

Does tusker's attacks on female elephants are indicating towards sexual conflict in north-western Shivalik landscape?

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ABSTRACT

Unusual interaction between male and female elephants was observed once in Chilla and twice in the Dholkhand forest range of the Rajaji National Park, in which two female elephants were killed by the tuskers. Preliminary field observations indicated that these interactions were the results of male aggression during musth and female's avoidance of courtship. In 1970s, after the establishment of Chilla hydro-electric power plant/channel, Rajaji National Park had divided into two major parts—the eastern and western part. Further, after the establishment of Uttarakhand state in 2000, increased traffic pressure in Haridwar–Dehradun national highway and railway track, which are running across this protected habitat, has restricted elephants to interchange these forests. In Chilla forest's case, since some non-resident males are known to arrive on seasonal basis, sometimes from the Corbett Tiger Reserve area, the chances of such conflicts are lesser, but in respect of Dholkhand forest range, as most of the bulls are resident, the chances of such sexual conflicts are higher. It is therefore proposed that these attempts of the tuskers were the results of habitat's isolation and disconnectivity of large migratory corridors, which is affecting inter breeding between different populations. An adaptive management approach will be crucial with corridor connectivity being of paramount importance, as we continue to gain knowledge on elephant's behaviour and response to such derisive impacts.

Key words: Asian elephant, male-female interactions, sexual conflict, Rajaji National Park, Shivalik Elephant Reserve

INTRODUCTION

Male aggression against females is a prominent feature of many primate societies, which also occur in many other mammals and sometimes includes the phenomenon of sexual coercion and infanticide (Smuts & Smuts, 1993). Elephants live in a matriarchal society, where the oldest female usually leads the group. In contrast, bull elephants prefer to live solitary life after attaining the pubertal stage although, their movements are confined nearer to the groups during mating period in search of oestrous females; during this period they randomly join and leave the groups. However, it is a disputable subject, whether bull form the part of the herd or not. Like many other mammals, fight among male elephants is a common phenomenon, which mainly occurs to mate. Generally these fights do occur, if two different bulls perform co-movements with the group having oestrous females, if a bull forms the part of group and some other bull found receptive female within that group and trying to approach her and if a male is guarding any oestrous female after mating and any other bull is trying to enter the group. Male sexual aggression appears to be most common in gregarious species in which female do not form long-term bonds with a single male, so that females are exposed to a number of males competing for sexual access to them (Smuts & Smuts, 1993).

Even though these fights between adult bull elephants are a common natural phenomenon but occurrence of serious fights between bull and cow elephants

is really unbelievable. And if, any bull had killed any female, then this would be a disputable subject, which needs further investigations. Unusual interactions between tuskers and cow elephants were observed on three occasions in Rajaji National Park, which explicates on the aggressive behaviour of tuskers during musth and to mate with females. Such reports are highly required to know our competence in illustrating success and failures of wildlife management besides, in conservation of endangered species. Several workers have studied interaction among male and female elephants and fights among male elephants and illustrated on the aspect, however such kind of unusual interaction between males and females has not studies so far, especially in Asian elephant range countries.

MATERIALS AND METHOD

Rajaji National Park is located in north-west India at 29°15'-30°31' N 77° 52'-78° 22' E, elevation 250-1100 m, falls under the Gangetic plains biogeographic zone and upper Gangetic plains province (Figure 1). Maximum portion of the park lies under Shivalik's biogeographic sub-division. Rajaji National Park was established in 1983 with the aim of maintaining a viable Asian elephant's *Elephas maximus* population and is, designated a reserved area for 'Project Elephant' by the Ministry of Environment and Forests, Government of India. The total geographical area of the park is 820 km². The dominant vegetation of the area comprises Sal (*Shorea robusta*), Rohini (*Mallotus philippinensis*), Khair

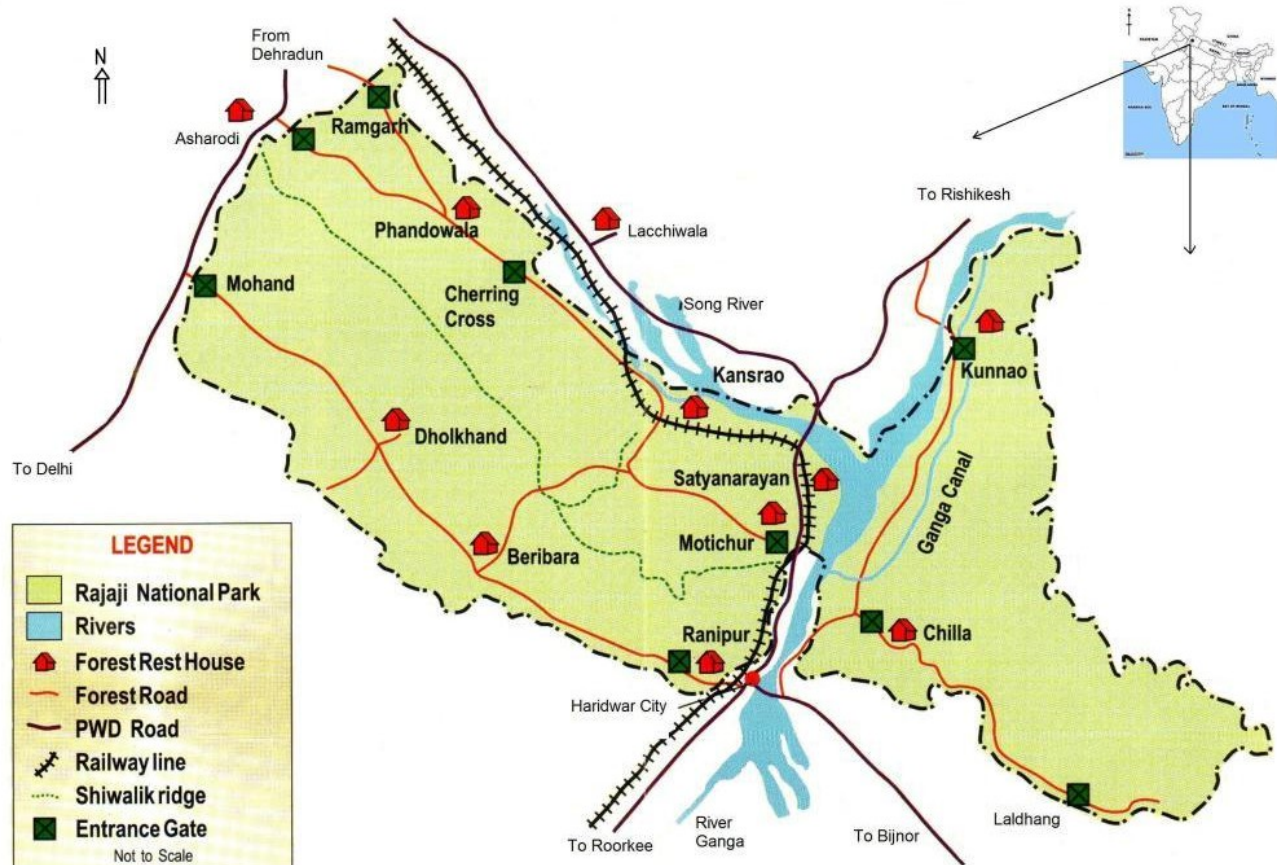


Figure 1. Location map of the Rajaji National Park.

(*Acacia catechu*), Haldu (*Adina cordifolia*), Bahera (*Terminalia bellirica*), Bar (*Ficus bengalensis*) and Shisham (*Dalbergia sissoo*). Besides, dominant fauna of the park consists of tiger (*Panthera tigris*), leopard (*Panthera pardus*), sloth bear (*Melursus ursinus*), Hyaena (*Hyaena hyaena*), barking deer (*Muntiacus muntjak*), goral (*Nemorhaedus goral*), spotted deer (*Axis axis*), sambar (*Cervous unicolor*), wild boar (*Sus scrofa*) and among reptilian fauna the mugger crocodile (*Crocodylus palustris*) and king cobra (*Ophiophagus Hannah*) represents Rajaji's faunal diverseness.

This note is a part of my long-term study on elephants in Rajaji National Park (up to May 2011). Field data was collected randomly in between 2006 to 2011, however in respect of two incidents happened in 2012, information was collected from local residents and published information in various national newspapers. To know whether such incidents are happening in other areas or not, information was collected from internet using Google search engine. Literature was also consulted to compare the results with other such observations made in various Asian and African elephant range countries. Views of forest officials, Gujjars, who were rehabilitated outside from the park area, and local people were obtained on the matter. Field binocular (Nikon Action Series, 10x50 CF) was used to observe the incidents and Nikon Coolpix 8700 Camera was used to capture photographic evidences. Garmin made GPS was also used to denote geographical coordinates.

RESULTS AND DISCUSSION

Tusker's Behaviour during Musth

It was the incident of 23rd May 2007, when I along with the research team started for the field trip at 14:30 hour in the Chilla forest of the Rajaji National Park. After covering the distance of nearly five kilometres, near to Gau shroath (water stream, N 29°56'28.8", E 78° 14'10.9"), we came across a group of thirteen elephants, five adult cows, three sub-adult cows, a juvenile male, a juvenile female and three calves feeding on the riparian vegetation. Noticeably, two of them (a female-aged about forty years and a calf-nearly one & half years old) were feeding some 100 meters far from the group. Suddenly, they ran away to a narrow patch of the stream, which occurred because of our arrival. We stopped our vehicle at a place and reversed back our vehicle to a short while with a view to not hinder their activities and keep a safe distance.

After few seconds an adult bull, having one tusk (Ganesh) emerged out from nearby forest and moved towards the group (Figure 2). He was in musth and communicating his presence by releasing different audible voices and by uplifting his trunk in the air. Some of the adult cows from the group were also responding to those voices. He stayed near to the group for hardly 3-4 minutes and thereafter moved towards those two elephants, which were standing some 100 meters far from the group and feeding on the roots of sarkanda (*Saccharum*

munja), growing in the dry river bed. After a while other group members escaped from there. I had enough time to record the moment in a video camera and capture the images with a still camera.



Figure 2. Bull elephant (Ganesh) in musth, trying to approach a cow elephant in Chilla forest (Photo: Ritesh Joshi).

Bull elephant was making efforts to impress the cow through uplifting his trunk, throwing mud in the air, making noise and wandering here and there maintaining a distance of nearly 50 meters, but cow elephant was not responding to him (Figure 3). Sometimes, bull had made attempts to push up the infant to abduct away, but cow in every attempt moved together with the infant and responded badly by chasing-off him. This process continued for nearly two & half an hour. During this course, bull elephant charged our vehicle two times, however, all of these attempts were mock charges in which he ran behind us up to 100-150 meters and after every charge, he returned back quickly to the individuals and started wandering there. We were amazed to see this behaviour of bull elephant and ultimately at 18:40 h, bull had made an attempt to mount over the cow to copulate but cow had not supported the act. For next 25 minutes, bull continued these false attempts. Unfortunately, at 19:05 h, sunlight became mild, and we were unable to see the ongoing with our naked eyes and therefore, returned back from the spot/forest. Is this incident a conflict for mating/courtship or the characteristics feature of musth; some of these questions became a puzzle for me for more than a week.



Figure 3. Tusker during musth in Chilla forest (Photo: Ritesh Joshi).

On 16th September, 2009, a female elephant aged about 35 years was found dead in the Dholkhand range (Ganjarvan forest, N 30°05'39.5", E 77°58'42.5") of the Rajaji National Park. After examining the carcass carefully, it was found that elephant died due to tusk penetration by a bull elephant. At four different places big wounds of tusk penetration were noted over to carcass. Struggle signs were also recorded from the spot (fallen trees and signs of pushing over & footprint abrasion). Officials and locals informed that both male and female elephants were moving together since last one week and disparaging fights were also observed within a small group of five elephants. I then for next couple of days searched and frisked the area and found that only one bull elephant having one only tusk (Ganesh), aged about 45 years was moving in this range, which was in musth (Figure 4). In between 2006-2010, the movement of this bull was observed in south-western axis of the Rajaji National Park, which includes the part of Haridwar, Beribara, Dholkhand and Kansrao forest ranges. Remarkably, this type of abnormal fight between bull and cow elephant was observed for the first time in this region, which was specifically for mating needs and in which eventually, a female elephant, was brutally killed by a bull elephant.

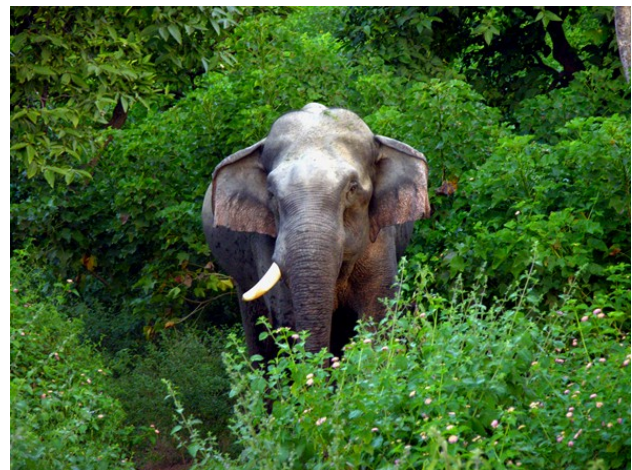


Figure 4. Bull elephant in Dholkhand forest of the Rajaji National Park (Photo: Ritesh Joshi).

On 22nd April 2012, a two days old carcass of a female elephant (nearly 25 years old) was found in Dholkhand forest. At three places, the signs of tusk penetration/wounds were noted over to the body, and thus cause of death was assumed as fight with tusker. Noticeably, in such fights, which are mainly occurring between bull elephants, the signs of scratches, tusk penetration and struggle could be identified easily. Another such case happened on 2nd October, 2012 in the Thano forest range of the Dehradun forest division nearer to Chak-Chaubewala village, where a female elephant was gored to death by a tusker. Right portion of her abdomen was found fissured and it was assumed that it had a fight with a male elephant, which had gored it. However, due to 2-3 days old carcass, acute cause of death was not identified.

In another similar case happened in this region in 2006, a tusker aged about 50 years had attacked a domesticated female elephant 'Arundhati' in Chilla forest of the Rajaji National Park. This bull had approached

Arundhati for more than a week, and elephant riders (mahawat) also used to drove-off him by firing in the air. Unfortunately, this majestic elephant died in 2007 due to multiple compound fractures in her forefeet. In 2011, an adult tusker aged about 50 years, who had killed five persons in between July 2010–November 2011 in Rishikesh area, had attacked a domesticated female elephant, which was brought from Corbett National Park to tranquilize this tusker for translocation to some other region (The Pioneer, 2011). These incidents stressed the need of having detailed biological information to be documented, so that such unusual male-female interactions and tuskers' aggressive behaviour would be resolved scientifically.

Smuts & Smuts (1993) has precisely studied the male aggression and sexual coercion of non-human Primates and other mammals and pointed out that in species in which estrous females are exposed to several competing males, they are typically chased and herded, and sometimes kicked, pushed or bitten by males attempting to mount. However, in some species like African elephants, males apparently do not frequently injure females, and the main costs to females of sexual aggression are probably loss of feeding time and energy expended to escape out.

Cases from other regions

In some other elephant ranges, few similar cases were also noticed which exposed on the deviant behavior of tuskers. On 30th January 2012, a pregnant elephant was gored to death by a tusker in Rajabhatkhawa west range of the Buxa Tiger Reserve. Signs of struggle and tusk penetration in abdomen part were also noted, which had reinforced the incident (Times of India, 2012). In another such incident happened on 28th October 2012 in Coonoor–Barliar area of Tamil Nadu district, an 18 years old female elephant was found dead in a private tea estate and fight with tusker was assumed as the death cause (Business Standard, 2012). Similarly, on 23rd June 2013, a 28 year old female elephant was found dead in Ekkathur forest range of the Sathyamangalam Tiger Reserve and examination of the carcass revealed that it was killed in a fight with a tusker. Injury marks were also observed in abdomen portion (Business Standard, 2013). In Kottayam, a tusker 'Alpha male' was blamed as killer of more than seven female elephants, died in between November 2012 to February 2013. Allegations of killing of some other female elephants by him in the past were also there, but due to lack of strong evidences, this incident remained unsolved (Deccan Chronicle, 2013). As all these reports were preliminary observations and mentioned on the unusual male-female interactions, long-term studies are needed on this aspect, which could give insight on such unusual interactions and justifiable remarks.

McKay (1973) in his long-term study on the elephant of south-eastern Ceylon has given an example of such kind in which an adult female was observed to react aggressively to a male elephant, which approached her group. This study also revealed that such aggressive interactions between males and females were not observed frequently; besides, no instance of aggressive interaction was observed between females. Mentioning

on a field observation, McKay stated that "on 13th June 1968, at Hatpata, a number of elephant groups were feeding in an open area in the mid-after-noon hours. At 17:15 h, one male, who was also feeding in the same area, approached one of the groups. He made trunk to genitalia contact with one female and moved on toward another. Later on, when he moved toward the center of the group, the largest female in the group turned and rushed toward him. The male turned off and moved at a fast walk toward the forest; and after reaching 75 meters, cow returned to the group. Five minutes later, the male also returned to the group and once again that cow ran toward him, chasing him about 150 meters".

Musth, Female's Preferences and Elephant's Mating

Since musth is one of the exceptional aspects in male elephants, various workers have explained this in different ways. In this stage, male elephants undergo noticeable physiological and behavioural changes. A fluid could be seen easily, secreting from the temporal gland located in between eyes and the ears. Besides, a strong pungent smell could also be sensed arising from the elephant and his urine. Dribbling of urine from extended penis is also one of the characteristic features of musth. It is also said that the level of testosterone is enhanced in the blood, which governs the real transformation during musth, which also strengthen the successful reproduction.

At several occasions, it was observed that the males exhibiting musth were more aggressive than other males who had not exhibit musth. During this period, male elephants were found hovering within the range of different groups, trying to find a receptive mate. Movements of these bulls were observed higher and they were found covering long distances, however group movement was observed restricted to shorter ranges, mainly due to presence of calves within the groups. In musth, the animal feels irritated by the discharge and naturalists have noticed that it tries to increase musth flow by pressing the tusk root against a hard surface, possibly for scent marking as well on objects like tree trunks (Rajaram, 2006). In contrast some bulls had been observed spending solitary life, sometimes accompanied by a companion who is of equal age group.

In evolutionary biology, social behaviour of mammals is one of the most fascinating and challenging aspect. Like many other animals elephants also show the phenomenon of love play, which includes mixing of bull elephants in the groups, selecting prospective partner to mate, smelling of genital organs, sniffing the urine and dung, touching the trunk especially temporal gland and discharge of urine. This whole process was observed to happen within 15-20 days but sometimes it took one month, especially if environmental conditions are unfavourable i.e. scarcity of fodder and water and higher rate of movements.

Traditionally, the role of female mate choice, especially in polygynous mammals, has been considered negligible compared with male-male competition (Charlton, 2008). Trivers (1972) has given a detailed insight on the parental investment and sexual selection, which highlighted that sexual selection, favours different male and female reproductive strategies and the relative parental

investment of the sexes affects the criteria of female and male choices. Several studies on non-human mammals and African elephants have established the fact that female mate choices and oestrous behaviour plays an important role in successful reproduction in many mammals, which gave an insight on sexual selection theory mechanism of inbreeding avoidance (Moss, 1983; Smuts & Smuts, 1993; Archie et al., 2007; Charlton, 2008; Bates et al., 2010).

Since bulls join the family groups temporarily for mating with oestrous cows, there is no evidence that a bull always associates with a particular family group. Further, the associations are opportunistic and depend upon other factors, such as dominance hierarchies among bulls or even the choice of the cows (Sukumar, 1994). In addition, inbreeding or mating between closely related individuals in a small population may also occur, which results in genetic abnormalities, reduced growth, or even the sterility of the offspring. In African elephants, sex-biased dispersal does not lead to the complete separation of male and female relatives, and so individuals may experience selection to recognize kin and avoid inbreeding; however, because oestrous females are rare and male-male competition for mates is intense, the opportunity costs of inbreeding avoidance may be high, particularly for males (Archie *et al.*, 2007).

In one such study on African elephants, it was revealed that female elephants have a strong mechanism to show oestrous behaviour for attracting males, which includes characteristic changes when sexually receptive and for inbreeding avoidance (Bates *et al.*, 2010). In a study carried out on oestrous behaviour and female choice in African elephants by Moss (1983), it was revealed that female elephants do have choices for mating partners and some females preferred to mate with males in the largest size class, particularly those in musth. In one such case recorded from Idukki Wildlife Sanctuary, southern India, solitary movement of female elephants were observed on five instances, and oestrous behaviour was considered as the possible reason behind this solitary movements (Govindaraj, 2010).

Maximum bulls, which had been observed from different forest ranges of the park were recognized based on their physical appearance/features and their movements were found confined to particular forests on seasonal basis. In eastern part of the Rajaji i.e. Chilla and Gohri forests, elephant's movement is concentrated at the onset of summer (from February to June) and at the onset of monsoon they perform movements towards Dogadda forest of the Lansdowne forest division. However, only few groups and bulls used to stay in parts of Haridwar forest division and adjoining areas of Rajaji National Park. On the other hand, in south-western part, same bulls were observed performing movements across the Motichur, Kansrao, Beribara, Dholkhand and Haridwar forest ranges. Occasional movements of recognized bulls were also recorded from parts of Dehradun and Saharanpur forest divisions. In this situation, there are chances of inbreeding in south-western elephant's population and less options for mating preferences. However, the populations, which exist in eastern axis have more options for these preferences.

In elephants, breeding occur throughout the year, however it would be pronounced with favourable environmental conditions. In Rajaji, maximum of the newborn calves were observed in between January to May, which corresponds to the wet as well as hot season. The gestation period in Asian elephants varies from 18 to 22 months and if an average value of twenty months is taken as the gestation period, then the breeding season seems to be maximum to extend from May to November, which through embraces the hot, rainy and beginning of cold seasons, but can be taken up by and large as-warm period. On the basis of these observations, it is clear that there are some distinct months of breeding. However, the important ultimate factors that influence the animal's reproductive cycle are probably the seasonal availability of food and water (Lyppu, 1990). Since, there is never any extreme shortage of food in Rajaji National Park area therefore; the breeding season of elephant's was never so pronounced and drastic and this could be correlated with the sexual conflict, which has been recorded. From all the incidents, it is clear that tuskers' attacks are more frequent during hot period, which is also the peak breeding season.

The male-female sex ratio in Rajaji and Corbett National Parks has one of the least skewed sex ratios, 1 : 1.8 male : females in Rajaji National Park and 1 : 1.5 – 2.1 male : females in Corbett National Park (Williams, 2002). However, a study carried out in Chilla, Motichur and Haridwar forests of the Rajaji National Park has estimated this ratio as 100 females : 22.4 males, which revealed a good elephant population along with ratio, i.e. on an average it comes to male : female is about 1 : 4.4 (Joshi *et al.*, 2007). It can be observed from the above figures that Rajaji and Corbett National Parks, which forms the part of the Shivalik Elephant Reserve, consists of a healthy sex ratio of elephant's population. However, Joshi & Singh (2010) had illustrated on unnatural deaths of tuskers in this region, which exposed that wide ranging tuskers are pocketed in small areas and are facing confrontation with human beings. This study has also indicated that in the recent past, this region had loosed tuskers rapidly. In this situation, what could be the reasons behind such male-female interactions? This has to be explored scientifically, which would further need some long-term observations on oestrous females and tuskers in musth.

Are these the attempts of Resident and Non-Resident Males?

Elephants are wide ranging animals and are well known for large migrations. Once elephants of this tract were known to perform extensive migration from river Yamuna to Sharda, but since last four decades, elephants were found pocketed in small areas due to escalated rate of developmental activities and fragmentation of large habitats into smaller ones. Besides, their large migratory corridors are disrupted due to expansion of human settlements, agriculture lands and expanding network of national highways/motor roads & a railway track running across this reserve. All these activities have divided Rajaji into two parts (eastern and south-western), which has restricted the frequent movement of elephants within Motichur-Chilla corridor, which is also a connecting track for elephant movement in between Rajaji-Corbett National Parks and in parts of Bijnor forest division.

In 2000, after the establishment of Uttarakhand state, various wildlife corridors had been affected severely, primarily due to increased vehicle traffic pressure in different motor roads. If we consider the case of Chilla forest, which lies in eastern part of Ganges, where elephant groups were found performing their movements upto Dogadda forest (part of Lansdowne forest division), and some bulls were observed moving up to parts of Corbett Tiger Reserve through crossing the Kotdwar–Lansdowne road running parallel to the Koh river, such male-female interactions would be comprehensible. At some places, from where elephants are known to cross the road, steep edges and walls were built to prevent landslides and thus, this hilly pathway is being used only by some adult bull elephants. Some herds, especially those in the eastern and western regions of Corbett Tiger Reserve, showed distinct seasonal movements, whilst others, such as the elephants in the Kalagarh region, show little seasonal movement (Singh, 1969; Sunderraj *et al.*, 1995). The elephants' movement in the Shivalik Elephant Reserve was drastically affected in the recent past due to the increasing traffic pressure on the motor roads existing across various elephant's habitats and encroachment in their traditional corridors (Joshi, 2012).

In contrast, the Dholkhand range of the Rajaji National Park lies in the south-western axis, where the elephant's populations are considered as isolated, except some recognized bull, whose movements were reported both from eastern and south-western parts. Hence, in Chilla forest's case, since some non-resident males are known to arrive, sometimes from the Corbett Tiger Reserve area, the chances of such conflicts are lesser, but in respect of Dholkhand forest range, as most of the bulls are resident, the chances of such sexual conflicts are higher. Since in some forests elephant's populations are facing the consequences of habitat isolation, restoration of ecological corridors would be an important approach, which would further strengthen elephant's migration within their traditional home ranges.

Mating behaviour of elephants especially in isolated habitats represents a challenging research area with many issues to be explored. The results of this note provide the information on male-female interactions and tusker's abnormal behavioural responses during musth; however, these observations are limited to only preliminary observations. Based on the cases observed and reports of the cases of similar kind, it was revealed that these conflicts were probably related with sexual aggression. Since last one decade, Shivalik landscape has undergone a drastic change primarily due to rapid enhancement of human population and industrialization. In this situation, these interactions might be the results of isolation of habitats or the anomalous behaviour of tuskers during musth. To answer all these questions, additional detailed studies are urgently needed especially on the behaviour of tuskers, which may be helpful in reinforcing our knowledge and database on such unusual interactions.

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REFERENCES

- Archie, E.A., Hollister-Smith, J.A., Poole, J.H., Lee, P.C., Moss, C.J., Maldonado, J.E., Fleischer, R.C. and Alberts, S.C. 2007. Behavioural inbreeding avoidance in wild African elephants. *Molecular Ecology*, 16: 4138-4148.
- Bates, L.A., Handford, R., Lee, P.C., Njiraini, N., Poole, J.H., Sayialel, K., Sayialel, S., Moss, C.J. and Byrne, R.W. 2010. Why do African elephants (*Loxodonta africana*) simulate oestrus? An analysis of longitudinal data. *PLoS ONE* 5 (4):1-6.
- Business Standard (2012) Female elephant killed by tusker. <http://www.business-standard.com/article/pti-stories>. Cited 4th July, 2013.
- Business Standard (2013) Female elephant killed in fight with tusker. <http://www.business-standard.com/articles/pti-stories>. Cited 4th July, 2013.
- Charlton, B.D. 2008. Female mate choice in non-human mammals. Pp. 35-56. In: Animal behaviour: new research (eds Weber, E.A. and Krause, L.H.), Nova Science Publishers, Inc.
- Deccan Chronicle (2013) Alpha male gores 20 female elephants to death. <http://www.deccanchronicle.com/130402/news-current-affairs/article>. Cited 4th July, 2013.
- Govindaraj, K. 2010. Solitary behaviour of female elephants in Idukki Wildlife Sanctuary, Kerala. *Gajah* 32: 40-41.
- Iyppu, A.I. 1990. Sex in elephants. Pp. 76-81. In: Ecology, behavior and management of elephants in Kerala, India (ed Karunakaran C.K.), Kerala books and publications society, Kakkannad, India.
- Joshi, R., Joshi, B.D. and Singh, R. 2007. Population composition of Asian elephant (*Elephas maximus*) in the Rajaji National Park, Uttarakhand, India. *Himalayan Journal of Environment & Zoology* 21 (2): 189-202.
- Joshi, R. and Singh, 2010. Does wide ranging tuskers survive in north-west India? *National Academy Science Letters* 33 (7-8): 205-215.
- Joshi, R. 2012. Railway track, road network and electrification of habitats in and around the Rajaji National Park, India: A serious threat for north-west population of Asian Elephant. *International Journal of Ecosystems & Ecology Sciences*, 2(1): 47-60.
- Mckay, G.M. 1973. Behaviour and ecology of the Asiatic elephants in southeastern Ceylon. *Smithsonian Contributions to Zoology* 125:1-113.
- Moss, C.J. 1983. Oestrous behaviour and female choice in the African elephant. *Behaviour*, 86(3-4): 167-196.
- Rajaram, A. 2006. Musth in elephants. *Resonance*, October, 2006: 18-27.
- Singh, V.B. 1969. The elephant (*Elephas maximus* Linn.) in Uttar Pradesh India. *Journal of the Bombay Natural History Society*, 66 (2): 239-250.

- Smuts, B.B. and Smuts, R.W. 1993. Male aggression and sexual coercion of females in nonhuman Primates and other mammals: evidence and theoretical implications. *Advances in the study of Behaviour*, 22:1-63.
- Sukumar, R. 1994. Elephant days and nights, ten years with the Indian elephant. Oxford University Press, New Delhi, India.
- Sunderraj, S.F.W., Mishra, B.K. and Johnsingh, A.J.T. 1995. Elephant use of the Rajaji–Corbett forest corridor, north west India. Pp. 261-269. In: A week with elephants (eds Daniel, J.C. and Datye, H.S.), Bombay Natural History Society, Oxford University Press, Mumbai, India.
- The Pioneer (2011) Rogue tusker attacks trained female elephants. <http://www.dailypioneer.com/state-editions/dehradun/24440>. Cited 4th July, 2013.
- Times of India ToI (2012) Tusker kills pregnant elephant. http://articles.timesofindia.indiatimes.com/2012-02-01/kolkata/31012269_1. Cited 4th July, 2013.
- Trivers, R.L. 1972. Parental investment and sexual selection. Pp. 136-182. In: Sexual selection and the descent of man 1871-1971 (ed Campbell, B.), University of California, Los Angeles, Aldine Publishing Company, Chicago.
- Williams, A.C. 2002. Population age-sex ratios of elephants in Rajaji-Corbett National Parks, Uttarakhand. Technical Report, Operation Eye of the Tiger, Dehradun, India.