cases. Some basic steps, including DNA extraction, PCR amplification, DNA sequencing and sequence comparison, were included in the DNA profiling. A hierarchical protocol used for the detection of fake claws using morphometric and DNA-based analysis [41]. The subsequent analysis was performed only with those loci for which consensus sequence reveals the tiger population's estimation [42]. Behalf of using PCR amplification for Tigers and Leopards' molecular analysis SSP [Species-specific primers] is reliable for the result,

cost-effective and time-saving technique [43]. The MRI scan of the mature Bengal tiger reveals the typical appearance of the elbow joint's bony and soft tissue structure [44]. Analysing the fragmented tooth and anatomical evidence with the actual pair of the fragmented performed using a taphonomic signature [45]. The primary endpoint is the distribution of lymph node metastases in oesophagal and oesophagal junction carcinoma specimens. The analysis includes a map of the position of lymph nodes about tumour histology [46]. Next-generation sequencing [NGS] aims to solve the uncertainty around multifocal NGSC. They would expect to discover synchronous primary lung cancer [SPLC] or intrapulmonary metastasis as long as we have tissue [IPMLC]. Despite its promising findings, this paper has essential shortcomings that add to the issue of multifocal. The authors used a custom NGS panel to create a test based on their database, taking into account expense, length, and analysis time [47].

The Wildlife Department has been proactive in reducing the gap in "research– implementation" It is anticipated that recent advances in DNA and genetic science include innovative solutions to conserve the wildlife habitat [48]. According to the thermoregulatory behaviour, most of the time, tigers lying down [45%] and 19% of tigers facing direct sunlight and 20% of tigers observed in the shade [49]. Defecation does not play a crucial role in olfactory contact for free-range dogs, and standing and squat postures are consistent with natural excretion [50]. Lynx preferred conspicuous objects for marking and increased scent marking rate when walking along with linear structures, such as forest roads [51-53].

3. METHODOLOGY FOR THE FINDING OF ANIMAL BEHAVIOURS PATTERNS

Following table is about the evolution of animal behaviour since 1973-2021. Total 51 researches which were conducted have been reviewed. Behaviour in term of territorial marking, scraping, aggression, check rubbing, pug marking etc. has been studied throughout the period of time. Different method were carried out based on the behavioral pattern [non-destructive study, molecular analysis, felid survey method etc. the overall study suggests that the animal behaviour varies at different circumstance.

Table 1. Study survey from last 23 years related to animal behaviour

Main Findings	Method Use By Analysis	Observations by Author
In mammals, marking behaviour is said to be 'territorial' or to play a part in territorial defence. Scent marking is compared in many species with violent behaviour.	Non-destructive Method	Roger P. Johnson (1973)
In terms of aggression, fighting happens if the opponent poses a threat to the animal's reproductive success. Therefore, it is essential in monogamous species that both parents dedicate a considerable amount of time and resources to caring for their offspring. Adults of either sex can impair the reproductive success of a male. Cuckoldry, of course, is a challenge that only males encounter. They are the biggest threat to a monogamous male as his sexual success is challenged by both sexes' rivals. Conspecific populations at risk vary from species to species based on the species' biological and social nature.	Observational study	Pauline Yahr (1983)
Five marking observations like spraying of urine, scraping with deposits of urine faeces and secretions of anal gland; clawing; rubbing of cheeks; and flattening vegetation.	Non-destructive Method	James David Smith Charls McDougal (1989)
The scent of reproductively active felids is detected more often than that of reproductively inactive felids. No single scent-marking action, on the other hand, was a valid measure of reproductive activity. The most accurate predictor was the relative rates of a few social activities.	No-destructive Method	Jill d. Mellen (1991)
Analysis of the marking fluid of two tigers [Bengal and Sumatran] by Gas Chromatography using an amine-specific column and a nitrogen-specific detector has shown the following amines: ammonia, methylamine, dimethylamine, trimethylamine, triethylamine, propylamine, and butane-1,4-	Molecular study	G lyn R. Banks, A lan J. Buglass, and John S. W aterhouse, (1992)

Main Findings	Method Use By Analysis	Observations by Author
diamine [putrescine].		
In the survey based method, tracking of leopards is on a step-by-step basis. Male leopard data reflects 118 tracking days over 19352 km and 66 days and 729.6 km of tracking for females. In Kalahari leopards, tree scratching or clawing usually occurs. There is a clear set of scratch-posts for Acacia erioloba.	Survey based method	J.du bothma, E. A. N. Leriche (1993)
A transition in scent-marking behaviours is close to a shift in scent-marking behaviours. Female sage grouse [Centro cercus urn phasiunus] are drawn to male displays by their vocal traits, but they choose between them using other signals, such as show rate. These results show that the number of possible males a female evaluates could well outnumber the percentage of individuals it visits.	Non-destructive method	Robert M. Gibson, Tom A. Langen (1996)
Total of 55 compounds discovered in urine and 7 species-identifying compounds in faeces samples using the GC-MS headspace technique. Males have higher relative acetone content than females, and females have higher relative acetone content than males.	Molecular Analysis	K. F. Andersen, T. Vulpius (1998)
Around puberty, male mammals' testosterone levels soar well past adult levels. Testosterone was given to male tree shrews during puberty or later in life. In the absence of conspecific smell or female scent, the testosterone peak during puberty has little effect on male marking activity. These findings suggest that testosterone organises male territorial-marking activity during puberty, controlling testosterone.	Pigment analysis	Florian Eichmann And Dietrich V. Holst (1998)
The densities of large herbivores, measured using line transects and population structures from area counts. Predators have shown substantial [$P < 0.05$] selectivity among prey species. The estimation of predator diets based on kill data is obtained. Despite variations in body size between tiger, leopard and dhole, there was significant dietary overlap.	Non-Destructive	Ullas karanth, Melvin E.Sunquist, (1995)
Claws can be protruded in two directions, either ventrally or more dorsal wards. Differential movements of the different digits suggest some degree of individual control of the digits.	Observational Study	L.G. Pettersson, S.perfiliev, (1998)
Scratching is a hereditary, common trait in cats used as a visual and olfactory territorial mark and stretching exercise for the forelegs.	Observational Study	M.Landsberg, (1999)
Research indicates that the tigers are individually marked with a high degree of precision from their pugmarks.	Survey based method	Sandeep Sharma,Yadvendradev Jhala, (2005)
A pilot study using DNA extracted from a faecal sample of tigers. PCR primers were developed based on tiger specific variation in the mitochondrial cytochrome-b. The subsequent analysis was performed only with those loci for which consensus genotypes, obtained. Thus the study revealed the estimation of the tiger population.	Pilot study	Jyotsna Bhagavatula , lalji (2006)
The only variations in volatiles found were between swabs from different seasons. a difference in scent-marking rate between males and females in the field; males mark twice as frequently as females	Non-destructive technique	R. Andrew Hayes , Toni lyn Morelli, 2006
Scrape seen at traces of urine ground site mean,length =1.06, mean width = 0.18cm. They also found 20 scraps with scats	Non-Destructive	Arash Ghoddousi, Taher Ghadirian

Main Findings	Method Use By Analysis	Observations by Author
placed inside or near the scrape. Most leopard scrapes in BNP [N=28.58.3%]		(2008)
98 volatile compounds and element sulfur were identified in the marking fluid. The urine fraction of the marking fluid contains lipid materials.	Molecular Analysis	B.V. Burger (2008)
36 tigers killed 88 people from 1979 to 2006. Most kills were made within 1 km of forest edge but equally in degraded and intact forests. 56% of tigers that were examined had physical deformities.	Survey-based study	Bhim Gurunga , James L. David Smitha (2008)
Categories mark as looking fresh, e.g. sharp edges, recent, e.g. absent woody grit, and the third one is the old mark, e.g. bark growth in the gouges. For the duration of age estimation, they used Kaplan-Meier Survival analysis	Non-destructive method	Robert Steinmetz , David L. Garshelis, (2010)
Scrapes were more closely associated with the appearance of male pumas than female pumas, as well as with either sex jaguars. High scraping frequencies were not correlated with particular individuals' presence, indicating that scrape-marking behaviour may not indicate dominance in this environment.	Observational Study	Bart J. Harmsen, Rebecca J. Foster, Said M. Gutierrez (2010)
A total of 100 volatile organic compounds were identified or tentatively identified from both cheek and forehead samples; 41 of them were previously found in feline urine and marking secretions. On the surface of the face, several new compounds have been discovered. 3-acetamidofuran was observed in all of the species studied	Molecular Analysis	Helena A. Soini and Susan U. Linville (2012)
Defecation does not play an essential role in olfactory communication among free-ranging dogs, and that standing and squat postures are associated with normal excretion. Results suggest that many of the proposed functions of marking behaviours are not mutually exclusive, and all should be explored through the detailed field.	Observational Study	Simono Cafazzo, Eugenia Natoli, Paola Valsecchi (2012)
According to the microscopical analysis, observed scratching mark and diagonal cut on the bones and those marks has penetrated the periosteum and Subjacent bone samples.	Microscopically Analysis	Bruce M. Rothschild , Bill Bryant, (2013)
Concentrations of FCM were determined using a polyclonal anti-cortisol antiserum. After that, all the faecal data are expressed as [ng/g] net dry faeces. $p<0.05$ was considered significant. study reveals to describe and to validate a faecal cortisol metabolite enzyme-immunoassay for two tiger species	Destructive method	Edward J. Narayan,Tempe Parnell, (2013)
Observation of microstructural features of medulla, unique lateral groove and types of cuticle patterns are seen. Guard hair of tiger shows variations according to different geographical location and seasons.	Non-Destructive technique	K.K. Sarma, P.C.Bhattacharje, (2014)
Observed wound, depth of marks, many scratches and linear abrasions of various dimensions and directions are located mainly over the arms and the torso. The internal examination observed a puncture wound at the left lung of length 0.5 cm, and on the spleen of length 1 cm. At autopsy, the internal organs were seen very pale.	Case study	Hrishikesh Pathak , Pradeep Dixit, (2014)
Used Taphonomic signature of large fields using a geographic Information system [GIS] Image analysis method for the study of a tooth marking and gross bone damage	Non-Destructive Study	Jennifer A. parkinson, Thomas Plummer (2014)
Effect of extraneous factors, soil depth, multiple tracers	Survey based	R.Sing , Q.Qureshi,

Main Findings	Method Use By Analysis	Observations by Author
and pugmark tracings were seen on the total length and total width of pads compared with pugmark photographs.	method	(2014)
Used Non-destructive technique for sampling .19 captive tiger Behavioral observation of 1254 hours was analysed for target behaviours using instances sampling and 1 minute sample period.	Non-destructive technique	Rajesh Kumar Mohapatra , SudarsanPand (2015)
Calculated tiger pockets mark according to area and location. The GPS points of tigers sighting locations are plotted on the map. Used GIS software ARC into 9.0	Transactional survey method	Abhijit Rabha,PrasantaKumar Saikia, (2015)
Lynx preferred conspicuous objects for marking and increased scent marking rate when walking along with linear structures, such as forest roads. On tracks with evidence of hunting behaviour, lynx engaged less in scent marking.	Non-destructive	Kristina Vogt, Elizabeth hofer (2015)
Lion holding territory and control of pride female are essential for male condition fitness: male lions' vocalisation and patrolling behaviour based on a five study.	Non-destructive	Meena Venkataraman (2015)
Observed 32 components in M.S., Territorial marking fluid consisted of ketones, nitrogen-containing compounds, sulfur-containing compounds, Alcohols, acids, phenols, amines and amides.	Chemical analysis	Simone B.Soso,Jacek A.Kozi, (2016)
124 forensic cases of dangerous human-carnivore encounters. They concluded the importance to understand behavioural changes during human evolution. All injuries, including bone damage and general body wounds, are observed. 92 cases are considered for the quantitative analysis as the damage can be observed. In this study, he identifies behavioural changes during human evolution.	Case Study	Adward quantabira (2016)
The study describes the identification of seized suspected tiger claws. Using the combined approach of morphometric and DNA based analysis	DNA based analysis	Vipin Vinita Sharma,Ved P.Kumar, (2016)
Behaviours olfaction scraping and cheek rubbing are most frequently recorded.	Observational study	Maximilian L.Allen Heiko U.Wittmer (2016)
The non- invasive sampling technique used carnivore scats as a sample for identifying species through a molecular approach.	Non-destructive technique	Pranay Amruth Maroju , Sonu yadav , (2016)
This paper discusses published literature [from 1950 to 2014] on the ecology and conservation of snow leopards in China. The goal is to recognise thematic and regional research holes and to recommend research goals. We first retrieved all the published articles that considered snow leopards in China [n=106]. We extracted 274 comments from these articles on Snow Leopard's presence in China and analysed a subset of papers. They also adopted a thematic system that allows for a systematic and thorough evaluation of the results.	Review	Justine S Alexander, Zhang Cheng Cheng (2016)
In this study, it is observed that pigmentation, and scale patterns in Claw nail have compounds such as amide bands, CH deformations cysteine oxides in Keratin protein.	Molecular study	H.ltaliya (2017)
Developed and tested a Non-exclusive hypothesis of scent marking object by Eurasian lynx [Lynx Lynx]. Used snow tracking to located and determine characteristics of the object was lynx used and selected for urine spraying lynx did not mark objects according to their availability. Thus the study	Observational study	Maximilian L. Allen, Lan Hocevar (2017)

Main Findings	Method Use By Analysis	Observations by Author
reveals to indicate trade-off faced by lynx if preferred marking object are not readily available therefore suboptimal marking objects were used.		
In the tea gardens, a total of 171 leopard attacks on humans. None of the attacks resulted in death. Leopards are more likely to use areas with more ground vegetation cover. According to a study of habitat use by leopards was high, whereas it was low in areas with a high density of buildings. However, there are several cases where Leopard attacks on humans did not occur in places where there was a greater risk of leopard attacks on humans	Case study	Aritra Kshettry, Srinivas Vaidyanathan (2017)
Finding a rate of 0.576 scraps/km. Most scraps were found in car tracks 0.629scraps/km, trails 0.094scraps/km. They observed car tracks mainly found in edges, pumas scraps mainly located in central areas, and jaguars' scraps located on both edges.	Transactional survey	Francisco Palomares , Noa Gonzalez-Borrajo, (2018)
Observed nine Bengal tigers, collect observational data every minute also collected thermal images of each individual wind speed , ambient temperature, and relative humidity recorded every 15 min. They observed 45% of time tigers lying down, 19%in direct sunlight, 20% in the shade. They Put a value on the table and describe No. of behavior like standing – with No. of location, walking slow motion.	Observational study	Jim L. Atkinson, Robert D. Brown , David Barney (2019)
The primary endpoint is the distribution of lymph node metastases in oesophageal and oesophageal junction carcinoma specimens. The analysis includes a map of the position of lymph nodes about tumour histology.	Distractive method	Eliza R. C. hagens, Mark I, van Berge henegoumen (2019)
The study is a small, single-centre retrospective study of 18 total pairs, with adenocarcinoma accounting for 90.2 per cent of the cases. Eight of the 18 tumour pairs that were tested using NGS were down staged to SPLC. It is a staggering 44 per cent reduction in point, which has substantial care consequences. The investigator concludes that NGS-based preoperative staging is the safest method to treat multifocal lung cancer.	Cytological analysis	John F. Lazar, MD (2019)
Male leopards in our research area used a boundary scent-marking technique, putting more effort into establishing marking sites on the outskirts of their home range, They also discovered that when travelling on tracks, leopards scent-marked four times more frequently and searched three times more frequently than when travelling along natural paths. According to the study, human-made environmental changes are now playing an essential role in promoting social harmony within this solitary carnivore	Observational study	Kasim Rafiq , Neil R. Jordan , Carlo Meloro (2019)
Observational study to investigate the behavioural repertoire of tigers via continuous observation, observed nine Bengal tigers [n=6 Females, N=3males]They collect observational data in every minute also collected thermal image	Observational study	Judith A. Stryker, Jim L.Atkinson, (2019)
Magnetic Resonance Imaging and Cross dissection. This article described the standard elbow joint anatomy in a Bengal Tiger. This, study reveals that the regular appearance of the bony and Soft tissue Structure of the elbow joint in a cadaver of a male mature Bengal Tiger and scanned Via MRI.	Physical examination	Mario Encinoso, Jorge Oros, (2019)

Main Findings	Method Use By Analysis	Observations by Author
The study aims to create baseline data on the skin of a leopard, leopard cat, Bengal tiger, Golden Jackal and were the data obtained from the study may use as an Indispensable tool in wildlife forensics.	Destructive method	Chukkath Vijayan Rajani, Harshad Sudhir Patki (2020)
The Wildlife Department has been proactive in reducing the gap in "research– implementation" It is anticipated that recent advances in DNA and genetic science include innovative solutions to conserve the wildlife habitat	Research	Vincent Bourret , Vicky Albert (2020)
Researchers sampled eleven study areas and reported 58 observations in 2013–17, about Anatolian leopards found in northeast Anatolia, Turkey	Pilot study	Alptuğ Sarı, Ebubekir Gündoğdu, Şağdan Başkaya (2020)
The study reveals that restoring a large population of prey and reducing the level of human disturbance are the key measures necessary for the effective conservation of the Tiger and Leopard.	Non-destructive method	Bishny Prasad Bhattaral, (2021)

4. CONCLUSION

The present review demonstrates the behaviour of the Felaede family. Scent marking is a type of olfactory communication used by an animal that deposits its odour in particular locations to send a signal to another animal. Just a small number of species exhibit territoriality. The home range refers to an area that an individual or a group of animals uses often but does not generally protect. Territory security has a variety of proximate features. The purpose of such defensive behaviour in certain animals is to obtain and defend food sources, breeding sites, breeding areas, or to attract a mate. Scent marking is mainly characterised as conduct displayed to mark territory ownership. Scent marking, also known as territorial marking or spraying, is an animal's behaviour to distinguish their territories. Most frequently, this is achieved by depositing strong-smelling compounds in urine, faeces, or specialised fragrance glands found in different parts of the body. Pheromones or carrier proteins, such as major urinary proteins, are commonly used to stabilise odours and hold them for prolonged periods. Another behaviour is that Visual sign-posts can be a short-term or long-term means of marking the territory. Short-term contact requires the animal panting or only be communicated while the resident is present. Some animals could use longer-term visual cues such as faecal deposits or vegetation or soil markings. Another behaviour is Vocalisations for promoting their territories. These are short-term signals sent only while the animal is present, but they can travel long distances and across various habitats. Marking behaviour includes scraping, Claw raking and rubbing the cheek/head. Scraping is another behaviour, Even urinating on the pile of content behind the scratch. And these scrapes are produced at areas with unique topographical features [usually around cliffs or boulders] where trees are present; isolated trees or trees along travel paths or crossroads are often marked with claws vertically around the trunks.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bishnu Prasad Bhattarai, Pavel Kindlmann, et al. Interaction between Bengal tiger (*Panthera tigris*) and Leopard (*Panthera pardus*): implications for their conservation. Biodivers Conserv. 2012;2075-2094.
2. Ullas Karanth K, Melvin E. Sunquist. Prey selection by tiger, Leopard and dhole in tropical forest. Journal of Animal Ecology. 1995;439-450.

3. "what-when-how," [Online]. Available:https://what-when-how.com/forensic-sciences/wildlife/
4. Pawar B. 10 Endangered Animals in India That You Should See Before They Vanish!; 2019. [Online]. Available:https://www.india.com/travel/articles/10-endangered-animals-in-india-that-you-should-see-before-they-vanish-3241001/
5. Aritra Kshettry, Srinivas Vaidyanathan, et al. Leopard in a Tea- cup: A Study and human - leopard interaction in North Eastern India. Plos One. 2017;1-15.
6. Hrishikesh Pathak, Pradeep Dixit, et al. Unique fatality due to claw injuries in a tiger attack: A case report. Legal Medicine. 2014;381-384.
7. Rajesh Kumar Mohapatra, Sudarsan Panda, et al. Study on activity pattern and incidence of stereotypic. Journal of Veterinary Behaviour. 2014;1-5.
8. Bhim Gurunga, James L. David Smitha, Charles McDougalb. Factor associated with human-killing tigers in Chitwan National Park, Nepal. Biological Conservation. 2008;3069-3078.
9. Maximilian L. Allen, Lan Hocevar, et al. Where to leave a massage? The selection and adaptive significance of scent marking sites for eurasion lynx. Behaviroral Ecology and Sociobilogy. 2017;1-25.
10. Yahr P. Hormonal Influences on Territorial marking behavior. Harmones and Aggressive Behavior. 1983;145-175.
11. Robert M. Gibson, Tom A. Langen. How to animal choose their mates?. TREE. 1996;468-470.
12. Burger MEBV. Chemical characterization of territorial marking fluid of male Bengal Tiger, *Panthera Tigris*. pp. 1-22.
13. Simone B. Soso, Jacek A. Koziel. Analysis of odorants in marking fluid of siberian tiger (*Panthera tigris* altaica) using simultaneous sensory and chemical analysis with headspace solid -phase microextraction and multidimension Gas Chromatography-Mass Spectrometry-Olfactometry. MDPI. 2016;1-22.
14. Glyn R. Banks, Alan J. Buglass, John S. Waterhouse. Amines in the marking fluid and anal sac secretion of the tiger, *Panthera tigris*. Z. Naturforsch. 1992;618-620.
15. Andrew Hayes R, Toni Lyn Morelli, et al. Volatile components of Lemur scent secretion vary throughout the year. American Journal of Primatology. 2006;1202-1207.
16. Florian Elchmann, Dietrich V. Holst. Organization of territorial marking behavior by testosterone during puberty in male tree shrews. Physiology and Behaviour. 1998;65: 785-791.
17. Andersen KF, Vulpius T. Urinary volatile constituents of the lion, Panthera leo. Chemical Senses. 1998;179-189.
18. Kasim Rafiq, Neil R. Jardan, Carlo Melora. Scent-marking strategies of a solitary carnivore: boundary and road sent marking in leopard. Animal Behaviour. 2019;115-126.
19. Mellen JD. A comparative analysis of sent-marking social and reproductive behavior in 20 species of small cats (felis). Annual meeting of American society of zoologists. 1991;27-30.
20. Roger P. Johnson. Scent marking in mammals. Animal Behaviour. 1973;521-535.
21. Venkataraman M. Observation of petrolling behaviour in male lions in Gir protected area, India. CAT News62. 2015;1-28.
22. James L. David Smith, Charles Mcdougal et al. Scent marking in free-ranging tigers, *Panthera tigris*. Animal Behaviour. 1989;1-10.
23. Pettersson LG, Perfiliev S, et al. Role of claws and pads in taking and holding food in cats. Neuroscience Research. 1998;343-346.
24. ltaliya AH. Non-distructive technique for individualizing trace evidence analysis of tiger nail. Forensic Science and Criminology. 2017; 1-5.
25. Landsberg GM. Feline scratching and destruction and the effects of declawing. Advances in Companion Animal Behaviour. 1991;265-279.
26. Robert Steinmetz, David L. Garshelis. Estimating ages of bear claw marks in Southeast Asian tropical forests as an Aid to population monitoring. Ursus. 2010;143-153.
27. Bart J. Harmsen, Rebecca J. Foster, Said M. Gtierrez. Scrape-marking behavior of jaguars (*Panthera onca*) and pumas concolar. Journal of of Mammalogy. 2010;1225-1234.
28. Francisco Palomares, Noa Gonzalez-Borrajo. Scraping marking behaviour of the large Neotropical fields. Peer J. 2018;1-25.
29. Arash Ghoddousi, Taher Ghadirian. Territorial marking by the persian leopard (*Panthera pardus* saxicolor pocock, 1927) in Bamu National park, Iran. Zoology in the Middle East. 2008;101-103.
30. Alptuğ Sarı, Ebubekir Gündoğdu, Şağdan Başkaya. Habitat preference by the anatolian leopard (*panthera Pardus* talliana valenciennes), 1856. Belgian Journal of Zoology. 2020;153- 168.
31. Du Bothma J, Leriche EAN. Evidence of the use of rubbing, scent-marking and scratching - post by kalahari leopard. Journal of arid Environments (1995). 1993;511-517.

32. Bruce M. Rothschild, Bill Bryant. The power of claw. Plos One. 2013;8:1-4.
33. Maximilian L. Allen, Heiko U. Wittmer et al. Scent marking in Sunda clouded (*Neofelis diardi*): Novel observation close a key gap in understanding field communication behavior. Scientific Reports. 2016;1-9.
34. Helena A. Soni, Susan U. Linville. Investigation of secent on check and foreheads of large felines in connection to the facial marking behavior. Journal of Chem Ecology. 2012;145-156.
35. Sarma KK, Bhattacharjee PC, et al. Microscopical analysis of guard hair of tiger, *panthera tigris*, with reference to wild life forensic application. Journal of Advanced Microscopy Reaserch. 2014;1-7.
36. Abhijit Rabha, Prasanta Kumar Saikia, et al. Distribution location of Royal Bengal Tiger-*panthera tigris* in manas National park, Assam, India. Journal of Global Bioscience. 2015; 2174-2180.
37. Chukkath Vijayan Rajani, Harshad Sudhir Patki. Histomorphological differentiation of the skin of leopard (Leopard Pardus), leopard cat (Prionnailurus Bengalensis), Bengal Tiger (*Panthera Tigris*) and Golden Jackal (Canis aureus). Veterinary World. 2020;827-832.
38. Sandeep Sharma, Yadvendradev Jhala, et al. Identification of individual tigers (*Panthera tigris*) from their pug marks. Zoological Society of London. 2005;9-18.
39. Sing R, Qureshi Q, et al. Distinguishing sex of free-ranging tigers using pugmark measurement. Italian Journal of Zoology. 2014; 1-6.
40. Edward J. Narayan, Tempe Parnell, et al. Faecal cortisol metabolites in Bengal (*Panthera tigris* tigris) and Sumatran tigers (*panthera tigris* sumatrae). Gernal and Comparative Endocrinology. 2013;318-325.
41. Vipin Vinita Sharma, Chandra Prakash Sharma, Ved P. Kumar, et al. Pioneer identification of fake tiger claws using morphometric and DNA-based analysis in wildlife forensic in India. Forensic Science International. 2016;2-18.
42. Jyotsna Bhagavatula, Lalji Singh, et al. Genotyping faecal sample of bengal tiger *Panthera tigris* for population estimation: A pilot study. Biomed Central. 2006;1-12.
43. Pranay Amruth Maroju, Sonu Yadav, et al. Schrodinger's scat: A critical review of the currently available tiger (*Panthera tigris*) and Leopard (*Panthera pardus*) specific primer in India, and a novel eopard specific primer. Biomed Central. 2016;1-6.
44. Mario Encinoso, Jorge Oros, et al. Anatomic Study of the Elbow Joint in a Bengal Tiger (*panthera tigris* tigris) using magnetic resonance imaging and Gross dissection. MDPI. 2019;1-13.
45. Jennifer A. Parkinson, Thomas Plummer, et al. Characterizing feil tooth marking and gross bone damage patterns using GSI image analysis: An experimental feeding study with large feilds. Human Evolution. 2014;1-21.
46. Eliza R. C. Hagens, Mark I, Van Berge Henegoumen. Distribution of lymph node metastases in esophageal carcinoma (tiger study): Study protocol of a multinational observational study. BMC Cancer. 2019; 1-8.
47. M. John F. Lazar. Commentary: How to "spot" a leopard its in the gene. The Journal of Thoracic and Cardiovascular. 2019;1-2.
48. Vincent Bourret, Vicky Albert, et al. Past, present and future contributions of evolutionary biology. Evolutionary Application. 2020;1420-1435.
49. Judith A. Stryker, Jim L. Atkinson, et al. Behavior repertoire assessment of Bengal tigers (*panthera tigris*) with focus on thermoregulatory behavior. International Journal of Biometeorology. 2019;1753-1757.
50. Simono Cafazzo, Eugenia Natoli, et al. Scent-marking behaviour in a pack of free-ranging domestic Dogs. Ethology International Journal of Behavioural Biology. 2012;1-12.
51. Kristina Vogt, Elizabeth Hofer, et al. Is there a trade- off between scent marking and hunting behaviour in a stalking predator, the eurasion lynx, Lynx Lynx?. Animal Behaviour. 2015;59-68.
52. Edgard Camarós, Marián Cueto, Carlos Lorenzo. Large carnivore attacks on hominins during the Pleistocene: A forensic approach with a Neanderthal example. Archaeological and Anthropological Science. 2015;635-646.
53. Justine S. Alexander, Zhang Cheng Cheng, Shi Kun. Spotlight on snow leopard conservation in China. Integrative Zoology. 2016;1-27.