



Research Article

Tusker's social bonds in Rajaji

Ritesh Joshi^{a,1,*}^aConservation & Survey Division, Ministry of Environment, Forest & Climate Change, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi 110003, India

Keywords:

Asian elephant
male social behaviour
long-term association
conservation
Rajaji National Park

Article history:

Received: 5 March 2014
Accepted: 4 May 2015

Acknowledgements

Author would like to acknowledge the anonymous reviewers and the Associate Editor who have provided valuable inputs and comments on the previous versions of the manuscript and contributed significantly to improve the manuscript to its present form. Author would also like to acknowledge G.B. Pant Institute of Himalayan Environment & Development, and Doon Institute of Engineering and Technology for infrastructure support, and to the Uttarakhand Forest Department, especially the administration of the Rajaji National Park and Haridwar forest division for providing permission to conduct research on elephant behaviour. Thanks are due to Mr. Somnath and Mr. Umed Singh, Haridwar Forest Division, Mr. Shanti Prasad, Field Assistant and Mr. Sumil Pal and Mr. Swarup Puri for their valuable help in collection of the field data. Finally, I would like to thank Dr. Kamal Kant Joshi, Assistant Professor, Graphic Era Hill University for assisting in data analyses.

Abstract

Male elephants are known to live a solitary life after attaining the pubertal stage which is considered at the age of about 15 years. However, observations of single young males (about 10 years old) have also been reported. In contrast, few studies have explored that male elephants do have associations; however these associations are occasional and temporary. In Rajaji National Park, north-western Shivalik landscape of India, bull elephants were observed to have a year round association, mainly to perform movements outside the boundaries of protected habitats and to enjoy palatable crops. A recognised group of bull elephants (c. 2–8) was recorded between 2006–2010, performing movements in parts of Rajaji National Park, Haridwar forest division and agriculture fields nearby the protected habitats. Bull elephant interactions and social bond are illustrated. Since a long continuous chain of forests, which existed in the Rajaji–Corbett wildlife corridor, has been disrupted mainly because of habitat fragmentation, and since man–elephant conflict is increasing rapidly, regular monitoring of elephant habitat and population dynamics is of paramount importance. This is the first time that male–male interactions/male elephant behaviour in groups has been recorded from north-west India and possible explanations for the behaviour are discussed.

Introduction

Elephants live in a matriarchal society, where the oldest female usually leads the group. In contrast, bull elephants prefer to live solitary life, especially after attaining the pubertal stage. However, their movements are confined nearer to the groups during mating period in search of oestrous females. During this period, bull elephants randomly join and leave the groups. Male elephants leave their families when they are on the threshold of sexual maturity, usually between the age of ten and fifteen years, and bulls use to wander on their own or seek the company of other bulls after leaving their families. Besides, since male elephants cannot recognize their children, they do not show interest in taking care of young (Sukumar, 1989, 1994). Various aspects of social organisation have been studied in African Savannah elephants (*Loxodonta africana africana*) (Vidya and Sukumar, 2006). However, only few studies have been conducted on this aspect in the range of the Asian elephant (*Elephas maximus*) and more information on their complex social organization is yet to be documented.

In a long-term study carried out on the behaviour and movement of adolescent male African elephant in the Okavango Delta, Botswana, it was revealed that adolescence in male African elephants is an important social period, reflecting in higher levels of social interactions and a preference for being in larger social groups than older males (Evans and Harris, 2008). This study also revealed that adolescent males can gather

information about new areas and learn about the new social system they have entered into, using the mature bulls as social and ecological repositories of knowledge and therefore, post-prime bulls still have an important role to play in the social system of male elephants. Bradshaw and Schore (2007) based on their review on relationship between developmental context and behaviour outcome, have exposed that ethological, psychological and neurobiological models are needed to gain deeper insights into the relationships between developmental contexts and behaviour outcomes. In another similar study carried out on elephant's association network, it was argued that male social clusters have a heterogeneous age distribution and most of the males prefer to associate with age peers and some prefer to associate with individuals younger or older than them (Chiyo et al., 2012). This study suggested that raiding is acquired through social learning from older males which are raiders. The tendency of individual elephants to associate with one another to form transient or stable same-sex or mixed-sex groups, or to remain solitary may be an important component of their life-history strategies (Srinivasaiah et al., 2012).

The above referred studies are examples that illustrate new dimensions in conservation based research, showing that elephant complex social behaviour should be studied in the context of changing environment. The factors motivating individual Asian elephants to form specific associations in different socio-ecological environments needs to be thoroughly investigated (Srinivasaiah et al., 2012).

Here, I present a study of the social bonds and long-term association among male Asian elephants in eastern part of the Rajaji National Park and north-eastern part of the Haridwar forest division, India, in relation to the social behaviour of bull elephants and strategies to raid crops. By

*Corresponding author

Email address: ritesh_joshi2325@yahoo.com (Ritesh Joshi)¹During the study period the author was associated with the G.B. Pant Institute of Himalayan Environment & Development, Garhwal Unit, Srinagar-Garhwal, Uttarakhand, India, and Doon Institute of Engineering & Technology, Rishikesh, Uttarakhand, India.

my knowledge, this is the first study of this type of behaviour among male Asian elephants.

Study Area

Rajaji National Park (RNP) is located in north–west India at 29°15'–30°31' N 77°52'–78°22' E, falls under the Gangetic plains biogeographic zone and upper Gangetic plains province (Fig. 1). Maximum portion of the park lies under Shivalik's biogeographic sub-division. RNP was established in 1983 with the aim of maintaining a viable Asian elephant (*Elephas maximus*) population and is designated a reserved area for "Project Elephant" by the Ministry of Environment, Forest & Climate Change, Government of India. The total size of the park is 820.21 km². The dominant vegetation of the area comprises Sal *Shorea robusta*, Kamala *Mallotus philippinensis*, Cutch *Acacia catechu*, Kadam *Adina cordifolia*, Bahera *Terminalia bellirica*, Indian Banyan *Ficus bengalensis* and Indian Rosewood *Dalbergia sissoo*. The dominant fauna of the park consists of tiger *Panthera tigris*, leopard *Panthera pardus*, Himalayan black bear *Ursus thibetanus*, sloth bear *Melursus ursinus*, Striped Hyaena *Hyaena hyaena*, barking deer *Muntiacus muntjak*, goral *Nemorhaedus goral*, spotted deer *Axis axis*, sambar *Cervus unicorn* and wild boar *Sus scrofa*, and among reptiles the mugger crocodile *Crocodylus palustris* and king cobra *Ophiophagus hannah*. Haridwar Forest Division (HFD) is located adjacent to the RNP (in the north) at 29°58'6.02" N, 78°13'9.82" E and well connected with the Lansdowne Forest Division. The dominant fauna in HFD is the same as in RNP.



Figure 1 – Location map of the Rajaji national Park.

Methods

This paper is part of my long-term study on elephants in RNP and HFD. Field data was collected randomly between 2006 to 2010 from Chilla and Gohri forests of the RNP and Shyampur and Chiriapur forests of the HFD. Since all these forest ranges exists in a same biological area and movements of various groups and bull elephants can be defined on a seasonal basis, I was able to identify all those bull elephants whose movements were confined within these forest ranges. Male elephants were identified on the basis of their tusk shape and size (tusk length and thickness, pointed or curved shape, upward or downward tilt, broken signs, if having only one tusk, left or right tusk, etc.), tail shape and size (full or cut tail, bunch of hairs at tip etc.), ear forms (ear fold, pigmentation, scars, holes, etc.), and pigmentation on trunk base.

Movements of single bulls and bull groups in buffer zones and crop fields were also recorded on a seasonal basis. In addition, information on the movement of bull elephants was also collected from the forest officials, Gujjars residing in HFD and local people. Field binocular (Nikon Action Series, 10×50 CF) was used to observe the elephants in forests and Nikon Coolpix 8700 Camera was used to produce photo-

graphic evidence. Geographical coordinates of each observation were taken (Garmin GPS 72).

Results and Discussion

A year round association of a recognized group of eight adult/sub-adult bull elephants was observed in RNP and in part of HFD from 2006 to 2010. A total of 521 random observations, made between January 2006 and December 2010 revealed that this recognized group of eight bulls performed co-movements in outskirts of RNP and HFD and outside of the protected areas, in the agriculture fields. However, movements of single bull elephants from this group were also recorded at several occasions. Elephant group formation was analysed between two major seasons (summer and winter) over the entire study period. Results revealed that groups were seen more often than expected in summer season (mean number of observations per year±SD=40±13) as compared to winter season (mean value±SD=6±2; One-sample goodness-of-fit test $\chi^2=263.5$; df=1; $p<0.0001$). There was no difference between years (year-effect $\chi^2=4.29$; df=4; $p=0.37$) These recognized bull elephants were found moving in a stable group on 284 occasions (55%) i.e. they moved in a close group composed of all individuals, whereas on 173 occasions (33%), loose group movements were recorded i.e. only some individual of the recognized group were found moving together (2–5 bulls). However, solitary movement of some bull elephants of the group was recorded on 64 occasions (12%).

Comparison between the recognized group movement and solitary movement of individual bull elephants from the group in summer and winter seasons respectively revealed that movement of bull elephants in group was significantly higher as compared to solitary movement of the bulls in summer season as compared to winter (One-sample goodness-of-fit test on solitary movements between seasons $\chi^2=10.6$; df=1; $p=0.0012$) However, at the onset of summer, elephant movement outside from the protected area was observed rarely (mean

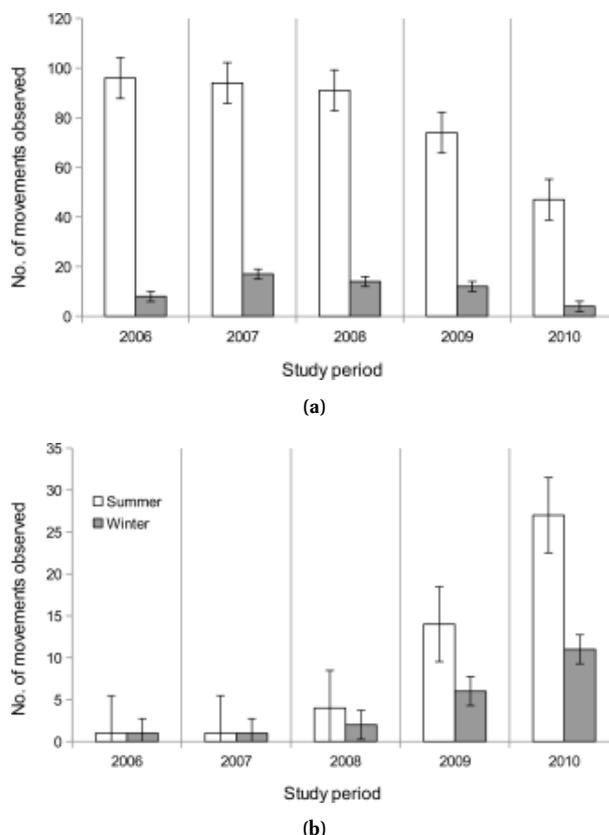


Figure 2 – a) Number of observations of group movement of recognized bull elephants (with standard error); b) Solitary movement of individuals from the recognised group of bull elephants (with standard error), during summer and winter seasons respectively from 2006 to 2010.

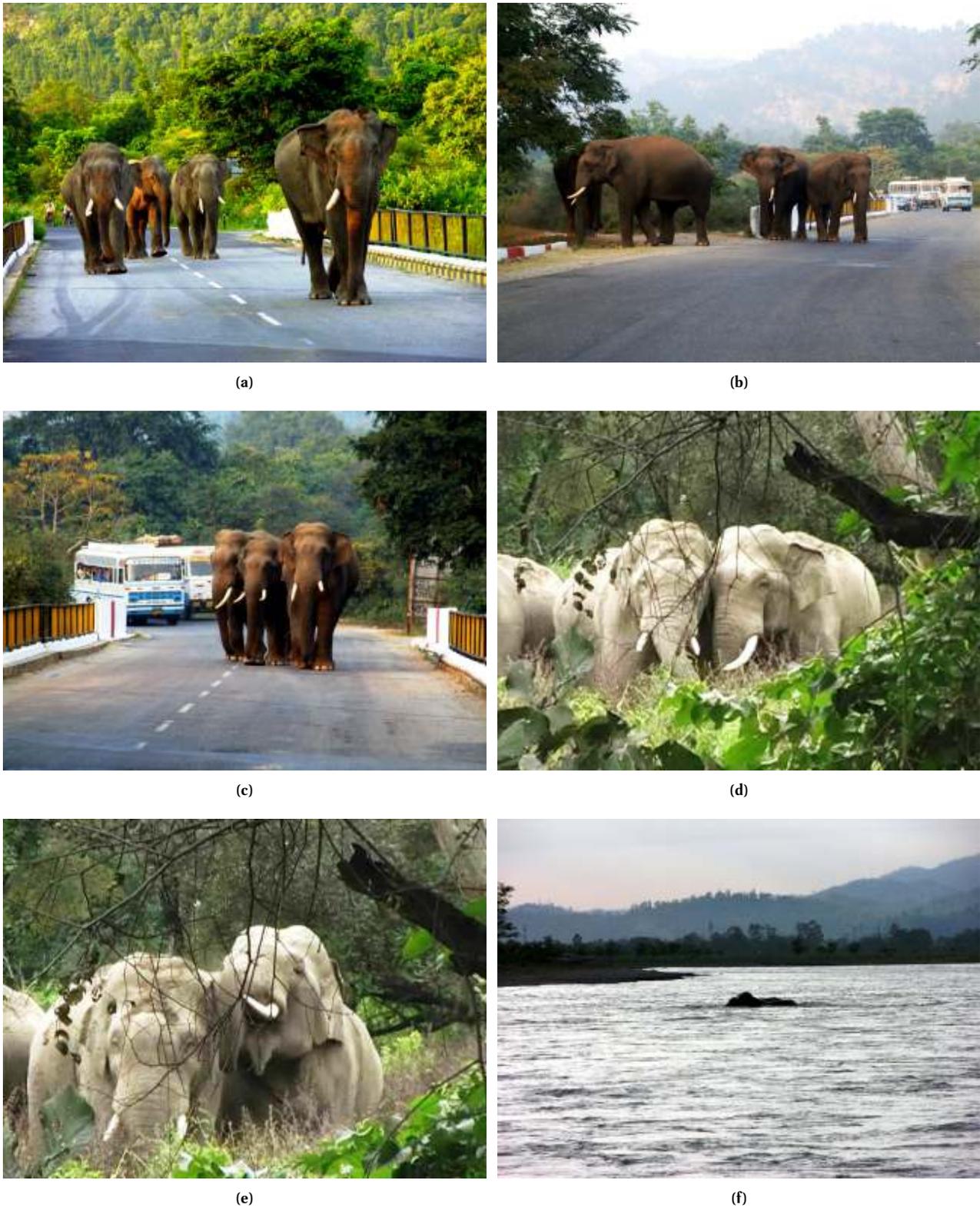


Figure 3 – a, b, c) A group of male elephants on Haridwar–Bijnor national highway existing across Haridwar forest division, while moving towards Ganges; d, e) Made for each other: bull elephants are playing in Haridwar forest division; f) Bull elephant swimming in Ganges.

value= 5.5 ± 1.2), and in smaller groups (c. 2–4) or solitary (Fig. 2a–b). Usually, bull elephants used to form such groupings in evening hours, when they start moving towards agriculture fields to enjoy palatable crops, especially from early evening hours to dawn (for nearly 14 hours). However, from early morning hours to evening hours, generally they used to perform solo movements, which include hovering nearer to the groups, which had receptive females. Sometimes they spent whole day in a female group as well.

Joining of new bull in the group and separation of one or two bull from the group was recorded randomly, which influenced the size of the recognised bull group (sometimes to 6, 7 or 8 elephants). Largest association of the recognised bull elephant group was observed in May 2006 and June 2007 consisting of seven individuals and in December 2008 and June 2009 consisting of eight individuals. In contrast, in 2010 the largest association of the group was recorded in November and December consisting of six individuals.

Observations on co-movements and social behaviour of these bulls revealed that they had a strong social bond and well developed strategies to move across the buffer areas (outskirt areas) of the protected habitats. An adult bull elephant aged more than 50 years was observed leading the group especially when they were performing movements across the populated areas and agriculture fields. On several occasions especially during summer, they were found standing under cool shaded trees like *Ficus bengalensis* and *Adina cordifolia* to take rest. Several times they were found playing together, by pushing each other with trunk and placing trunk over to back of others and enjoying swimming in Ganges (Fig. 3a-f). Play fighting is important in developing male social organisation and new hierarchies and helps in avoiding serious conflict when there is competition for resources (Desai, 1997). On occasions, when any one of them remained behind, they were observed waiting for the companion. Some bull fights were observed during the course, however, any conflict for courtship preferences was not observed.

Unfortunately in the night of 15th July 2008, the oldest bull elephant died due to electrocution in Shyampur forest. This master bull ruled over to the eastern part of the RNP for more than a decade. The magnificent bull elephant had assisted other bull elephants especially juveniles in learning about the traditional journeys and feeding grounds. Since this oldest bull was leading and educating other bulls about itinerant in traditional grounds, after its death changes in the behaviour of other bulls were observed (movement of remaining bulls was observed isolated or in small group of 2–3 animals, they faced problems in crossing the highway especially in evening hours, their movements across the Ganges was restricted to night hours etc.).

Factors that influence learning and the spread of behaviour in wild animal populations are important for understanding species responses to changing environments and for species conservation (Chiyo et al., 2012). An important, often neglected aspect of behavioural ecology concerns the ability of animal populations and individuals to respond to changes in their immediate environment, both in the long and short term (Srinivasaiah et al., 2012).

In 2009–2010 temporary co-movements of remaining six bull elephants were observed randomly and recorded. They were found performing solo movements during day hours, however used to assemble at a place in evening hours, particularly to move in a group towards crop fields. Since bull elephants are known to live solitary life and used to raid crops in groups, this association might be a strategy for enjoying palatable crops. Such strategies of bull elephants however are temporary and for achieving some particular object, but can affect their social behaviour especially in context of ranging pattern. This could also enhance the rate of man-elephant conflict. Adult and sub-adult male elephants represent a higher propensity of occurrence in high-disturbance areas when associated in a group, while solitary elephants exhibit the least propensity to occur in such areas (Srinivasaiah et al., 2012). A study carried out on the influence of life history milestones among male African elephants revealed that older males are more likely to be raiders than younger males, that males are more likely to be raiders when their closest associates are also raiders, and when their second closest associates are raiders older than them (Chiyo et al., 2012).

Studies carried out on male-male interactions and bonds in parts of Asia recorded that bull elephants do have associations, though temporary, ranging from 2–6 individuals (recorded in Ceylon), 2–3 individuals (recorded in southern India) and up to 5 individuals (recorded in north-west India) (McKay, 1973; Sukumar, 1994; Joshi and Singh, 2008). For male African elephants, it was shown that younger male elephants seek out older males and learn social behaviour from them and that larger groups of bull elephants (up to 15 individuals) of mixed age groups can persist for many years (O'Connell-Rodwell, 2010).

Since most of the associations among bull elephants have been observed in parts of RNP and HFD for raiding crops, some of the cultivators of affected villages, situated along the Ganges were consulted and the datasets were compared with elephant movement. Elephant group (c. 4–18) which includes adult males and females, sub-adult males and females and juveniles were observed frequently before 2001–

2002 in eastern part of RNP, visiting Ganges, flowing across the HFD, and crop fields through crossing the Haridwar-Bijnor national highway. However, movement of groups with calves (infants less than 6 months) was only observed up to Ganges and not in the agriculture fields. In HFD, the tracks from where elephants are known to perform movements towards Ganges are adjoined to the central part of RNP, which holds Motichur-Chilla wildlife corridor as well. Soon after the establishment of Uttarakhand state in late 2000, group movements were bunched mainly because of increasing rate of development activities, including expansion of road network, construction of six bridges over to various annual rivers (that served as passage for elephants), establishment of human settlements, etc. Thereafter, solo movement of some recognised bulls (≈ 2) continued for nearly two years (2003–2004) and slowly other bull elephants, especially sub-adults and juveniles started to follow some older bulls, which finally converted to a big group (c. 2–9) (Fig. 2a-b).

Based on the field observations, it seems that crop raiding by elephants will continue in various parts of north-western Shivalik landscape. Does these aberrant behaviour among male elephants is a strategy to raid crop? Are these male-male aggregations the result of habitat isolation? To address all these issues, long-term monitoring studies are needed, which can then serve to propose possible conservation actions.

Finally, it needs to be mentioned that in 1970s, after the establishment of Chilla hydro-electric power plant/channel, RNP was divided into two major parts — the eastern and western part. Later on, after the establishment of Uttarakhand state in 2000, increased rate of traffic pressure in Haridwar–Dehradun national highway and railway track, which exist across RNP, had restricted elephant movement in between these forests, as a result of which larger population of elephants were pocketed into smaller ones. This had disrupted the connecting corridor for elephant movement in between Rajaji and Corbett National Park as well and escalated man-elephant conflict in north-western Shivalik landscape.

Conclusions and management guidelines

The eastern part of RNP and north-eastern part of HFD are one of the crucial elephant habitats in north-western Shivalik landscape. However, isolation of large migratory corridors, increasing rate of anthropogenic activities and unnatural deaths of tusked are growing problems threatening long-term survival of the elephant population (see also Joshi and Singh, 2010). Generally, elephants used to migrate towards parts of Corbett Tiger Reserve (in Lansdowne forest division and Sonanadi Wildlife Sanctuary) at the onset of monsoon and return back to the RNP and HFD, in the upper Gangetic plains at the onset of summer. However, it is uncertain whether some of the bulls are still following these traditional journeys.

For sustainable management of the elephants in this region, the following recommendations can be made: 1) Shyampur and Chiriapur forest ranges of HFD should be merged in RNP to strengthen conservation approaches. 2) Three to four large underpasses (siphons) should be constructed in Haridwar-Bijnor national highway at the points where elephants are known to cross. They need to be kept clean, since debris and stones are deposited rapidly through annual streams especially in monsoon. 3) Few small islands situated in Ganges and riparian corridors should be restored and freed from anthropogenic activities. 4) Gujjars (a nomadic pastoral community) who are residing in the Shyampur and Chiriapur forest ranges of the HFD, need to be rehabilitated, to restore the ecosystem. 5) Within the recognised bull group, one of the older bull should be radio-collared to monitor their movements and facilitate studies on social behaviour. 6) Chilla-Motichur (c. 3.5 kilometer long and 1.0 kilometer wide) and Rawasan-Sonanadi (c. 10.0 kilometer long and 5.0 kilometer wide) wildlife corridors should be restored avoiding anthropogenic and developmental activities. 7) Bridges, which are located over to Chilla power channel, one at Soni shroath and another at Kunao shroath (water streams), should be widened. These bridges are ≈ 3.5 meter wide. Two more bridges could be constructed over to the power channel, one at Ram shroath, in

between Chilla power house and Kaudia village and another at Kunao, in between Binj river and Kunao bridge. These possible approaches can give elephants a larger number of corridors to move across Ganges, which lies in Chilla-Motichur corridor as well. ☞

References

- Bradshaw G.A., Schore A.N., 2007. How elephants are opening doors: developmental neuroethology, attachment and social context. *Ethology* 113: 426–436.
- Chiyo P.I., Moss C.J., Alberts S.C., 2012. The influence of life history milestones and association networks on crop-raiding behaviour in male African elephants. *PLoS ONE* 7(2): e31382.
- Desai A., 1997. The Indian elephant. Vigyan Prasar, New Delhi and Sanctuary Magazine (NCSTC-Hornbill Natural History Series), Mumbai joint Publication, India.
- Evans K.E., Harris S., 2008. Adolescence in male African elephants, *Loxodonta africana*, and the importance of sociality. *Animal Behaviour* 76: 779–787.
- Joshi R., Singh R., 2008. Unusual behaviour of Asian elephants in the Rajaji National Park, North-west India. *Gajah* 29: 32–34.
- Joshi R., Singh R., 2010. Does wide ranging tuskers survive in north-west India? *National Academy Science Letters* 33(7–8): 205–215.
- O'Connell-Rodwell C., 2010. How male elephants bond. Article published in the *Smithsonian Magazine*, November 2010. Available from <http://www.smithsonianmag.com/science-nature/how-male-elephants-bond-64316480/>
- McKay G.M., 1973. Behavior and ecology of the Asiatic elephant in southeastern Ceylon. *Smithsonian Contributions to Zoology* 125, Smithsonian Institution Scholarly Press, Washington, D.C.
- Srinivasaiah N.M., Anand V.D., Vaidyanathan S., Sinha A., 2012. Usual populations, unusual individuals: insights into the behaviour and management of Asian elephants in fragmented landscapes. *PLoS ONE* 7(8): e42571.
- Sukumar R., 1989. *The Asian Elephant: Ecology and Management*. Cambridge Studies in Applied Ecology and Resource Management, Cambridge University Press, Cambridge.
- Sukumar R., 1994. *Elephant Days and Nights: Ten Years with the Indian Elephant*. Oxford University Press, New Delhi, India.
- Vidya T.N.C., Sukumar R., 2005. Social and reproductive behaviour in elephants. *Current Science* 89(7): 1200–1207.

Associate Editor: L.A. Wauters