Spatial relationship between mother-calf of *Rhinoceros unicornis* in a predator dominated landscape, Kaziranga National Park, Assam, India

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ABSTRACT

Spatial distance preserved by the calf around the mother can be regarded as the life secured strategy against potential predators. The present study of spatial relationship between mother and calf of great Indian rhinoceros *Rhinoceros unicornis* was carried out during 2016-2018 in Kaziranga National Park of Assam, India. Spatial distance, approach/follow/leave behaviours and major cause of calf death were the main objectives of the study. Photographic technique and range finder was used to measure the distance opportunistically along the road side and near major water holes. Data were collected using Scan animal sampling. The calves were divided into three age groups- 0-1 year, 1-2 years and 2-3 years. Each age group showed different spatial distance requirement which was found to be statistically significant. The distance increased gradually from the first group to the third group with the increase in age. Moreover, leave behaviors was found more in first group of calf and approach was higher among second calf group. First and second calf group prefer the range of 0-5 meter distance around the mother, whereas the third group prefer 5.1-10 meter range. This range around the mother was found to be secure for the calf survival. The occurrence of calf following mother was found higher than mother following calves. Tiger kill of rhino calf was found to be the major threat in Kaziranga National Park. Male rhino calves were more vulnerable than the female calf, which indicates the use of larger territory and stray behaviour of the males.

Key words: Great Indian rhinoceros *Rhinoceros unicornis,* Kaziranga National Park, mother-calf relationship, mortality, flood, spatial distance, survival strategy, tiger kill.

INTRODUCTION

Survival of the wildlife has become a challenge due to the limited habitat, habitat degradation, fragmentation and potential predator pressure. Mothers play a great role to make their offspring adapt to the challenging situation and guard them from the predators. During the post-partum periods, they rapidly make close maternal bonds with their offspring's and take initiative in strengthening the bond (Lent, 1974; Lentfer, 1955; Wackernagel, 1965). In fact, immediately after parturition in all ungulates, mother and calf enters into a phase of intensive contact and reciprocal stimulation by each other. Several studies on mother-calf relationship have been carried out in giraffe (Langman, 1977), black rhinos (Greene *et al.,* 2006), right whales (Taber & Thomas, 1982). Mother-calf relationship has widely studied in primates (Jensen *et al.*, 1967; Altmann, 1980; Nash, 1978; Hind & White, 1974; Struhsaker, 1971). Laurie (1978) had mentioned about maternal care in his studies. He reported that the nursing period is 16 months in Indian rhinoceros in the wild. The two basic classification of ungulate mother-calf relationship is hinders and followers (Walther, 1961). Amongst hinders, the infant remains hidden and separated from the mother. In contrast, the follower's mother-calf shows close and frequent contact. *Rhinoceros unicornis* is one of the follower's category large mammal (Walther, 1961) and remains in close contact with the mother. It is a K-selected species and has the lowest reproductive rate among the mammals (Dinerstain *et al.,* 1988). Bettelheim (1988) had stated that, the successful rearing of the infants depends on the pattern of mother-calf relationship.

Studies on maternal care of *Rhinoceros unicornis* was done in both captive (Mackler & Buechner, 1978) and wild condition (Laurie, 1978). However, no detailed study has been carried out on the spatial distance maintained between mother-calf during the nursing/ caring period. Hence, the current study has been carried out to find out the spatial distance maintained between mother-calf and the range of independence it could roam around without the fear of strongest predators.

The study tested the null hypothesis that the rhino mother-calf never maintained the spatial distance while foraging in the habitat and that, if maintained, spatial distance has no differences amongst different age groups of rhino calf. Study has also emphasized to find out the major causes of calf mortality in Kaizranga National Park, Assam. Detailed studies on the mother-calf relationship and the threats to the calf can act as an important tool in the implementation of management strategies and will also help in captive breeding or translocation of the expanding population for conservation and management plan in near future.
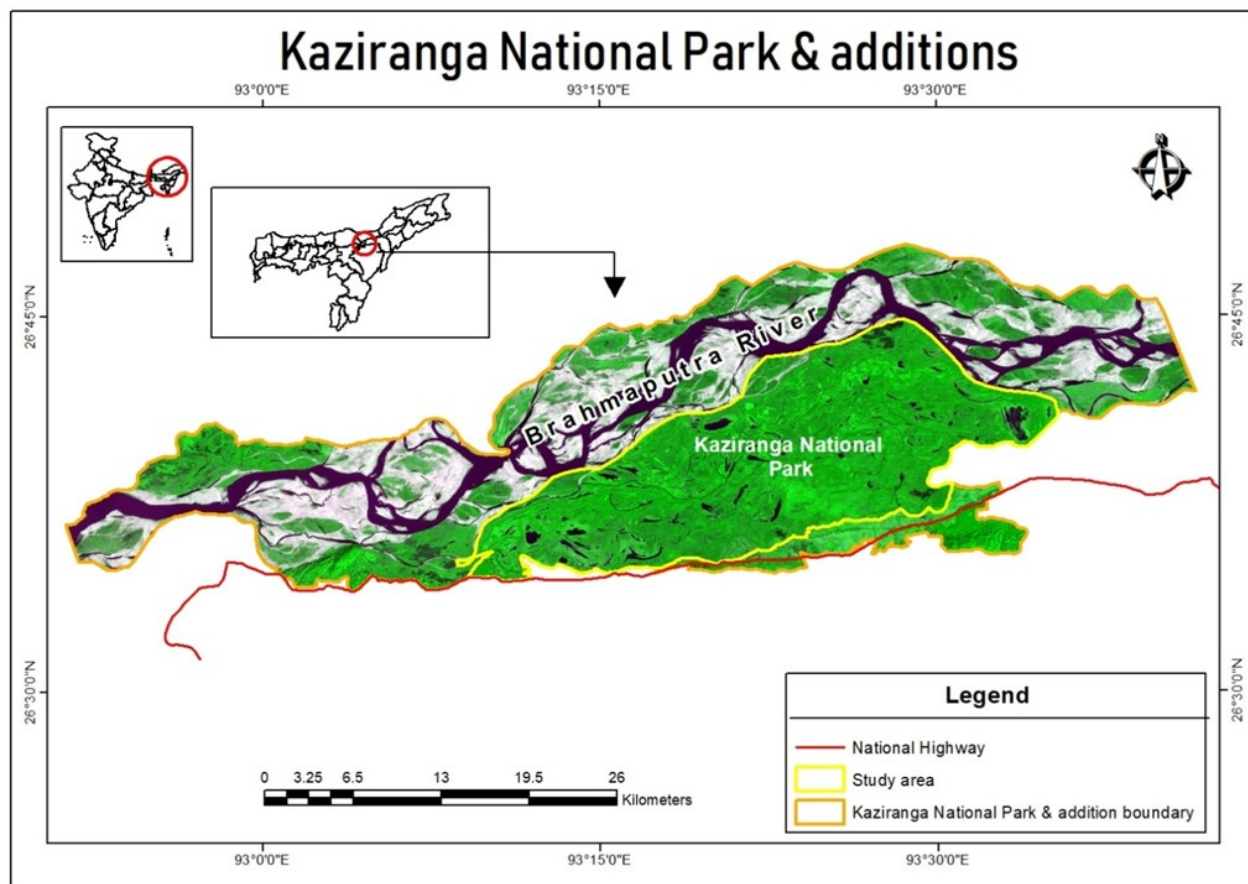
Figure 1. Map of the study area Kaziranga National Park.

## MATERIALS AND METHODS

Study area

The study area Kaziranga National Park (KNP) is located in the southern bank of river Brahmaputra of the Brahmaputra valley of Assam. The geographical location of KNP is between latitudes 26°30' N to 26°45' N, and longitudes 93°05' E to 93°40' E. Overall, KNP covers 859.4 km^2 area including all the new additions for Tiger Reserve establishment (Mishra *et al.*, 2005). The area taken for this study was 482.9 km^2. The study was done in four ranges of KNP **viz**., Agaratoli range, Kohora range, Bagori and Burapahar range. However, most of the studies have been concentrated in Agaratoli, Kohora and Bagori range (Figure 1).

The river Brahmaputra flows through the park enriching the soil by nutrients and minerals that supports the grassland vegetation. Kaziranga comprises four main habitats **viz**., grassland, woodland, wetland and sand-bars (Kushwaha & Unni, 1986). The entire park is dominated by grass sp. **viz**. *Saccharum spontaneum, Imperata cylindrica, Erianthus ravennae, Arundo donax, Phragmites karka, Imperata arundinacea, Neyraudiarey naudiana, Typhael phantina* etc. The climate of Kaziranga National Park is typical subtropical monsoon climate (Rodgers *et al.,* 2002). The park experiences four distinct seasons: pre-monsoon, monsoon, re-treating monsoon and winter (Borthakur, 1986). The average annual rainfall of KNP is about 2293mm (Taher & Ahmed, 2005; Deka *et al.,* 2013).

The study of spatial relationships between mother-calf of Indian rhino was carried out from 2016-2018. Direct observation was done opportunistically, when a pair of mother-calf was found. The study was conducted from 06 00 hours to 18 00 hours. The data were recorded through Scan animal sampling (Altmann, 1974) in the interval of five minutes. During the data collection of mother-calf distance, the occurrence of approach, leave and follow behaviours of both mother and calves were recorded through scan sampling. The data points were taken from a pool of animals i e, each mother-calf pair had several data points. However, the focal pair was not taken for the study as it was difficult to identify the individual pair in the wild. For the study, the calves were categorized into three age groups; below 1 year, 1-2 years and 2-3 years. The Rhino calves were considered up to the age of three years as per Laurie (1978). To estimate the distance between mother-calf of different age groups, two methods were used photogrammatry (as per Kovats, 1997) with few modifications and measuring the perpendicular distance and the angle. Kovats (1997), determined tree height from successive photo measurements using permanent ground targets. But in the current study the distance was measured with respect to the length and height of the rhinos. Both the methods were used according to the convenience and wherever it is applicable in the field.

Photogrammatry

In photogrammatry, the photographs were obtained at the interval of five minutes time period. The distance was
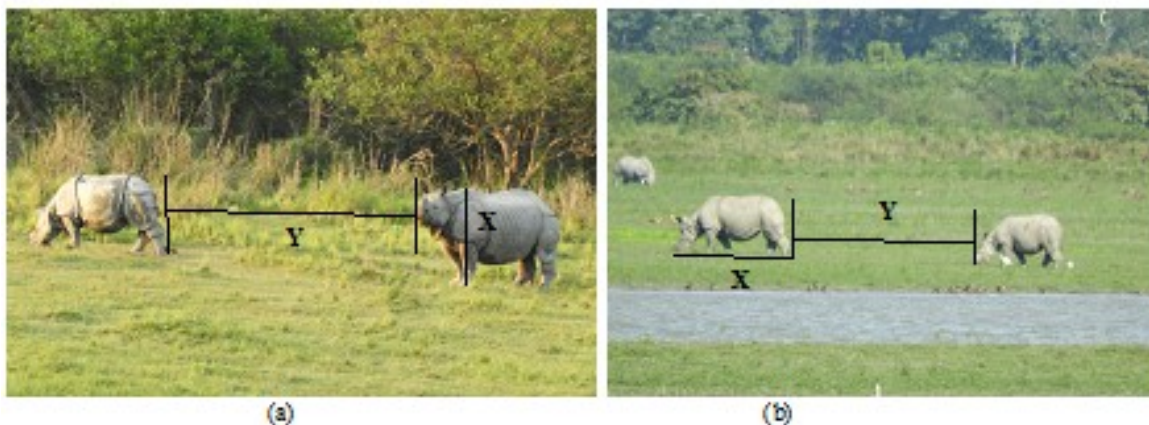
Figure 2. Measurements of distance between mother-calf with respect to (a) height and (b) length of the observed animals.

measured in the photographs with respect to the body length and height of the adult female. For the standard measurement of length and height, 25 samples were collected from accidental, flood and other types of death rhino during the study period in KNP. It was also collected from the record of postmortem report in the Divisional Forest office (DFO) of the park. The mean length and height of adult rhino was found to be 2.7m and 1.7m respectively. By calculating the ratio of the length or height of the photographs (Figures 2a, 2b) with the standard length or height, the proportional distance between the individual was calculated. The formula used to calculate the proportional use was as follows-

The length was calculated using the following formulae - X: A::Y: B
Where, X= Height/Length of Rhino in the photo
A= Original standard height/length of Rhino
Y= Distance between mother-calf in the photograph
B= Original distance between the rhino and calf.

The measurement of length and height of the mother and the distance between them in the photograph was taken from the shape (line) measurement present in MS Word.

Measuring the perpendicular distance and the angle

In this method, first the perpendicular point from either mother or calf was obtained and afterwards, the distance of both the studied animal was recorded using range finder. The angle was obtained with the help of compass. From those variables using trigonometric formula, the distance between the animal was calculated (Figure 3). The formula used was as follows-

Trigonometry formula (Distance between mother and calf) - $\sin \theta = b/c$ or $b = c \times \sin \theta$
Where, b= Distance between mother and calf
c= distance from observer to the animal

Calf mortality

The report of calf deaths were recorded during the study period based on the death information from the guards and other officials. Moreover, collection of secondary data from the year 1976-2018 on calf mortality from the Divisional Forest Office of KNP, Assam was also used.

Data analysis

The calculated distances collected using both the methods were analyzed with the help of MS Excel and SPSS software. One Way ANOVA was performed to find out the variation in distance maintenance in different calf age groups of *Rhinoceros unicornis* in the study area.
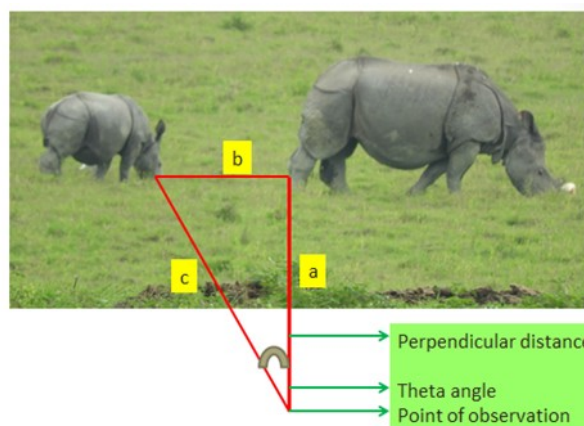
Figure 3. Distance measured using trigonometry formula

RESULTS

Behaviours of mother and calf

Approach

During foraging the rhinos (mother and calf) after going to some distance suddenly looks for each other in a worried mood or conforms itself that the other is safe and nearby. This type of behaviour when mother looks for the calf or the calf looks for the mother is approach behaviour.

Leave

While foraging the mother and the calf moves away from each other to some distance, This behaviour was regarded as leave behaviour.

Follow

While foraging or during escaping due to some intruders existence or while chasing someone the mother and calf

Table 1. Mean spatial distance between mother-calf in different age groups of calves in *Rhinoceros unicornis* in the study area (m = meter)

Age group	Mean(m)±SE	N	Minimum (m)	Maximum (m)
0 to 1yr	1.96±0.58	65	0.0	05.5
1 to 2yr	3.53±0.52	82	0.5	12
2 to 3yr	7.20±0.52	82	1.0	22.9

follows each other. After leaving each other when both reach to a distance then either of them follow the other.
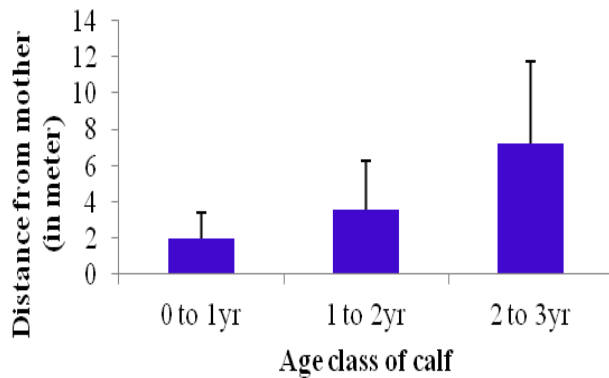
Figure 4. Mean spatial distance between mother-calf of different calf age groups of Indian rhino in KNP, Assam (the error bars indicates the SD).

Spatial distance between mother-calf

Study sampled altogether 229 data for the spatial distance maintained between mother- calf and 680 records of calf deaths were used for data analysis. The mean spatial distance between mother- calves were found to vary in different age group of calves. Study revealed that, the mean spatial distance maintained by the mother-calf was 1.96m in 0 to 1 year calf with a range of 0-5.5m distances. The mean spatial distance in 1 to 2 year calf was found to be 3.53m with the range of 0.5-12m, whereas, the mean spatial distance in 2 to 3 years calf was 7.20m with the range of 1-22.9m (Table 1, Figure 4, Plate 1.a-c). Analysis of variance using SPSS software revealed

that, the observed variation of spatial distance between mother-calf in different age group of rhino was highly significant in the study area (One way ANOVA: $F_{2,226}$= 51.05, P = 0.001).

Study revealed that, the calves of 0-1 years were mostly found in the close range of 0-5m (96.92%) followed by 5.1-10m (3.08%). The calves of 1-2 years were found highest within the range of 0-5m (74.39%) followed by 5.1-10m (24.39%) and 10.1-15m (1.22%), whereas, calves of 2-3 years were mostly found confined to the range of 5.1-10m (42.68) followed by 0-5m (34.15%), 10.10-15m (19.51%), 15.1-20m (2.44%) and 20.1-25m (1.22%; Figure 5). Overall spatial distances amongst total occasions in all calve groups, the calf remained 66.38% close (0-5m) to the mother and 33.62% at a distance beyond 5m (Figure 6).

The result rejected the proposed null hypothesis and accepted the alternative hypothesis that the rhino calf and mother maintained a specific spatial distances while foraging in the habitat and also found that distances amongst different age groups of rhino calf and mother increases significantly with the increase of the calf age.

Approach, leave and follow behavior

A total 445 number of scan samples were collected for approach and leave behaviour and 157 samples for follow behaviour. In case of Indian rhinoceros it was found that, the occasions of calf following the mother while walking and running was more (N= 102) than mother following the calf (N=55; Figures 7a, Plate1.d, e). Moreover, the approach and leave behaviour was found to be different in various age groups as well as between mother and calf. In calf of 0-1year, approach (20.14%) < leave (50.17%) and in their mother approach (17.41%) > leave
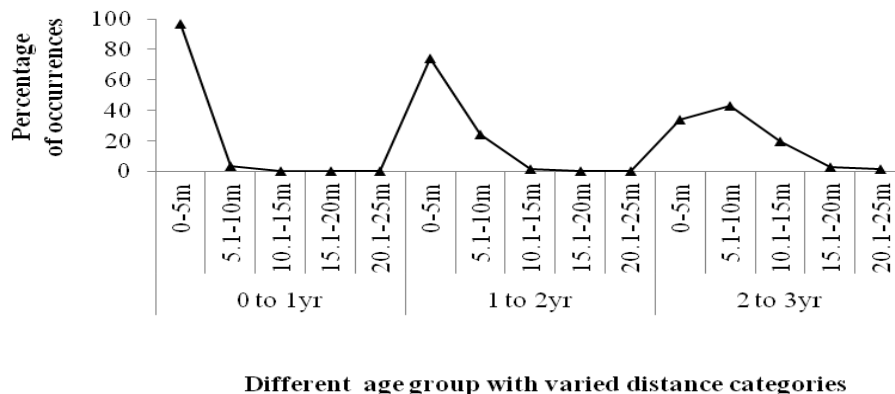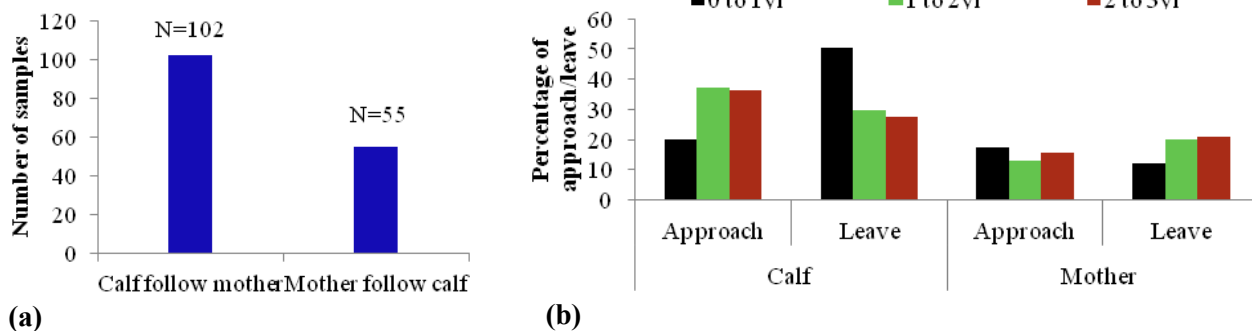

Figure 5. Percent of occurrence of different age groups of calf at different distance in *Rhinoceros unicornis* in the study area.
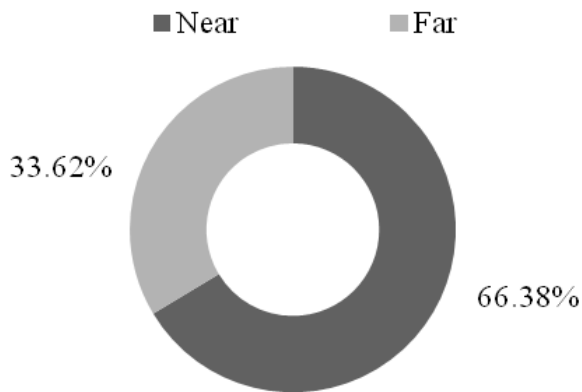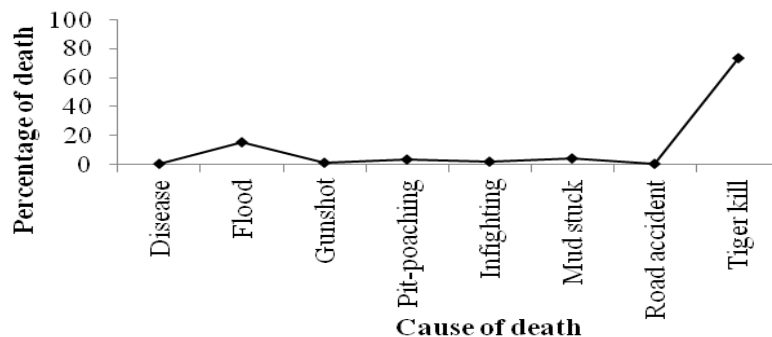
Figure 6. Percentage of occasions of calf found near and at distance

(12.29%). In 1-2 years calf approach (37.23%) > leave (29.79%) and in their mother approach (12.77%) < leave (20.21%). However, in 2-3 years calf approach (36.21%) > leave (27.59%) in their mother approach (15.52%) < leave (20.69%). The study revealed that, in calf leave behaviour was found to be higher in 0-1year followed by 1-2years then 2-3 years and approach was found to be more 1-2years calf followed by 2-3years and 0-1year. On the other hand among the mothers approach was higher in case of mothers with 0-1years followed by 2-3 years and 1-2 years. Leave behaviour was found to be more in mothers with 2-3 years followed by 1-2 years and 0-1 year (Figure 7b). Overall, both leave and approach behaviour was found to be higher in calf and lower in mothers.

Causes of calf mortality

The causes of calf death in *Rhinoceros unicornis* was found to be highest due to tiger kills (73.24%; Figure 8, Plate1.f) followed by flood (15.59%), mud-stuck (3.82%), poaching through pitfall trap (3.38%), infighting (2.06%), gunshot (1.03%) and disease (0.74%) (Figure 8). Death of great Indian rhinoceros due to tiger kill was found to be highest in calf (N=498) followed by sub-adult (N=31) and adult (N=10) (Fig. 9a). However, among the calves, the death occurred due to tiger kill has been found to be higher in male calf (N=182) than the female calf (N=145; Figure 9b).

DISCUSSION

The spatial distance between mother-calf increases significantly with the increase of the calf age. The calf less than 1 year remains within 5.5m range around the mother. Rhino calves below the age of 1 year are not found beyond 5.5m during the study period. Rhino Calves more than 1 year of age can go away from mother up to 25m of distance. Moreover, 66.38 % occasions, the calves were found near (within 5m range) to mother. Whereas, Greene *et al.* (2006) have documented that the calf of black rhinoceros remains 75% of their time close to mother.

The calves were found to roam independently in the range of five (0-1years calf), twelve (1-2 years calf), and twenty three meter (2-3years calf) around the mother and no tiger predation was found within this range during the study period. Hence, this range can be regarded as the safe zone range for rhino calf in KNP (Kaziranga

**Figure 7.** (a) Number of samples of mother-calf following each other, (b) Percentage of approach and leave behavior of mother-calf spatial relationships.

Figure 8. Different cause of calf death in *R. unicornis* in Kaziranga National Park.

Plate 1. **(a-c)** Calf at different distance from the mother **(d)** Calf following mother, **(e)** Mother following calf, **(f)** Calf injured by tiger attack (**Source: (f)** - Departmental Camera trap data, Dept. of Forest and Wildlife, Kaziranga, Assam).
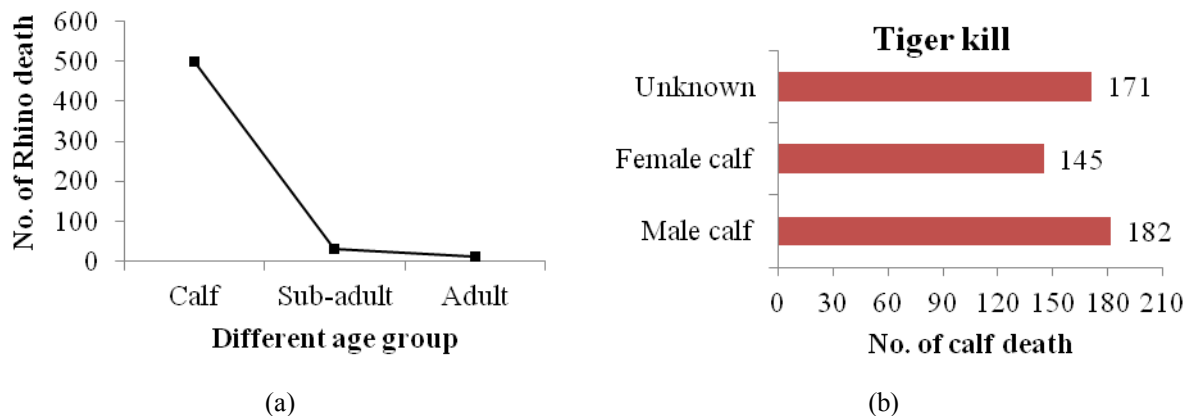
Figure 9. Deaths by tiger kill (a) in different age group & (b) in different sex group of *R. unicornis* in KNP.

National Park). Laurie (1982) on the other hand has reported that, the mothers can move up to 800m away from the calf. This variation is most likely due to the difference in the tiger density in Chitwan National Park (CNP) and KNP as we know that KNP consist the highest tiger density in India. Providing protection is probably the reason of smaller range between mother-calf in KNP. However, the range may vary in different habitat. The calves were seen more closely to mother in tall grassland areas. However, variation in habitat was not quantified in the present study.

During the current study, approach behaviour of the mother was found to be higher than the approach of 0 -1yr calf and this mother approach behaviour decreases with the increase in the calf age. On the other hand, the approach behaviour of the calf increases with the increase in the calf age. The calf around three years tends to remain safe from dominant male rhinos. The calf reaching the sub-adult stage are chased by bulls for either sexual (female) or territorial purpose (male). Hence, these calves intend to remain with their mother for their security. Again the approach behaviour helps in strengthening the mother-calf relationship. Hence, mother plays an active role in maintaining the maternal-infant bond (Lentfer, 1955). This bond is maintained up to three years in great Indian rhinoceros (Laurie, 1974). The duration of the mother-calf bonding varies in different mammalian species. According to Langman (1977), it is 3.5 months in pronghorn, 18 months in buffalo and 15 years in elephant. The females drove away their calves one week prior to the birth of the next calf. The calves are sometime temporarily separated at the age of three years when the mothers are chased by the bull rhinos, however, they rejoin with mother afterwards. Laurie (1978) suggested similar types of observation in CNP, Nepal. The calves needed a longer relationship to learn or acquire the skills for survival and life strategy. In this regards, the longer weaning period is responsible for solving the problems. According to Laurie (1978), the weaning period of rhino has only 16 months. Several other workers on mega herbivore species also suggested that, the weaning period is not sufficient for the calf to learn about home range, maintenance of the territory, self -protection and as well as mating (Innis, 1958; Foster & Dagg, 1972). The calves were observed to follow or

copy almost every events of the mother's behaviour during the study period. Laurie (1978) stated that, the calves are invariably defecating after their mothers. Being a solitary animal, rhino is found to be remain separated and maintained a specific distances from other individuals of same species. So, learning of all the behavioral settings from the mother is inevitable during early stage of life.

The calves of great Indian rhinoceros are the follower's type of ungulates. In any occasions, the calf was found to follow their mother in each and every instance. However, the mothers are also sometimes found to follow their calf. In the present study, the occasions of calf following the mother were found to be higher than the occasion of mother following the calf. The opposite was found in case of African rhinoceros, where the calves always move ahead of the mother (Selous, 1890). Owen-Smith (1988) has mentioned that, white rhinoceros are also follower's type. During the present study, the calves were occasionally found to follow other individuals of the same species. Similar types of observation were also found by Selous (1890). Moose (Knorre, 1961) and bison (Garretson, 1938) shows analogous behaviours and have also reported to follow the individuals of other species.

Regarding threats, the tiger predation is the major threats to great Indian rhinoceros calf in KNP. However, the risk of predation is less in sub-adult and adult rhinoceros than other age groups. Occasionally, the calves wander off from the mother and goes beyond the safe zone. The tigers avails this opportunity and predate the calves in this situation. High density of both the tiger and great Indian rhinoceros is another reason for higher tiger predation of calf in the park. In contrary, Dinerstein *et al.* (1988) in CNP has reported only 10% tiger predation of *Rhinoceros unicornis* calf. Flood and sticking in mud are other reasons of calf mortality. This is happening in KNP due to frequent annual flood yearly and the presence of many wetlands in KNP, where numerous fresh alluvial depositions were seen.

As per official records, males are higher victims of tiger predation than females in the park. The vital evidences found for this is higher wandering and stray behavior in the male calf. Laurie (1974) reported that males are known to use larger territory than females. The male calves most likely try to show this type of hereditary territorial behaviour and become the prey of tigers.

In addition, the mother-calf developed a bonding behaviour to remain in contact with each other, in which, the mothers contribute the best as a trainer. This attachment gradually decreases with the increase in the calf age and in contrast the calf develops the ability to be in contact with the mother by their own later on. This bonding is necessary for the survival of the calf in a high density of potential predator in KNP. Following behaviour also has been viewed as a strategy for avoiding predators in open habitat (Estes, 1967; Lent, 1974) and is associated with defense of the young against the predators. Defense on the other hand reduces predation risk (Estes, 1967; Lent, 1974), intra-specific competition (Mordock *et al*, 1983) and helps in conserving energy and body water (Langman, 1977).

In conclusion, the spatial relation and bonding behaviour acts as an important factor in the life strategies of the Greater Indian one-horned Rhinoceros. It varies in different age groups of calves. However, few questions remained unanswered. For example, what is the distance between mother-calf at the time when tiger predation to calf occurs? Do the calves stray out from their save zone? If yes, what are the factors that influence the calf to do so? A more detailed study should be done to answer the above questions.

ACKNOWLEDGEMENTS

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